THE PROFESSIONAL, THE SEMI-PROFESSIONAL, AND THE MACHINES:
THE SOCIAL RAMIFICATIONS OF COMPUTER BASED IMAGING IN RADIOLOGY

Vol. 1

by

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Submitted to the Sloan School
Of Management in Partial
Fulfillment of the
Requirements for the
Degree of

DOCTOR OF PHILOSOPHY

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 1984

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MAY 22 1984
ACKNOWLEDGEMENTS

One thousand seven hundred and fifteen days ago I left the real world for the academy. At the time, it was either this or carpentry. In looking back, I’m not sure the two are all that different. In both, you need to be careful about cutting yourself with a saw. It has now been seven hundred and two days since I left the academy for the world of radiology. Though I no longer watch CT scans, I suspect I haven't seen my last scanner. By Vonnegutian reckoning it has taken me some sixty-eight thousand six hundred cigarettes to finish my degree and a mere twenty-eight thousand and eighty to complete this dissertation. Some, no doubt, will wish to argue that I could have finished faster had I used Camels. In fact, I did. Lately it occurs to me what a long strange trip it's been. Make that sixty-eight thousand six hundred and one.

Everyone needs someone to lean on, and I might hasten to add, complain to. Amid the haze of all those Camels has been my wife, Debbi, who, for the most part, managed to put up with me even when I was bizarre enough to insist that I type my fieldnotes before doing anything else. Fortunately, she has more faith in me than I have and she has never shirked from telling me what I happen to be full of at the moment. Of course, I have usually thought her wrong on both counts, but that doesn’t mean she wasn’t right, at least in matters of the second kind. She also proofed this manuscript. The first law of writing is this: scut work falls to the spouse. At least her task will not go thankless. You would give thanks too if you had seen the first draft.

A number of other characters also lurk between the lines of the pages to follow and it is only through their messages that mine was ever written. From the first Camel, John Van Maanen pointed my energy and skepticism masterfully. John made sure I had opportunities to learn to do things that academics are supposed to know how to do, like give papers at national meetings and publish articles. He was good at passing me ropes to climb, and in the process, he taught how to be a sociologist -- even in a business school at an Institute where there is no sociology department. Up until two years ago, when he defected to the pipe, he was also a willing emergency source of cigarettes.

From his corner office, Ed Schein worked as an artesian well of novel ideas and connections. The relevance of certain notions woven into the body of the text (for instance, monochronic and polychronic cultures) bears witness to Ed's eclectic stamp. My urge to document qualitative data with numbers whenever possible, and my of hope of weaving talk of numbers into the flow of a readerly text reflect Lotte Bailyn’s influence. More than anyone else, Lotte encouraged me to think about
doing research explicitly. In a field full of methodological plots she still dares to work data with a hoe of thought rather than a roto-tiller supercharged by algorithms.

That I became interested in technology is Tom Allen's fault. Tom once suggested to me, in his off hand manner, that there wasn't much that could be called a "sociology of technology". After investigation, I was forced to the conclusion that Tom was probably right. Quite simply, "the pump don't work cause the vandals stole the handle." Finally, Dotte Leonard-Barton, who also studies technology, read every word of this dissertation, attempted to have me at least acknowledge the pragmatic implications of my work, became excited with some of it, and pointed out the flaws in the rest. In final months, it was Dotte's encouragement that got me back to the world on time.

These acknowledgements, which ironically come first when in fact they are a benediction, end with my comrades on the Group W Bench: Gideon Kunda, Deborah Kolb, Deborah Dougherty and Jeanne Lindholm. All have the good sense not to take "it" or themselves too seriously. They should give seminars. Such a long, long time to be gone, and a short time to be there.
THE PROFESSIONAL, THE SEMI-PROFESSIONAL, AND THE MACHINE:
COMPUTER BASED IMAGING MODALITIES IN RADIOLOGY

by

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Submitted to the Alfred P. Sloan School of Management
on May 18, 1984 in partial fulfillment of the
requirements for the Degree of Doctor of Philosophy in
Management.

ABSTRACT

Over the past decade there has appeared a handful of computer
technologies that may herald an increasingly important aspect of our
future. Rather than simply calculate; rather than merely compile;
rather than even synthesize and spew forth that which was in principle
available; these new technologies create and dispense incipient forms of
knowledge. As "knowledge processors," the technologies have strayed
beyond the grey walls of bureaucracies where "data processors" hide and
into settings formerly untouched by computers. In the process they have
begun to reorient the work of persons whom we call professional. For
these two reasons, the epistemic and the social, the new machines may
foreshadow an era in which technologies alter the organization of work
in fields quite remote from back rooms of banks and the data vaults of
insurance companies.

No where have new "knowledge processing" technologies been more
important or more prevalent than in the field of Radiology. In the past
decade the possibility of peering inside the human body has been
immutably altered by a stream of new technologies each driven by a
computer capable of transmuting a specific form of information into
pictures: ultrasound, computerized axial tomography (CAT), dynamic
spatial reconstruction (DSA), digital subtraction angiography (DSA),
nuclear magnetic resonance (NMR), and positron emission tomography
(PET). As the new technologies have left the laboratories and medical
centers and migrated to community hospitals, the normal work worlds of
radiologists and radiological technologists have begun to change. In
fact, some radiology departments have signaled the transformation by
adopting a new name, "Departments of Medical Imaging".
As Everett C. Hughes once noted, what an occupation chooses to call itself is a clue to the social organization and the social identities of its members. When an occupational group as insitutionalized and as prestigious as Radiology changes its name, one can be sure that something sociologically intriguing is afoot. The purpose of this research has been to discover the direction in which the new imaging technologies may have pointed the lead foot of Radiology.

This dissertation reports results from a year long, field study of two radiology departments during the first year that each operated its first whole-body CAT scanner. The study was designed to yield a comparative analysis of the social organization surrounding the use of five radiological technologies in each department as well as a longitudinal investigation of the evolution of both CAT scanning operations. The substantive focus of the present work is the comparative data. Of concern then is the broad question: "Have new imaging technologies generated social orders of work that are simultaneously similar to one another and different from the organization of work that surrounds the use of older technologies?"

In specific, data are presented on the following topics: (1) the tasks and work roles of technologists operating each of the technologies, (2) the tasks and work roles of radiologists operating each of the technologies, (3) the relationships that exist between technologists and radiologists in each technological subculture, (4) the relationships that exist between radiologists and patients in each of the technological subcultures, and (5) the relationships that exist between technologists and patients in each of the technological subcultures.

The analysis suggests that when compared to technologists working older technologies, those who operate the newer technologies have begun to assume types of work and responsibilities traditionally reserved for radiologists and departmental administrators. Moreover, the data suggest that new technologies spawn tighter links between technologists and radiologists as members of the two groups cooperate to make sense of the technology and its output. Together, these social processes may act as schismatic forces that divide radiology departments into two distinct realms each with its own organizational form. Finally, there is evidence that each technology substantially influences how patients are treated by technologists, but that these ramifications are idiosyncratic to each technological milieu. The research found little evidence that the new technologies affect relationships between patients and radiologists.

THESIS SUPERVISOR: Dr. John Van Maanen
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"Somebody's got to sleep with the machines"
Paul Kantner (1983)

With a muffled hiss two floors below ground level, the elevator doors slid open onto a well lit corridor whose concrete walls were the pastel yellow of the rest of the hospital. At eye level on the wall opposite the elevator an engraved plastic sign arrow pointed to the right: "Medical Imaging." Turning right onto the grey linoleum, Smith, the chief radiologist and appointed tour quide, quipped, "Welcome to the hole! Until five years ago only janitors and the laundry lived down here. The laundry's still here, but the janitors moved upstairs." Compared to the hubbub of the comings and goings on the floors above, the desolation of the hallway was stark.

Thirty yards down the corridor a door on the right stood open revealing piles of white and blue linens neatly folded and stacked on metal shelving. A middle aged woman, slightly dumpy, wearing a faded, but rigorously starched, green dress stood before the shelving with a pencil and clipboard in hand. Despite the echo of our walking talk, the woman did not turn as we passed. Smith had been saying, "This was the only place where we could house all the machines in one place. Of course we'd rather be upstairs nearer the action, but that wasn't in the cards. We hope that we'll be able to corner a wing of the new building, but there's politics there too."

From around the corner of a hallway that branched off to the left twenty yards ahead came a young black man pushing a gurney. On the gurney lay an elderly male with a tube running from his arm to a bag of saline suspended from a pole attached to the head of the gurney. The patient was curled into a fetal position, apparently asleep. As the orderly passed he greeted the radiologist, "Good morning, Doctor. Full house today!"

Smith returned the greeting, "Another Monday, eh Joe?".

Turning to me the radiologist explained, "Mondays are our busiest days. Requisitions for studies that physicians order over the weekend are held until the first of the week, unless the patient's an emergency. We try to run a skeleton staff on the weekends. But if we have an emergency, we'll come in." We turned into the hallway from which the
orderly had emerged. Smith reached out and slapped a red button on the wall with his right hand. The doors that blocked access to the corridor beyond swung open and the hubbub returned.

To the left and right off the hallway that stretched ahead half the length of a football field, opened rooms at irregular intervals. Beside some doorways in molded plastic chairs sat patients dressed in street clothes. Other patients wearing white "johnnies" waited in wheelchairs or on gurneys. Technologists, young men and women dressed in white lab coats or blue surgical scrubs, hustled back and forth between rooms carrying films, greeting new patients, and sending other patients on their way. At the far end of the corridor, three men stared into a large rectangular box that cast a soft white light on their faces from its mount on the wall. By the ties beneath their lab coats, it was clear that they were radiologists. One pointed into the light with his index finger and tapped the box vigorously.

Smith called my attention to a device in an alcove just inside the doorway, "Here's one we designed ourselves." The device was twenty-four inches square and an inch thick. On top was a glass face plate into which had been inscribed a grid. "We use this to measure distances on films," the radiologist said as he placed an x-ray on the face plate. "It's far more accurate than a ruler." He picked up a pen-like stylus which was attached to the device by a coiled electrical cord and touched the stylus first to one point on the film and then another. A vacuum tube counter on the front of the device flashed rapidly through a series of numbers.

"It reads distances in millimeters. Quite useful when you want to compare structures on the same film. Of course, it doesn't get much use these days since most of our pictures are immediately digitized," said Smith.

"Digitized?"

"All of our work is done with computers," Smith explained. "When we take pictures, they are immediately converted into electronic impulses and stored on computer. Later we transfer the images to magnetic tape and floppy disks, small record-like things about the size of old 45's. The only time we make films is when a physician wants them for his own files. House physicians can view recent studies on any floor by simply sitting down at a terminal and typing in the patient's name or number. Our software lets them measure areas as well as distances, and calculate other indices too. After a week, we transfer the images from the computer to floppies which we keep in our library. Any doctor can come to the library and view a floppy on a micro-computer we use for that purpose."
We turned away from the alcove and headed back down the corridor. A television monitor was mounted near the ceiling of the hallway outside the first door we passed. Noticing that I had seen the monitor, the radiologist remarked, "If we want, we can watch what's going on inside the room from out here. This is particularly useful when we have to leave patients alone for any period of time. We can also rig the monitor to display the pictures that are currently being taken inside the room. If we want to view an interesting case at the time it happens, we don't have to crowd the techs while they work. We have other monitors in our reading rooms. Those we use more often since the rooms are more private. This room contains some of our ultrasound equipment."

The radiologist opened the door. On an examination table in the corner of the room lay a male patient who was naked to his waist. A woman stood beside the patient holding a small device to the patient's side. The lights in the room were turned down and the technologist was peering into a small video monitor housed in a bank of electronics equipment stacked beside the table on a rolling cart. The technologist turned around on our entry and then said to the patient, "Mr. Plovnik, this is Dr. Smith one of our radiologists". Smith and I went to the technologist's side.

After greeting the patient and inquiring about his ailment, Smith turned to the images on the monitor, patterns that looked suspiciously like snow on a TV set. "These are real-time images of the kidney," he explained, "an instantaneous motion picture if you will. We use sound beams emitted by the transducer she has in her hand to create the images. The sound bounces off the various organs, the echoes are picked up by the transducer and are fed into a micro-computer which constructs the images you're looking at. Since ultrasound involves no radiation and since it is completely non-invasive, we can do studies we couldn't do before. You've probably heard that we use this to diagnose pregnancies. We can also use it to look at the heart while it's beating. Believe it or not you can see the valves of the heart open and close."

Taking leave of the technologist, Smith led me back into the hallway and to a room two doors further down the corridor on the left. A sign on the door read: Angio in progress. "Need to be quiet here," the radiologist cautioned. "Digital subtraction involves inserting a catheter into a brachial vein and injecting an iodine dye so that we can take films as it flows through the carotid artery into the patient's brain." Smith opened the door and we entered a control room.

To the left beneath a large picture window overlooking what appeared to be an operating room stood a computer console. The console reached waist height and contained two video monitors as well as a keyboard. One monitor displayed commands that had been typed into the computer; the other sported an image that the radiologist assured me was
a picture of the patient's neck. Through the window a technologist, a nurse, and a radiologist wearing a surgical gown could be seen hovering over an examination table on which lay a patient whose upper body was covered by green drapes. The drapes were splattered red and the radiologist appeared to be moving a plastic tube into the patient's arm while watching intently a television screen. The nurse held the patient's left hand. The technologist, also dressed in a surgical gown, stood at the radiologist's elbow holding the far end of the tube.

Smith whispered, "He's trying to position the catheter right now, using a fluoroscope to see where he's at. As soon as the catheter is in position they'll attach the catheter to a pressure injector which will automatically inject the contrast when that button there is pushed. The x-ray tubes will be lined up by the technologist and then everyone will come in here. A film will be taken to make sure that the computer is set correctly, then the button will be pushed and the run will begin. As the dye enters the system the computer takes a rapid series of x-rays and converts them into digital impulses that are stored on a disc. The computer subtracts the first picture from every other picture so only what's not in the first remains. This creates clean images of the dye-filled vessels. That's why it's called 'digital subtraction'. We use it to study occlusions in the vascular system leading to the brain, the kidneys, and, just recently, we've gotten fast enough to study the heart itself."

Back out in the hallway, a radiologist stopped to speak to Smith, "I was headed down to look at the panc we did yesterday. Rhuttman. You wanna stop in?" Smith replied, "Sure, in a second." The radiologist hurried down the hallway and entered a room off to the left.

As we followed in the direction the other radiologist had taken, a noise grew progressively louder: whal-la-lumph, whal-la-lumph, whal-la-la-lumph. "What you're hearing is coming from a room several doors down. It's an experimental use of ultrasound that we've been playing with. We use a transducer and an amplifier to pick up the sound of blood flowing through the carotid artery. We hope to distinguish the eddying of blood around occlusions."

Smith and I entered the room into which the other radiologist had disappeared. The room was ringed with terminals, some of which displayed images, others text. On the walls hung view boxes, most of which were switched off. Various types of x-ray films were suspended from the few illuminated boxes. Several radiologists sat at the consoles. The radiologist who approached Smith in the hallway was seated in front of a panel of boxes reviewing films. Each contained nine small images arrayed in the fashion of a three by three matrix. The images, products of a CAT-scanner, portrayed highly detailed cross-sectional slices of a person's abdomen.
The radiologist wanted Smith's opinion about some small dark areas in the patient's liver. The patient had been scanned for pseudocysts in the pancreas, large fluid filled areas that the radiologists claimed were caused by a long history of alcohol abuse. But, it also seemed that the patient might have metastases in his liver even though he had not been diagnosed as having cancer. After several minutes of discussion, the two radiologists agreed that they could not rule out 'mets' and that the 'incidental' finding should be included in the report.

The radiologist swung his chair to the left and typed the patient's name and number into a computer terminal. The computer responded by displaying a list of body parts. The radiologist touched a pen-like stylus to the screen in front of the option "abdomen", and a new list appeared from which the radiologist selected, in the same manner, the option "pancreas".

Smith narrated as the other radiologist continued to move through successive lists, "We used to dictate our readings and have them transcribed by secretaries. We no longer have to do that. As you see, we hone in on the organ system by selecting options from successive menus. We simply touch the screen with a light-pen. No typing involved. Which is a damn good thing as far as I'm concerned.

"When you get down to the organ system you want, you switch from anatomical to pathological menus and describe the problem in detail, again by choosing options. Although most of the problems we run into are included in the menu tree, if we run across something we haven't coded we can override the software and type the information directly into the patient's file. In that case we'll have our programmer add the problem to the system's options as soon as we've got enough additions to make modification worthwhile. When we've finished entering our reading, the computer automatically constructs a report in standard English.

"We always used set phrases even when we used to dictate. So the computer simply interleaves these phrases with the information we select. A fill in the blanks sort of thing. The finished text is appended to the patient's images in the computer and will be transferred to the floppy when the images are. Hardcopies of the text are printed out on gummed labels at one of the secretaries' desks and she sticks them on the reading form. As you might guess, we've cut down on the secretaries' work load and all but eliminated mistakes in transcription. If diagnostic mistakes are made, we know they're ours and not the transcriptionist's. Let's look at the scanner's".

After leaving the reading room we walked to the end of the hallway where a second set of double doors opened outward automatically. The corridor beyond intersected the hallway we had just left. Signs on the wall directed traffic to the left for "CAT" and to the right for "NMR".
Smith explained that the corridor was reserved for the 'big machines'. At the very end of the corridor to the right was the film library and the mainframe into which are fed studies from the micro-computers linked to each machine. Physicians use the mainframe when they view films at terminals located on the hospital's wards.

Smith turned left and led me to the second door which opened into yet another control room. On both sides of the room stood identical consoles. At each console sat two technologists wearing lab coats. The consoles contained a computer terminal on the left and a video monitor on the right. The video monitors displayed cross-sectional images, CAT-scans. A keyboard was below the terminal. Beneath the video monitor were a series of touch sensitive buttons and a joy-stick. In front of each console was a large plate glass window through which the gantry in the adjoining room was visible. On the back wall between the consoles were sliding glass doors. Beyond the doors stood computer equipment and other electronic devices.

The room was cooler than the other rooms we had visited. Several of the technologists were wearing sweaters. We crossed the room and stood behind the technologists seated at the console on the right. The woman at the keyboard said to Smith, "We're looking for pulmonary nodes and hepatic mets. She had a resection six months ago. I think the lungs are clear, but there are some funny areas in the liver."

Through the window the patient and the gantry were clearly visible. The gantry itself was a large square device about six feet wide and seven feet tall. In the middle of the device as a circular opening two and half feet in diameter. The patient lay on a table with her body halfway through the opening. At regular intervals the table moved the patient out of the device several millimeters at a time, a "swhoosching" noise occurred, and moments later, a new image appeared on the video monitor at the console. Smith explained, "This patient has had a cancer removed and her doctor wants to see if it's spread. The scanner takes pictures of cross-sectional slices of the body several millimeters thick. You'll note how clear and detailed the pictures are. Even the small structures are visible. Before these machines were invented, we had no way of looking at the whole body in cross section."

"Sally thinks she's seen something that looks like cancer in the patient's liver. We'll have to see if she's right. Sometimes blood vessels look like mets. The techs gave the patient an injection of iodine dye before we came in. This will light up the blood vessels, make them appear white rather than dark on the images. If those areas turn color, become denser, then we'll know that we've just got blood. We're coming into the liver now."

Smith leaned over the console and pushed several buttons. A circle appeared on the video monitor. Using the joy stick the radiologist
moved the circle over an organ that he said was the liver. With a dial on the control panel he reduced the size of the circle and then positioned it over a small area of the liver. A digital counter on the left of the image changed numbers rapidly as he moved the circle about the image. When the radiologist had the circle positioned where he wanted it the counter came to rest.

"We can tell by those numbers as well as the appearance of the liver that what Sally thought might have been a metastasis is actually a large blood vessel. From what we can see here, it doesn't look like the cancer's spread. We would never have been able to provide this information eight years ago. The other scanner is just like this one except that we only scans heads and spines over there. We use this one for abdomens and chests."

We returned to the hallway. "Our NMR's not up yet. The engineers have been assembling it for the past two weeks. Unlike the CT which uses x-rays to do cross sections of the body, NMR uses large electromagnets to create a magnetic field around the body. The magnetic field aligns the nuclei of certain atoms in the body. We can tune the magnetic field so that it only affects types of atoms: hydrogen, phosphorous et cetera. When introduce a second field at a right angles to the first, the nuclei turn. When the second field is shut off, the nuclei bounce back to their former position, and in doing so, emit energy. Detectors pick up these shifts in polarity and use them to create images. This is a real advance over CT. Right now we can only look at structural changes. But since we can tune the magnetic fields to different atomic structures, we can get data on pathological processes long before they bring about changes that result in structural abnormalities. For the first time we're going to see function and not just structure.

"We like to think that we've crossed into the future. You've got to remember that 15 years ago, all we had to work with were plain x-rays. Sometimes I feel like McCoy on Startrek. These are the first 'tricoders'."
CHAPTER 1
RADIOLOGY AT THE TECHNOLOGICAL CUSP

"This is the age of machinery!...
The wonderful world of technology!"

Ray Davies
"Twentieth Century Man"

While the preceding scenario is fiction, it is not science fiction. Every device mentioned in the scenario actually exists. Some are presently used by most large hospitals across the United States; the rest are prototypes being tested by medical centers in Boston and other metropolitan areas. Neither is the inventory of devices exhaustive. Omitted from the description are several nascent medical imaging technologies, such as positron emission tomography, which I have not personally observed. What is fictional is that to my knowledge, no hospital yet has every device mentioned, nor has an integrated system for storing and retrieving data from multiple technologies been developed. However, if one accepts predictions made by radiologists and prognoses offered by computer scientists, even this small fiction will soon become reality. ¹

The vision of a totally computerized radiology department conjures up the much touted technological transformation that has captured the imagination of the American press and the attention of scholars in a number of disciplines. One need not listen too intently to hear proclamations that the computer has thrust us into an era of social change reminiscent of the Industrial Revolution. Just as the steam
engine, the turbine, and the railroads created a technological infrastructure for early industrialization, writes Daniel Bell (1979), so will the computer become infrastructural in an "Information Society". Two entwined trends buttress Bell's heralding. Although Western economy has revolved around the the production and exchange of goods for more than a century, the bedrock of economic prosperity is shifting increasingly from manufactured products to the provision of services, the creation of knowledge, and the barter of information. At the same time, mental effort is displacing physical effort as the primary source of added value. A number of long term economic indicators, such as the proportion of the workforce engaged in service occupations, already reflect these trends (Ginsberg, 1982).

It would take us too far afield to review in detail the burgeoning speculative and policy oriented literature on the ramifications of such a shift in the technological infrastructure. For our purposes it will suffice to note that three areas have been of general concern for a coterie of humanists, physical and social scientists, and representatives of government and industry. The most speculative debate centers on how new technologies may shape human society in general and Western culture in particular. That technology changes culture is a venerable thesis, long held by anthropologists and historians (White, 1949, Mumford, 1970). In the fifties and sixties, humanists extended the thesis to propose that the complexity of modern technology had become dehumanizing and that technology was approaching an abstract, self-perpetuating monolith over which no one has control (eg. Ellul, 1964). The computer was at the nexus of the debate. Some writers claimed that computers presaged a world of the complacent many run by
the knowledgable few. Others hailed computers as liberators that would eventually open new vistas for mankind. Two decades have tempered both points view (see Matthews, 1980). As Winner (1977) suggests in his careful treatise on technological determinism, societal change wrought by any technological milieu is likely to be subtle and long in fruition. If there is a danger in the modern situation, it is the distancing of users from designers and the massive complexity of technical systems. The two may combine to create an illusion of an autonomous technology that cripples the political will.

Political implications of new technologies have been a second area of concern. For example, advanced telecommunication systems not only enable rapid transmission of information to and from any point on the globe, they may also allow technologically dominant nations (or corporations) to control the flow of information. The specter of information domination has been especially troublesome to European nations that fear technological control by the United States and multinational corporations (Nora and Minc, 1982). On this side of the Atlantic, American political scientists have begun to show renewed interest in the amassing of centralized data bases on citizens by their governments (Lowi, 1981; De Sola Pool, 1983). Integrated surveillance capabilities threaten notions of individual freedom central to American political philosophy.

However, most pertinent to the present monograph is the third area of debate—what new technologies imply for the workplace. Historically, two disciplines dominate discussions of work: economics and sociology. So far, economists have had the most to say about the new technology, particularly as regards shifting labor markets. Most economists and
government officials foresee acceleration towards a service economy, but
disagree on whether the acceleration is imminent and whether it will
entail intolerable structural unemployment (See Ginzberg 1982; Leontief,
1982; Stonier 1981; Freeman, 1981; Simon, 1977). While sociologists
have also attended shifts in the occupational and industrial structure
that parallel economic trends, an equally important avenue for
sociological inquiry concerns changes in the social context of work as
it is experienced by those who use the new technologies. By
comparison, this topic has been given short shrift. Aside from recent
research on office automation, we know very little about "knowledge
workers" and how advanced computer technologies affect occupations and
organizations.

To speak loosely of advanced computer technologies and knowledge
workers is to create the perception that all computers and their users
are equal. Nothing could be further from the truth. Haugeland (1981)
notes that computers are "universal machines," that is, they are
extremely malleable and are, in theory, capable of mimicking any rule
based system that can be expressed in digital form. Consequently
computers can be used to perform a large number of radically different
tasks. Distinguishing between different uses of computer technology is
as critical for sociologists as it has been for computer scientists and
systems designers. Computers that perform different functions are
likely to catalyze different social dynamics. As a social object, the
meaning of a computer, like the meaning of a word, is contingent upon
how it is used. Before we can study how computers affect work, we will,
at minimum, need a typology of advanced computer technologies based on
social use.
The social use of a technology can be addressed at several levels of analysis. We could, for example, consider specific persons using specific machines in particular contexts. Alternately, we might typify social use by a technology's relationship to the historical context of the work setting into which it is introduced. In later chapters particularistic uses of technologies will be discussed in some detail. At present, we shall consider briefly a broad partitioning of advanced computer technology that claims no exhaustiveness, but merely the heuristic of face validity.

Early computers were used almost exclusively to perform complex mathematical calculations which are far too tedious to do by hand, particularly when results are needed in a relatively short period of time. As Winograd (1979) points out, the early computers gave rise to the metaphor of the computer as a "giant adding machine" (a conception that still dominates the world view of many individuals). As calculators, computers are most likely to be used as tools, devices that assist, but remain adjunct to a worker's task. Although the computer as calculator affects the speed and accuracy of work, it changes the substance of the work only slightly. As with other tools, control of the task still resides with the worker who decides how and when to use the technology. In this sense, word processors may also be regarded as "calculators," albeit ones that manipulate text rather than numbers.

The second most common type of computer use is "data processing", the coding and storing of large amounts of information that previously would have been recorded on paper and kept in file cabinets (if it was collected at all). Data processing proliferated in the 1950's and 1960's when transistors replaced vacuum tubes to sire a "second
"generation" of computers whose speed and storage capacity surpassed that of earlier machines. With data processing, information can be more flexibly compiled, transformed, and analyzed. Data processors are most often deployed in settings where financial, accounting, and record keeping tasks abound. These systems usually take over work that clerks previously performed by hand, although they may also create incentives to produce reports not feasible or even desirable at an earlier time. Since most research on the occupational and organizational implications of computing examines data processors, computing is often depicted as an extension of automation into lower white collar settings, and as a process that alienates and deskills clerical workers (Braverman, 1974). Furthermore, since data processing technologies are deployed in bureaucratic organizations, attributes consistent with the automation of hierarchically and functionally organized work, such as centralization, decentralization, span of control and information flow, are usually assessed.

Although computers are traditionally associated with the automation of clerical work, computer controlled machine tools, robots, and computers that control other computers each promises to increase the rate of automation in manufacturing industries (Gunn, 1982; Ruzic, 1981; Dickson, 1981; Johnson, 1982; Appleton, 1982). Computer Assisted Manufacturing (CAM) refers to multilevel, hierarchical systems of computer technologies composed, at the lowest level, of robots and computerized machine tools on the shop floor. These machines are connected to larger computers which in turn are larded over by a mainframe. Consequently, it is possible to direct the operation of whole factories or portions of factories by programming a central
computer that, without further human intervention, programs and monitors all machines under its control. Ruzic (1981) describes one such factory:

Your first impression when you view the McDonnell Douglas parts fabrication plant in St Louis is the sheer size and loneliness of it all. Some two dozen acres of milling machines nosily grind grooves, slots, and intricate patterns in airframe parts to a tolerance of 0.0025 inch. The machines, for the most part, work alone--watched by only a few men who glance occasionally at a control panel or sweep the cuttings. Nor are these men in charge here. The machine tools are directed by numerical controllers, which in turn are directed by a whole hierarchy of computers presided over by a master computer. This 750,000 sq. ft. aircraft parts plant is among the most advanced computer aided manufacturing factories in the world. But it is far from unusual (p.165).

As Ruzic's description suggests, computer aided manufacturing is likely to transform mass production industries into continuous process industries. Making cars will become more like making gasoline. As a result, the social organization of mass production may become less alienating as assembly lines and semi-skilled jobs are eradicated (See Chapter 2 on automation research).

The social use of data processors and CAM systems is termed automation because each performs work that humans previously executed with less complex machinery, or by hand. In each instance, the nature and social context of work change, but the final product remains largely the same. While these uses of computers are significant and their proliferation strengthens the argument that "computerization" is equivalent to the "mechanization of work", it would be a mistake to conclude that all advanced computer technologies engulf work formerly
performed by lower white collar and blue collar workers. To do so would be to overlook what, in the long run, may prove to be the most revolutionary social use of advanced computer technology.

Terry Winograd (1979) claims that we have left behind an age when computers were merely data processors and have entered an era when computers will increasingly become "knowledge processors". Knowledge processors do more than manipulate data or control machine tools, they transform information to arrive at complex judgements and, in some cases, create forms of knowledge previously unavailable by other means. Moreover, knowledge processors are most likely to alter the work of professionals and semi-professionals and to be deployed in architectural firms, scientific agencies, law firms, and hospitals. In short, knowledge processing promises to transform work and to affect occupations largely untouched by earlier computer technologies.

Knowledge processors that simulate mental work to arrive at complex judgements traditionally in the province of professionals and semi-professionals are typified by Computer Aided Design (CAD) and "expert programs". CAD systems allow those who design physical objects to create and test prototypes without building models. For example, with a CAD system, a structural engineer in the aerospace industry can design a "virtual" nosecone for a rocket, and then test the nosecone's points of stress by smashing the "virtual" nosecone into a "virtual" brick wall without ever walking away from a computer terminal. Points of stress are defined mathematically and depicted visually in the form of computer generated drawings. While engineers are currently the most frequent users of CAD systems, some architects are beginning to employ the technology. Armed with a CAD system, an architect can examine
proposed layouts from multiple perspectives on a video monitor. If either the architect or the client is displeased by the effect, the design can be changed more or less immediately to conform to either's preference.

Whereas CAD systems simulate objects and properties of objects that professionals design, expert systems simulate professionals themselves. Expert programs are so named because they have been constructed to mimic the judgements of actual individuals who are members of a particular profession. To build an expert program, computer scientists pose problems for an expert to solve and then carefully debrief the expert about the stream of thought he or she used to arrive at a solution. By analyzing the expert's thinking in minute detail, the computer scientist gradually constructs a rule system that mimics the professional's judgement in specific situations.⁶

To date, most expert programs are prototypes used experimentally in a few medical settings to diagnose diseases of specific organ systems (Shortcliffe 1981; Ludwig, 1981; Lindberg et al. 1981). However, several programs for locating oil and mineral deposits are also being tested in the field (Businessweek, 1982). The most extensive expert program in medicine is probably INTERNIST-I, developed at the University of Pittsburg. INTERNIST-I can diagnose over 500 diseases with approximately the same accuracy as the average physician. There has been much debate, but little research, on whether professionals will use expert programs. The technology can be understood to threaten the status of a profession by encoding and making widely available the knowledge for which the professional is paid (see Schwartz, 1970). As
Winograd (1979) notes, with expert programs the recurrent fantasy of computers as giant brains gains some credence.

Depending upon how they are used, CAD systems and expert programs vary between being tools and technologies that automate mental work in the province of specific occupations. Given the recency of both technologies and the lack of social research on their use, it is simply too early to predict their social ramifications for work settings. However, in each case, the technology essentially performs old tasks in dramatically new ways. While CAD systems and expert programs can be said to process knowledge, neither opens up radically new areas of inquiry. However, other knowledge processing technologies have created opportunities for new forms of knowledge and understanding.

Vian, Johansen and Griebstein (1981) discuss a technology known as Dynamic Spatial Reconstruction (DSR) that allows three dimensional imaging of organ systems. Because DSR distinguishes small changes in structure over short periods of time, physiologists foresee an eventual integration in their understanding of structure and function:

Traditionally, both experimental and theoretical approaches to organ systems have been divided. They have been divided between two concepts: structure and function. Structural studies have sought to describe the relationships between elements of an organ by describing each of them individually and the ways they are joined together. Functional studies, on the other hand, have attempted to determine different responses of an organ systems to various stimuli and from those responses to project its 'rule of functioning'. The bridges between these two concepts, when they've existed, have been awkward and unstable, largely because there has been no way of 'seeing" both structure and function operating together. So two different perspectives have developed around the two different concepts, with holders of either perspective finding it difficult to make the trek across the bridge. With DSR's ability to represent structural
changes synchronously with functional processes that create them, the bridge between structure and function may be strengthened. In fact, there could even be a merging of the concepts of structure and function and the emergence of a new description of anatomical systems (Vian, Johansen, and Greibstein, 1981:8-9).

Crucial to Dynamic Spatial Resolution's promise is the opportunity for physiologists to literally "see" structure and function in combination. The technology creates potential for radically new knowledge precisely because it produces a formal system of signs, a language of images, that carries new information. One might hypothesize that when a technology allows visualization of previously opaque processes and the genesis of new semiotic systems, then we have at least one set of conditions under which a technology generates new ways of knowing.

To understand how these various computers change occupations, organizations and work itself, we require a corpus of research on diverse technologies. If we can also devise an informed typology of potential social use, then we may be able to build a comparative, empirical theory of advanced technology's implications for the workplace. However, much preliminary research needs to be done before we can even propose an adequate typology. Nevertheless, using the crude categorization of social use outlined above as a preliminary yardstick, we find that there is a small but growing literature on the social implications of data processors and other forms of computerized automation, little social research on computers used as tools, and no published research on knowledge processors. While most knowledge processors are still prototypes that are likely to spawn social dynamics unlike those to be found under conditions of routine use, several knowledge processing technologies have diffused to a point where they
may be fruitfully studied by social scientists. Medical imaging technologies are an excellent example. Like Dynamic Spatial Reconstruction, each of the technologies described in the prologue offers a radically new way of viewing the human body and creates a new system of signs. Since these new technologies are also likely to reshape the work milieu in which they are used, radiology departments may offer the best laboratories currently available for studying the social ramifications of technologies that generate new knowledge.

The Technological Transformation of Radiology

A hospital's radiology department is staffed by two main occupational groups: radiologists, who are physicians and who have the legal right and formal training to interpret x-rays, and technologists who possess two-year associates degrees in radiological technology and who operate the machines to produce films needed by the radiologists. In addition, several orderlies and nurses also typically work for a department on a permanent basis. One or more technologists who have been promoted to supervisory positions coordinate the day to day logistics of the work. These individuals often hold the titles of Chief Technologist or Assistant Chief Technologist and are collectively referred to by members of the department as "the administration".

Unlike most medical specialties that developed as physicians concentrated on particular organ systems, patient populations, or diseases, radiology grew up around the use of a scientific and technological breakthrough: the discovery of x-rays by Wilhelm Roentgen in 1895. By 1896, the diagnostic potential of x-rays had not only been
discussed in leading medical journals, but several professional
societies and a new journal had been founded to further radiographic
work (Dewing, 1962; Reynolds, 1956). Radiology's development as a
medical profession pivots historically on three points: the gradual
exclusion of physicists and engineers from medical radiography, the
construction of legal constraints to bar technicians from interpreting
films, and the progressive refinement of diagnostic signs correlated
with incremental innovations in technological capability.  

At the outset, physicists and engineers were as interested in the
medical applications of radiography as were physicians. In fact, the
first radiographic societies were actually arms of established
scientific bodies that included members of all three occupations.
However, during the first decade of the twentieth century, the
physicians began to break away from the scientific societies to
establish their own journals and associations. At the same time,
physicians interested in radiography began to fight for radiology's
inclusion in the formal curriculum of medical schools.

In the early years, physicists, engineers and technicians could
easily open their own radiographic practices and provide referring
physicians with films. Since most physicians could not read x-rays,
these individuals also provided interpretations or "readings". The
close of World War I exacerbated the situation when numerous medical
corpsmen returned to Britian and the United States having been trained
to perform radiographic studies on the battlefield. Apparently many
industrious veterans found they could support themselves quite
handsomely in civilian life by setting up a small x-ray business. After
winning a series of legislative battles in Congress and the medical
societies themselves, radiologists finally drove non-physicians out of independent practice and were able to require x-ray technicians to work under the direction of a physician. With the founding of the American Board of Radiology in 1934, which grants certification to radiologists who pass an examination administered by the American Medical Association, radiology became an established medical specialty. Dewing (1962:82) states the profession's case boldly when he reminds his readers:

There were many non-medical persons ranging from physicists, engineers, and electricians through nurses, hospital orderlies, and photographers, to frank charlatans and side-show exhibitor types. These latter did little to elevate the professional level of radiology and insofar as they were in the public eye, damaged its tone. It took some years before the more professional physicists and engineers either entered medicine fully...or lost interest and returned to their primary academic or commercial pursuits. It took a little vigorous shaking to root out the riff raff. But by 1905, the conscientious physicians were in the ascendance and have kept control fairly well since.

Aside from successfully monopolizing the taking of x-rays, the profession also sought barriers against the interpretation of films by outsiders. By and large, the group most prone to provide "illicit" interpretations, often at the urging of a referring physician, were the technologists. Organized radiology first sought control over the training and licensing of technologists. In the United States, the American Medical Association set up the American Society of Radiological Technologists in 1920 and the American College of Radiology established a registry of trained technologists in 1922 (Brown, 1973). Since radiologists dominated the governing boards of both organizations, over
time they were able to direct certification of training programs, shape the content of curriculum, and set terms for employing technologists (Brown, 1973). Ultimately the curriculum of certified programs excluded instruction in reading films and the AMA passed rulings that forbade employing any but registered technologists. A similar process occurred in England, so that by the 1940's radiologists in both countries controlled the technology and its use (Larkin, 1978, 1983).

Radiology shares with pathology a number of characteristics that distinguish it from other medical specialties. First, the radiologist's client is likely to be another physician rather than a patient. Patients rarely visit a radiology department unless a clinician has referred them for diagnostic tests. In all cases, radiologists report results of a study to a referring physician, not to the patient. Hence, within the medical division of labor, radiology provides diagnostic support for the relatively more glamorous work of the clinician and surgeon. Other medical specialties view radiology as less prestigious (Knowles, 1969), while radiologists see themselves as the bedrock of the medical community and as the profession's academics. Like pathologists, radiologists are almost always fulltime members of a hospital's staff. Although radiologists associated with a hospital may also run a private group practice, most of their work comes through the hospital which is likely to own the more advanced and expensive equipment. Finally, like pathology, radiology's importance has grown in step with technological capability and the medical profession's increasing reliance on diagnostic technology.

Until as recently as twenty years ago, the work of a radiology department consisted primarily of the production and interpretation of
images captured on radiographs and the execution of fluoroscopic examinations. Radiographs are static pictures taken at a point in time on photographic film using an x-ray tube as a source of radiation. As a gross oversimplification, electrons hurled from the tube penetrate the body and strike the film at different rates depending upon the density of the tissue through which they have passed. The denser the tissue, the fewer electrons that strike the film. On developed film, denser areas, such as bone, appear white, while "soft tissues" are imaged more darkly. Thus radiographs or "x-rays" are actually records of tissue density. The chest x-ray which most of us have had at one time or another is the most frequent radiograph produced in a radiology department.

Fluoroscopes also use x-rays to image bodily organs, but unlike radiographs, they allow continuous observation of organ systems over a period of time. In fluoroscopy, the radiation emitted by an x-ray tube strikes a device known as an "intensifier". The intensifier contains a screen coated with a phosphorescent material that glows when struck by electrons. The electrical signals produced by the screen are amplified electronically and displayed on a TV monitor. With fluoroscopy it is possible to observe motion, and hence function as well as structure, so long as the organ of interest can be filled with a "contrast agent" which will make the organ "radio-opaque" or visible under x-rays. Examinations or studies representative of fluoroscopy include the barium enema, the barium swallow, the upper gastro-intestinal study (UGI), and cardiac fluoroscopy.

Before the mid-1960's radiology experienced a fairly constant history of technological change. However, most changes hinged on incremental innovations in existing technologies and techniques (Dewing,
1962). In the late 1960's an increasing number of radiology departments began to perform angiography and other special procedures. Significant improvements in automatic film changers and intensifiers along with the development of plastic catheters and new catheterization techniques made possible study of the circulatory system by taking a rapid series of x-rays. Angiography, the radiographic study of the circulatory system, involves inserting a catheter into a artery, moving the catheter through the vascular system to a predetermined point under fluoroscopy, and then injecting an iodine dye while rapidly filming a series of x-rays to capture the dye's course through specified blood vessels. Since iodine is radio-opaque, the arteries show up on film, and the resulting pattern of vascular branches can be used to diagnose full or partial occlusions.

Other special procedures involve implanting catheters into organs either to study their structure or to drain abscesses. For example, in a nephrostomy, a catheter is placed in a kidney that has ceased to function correctly in order to drain urine which can no longer reach the bladder. Special procedures changed the radiologist's work role rather dramatically. In addition to reading films and performing fluoroscopy, radiologists now found themselves performing what amount to minor operations and biopsies. Moreover, as special procedures became common, a new subspecialty of radiological technologists arose: "specials techs", who are considered my most members of a radiology department to be the most skilled of all technologists.

At about the same time that angiography spread to radiology departments, a new wave of imaging technologies began to appear. Because the machines imaged the body in dramatically new ways, they are often referred to as "new modalities". The term "modality" refers
loosely to the means by which diagnostic information is captured. A modality can also be thought of as a unique system of signs or a separate language of images.\textsuperscript{11} It is in the creation of new modalities that computers have played their greatest role in radiology. In the long run, the invention of new modalities may prove far more significant than special procedures in changing the face of radiology.

Nuclear medicine, the introduction and tracing of radio-isotopes throughout the body, was the first new modality to gain widespread use. While isotopic studies had been performed for a number of years prior to the late 1960's, the invention of the gamma camera and the use of computers to create images dramatically boosted the technology's diffusion (Rapoport, 1978). Certain radio-isotopes are known to collect in different parts of the body and in specific types of tissues. When injected into a patient, the isotopes can be traced by exposing film to electrons liberated as the isotopes decay. On film, target organs and points of pathology, known as "hot-spots", appear dark since the radioactivity in these areas is higher than in other areas of the body.

In the early 1970's ultrasound also began to enter radiology departments. Ultrasound couples sonar to a minicomputer and a video monitor to produce images of internal anatomy. Sound waves projected into the body by a hand held transducer rebound off of anatomical structures and are picked up by the piezoelectric crystal that produced them. The echoes, converted to electrical impulses, are fed into a computer where they are correlated to the shades of a "grey scale" on the basis of intensity which varies by the density and depth of the structure that reflected the sound. The body can be viewed from almost any plane with ultrasound, whereas radiographs and fluoroscopy are
limited to longitudinal views. Ultrasound also discriminates between soft tissues of different densities that appear indistinct on standard x-rays. Consequently, ultrasound can be used to study organs, such as the pancreas, that are transparent on traditional radiographs. Because ultrasound is non-invasive and involves no known health hazards, radiologists can now diagnose pregnancy and diseases of the reproductive system. Finally, with the invention of "real-time" sonography, one can capture an on-going stream of images almost instantaneously so that it is possible to view organs in motion. With this ability, a beating heart can be imaged in relative detail. Hence ultrasound has revolutionized the diagnosis of heart disease which often involves irregular motions of the cardiac muscles and the valves of the heart.

In 1971, the Computerized Axial Tomography (CAT) scanner debuted as a prototype device at the Atkinson Morley Hospital in London, England. Two years later the Mayo Clinic installed the first commercial scanner available in the U.S. By 1974, several companies were marketing scanners. A year later the number of scanners on the market was twenty (OTA, 1978). The CAT-scanner, or CT-scanner as it is also called, uses a computer and one or more x-ray tubes to construct in fine detail, cross-sectional images of the body. A scanner's ability to differentiate between anatomical structures is so refined that its images approach depictions of anatomy found in textbooks. The first scanners were "head scanners" and were used to study the brain which could be imaged previously in no other manner. In fact, before the CT scanner, total cross-sectional views of any area of the body were technologically impossible. By 1975, scanners had been refined to a point where images could be captured in a few seconds and where
non-circular objects would not create artifacts. These improvements led to scanning of the torso without serious interference from the torso's shape or the motion of breathing. Thus body scanning and "body-scanners" became viable.

In brief, a scanner is a massive machine which consists of three major subsystems: a gantry, a console, and a computer that connects the two. The gantry, a large rectangular device, stands five to six feet high, measures five to seven feet wide, and is approximately a foot and a half thick. A circular opening dominates the center of the gantry. The patient lies on a mechanical table that automatically moves in or out of the opening at a programmed rate. An x-ray tube that emits a fan beam of radiation is mounted on a circular track inside the gantry. When activated, the x-ray tube moves rapidly around a 180 degree arc firing its beam of radiation. The beam of electrons passes through the patient and strikes a series of "detectors" mounted opposite the tube. The electrons generate electrical impulses at the face of the detectors and these are fed into the computer.¹²

As the tube rotates through its arc, multiple measurements of the density of a given area of the body are collected from various angles. The computer enters these multiple readings into a series of simultaneous equations that when solved, yield average values (known as Hounsfield numbers after G. N. Hounsfield the scanner's inventor) for a defined area within the circular field of the scan. The numbers are correlated to values of a "grey scale", and the computer displays the data as black and white images of the console's video monitor.¹³ The action of the gantry and the computer are directed from the console using a keyboard and preprogramed switches. Data from each scan is
stored by the computer on a systems disk and can be transferred from the computer to magnetic tape for storage. "Hard copies" of images are made using a special camera that films the image while displayed on the monitor.

Whereas nuclear medicine, ultrasound and CT scanning are used rather widely across the country, several other new technologies are just beginning to invade radiology departments. Digital subtraction angiography uses a computer to capture, store, and analyze information during an angiogram. The equipment allows a technologist or radiologist to create images of contrast enhanced blood vessels from which have been removed all other internal structures not containing the dye. At its theoretical limit, digital subtraction leaves an image that maps only the circulatory system. Since the computer detects very small differences in density, digital angiograms can be done by injecting less dye into a vein rather than an artery. Since entering a vein is far less risky than entering an artery, digital subtractions can be performed on outpatients while regular angiograms require hospitalization.

Two other computer based modalities are currently in the prototypical stage of development: nuclear magnetic resonance (NMR) and positron emission tomography (PET). The former uses large electromagnets to image anatomical structures. The electromagnetic field can be tuned so that it causes the nuclei of various atoms (usually hydrogen) to align themselves in a particular position. When the magnetic field is broken by a second field perpendicular to the first, the nuclei shift. When the second field is eliminated, the nuclei rebound, releasing energy. Detectors measure the energy given
off by the relaxing atoms and convert the measurements to
cross-sectional images. PET scanning involves injecting radioactive
compounds with a short half-life into the blood stream. Positrons
emitted by the isotope strike other atoms and release electrons which
produce gamma rays. The gamma rays are picked up by detectors and a
computer converts the impulses into images on a color video screen. NMR
and PET differ from the CAT scanner in that they allow the study of
metabolic activity as well as anatomical structure.

Each of these new modalities have opened new vistas for medical
diagnosis. All image organs and disease processes opaque in routine
radiography and fluoroscopy. In addition radiologists can now study
motion and, to an increasing degree, function or metabolic process.
Moreover, each of the technologies brings with it a new language of
images whose meaning must be mapped before its clinical utility can be
fully exploited. While the technologies have created an era of
excitement in the medical community and have captured the public's love
for technological wizardry, they have also raised serious questions
about the direction of medical care in the late twentieth century.

In the early 1970's, critics of the health care system began to
question the wisdom of investing an increasingly large proportion of the
gross national product in health care. Reliance on sophisticated
technologies that cost exorbitant amounts of money stood at the center
of the health cost debate. Elison's (1978:9) comments can be taken as
typical:

In the past few decades the diagnosis and treatment of
disease has increasingly relied upon technological devices
centralized in hospitals. That change in technology has
profoundly changed the occupational system. In 1946, there were 156 personnel per 100 patients in short stay hospitals. In 1963, there were 244 personnel per 100 patients. Although increases due to wages cannot be denied, it has been estimated that 50% of the increase in costs of hospital care, from $13.2 billion in 1965 to $40.9 billion in 1974, was due directly or indirectly to medical technology.

Aside from their direct and indirect costs, critics of the current health system indict advanced medical technology on a number of other counts. For example, the decision to allocate limited resources to purchasing expensive hardware of necessity entails an opportunity cost: money spent on technology can not be channeled to other health related programs such as health education and preventative medicine. Critics have taken the position that the latter programs are of greater overall benefit to society (Stocking and Morrison, 1978; Elison, 1978). Because treatment and diagnosis by advanced technology is costly and because the machines can handle only a few persons each day, it is claimed that technology benefits an elite few who can afford the service while robbing the poor of benefits that could be derived from alternate uses of funds. Advanced technology has also been charged with the demise of the general practitioner and the alienation of patients from providers of medical care (Field, 1971; Sidel, 1971). Finally, medical technology has undeniably led to a host of moral problems with which traditional social values are ill-equipped to cope. Euthenasia, the redefinition of life and death, and the wisdom of being able to diagnose accurately at early stages diseases for which treatment is currently impossible are but three moral delimmas linked to technology in medicine.

As public concern with the cost of medical care and the long term social and moral implications of advanced medical technology grew, the
issue became increasingly political. Consequently, the Federal
government entered the medical technology debate. In 1972, Congress
passed legislation establishing the Congressional Office of Technology
Assessment after a series of hearings conducted by the House Science and
Technology Committee convinced legislators that there was a need to
monitor new technologies for the public benefit. The OTA's directive
was to advise Congress on issues having to do with science and
technology by comprehensively assessing the physical, biological,
economic, social, and political implications of specific technological
developments (Banta and Behney, 1980). By 1975, OTA had formed a
specific division to attend to medical technology.

Under the Medicare and Medicaid amendments to the Social Security
Act of 1972, Congress also established regional Professional Standards
Review Organizations to review medical practice. In 1974, further
legislation created a series of programs known as Health Service
Agencies (HSA's), regional bodies charged with the task of regulating
large health care purchases by hospitals that accept federal funds (OTA
1978; Banta and Behney, 1980). These legislative acts require hospitals
that wish to expand facilities or purchase expensive equipment to file
first a Certificate of Need with their local HSA. Following guidelines
and criteria laid out by each local agency, the hospital's task is to
convince the HSA that there are sufficient reasons to approve the
proposed expenditure.

Since CT-scanners range in price from .5 to 1.5 million dollars and
since they became available at the same time that the new regulatory
machinery was being established, it is not surprising that in the
mid-1970's the CT-scanner became the quintessential symbol of
"technological medicine". The scanner neatly juxtaposed the problem of rising costs with the marvel of a technological breakthrough to reveal the irony inherent in regulating medical technology. While on the one hand society deplores the high costs of medical care, on the other, it is fascinated by inventions that symbolize, in dramatic form, the promise of progress through revolutionary science and technology. Nowhere can the conflict be seen more clearly than in the popular press where articles on the cost of scanners are infused with unabashed marvel.¹⁴

Because of its prominence in the controversy over medical costs, the CT-scanner has been the focus of numerous studies and government sponsored reports. Current research on the CT-scanner and other medical imaging technologies falls into one of three categories: research on medical and diagnostic utility, economic and policy implications of the technology, and diffusion studies. By and large, the diagnostic and medical implications of the CT-scanner and other modalities are to be found in an extensive literature scattered across two dozen or more medical journals. Most of these assessments are clinical in nature and pertain to the diagnosis of specific diseases (See OTA 1978; 1981; and Wiener, 1979 for reviews).

Research on the economic and the policy implications of CT-scanning composes the second most prevalent literature on the technology. The Office of Technology Assessment (OTA 1978; 1983) has published two reports dealing with the efficacy, safety, and policy implications of the scanner. The most firm conclusions regard economic demographics: the number of scanners in use, their distribution, the cost of an average scan, and the rate at which the technology has diffused (Baker,
1977). Whether or not the scanners' costs outweigh their benefits is a question whose answer has proven elusive. It is difficult to perform cost benefit analysis on medical technologies, particularly when clinical knowledge about technology's use is evolving. Moreover, precisely what efficacy might mean is debatable. Different conclusions can be reached by assessing diagnostic effectiveness on one hand and improved morbidity or mortality on the other (Banta and McNeil 1978). Most policy research has focused on the scanner's diagnostic efficacy and its ability to replace other procedures. As might be expected, the data suggest that the scanner is incredibly accurate for some pathologies and less accurate for others (OTA 1978; 1983; Banta and McNeil, 1978; Weiner, 1979). The scanner's impact on alternate procedures is more difficult to assess. While CT-scanners have all but eliminated pneumencephalography and there are indications that angiography and myleography may have also been reduced, results for other diagnostic procedures are conflicting. The vague conclusions reached by this literature result in part from the difficulty of obtaining accurate data and in part from the fact that the use of a technology is often influenced by the particular setting in which it deployed.

While the economic, medical, and policy implications of CT-scanning and other diagnostic technologies have been the focus of much research, there have been no studies of how these technologies alter the social organization of radiology departments or the work of radiologists and technologists. Farlee (1980a, 1980b, 1980c) notes that there are few data on how any bio-medical technology shifts the occupational and organizational milieu of medicine. Yet, belief that medical diagnosis has been radically transformed is obviously widespread. In fact, there
are a number of incidental indications that the new modalities have brought significant social change to radiology.

First, each of the new modalities has divided the labor of radiological technologists. While the social contours of the differentiation have not been documented, there can be no doubt that nuclear medicine spawned the "nuclear medicine tech"; ultrasound the "sonographer"; and CT-scanning the "CT-tech". That these groups may have fledgling occupational identities separate from x-ray technologists is suggested by the recent formation of a professional organization and registry for sonographers. Second, Stocking and Morrison (1978) argue in passing, that new modalities change the skills required of technologists and that those who operate new modalities may be more likely to interpret images for physicians. Moreover, they suggest that the new technologies could create schisms between radiologists who have access to the new technologies and those who don't, as well as schisms between those who can read the new images and those who can't. But perhaps the most intriguing evidence of social change in radiology is that some "Departments of Radiology" are beginning to change their names to "Departments of Medical Imaging".

The new name, "Medical Imaging," probably signals more than an accumulation of divergent technologies under a banner thought to reflect more accurately the technological reality. As occupational sociologists of symbolic interactionist persuasion repeatedly counsel, what an occupation or organization chooses to call itself is a clue to the social organization and social identity of its members (Hughes, 1958; 1971, Park and Burgess, 1924; Becker et al. 1968). Titles not only refer to the work that an occupation or organization performs, they also
perform work for the occupation or organization. Occupational titles are implements of self presentation (Goffman, 1959), indispensible tools that assist members of a group in carving out niches in their social environment (Kunda, 1983; Strauss et al. 1964), in establishing claims to status (Van Maanen and Barley, 1984), and in settling the territories of a division of labor (Miller and Van Maanen, 1982).

The fact that an occupation or organization should seek to change its name suggests, at minimum, a period of social reorganization in which occupational and organizational identities are in flux. To the degree that "Medical Imaging" is less specific than "Radiology", one may entertain several speculations about the nature of that flux. For example, the greater generality may be seen as useful for integrating newly divergent social roles and relationships that don't quite fit under the old title. Alternately, to the extent that "Medical Imaging" implies a larger technical domain, one might propose that radiology departments adopt the name to signal other occupational groups that they have staked out claim to certain territories: perhaps in reaction to or anticipation of disputes over appropriate divisions of labor. As such, the change of name may imply a new twist in the ongoing evolutionary politics of medical specialization.

While these speculations are consistent with the tenets of previous studies in occupational and organizational sociology, there is little data to pass on their accuracy. At best, we can say that there are signs of social change within the world of radiology, but that the exact shape of that change and its implications for the work are unknown. The purpose of this study is to trace more clearly the contours of change that new imaging technologies may have wrought in the social
organization of radiological work and, at the same time, to provide preliminary information about the social implications of advanced technologies that create knowledge. To do so we need some notion of how to most profitably approach the study of technological change in work settings: the topic to which we now turn.
FOOTNOTES

1. All the radiologists who were observed in the course of this study believe that the electronically integrated radiology department is no more than a decade away. Experts in computerized medicine whom I interviewed in the early stages of the project concur. Furthermore, there is a sizable professional literature on the topic which ranges from futuristic discussion to reports on preliminary developments currently underway (see Lehr, 1981; Davis, 1981; Quintin et al. 1981). At present the major roadblocks seem to be costs, governmental regulations designed to control costs, and the tremendous amount of memory space that would be necessary to store centrally data from multiple imaging devices. Current governmental regulations limit all but the largest medical centers from purchasing newly developed imaging devices (Office of Technology Assessment, 1978, 1981). However, if one argues that most new devices will eventually be widely disseminated, as has been the case with CT scanners, then regulations would seem only to slow the process. Moreover, if one extrapolates from past geometrical decreases in the cost of computing and concomitant increases in storage per microchip, then memory limitations are also likely to be temporary (Noyce, 1981a 1981b; Bylinsky, 1981; Abelson and Hammond, 1981).

2. Dertouzos and Moses (1979) and Forester (1981) have edited volumes that offer an excellent overview of the "Computer Age" and the "Microelectronics Revolution" from a variety of perspectives. Hiltz and Turoff (1978) and Nora and Minc (1981) provide alternate viewpoints on advanced telecommunications. Benson and Lloyd (1983) address issues of social policy stemming from a shifting economic base and are concerned to redefine the role of labor in the computer society. Bell's (1974) The Post-Industrial Society is perhaps the earliest attempt to augur the shape of an information based society.

3. Digital systems have three attributes: they are self-contained, perfectly definite, and finitely checkable. This means that factors exogenous to the system are irrelevant to its operation, that any current state of the system can be known exactly, and that only a finite number of options are available when the system moves from one state to the next. Games are examples of digital systems as is mathematics.
Anything that can be expressed mathematically is hence, in principle, a digital system.

4. The recent dedication of an entire issue of *Scientific American* (September, 1982) to "The Mechanization of Work", is symbolic of the gravity of these trends as well as the generally narrow perspective on how computers change work worlds.

5. Winograd uses the term "knowledge processing" to refer specifically to advances in artificial intelligence. I have chosen to adopt his term rather than to create a new one, and to extend its application. There seems no reason to restrict "knowledge processor" to expert programs when the term seems adequate for a host of new technologies that literally create new forms of knowledge and intellectual capabilities, but which can not be considered "artificial intelligence" in even its loosest sense.

6. Expert programs are at the cutting edge of what computer scientists' call artificial intelligence. Artificial intelligence refers to the creation of machines that simulate perception as well as judgement. As a cognitive science, artificial intelligence involves a psychology of cognition as well as a philosophy of mind. Useful books on artificial intelligence and cognitive science include Haugeland (1981), Dreske (1981), and Fodor (1981). One should also consult essays by Pappert (1979) and Minsky (1979). Although most AI research is housed within universities, a number of companies have been founded to develop and market expert programs. Consult *Businessweek*, March 8, 1982, for a partial listing of such firms.

7. The following brief overview of the sociological development of radiology as a profession draws heavily and liberally from Gerald Larkin's (1978, 1983) superbly detailed, historical scholarship on radiology's rise as a profession in England. Larkin's work represents one of the best available accounts of how a medical specialty establishes an occupational monopoly and regulates paraprofessionals. The present work excluded, Larkin's is the only sociological treatment radiology or radiological work. I have found Dewing (1962), Stead, et al. (1956), Reynolds (1956), and Knowles (1969) useful sources on the early history of the profession and the technical development of early radiological apparatus and technique.

8. One of the radiologists with whom I associated over the course of this study was quite fond of telling me that as a radiologist, part of his job was to help create knowledge useful for his clinical and surgical colleagues. "We are more like academics", was his way of stating the difference between radiologists and other physicians. Other radiologists also echoed this notion, but never so frequently.
9. While it is important for the reader to have some acquaintance with the physics of radiography and other radiological modalities in order to appreciate the ethnographic results to be presented in later chapters, a thorough discussion of any technology and its principles of operation would require a separate monograph. My intention is to keep technicalities to a minimum. Readers interested in a more accurate portrayal of the physical attributes and principles of radiographic and fluoroscopic technology should consult Selman (1977). "Selman" is the standard text used by radiological technologists while they are students.

10. "Examination", "test" and "study" are terms that refer to a radiological procedure of any type. Technologists usually use "examination" or "test", while radiologists are likely to use "study". The term, "study", may also refer to the set of films produced by a radiological procedure.

11. Radiography and fluoroscopy are separate modalities because they display information differently, but "special procedures" is not a modality. Rather as traditionally performed, special procedures combine radiography and fluoroscopy with catheterization techniques to yield a new form of practice, but not a new imaging system.

12. This description pertains to third generation CT scanners such as those I observed. Earlier scanners are built differently and scanners produced by different companies are also slightly different. Differences between generations of scanners, the technicalities of scanner construction, and the physics and mathematics of their operation are described far more accurately and in far greater detail in the following references: Office of Technology Assessment (1978; 1979), Wiener (1979); Zamenhof (1979).

13. In point of fact, the images are composed of tiny squares known as pixals. Each pixal has associated with it one Hounsfield number and is a two dimensional representation of a three dimensional space (a voxel) which in turn represents a tiny segment of the body through which the scan has been taken. The degree of refinement in CT images is therefore measured in terms of the number of pixals in the matrix that compose the image. The scanners I observed were capable of taking and displaying information with a 256 matrix or a 512 matrix. The latter is four times better than the former. Among the many ways that scanners have been improved since their beginning is in the relative refinement of the imaging matrix.

14. The degree to which the newest modalities have captured the public imagination can perhaps be gauged by the frequency of articles in the public press regarding their use. Since beginning this research I have casually collected articles from newspapers and magazines that discuss the new modalities.
Between May, 1982 and January, 1984 (an 18 month period), the Boston Globe alone published 7 articles on CT, NMR, or PET scanning. One of these was a feature length article on new diagnostics technologies in The Boston Globe Magazine (April, 1983). During the same period, the New York Times, which I do not regularly read, ran at least two articles. Both Newsweek and Time featured NMR and CT in their medical sections. All of these articles to various degrees focus on costs or wonders. One Globe article speaks of subjecting mummies to CT-scanners in order to get data on how the old Egyptians died. During John Hinkley's trial for the attempted assassination of Ronald Reagan, the defense attempted to introduce a CT scan as evidence that Hinkley was schizophrenic. The judge ruled the evidence inadmissible as well he should have, since the CT would be "non-diagnostic" unless Hickley has structural brain damage. Apparently Hinkley's alleged schizophrenia had no structural origin, but the press did not make this clear.

15. While there have been no studies of how bio-medical technologies change medical work, Alan Meyer has for the past several years been studying decisions to adopt 12 different bio-medical technologies in an HSA in Wisconsin. His data suggest that the decision to adopt can only be understood when one factors together political, medical, and administrative perceptions of the machines. Meyer's data suggest that the social construction of a technology is multidimensional and shifts with time. See Meyer (1984) for preliminary results.
CHAPTER 2
TOWARDS A SOCIOLOGY OF TECHNOLOGY AND WORK

The work force is disgusted downs tools and walks
innocence is injured, experience just talks
everyone seeks damages and everyone agrees
that these are 'classic symptoms of a monetary squeeze'
on ITV and BBC they talk about the curse
philosophy is useless, theology is worse
history boils over there's an economics freeze
sociologists invent words that mean
'Industrial Disease'

Mark Knopfler
"Industrial Disease"

Indicative of the state of sociological knowledge about technology
is the fact that there are several bodies of empirical work to which one
can point under the rubric of a "Sociology of Science," but none
coherent enough to deserve the name "Sociology of Technology." We know,
for example, a good deal about the nature of scientists' work (Marcson,
1960; Kornhauser, 1962; Glaser, 1964; Merton, 1973), but aside from an
extensive literature on the careers and values of engineers (Dalton and
Thompson, 1982; Bailyn, 1980, 1982; Perrucci and Gerstl, 1969; Ritti,
1971), we know very little about technologists and the doing of
technology. Likewise, a literature delimiting the boundaries and
normative systems of scientific communities has accumulated. (Merton,
1942; Cole, 1970; Cole and Cole, 1967; Crane, 1972), but our knowledge of
social cleavages within technological communities and subcultures is at
best embryonic (Kling and Gerson, 1977, 1978; Turkle, 1980). Finally, a
growing number of sociologists have become interested in the question of what constitutes scientific knowing, (Latour and Woolgar, 1979, Garfinkel et al. 1981). However, the parameters of technological knowing have yet to be determined.

The dearth of sociological information about technology arises not from disinterest, but from a number of problems that plague the study of technology. First, and perhaps foremost, technology is simultaneously a prevalent and diffuse social phenomenon. Technology is literally everywhere, from the pencils we less frequently write with to the nuclear power plants, missiles, and space shuttles that dominate the news. Science, however, being a mode of thought and a specific type of work rather than a catch-all term for the products of human invention, is less ubiquitous. Scientists operate within well known occupational and disciplinary boundaries, and tend to work for universities and research institutes (both public and private) whose existence is relatively well publicized. The creation and use of a technology, on the other hand, is not so easily confined to a small, visible segment of the population. Designers and users of technology have many titles and work in a plethora of organizations and locations including secluded basements and garages. Moreover, scientists tend to leave traces of their social order in the form of published records, but the creators of technology are typically silent and anonymous (De Sola Price, 1964). Science is dominated by a norm of open exchange of information (Merton, 1942), and scientific organizations, especially universities, offer relatively easy access to social scientists. The development of a technology is often proprietary knowledge, and the people who design and use the technology are often encased in the bowels of private firms not
easily accessible to even those sociologists who are aware of their existence.¹

Social scientists also fall prey to the lure of technology's full connotative embrace. Consequently, the meaning of the term, technology, vacillates from the context of one article to the next, and in some cases, within the same work. Winner (1977) cites three usages prevalent among social scientists. First, technology may refer to apparatus, actual machines and physical devices. Second, technology can mean technique, the stylized sequence of behaviors or processes that comprise some instrumental action. Finally, technology is frequently used in the sense of organization, some particular association of people, tools, and tasks for getting a job done. At the margins, boundaries between apparatus, technique, and organization become blurred. Nevertheless, confounding the three usages may lead unnecessarily to miscommunication and to empirical as well as conceptual muddiness.

In addition to divergence in bounding the concept of technology, social scientists differ over the nature of technology's influence on social settings. Stated boldly, the point of disagreement pertains to how strongly we wish to claim that technology can "cause" anything social. At one end of the continuum stand strict determinists who argue that technologies directly and unambiguously influence social orders. Opposing the stand of those who seek "technological imperatives" are others who argue that technologies are essentially neutral tools whose social ramifications are created by the way the technologies are used and by conditions created by persons who order technologies to be designed and implemented (Nobel, 1977). Between these two extremes reside a number of thorny questions. How important are the symbolic
aspects of a technology for understanding its social ramifications? To what extent is a technology's use determined by the social and historical context in which it is embedded? Can the same technology be used differently and therefore have different social impacts?

Finally, there is the issue of level of analysis or locus of influence. Technologies may generate social change by affecting individuals, groups, organizations, or societies as a whole. If all four levels of analysis are viable, one may need to decide whether one locus of influence is more important than another for investigating particular substantive topics or particular technologies. Moreover, if technologies ramify across different levels, are we to conceptualize the resulting changes as discrete and different in kind, or as intimately interconnected?

Some coming to terms with these issues is necessary before any empirical sociology of technology can proceed, including the sociological study of technology and work. Even though most social scientists would agree that technology shapes work and the social order of occupations and organizations, empirical work on the topic lacks coherence and momentum partially because of the confusions just discussed. In contrast to the more or less continuous flow of speculative and ideological essays on technology's implications for work as one changing facet of modern society, actual research has occurred in spurts that clump across time and social space. Each spurt resembles a nascent school of thought or a research paradigm that eventually wanes as complexity confronts its original tenets or as its progenitors move on to other topics.
By and large there have been five more or less distinct genres of research on technology's implications for work: the sociology of automation, the study of socio-technical systems, research on 'organizational technologies', the study of computers and work, and occupational studies of technology. In the next section I shall examine each genre in light of the issues raised above to provide groundwork for the perspective presented in the final section of the chapter. That framework not only guides the research soon to be described, but is, in part, an incorporation of and a reaction to previous sociological study of technology and work.

Orientations to the Social Ramifications of Technology on Work

The Sociology of Automation

At the end of the Second World War, a spirited public debate arose over the implications of "automation", a term apparently coined during the late 1940's. Although a number of manufacturing industries (particularly the automobile industry) had begun to experiment with automatic machine tools and assembly lines as early as the 1920's, the war effort enhanced the use of both. After the war, manufacturers in search of increased productivity and reduced costs redoubled efforts to design and purchase machines that required less human involvement in the production process. Their efforts attracted publicity at the same time that news of the recently invented computer began to prompt ruminations about the possible value and dangers of "thinking machines". Together the two trends fueled speculation about the replacement of humans by machines, consequent unemployment, and dehumanization of the workplace.
Concern with the social implications of "automation" reached something of a crescendo in 1950, when Norbert Wiener published his now famous, *The Human Use of Human Beings*. No less an authority than MIT's celebrated professor who had coined the term "cybernetics" to refer to "control and communication in animals and machines" warned:

> Let us remember that the automatic machine, whatever we think of any feelings it may have or may not have, is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor. It is perfectly clear that this will produce an unemployment situation, in comparison with which the present recession and even the depression of the thirties will seem a pleasant joke. (p. 189)

In the midst of this post-war haggle, industrial sociologists in the United States began the first systematic studies of how technology influences the social organization of work. Since the automobile industry's assembly line was at that time the dominant symbol of the automated workplace, it is unsurprising that early investigations took place in automobile plants. Walker and Guest's (1952) and Ely Chinoy's (1955) studies of assembly line workers represent the beginning of what might be called the "sociology of automation". Both studies found that mechanically driven conveyors and highly specialized machine tools severely restricted the scope of a worker's job, and eliminated all but the slightest modicum of control over the pace of work. The automobile plant's technology favored minute divisions of labor and, by extension, highly repetitive, industry specific jobs that required little training or skill. But most important was Walker and Guest's and Chinoy's claim that although automobile workers were well paid, they found little
fulfillment in their work and considered themselves to be, as one of Chinoy's informants put the now infamous phrase, "cogs in the machine".

These and other studies of the automobile industry in the mid-1950's (Faunce, 1958) produced findings consistent with Wiener's dire prognosis and reinforced fears that automation would lead progressively to an alienated workforce as machines emptied manual labor of meaning and responsibility. However, as researchers branched out to study technologies in other industries the scenario became more complex. Mann and Hoffman's (1960) ground breaking study of two electrical power plants, one of which was held to be the most technologically sophisticated of its day, challenged general conclusions drawn from the automobile industry. Although Mann and Hoffman found a number of negative consequences associated with the more highly automated plant, the bulk of their results suggest that workers in the more automated setting found work to be more satisfying, challenging, involving, and responsible than did their counterparts in the older plant. Since these findings are more or less antithetical to data derived from automobile plants, Mann and Hoffman cast doubt upon any linear correlation between increased automation and alienation at work.

With his comparative study of man-machine relationships in the printing, textile, automobile, and chemical industries, Blauner (1964) seemed to untangle and integrate into a coherent perspective the discrepancy between Mann and Hoffman's results and conclusions from the assembly line. Drawing simultaneously on a secondary analysis of a 1947 Roper poll of industrial workers, previous case studies, and his own observation of printers, textile workers, and chemical plant operators, Blauner proposed that technology's implications for the social
organization of work ought best be considered industry specific.
Blauner agreed that the form of automation characteristic of the textile
and automobile industries led to alienated workers. But his data also
suggested that chemical workers were about as likely as printers to find
meaning, involvement, and a sense of responsibility at work. Since the
chemical industry at the time was far more automated than the other
three, Blauner contended that advanced automation might reverse the
alienation characteristic of machine tending and mechanically paced
production.

Although Blauner's distinctions hinge on a typology of industries,
theorists later extended his ideas in the direction of a stage theory.
Faunce (1965) broke production technology into four technical
components: power sources, conversion techniques, materials handling
technologies, and control apparatus. Any of these components can
involve differing amounts of animate and inanimate labor. Based on this
breakdown, Faunce suggested that industrial technology has evolved
through three stages of development: craft, machine and automated
production. Machine production is distinguished from craft production
by its use of inanimate power sources and its substitution of machine
labor for human labor. Automatic production goes further by employing
inanimate transfer and control technologies as well. According to
Faunce, the extensive division of labor that contributes to anomie is
found only under conditions of machine production, a rubric that
includes the automobile and textile industries. Whether or not patterns
of alienation across industries reflect stages of automation or merely
industry specific configurations, the inverted curvilinear relationship
between extent of automation and alienation implicit in Blauner's work
and explicit in Faunce's theory has been supported by more recent comparative research (Sheppard 1970, Wedderburn and Crompton, 1972; Hull et. al. 1982).

From the early studies of the assembly line onward, researchers in the tradition of the sociology of automation have stalked the "man-machine" relationships that define the contours of mechanized work. For sociologists of automation, technology means machines or configurations of machines. To study technology one must therefore document technical attributes that shape people's interactions with machines and with each other. Researchers have written about the social implications of machine pacing, levels of noise in the workplace, the presence or absence of automatic feeds, the extent of cybernetic control, interdependence between work stations, distance between stations, and the like. Although most have used comparative description as an analytic tool for differentiating technologies, several researchers developed formal systems for assessing technical differences. Notable among the latter are Bright's (1958) automation profile, Amber and Amber's (1962) automation scale, and Meissner's (1969) detailed typologies for classifying qualitative distinctions among man-machine relationships.4

The sociology of automation has also been bound up with anomie in the workplace. In fact, one might be justified in calling the sociology of automation a "sociology of technological alienation". While anomie was the implicit theme of the early studies of automobile assembly, Blauner (1964) clinched the tradition by comparing technological conditions across industries in terms of four dimensions of alienation set forth by Seeman (1959): (1) powerlessness, the extent to which
machines rather than workers control the particulars, pace, and conditions of work; (2) meaninglessness or the degree to which workers conceive of their work as unimportant; (3) isolation defined as a lack of human relationships on the job; and (4) self-estrangement or the degree to which workers are uninvolved in and feel unresponsible for their work. Most researchers after Blauner construe results in terms compatible with an assessment of degrees of alienation (Sheppard, 1970; Cotgrove, 1972; Sussman, 1970, 1972; Wedderburn and Crompton, 1972; Hull et al. 1982).

Since alienation marks an individual's existential situation, and since man-machine relationships reflect the actual work that people do, automation research locates technology's influence with the individual. Technologies are held to shape the social organization of the workplace by first shifting the parameters of tasks or man-machine relationships. In turn, shifting tasks are said to alter work roles. Role differences that have been important in automation research include: amount of individual autonomy, the extent to which workers control the quantity and quality of their work, the variety of tasks that workers perform, required and allowed social interaction, relative balances of physical and mental labor, and a long list of other characteristics the most important of which is amount of responsibility. Researchers argue that the attitudinal differences that define degrees of alienation reflect differences in task and work roles.\(^5\)

Of all the genres of social research on technology's implications for the workplace, the study of automation has produced the most consistent and coherent findings. With minor variations due to setting and research design, most studies regularly conclude that craftsmen and
workers who operate complex automated technologies (typified by the control room of a process plant) are less likely to report "alienated" attitudes towards work than are workers in other manufacturing settings. Whereas a craftsman's involvement with work arises from socially recognized skill, control over technique, possession of an occupational identity, and membership in an occupational community (Van Maanen and Barley, 1984); those who work with complex technologies become involved with work because they perceive that they control the technology, that judgemental acuity has replaced manual skill, and that the day to day success or failure of the plant is their direct responsibility.

Since the sociology of automation links differences in attitudes and behavior to differences in man-machine relationships (eg. attributes of tasks) and to the roles and role relations prompted by technology, its stance can be seen as more or less deterministic, at least at the level of the individual worker. Thus the study of automation appears to be the intellectual source of more recent attempts to improve the quality of work life by altering aspects of individual jobs. The work of Hackman and his collaborators provide the best case in point (Hackman, 1969; Hackman and Oldham, 1976, 1980; Hackman and Lawler, 1971; Lawler, 1978). Hackman's five dimensions for enriching jobs (skill variety, task identity, task significance, autonomy, and feedback from the job) are precisely the attributes of man-machine relations that sociologists of automation suggest ameliorate alienation in blue collar work. Moreover, Hackman's psychological states—experienced meaningfulness in work, experienced responsibility for outcomes, and knowledge of actual results—map rather nicely onto the dimensions of alienation important to Blauner and other sociologists of automation.
Socio-technical Systems

Whereas increased use of automation after the Second World War gave rise to the Sociology of Automation in the United States, the parallel development in Britain was the study of "Socio-technical Systems". The term was coined by Trist and Bamforth (1951) in their well-known report on "longwall" coal mining. Traditionally, pairs of miners had worked individual sections of a coal face with pick and shovel, carrying out as a team the range of tasks necessary to a mining operation. In the late 1940's and early 1950's the longwall method was introduced into British coal mines along with pneumatic drills, automatic conveyor belts, and other types of machinery that made the longwall method possible. Under what has come to be known as the "conventional" longwall method, shifts of miners work the coal face as a unit: one shift hewing coal, another transporting the coal to the surface, and a third moving tunnels, supports, and machinery forward so that the next round of excavation can begin. In a second form of longwalling, the "composite" method, eight to ten miners take responsibility for working their own face through all phases of the mining cycle. Decisions about organizing the work and distributing work roles are left to the miners themselves.

Trist and Bamforth's research compared the relative merits of conventional and composite longwalling. They concluded that the composite method is not only superior in terms of safety and productivity, but that miners are more satisfied when working in an autonomous group structure. In the conventional method, miners on each shift must trust miners on other shifts to work in such a way that everyone's safety is insured. Because members of different shifts do not work side by side, the conventional method generates little of the
trust necessary for miners to feel comfortable below ground. The composite method on the other hand, not only recreates the close knit social structure that characterized traditional mining, but allows the technology to be used as effectively as in conventional longwalling.

In summarizing their results, Trist and Bamforth suggest that organizations have a dual nature. They are at once a technical system made up of the machinery and techniques used to carry out the work, and a social system that derives from the psychological needs of workers. Although different technologies can be matched with different social organizations, they argue that for every technology there is a particularly effective social structure. A socio-technical approach to work would therefore seek an optimal match between technical and social systems.

Following Trist and Bamforth's work, socio-technical theorists continued to investigate mining (Herbst, 1962; Trist and Murray, 1958) and branched out to other industries including textiles (Rice, 1958) and power plants (Emery and Marek, 1962). But unlike sociologists of automation who emphasize how technology affects individuals, the socio-technical researchers concerned themselves with technology's implications for work groups. Along with spatial and temporal proximity, technology was portrayed as a catalyst that differentiates the social structure of the workplace. (Miller, 1959). Consequently, socio-technical researchers frequently explore the composition of work groups and the distribution of tasks, roles, and role relationships within or between groups. For the socio-technical theorist the relevant question to ask of a technology is: "How does the technology restructure the system of work relationships and what restructuring is
optimal". Optimality is generally taken to mean best for attaining suitable productivity as well as the personal satisfaction of workers. If individual attitudes are assessed during socio-technical research, they are used as an indication of the relative efficacy of one form of organization over another.

Given their focus on the structure of work groups, socio-technical researchers have sought to map group dynamics in situ. Most investigations are longitudinal case studies characterized by rich description fused with sophisticated, situation specific, quantitative indicators of group process. Herbst (1962, 1974) has been particularly active in developing quantitative, structural abstractions of group process. The contrast between the sociology of automation's and the socio-technical school's approach to interaction is instructive. While sociologists of automation view interpersonal interaction as an indicator of social integration or isolation in the workplace, socio-technical theorists are concerned with how interactions structure groups:

The study of group process requires a somewhat different conceptual framework from that used in the study of interpersonal relationships. Here we are no longer concerned with the personal relationship between individuals taken as a unit of study, but with the total on-going interactions. From the point of view of the group as a unit, the internal interaction process can be represented in terms of splitting, fusion, and boundary shifts between subgroups (Herbst, 1962:88).

Since socio-technical theory holds that a technical configuration can be joined to numerous social orders, socio-technical work is not characterized by a deterministic view of technology's social
ramifications. In fact, one major contribution of the socio-technical school to the study of technology in the workplace is its insistence that exogenous forces influence an organization's adaptation to a new technology. These other forces include, the decisions of managers, the political interests of organizational members, and the culture of the organization that adopts the technology (Jaques, 1951; Herbst, 1962). Consequently, over time, socio-technical theory evolved towards a variant of open systems theory (Emery and Trist, 1965; Miller and Rice, 1967). From the standpoint of a sociology of technology, the development brought problems. Because of the vagueness of systems language, it is often unclear what researchers mean by the term technology. In early studies, technology clearly referred to specific machines and techniques (Trist and Bamforth, 1951; Rice, 1958), but as the systems perspective became dominant, technology was often treated as a "production system" or as the "organization of workflow". With such a definition it is difficult to untangle what is to count as technology and what is to count as the social organization that surrounds it. While the stance may be phenomenologically accurate, it precludes precise statements about the relationship between technology and social structure.

Unlike sociologists of automation who rely primarily on comparative description as a research strategy, the socio-technical school leans towards action research. Socio-technical researchers typically investigate the relation between technology and forms of social organization by designing field experiments that manipulate the social order surrounding the technology so as to devise a social system that more adequately matches the technology. Consequently it may, in fact,
be something of a mistake to even claim that socio-technical research is
interested in understanding how technology shapes the organization of
work, since investigations are designed not to discover naturalistic
lines of social development, but instead, to bring about social
intervention.

While socio-technical theory suggests that the social organization
of the workplace should match the parameters of the technology, in
practice socio-technical researchers are interested in one preferred form
of social organization: the autonomous work group (Herbst, 1962;
Cummings, 1978; 1981; Pasmore et al. 1982). In recent years,
socio-technical theory has been intimately linked to the spread of
participatory democracy in the work place, and is considered by many
socio-technical researchers to be an organizational development strategy
(Pasmore and Sherwood, 1978). As socio-technical systems research has
moved away from the study of technology and towards evaluation of
self-regulating work groups, its interest in understanding the link
between technology and social structure has dimmed. Most of what the
tradition has to say about the implications of technology for the social
organization of work is confined to research produced before 1965.

Organizational Technology

In the late 1960's, a third perspective on how technology shapes
the organization of work gained momentum and, over the ensuing decade,
came to dominate organization theory. Rather than investigate the
implications of specific technologies for individuals or work groups,
studies of "organizational technology" have sought generalizations about
the overall structure of organizations and their major subdivisions
(departments, plants, bureaus, divisions etc.). Like the socio-technical school, the genre's interest in adaptive fit between technology and organizational form meshes propitiously with the managerial theorist's search for "optimal" organizational designs (Kandawalla, 1974; Gerwin, 1979; Hunt, 1970; Galbraith, 1977). By taking organizations and their major subdivisions as units of analysis, the study of organizational technology altered the intention, concepts, and methods that characterized earlier studies of technology in the workplace.

Although most studies representative of the genre presume that structural articulations are determined by a technology's shaping of work processes, technology's relationship to work itself ceases to be a subject of direct investigation. Instead, research centers on uncovering associations between attributes of technology and attributes of structure applicable to a broad range of organizations. Thus does the study of technology become a study of organizations. Although researchers draw on on theories of bureaucracy to formulate hypotheses and operationalize concepts (eg. Litwak, 1961; Hall, 1962, 1968; etc.), interest in the notion of "organizational technologies" initially stemmed from the empirical work of Joan Woodward (1958, 1965), and the theoretical formulations of Charles Perrow (1967) and J. D. Thompson (1967).

With her study of 100 manufacturing firms in the South Essex region of England, Woodward originally intended to investigate whether an organization's effectiveness is contingent upon its adherence to certain tenets of classical management theory regarding such structural attributes as span of control and unity of command. However, she was
unable to find relationships between structure and effectiveness until she hit on the idea of grouping firms by "modal" technology. Using a continuum said to reflect the "technical complexity" of production processes, Woodward assigned each firm to categories ranging from unit or small batch production (exemplified by craft and made to order industries), though large batch or mass technology (for example the textile and automobile industries), to continuous flow production (characteristic of the chemical and oil industries). Having been so categorized, Woodward's data suggested that technology was linearly or curvilinearly related to numerous structural characteristics and that the most effective firms in her sample were those that most closely approximated the structural form associated with its group's modal technology.7

Perrow (1967) offered a second and, perhaps in the long run, more influential system for conceptualizing an organization's technology. Unlike Woodward's taxonomy, Perrow's is not limited to manufacturing operations. According to Perrow, all technologies can be categorized along two dimensions: the number of exceptions encountered in the work process and the degree to which problems are analyzable or open to codification. The first dimension is said to pertain to workers' perceptions of the "raw materials" processed by the organization rather than to the "objective" nature of those materials. Since Perrow referred to persons as well as physical objects by the term "raw materials", his system is frequently applied to human service organizations. Perrow's second dimension reflects March and Simon's (1958) discussion of "search" processes and the "programming" of solution strategies. Technologies saddled with few, well understood and, therefore,
codifiable exceptions are called "routine" and are held to be associated with bureaucratic structures. "Nonroutine" technologies are employed when raw materials present many exceptions and when solutions to problems are not easily "programmed". Perrow claimed that bureaucratic structures are unlikely to occur with nonroutine technologies. Since "routine" is conceptually similar to "certain", Perrow's scheme maps nicely onto Burns and Stalker's (1961) distinction between "mechanistic" and "organic" organizations.

A third system for conceptualizing technology was offered by J. D. Thompson (1967). Thompson suggested that technologies may be classified by the interdependence required among persons or groups executing tasks. A "pooled" technology occurs when multiple groups can work independently to produce whatever products or services the organization is in the business of delivering. "Sequential" technologies are those in which the output of one task group becomes the input of another. Finally, "reciprocal" technologies require an ongoing reorientation of one group's work to the work of another. The fact that each technology is associated with a distinct structural arrangement is hardly surprising since Thompson's typology is arguably a system for classifying structural articulations and not a typology of technologies per se.

The doctrine of organizational technology aims at empirical relationships applicable to all organizations regardless of economic sector. A deterministic theory of technology equally pertinent to automobile plants and human service agencies is desired. Those who conduct the research argue that only by such a broad comparative perspective can a truly useful theory of technology in organizations advance (see Scott, 1975:139). But if it is to be applicable to
multiple organizations engaged in disparate types of work, the term
technology can not continue to refer to specific machines or techniques
and still remain useful. Consequently, theorists and researchers have
adopted from systems theory a perspective on technology which, in the
service of comparison, treats any particular technology as a "black
box". Beginning with Perrow's (1967:195) statement that technology is
"the actions an individual performs upon an object with or without the
aid of tools or mechanical devices in order to make some changes in that
object", conceptions of technology have become increasingly
parsimonious. In its most abbreviated form, technology is equated with
"transformation processes" or, more simply, "throughput" (Harvey,
abstractly, researchers then postulate dimensions along which all
"transformation processes" vary: for example, routineness (Perrow, 1967;
Hage and Aiken, 1969), workflow integration (Hickson et al. 1969),
complexity (Bell, 1967; Woodward, 1965), certainty (Lawrence and Lorsch,
1967), and variability (Grimes and Klein, 1973; Van de Ven and Delbecq,
1974).

To match the notion of an abstract, inclusive technology, equally
global measures of structure are required. Students of automation and
sociotechnical systems had been interested primarily in emergent
structure: patterns of social organization surrounding and presumably
linked to particular machines and techniques. With technology defined
as an organizational variable, notions of structure less proximal to any
given technical situation become appropriate. For the most part,
researchers have favored measures of structure that reflect aspects of
bureaucratic organization or that characterize an organization's
overarching configuration. Typical measures of structure include centralization (Hage and Aiken, 1969), formalization (Hickson et al., 1969), vertical integration (Kandawalla, 1974), differentiation (Blau et al., 1976), span of control and proportions of employees fulfilling particular organizational functions (i.e., maintenance, sales, etc).

Given the move to a higher level of analysis and more abstract concepts of technology and structure, it is not surprising that the dominant methods for investigating implications of technology for social organization also changed. With notable exceptions (Blauner, 1964), the earlier research on automation and sociotechnical systems pursued single or comparative case studies and sought to document change with historical or longitudinal data. Advocates of the organizational approach to technology explicitly chastize the earlier studies for their limited generalizability, and instead propound cross-sectional investigations of a large number of firms (Hickson et al. 1969:388-89; Scott, 1975:139-42). Although some researchers use observation and archival records to obtain data on the organizations they study (Hickson et al. 1969; Blau et al., 1976), all rely primarily, if not exclusively, on survey or interview data to test hypotheses. None of the studies in the tradition have yet to collect data at more than one point in time.

Over the two and half decades since Woodward's original study, accumulating cross-sectional, comparative research on the relation between organizational technology and structure has yielded a mosaic of occasionally insignificant, and often contradictory, results. This empirical morass has not gone unnoticed by the comparative researchers themselves who have created something of a tradition around introducing and concluding studies by lamenting the paradigm's failure to converge.
As early as 1969, Hickson and his colleagues wrote: "Conceptualization of an organization's technology is still at a stage where the word technology may have varying meanings...The overlap between concepts of technology and the meaning of such terms as charter, purpose, goal, and function presents a problem" (p. 380). Two years later Mohr (1971:456) concluded, "taking all clues together, there appears to be no sound justification for presupposing a strong relationship between technological routineness or predictability and any aspects of social structure. On the contrary, the most reasonable initial hypothesis for future research is that technology may have some impact, but not a dramatic one". Recognizing that neither common sense nor social theory justify Mohr's conclusion, Peter Blau and colleagues (1976:20) observe the crucial irony that the tradition confronts:

Few would question the impact of technology on society. Technological developments have caused the movement of people from farms to cities and from industrial to service occupations. They have stimulated the evolution of the modern economic organization, altered class structures, and affected political institutions. Technological change today occurs primarily in large organizations both public and private. Yet, research on the structural implications of technology for the organization of work has uncovered few unambiguous patterns.

To wit that the situation has not changed in the last eight years, Collins et. al. (1983:1) recently introduced a more complicated scheme for investigating organizational technology by asking, "What ever happened to the technology thesis? While it held great promise, most organizational theorists would argue that its promise had not been fulfilled".
Although the promise of a comparative organizational theory of technology (solid generalizations about relationships between technology, structure and efficacy at the level of the organization) may not have panned out, it would be a mistake to view the literature as having added nothing to our understanding of technology and work. The individual investigations can be read collectively as a research program that yielded a number of significant clues for reorienting the study of technology's impact on work organizations. However, the lessons to be learned are not those that the researchers originally intended. Rather, the important findings are embedded in the discourse that authors have used to frame their results, in their critiques of each other's work, and in patterns of findings that stretch across time. Ironically, these criticisms and results point back towards the earlier traditions.

In a seminal article, Comstock and Scott (1977) level several criticisms against the comparative study of organizational technology. They argue that the "creative use of" indicators has rendered studies essentially incomparable and that the assumption that organizations have but one technology inappropriately homogenizes an organization's diversity. More important is the observation that the literature contains studies conducted at individual, group, and organizational levels of analysis even though the theory deals with organizations. Comstock and Scott propose that researchers need to be specific about the level of analysis at which their hypotheses hold and argue that technologies probably affect different variables at different levels of analysis with different degrees of strength.

In a recent review of the organizational technology literature, Gerwin (1981) separates studies conducted at group and organizational
levels of analysis and compares the results within each set by laying out reported correlations. With the exception that many studies converge on the fact that modal technologies are associated with certain configurational patterns (i.e. chief executive's span of control, supervisor ratios, and proportion of employees associated with specific functions), the literature provides few consistent indications that technology determines structure at the organizational level of analysis. Most correlations disappear after the size of the organization is taken into account. In contrast, Gerwin shows that studies cast at the group level of analysis tend to converge: "Overall, the results...make a plausible case for structural and technological covariation. Within each of the four structural categories -- complexity, formalization, centralization, and configuration -- almost all of the correlations are significant, and all are in the same direction. Magnitudes are not particularly large, but neither are they small" (p. 12).

Gerwin's systematic comparison strongly suggests that technologies are more likely to influence the organization of work most proximal to their use. Although Gerwin himself does not draw such a conclusion, he does recommend that researchers attend more closely to what he terms "systems design", a normative approach which he grounds almost exclusively in the sociotechnical literature. Interestingly enough, though apparently ignored, the proposition that technology is most likely to affect individuals and groups is firmly implanted in the writings of those who adopted the comparative organizational approach. Perrow (1967) cautioned that technology's ramifications become more attenuated as one raises the level of analysis: "technology may predict task structure quite well in a large number of organizations, but these
two predict social structure less well, and these three only set broad limits upon the range of possible goals". Similarly, Grimes and Klein (1973:595) argue that technologies are most likely to influence social systems related to the work itself. Finally, although Hickson et al. (1969:378) suggest that the implications of technology for overall organizational structure are murky, for individuals and work groups, they are incontrovertible.

Computers in Organizations

Over the last two decades a diverse literature has accumulated on the use of computers by organizations and on the implications of computing for the social organization of work. Consultants, computer scientists, and professors of business who specialize in Management Information Systems have conducted most of the research, but recently, social scientists have begun to forage into the area. Although a handful of studies on computerized controls and the use of CAD systems are just beginning to surface, (Zuboff, 1983; Buchanan and Boddy; 1983), most of the literature pertains to data processing and information systems in business and government bureaucracies.

Investigations of computers can be divided into two camps. One contingent remains on dry land and attempts to chart the technical success and failure of a computer's use. The other wades into the muck of the social order surrounding the computer in hope of discovering where the computer fits into the ebb and flow of daily life, perchance to learn why and in what diverse ways computers wash for whom. Without doubt, the first camp is larger and is populated by computer regulars.
The second camp includes social scientists, most of whom wear hip boots for their wade and a hardy few who dare to swim headlong into the muck.

Markus (1979) calls the first camp the "implementation school" and the second the "organizational school". The implementation school attends to individual computer systems and focuses on what happens after designers turn machines over to the organizations that will use them. By measuring rates of use, frequency of breakdowns, and even the pleasure or displeasure of those who commissioned the system, implementation researchers pass judgement on success and failure. In contrast, the organizational school is more concerned with the social milieu of computing. According to Markus, its members tend to view all computer systems as equal, but search for the social change that computing brings to individuals, groups, and the organization as a whole. Markus argues that more swimmers are sorely needed, researchers who recognize the uniqueness of computer systems and at the same time tackle the system's social implications. Our concern here will be with the waders and swimmers of the organizational school.9

The first studies of the computer's implications for the organization of work appeared in the early 1960's and can be viewed as an extension of the sociology of automation into computing. Hoos (1961) examined twenty data processing installations and reported that computing converts clerical operations into mechanized paper factories. With computers, clerical jobs become less demanding, more routine, dull, and constrained. The division of labor after the computer is more minute, and as one would expect, indications of alienation rise. Mann and Williams' (1961) study of the implementation of a data processing system in the accounting department of a light and power company
presents somewhat conflicting data. While there was a trend towards centralization and formalization, the computer reduced the overall division of labor. Some jobs became more routine while others were enlarged. However, both studies agree on a crucial point: no employees were fired after the computers arrived even though many were transferred to other types of work.

Following the early studies of computing as a form of automation and the discovery that electronic data processing parallels the mechanization of blue collar work in machine tending industries (Faunce, 1965), a hiatus occurred during which the social ramifications of computers were little studied. Interest rekindled with the publication of Whisler's (1970) comparative work on how data processing restructured organizations in the insurance industry. Whisler claimed that with computers organizations adopt more centralized administrative structures, that decision making migrates up the hierarchy, that managers' jobs are enlarged, that clerical work becomes more routine and fractionated, and that the number of clerical employees falls by attrition. After Whisler's work, research became less interested in how computers changed the work of individuals and began to emphasize organizational and managerial issues. Would computing lead to greater centralization or decentralization of organizations? Would computers affect managerial decision making? Would middle managers find their work enhanced, or would they slowly be squeezed from the organization as computers took over. As the cross-sectional research results rolled in (eg. Stewart, 1971; Meyers, 1970; Simon, 1973, 1979; Blau et al. 1976; Malvey, 1981), it became clear that no easy answers would be obtained. Computers sometimes contributed to centralization, at other times led to
decentralization, and often did neither. Depending upon the situation, upper management might or might not use data to make decisions previously delegated to middle management, and by implication, middle managers might or might not find their work expanded. By and large, the message seems to be that the managerial and organizational implications of computing depend first on the nature of the computer system itself and second on the organizational milieu in which the computer is used.

In response to these less than consistent cross-sectional results, a number of researchers have adopted a different stance towards studying the computer's implications organizational life. The stance holds that computers are embedded in complex social situations that must be accounted for before one can understand a computer's relationship to the organization of work. The social context of the organization shapes the computer as readily as (or perhaps more readily than) the computer shapes the organization. This fledgling perspective, which has yet to gain more than a few adherents, has been labeled by Kling (1980) the "package" perspective on computing or a "web-model" (Kling and Sacchi, 1982):

The package conception of computing suggests that computing is not simply a "tool" which "impacts work life". Rather, dealing with computing can involve a complex array of social interactions. The key question then becomes how people do integrate computing into their working lives (and careers) rather than simply respond to a simply conceived technical stimulus". (Kling, 1980:80).

Although a number of approaches to studying computing as a social "package" are possible, the most frequent treats the computer as an entity embedded in an ecology of political interests. Computer systems
are designed, procured, used, and abandoned as social forces play themselves out using the computer as a backdrop or battleground. For example, a number of studies suggest that decisions to adopt computer technologies may have little to do with technical rationality. In his study of computing in a Scottish firm, Pettigrew (1973) argued that the firm's choice of a new computer system hinged on one manager's attempt to build personal power and that therefore, the opinions of technical experts were systematically ignored. Similarly, Laudon (1974) found that police departments in a particular state received computer systems because the governor wanted to establish an attorney general's office which local police departments opposed. By supplying the police with a centralized system for tracking warrants and criminal histories, the governor bought off police opposition. But computers not only arrive as political objects, they continue to remain political objects after they have come on-line. In her study of the introduction of a computer system in a chemical firm, Markus (1980) found that the computer provided convenient turf on which factions within the organization could continually battle each other. Kling and Sacchi (1982) even go so far as to argue that one can view the collection of software and hardware comprising a computer system as a historical record of political battles fought and won over the course of the system's life.

Zuboff's recent studies of advanced computerized control in pulp paper mills provide an intriguing glimpse of how computers may upset standard definitions of social reality in an organization. These systems have raised the level of automation in process industries beyond that characteristic of the plants studied by Blauner and his immediate successors. Operators no longer watch dials, but rather monitor and
control the plant's operation from a terminal. The operators can track up to 500 variables over periods of several years. Several systems even allow operators to analyze trends and project how particular decisions will affect the quantity, quality, and cost of production. Operators then use this data to tweak the system and to alter operating procedures.

Note that the tasks that operators now perform with computers in the control room were traditionally part of middle management's domain. At the same time that the new systems not only cut into the middle manager's territory from below, they also provide upper management with direct access to data that middle managers used to screen. Consequently, upper management is now more likely to circumvent middle management and deal directly with operators. According to Zuboff, the operators and upper managers are typically enthusiastic about the new technology, but middle managers are not as equally well pleased. In fact, Zuboff notes that some middle managers have devised tactics for subverting the technology so that it will not empower the operators. Ironically, these technologies invert common conceptions about who the proponents and saboteurs of new technologies in the workplace are likely to be.

Presumably, one could glean quite different meanings of computerized control if one were to ask Zuboff's operators, middle managers, and upper managers about the technology. The notion that a computer system becomes a different social object for different people is a topic occasionally discussed, but rarely researched (Zuboff, 1981; Kling, 1980). Turkle's (1980) work is an exception. Based on several years of ethnographic research with home computer users, Turkle
concludes that the symbolic value of a computer depends upon which computing subculture one belongs to. For some, computers are a means of becoming part of a future, for others they provide a sense of control and autonomy absent at work, and for others the computer is a means of self expression. In other studies, Turkle (1981) argues that different approaches to programing computers arise not only from different understandings of the machine, but different views of self. A task that seems to confront the study of new computer technologies is the tracing of how the social construction of a machine accrues over time. It is conceivable that the social meaning attached to a computer greatly influences its use and the social order that grows up around it.

It is difficult to characterize the mosaic of research on computers in the workplace succinctly. Most studies do examine what would appear to be a specific technology, the computer. Yet most researchers have failed to realize that one can not simply treat all computers as equals, as one might if one were investigating automatic looms. Computers are "universal machines", and therefore their use varies drastically from one setting to the next. Consequently, conditional statements about when computers will and will not lead to centralization or other organizational outcomes are not easily obtained by a cross-sectional research strategy that correlates computing to organizational forms. Since we can not yet partial by any reasonable typology of social use, the inherent variability of computers will drive correlations to zero.

While most studies have taken a rather deterministic view of the computer's effects, a small but increasingly vocal minority of computer researchers have begun to argue for a far less deterministic stance. From this point of view computers are seen as either political objects
or social objects open to interpretive construction. By and large, the latter approach is relatively new to the study of technology. Finally, given the diversity of the research it is fair to say that the study of computers and work has exhibited no bias towards and level of analysis. However, if there is a movement towards the study of computers as social and political objects, then the evolving interpretive schools of thought are likely to settle on group or individual level phenomena, for it is there that social constructions are secreted as byproducts of day to day action (Mead, 1930).

Technologies and Occupations

At the beginning of this section we embarked on a whirlwind tour of technology and work by reviewing the sociology of automation, an approach that frames the workplace in terms of individuals and their jobs. From there, we moved to literatures on socio-technical systems, organizational technologies, and computers, each of which typically construes the work setting as a collective, be it a number of groups, an hierarchically administered bureaucracy, or a political polity. It is fitting, therefore, that we conclude the tour by considering the implications of technology when the workplace is understood as a composite of occupations. An occupational orientation may be particularly apt for tracing dynamics in settings such as a hospital where the division of labor tends to follow the demarcations of occupational boundaries, and where authority flows from lines of professional, rather than administrative, dominance (Friedson, 1970).

From the perspective of a sociology of occupations, technologies shape work in one of two opposing directions. As a generative force,
technologies may sire occupations or extend an existing occupation's territory by expanding the types of work or knowledge that the occupation controls. Alternately, as a degenerative force, a new technology may shrink an occupation's domain by usurping or making obsolete particular skills. At the extreme, technologies may altogether eliminate the need for an occupational group as the automobile did the blacksmith. Processes of expansion or contraction set in motion by new technologies need not be limited to single occupations. Conceivably, a given technology can shrink the domain of one occupation while simultaneously expanding the domain of another. Moreover, when a technology seems to straddle the boundaries of two occupational groups, it may engender a period of interoccupational struggle as members of the two groups negotiate its use and control.

Very little has been written about how technologies stimulate the birth of occupations, even though a cursory glance at the latest edition of the Dictionary of Occupational Titles would suggest that the phenomenon is widespread. There we find in no particular order: backhoe operators, television repairmen, nuclear power plant operators, astronauts, genetic engineering technicians, radiologists, microeletronic engineers, auto mechanics and so forth. Perhaps sociological information on the technological genesis of occupations is so scant precisely because occupations are not born whole, but rather evolve slowly as the technology diffuses to more and more settings. By the time the occupation is recognized as such, the details of its evolution are lost in the haze of an unrecorded social history that remains, in most instances, an oral record of which only bits and pieces are known by any one person.
Partial exceptions to the rule have been those occupations that grew up around the computer. Since computers attracted considerable attention from the beginning, social scientists have been able to document the rise and fall of the programmer, the computer operator, and the systems analyst by piecing together oral histories, private documents, and an ongoing corpus of case studies. Pettigrew (1973) claims that when industries first began to use computers, programmers were scarce and were usually trained in mathematics. Since programmers understood the mysterious intricacies of the computer, they were treated as a special class of employees and were given considerable autonomy, respect, and leeway. A culture of independence grew up around programming and programmers themselves developed an occupational identity. Pettigrew writes that the first programmers in the Scottish firm he followed over a period of years were allowed to come to work whenever they pleased and to wear whatever they wished even though other employees were told to maintain schedules and wear suits.

The first programmers not only wrote code, they designed the computer system and maintained the hardware. Over time however, these various functions became differentiated as computer operators assumed responsibility for the hardware and as systems analysts cornered the design process. At the same time, programming became a course of instruction in an increasingly large number of secondary education institutions. Eventually, the status of the programmer fell beneath that of the systems analyst, while the computer operator's work became more akin to semi-skilled labor. Greenbaum (1979), who traces these developments through time, argues that the historical devaluation of computer programming grew out of managerial strategies for reigning in
an occupation whose autonomy challenged management's control. Greenbaum shows how the management of large companies fostered the introduction of programming as a course of instruction in trade schools to gain a competitive advantage in the computer labor market. Similarly, industry financed advances that simplified software and established positions for systems analysts that were decoupled from the writing of code. Generally, systems analysts have managerial training rather than training in computer science. Pettigrew's (1973) case study of how the management of a Scottish firm succeeded in gaining control over its computer operation can be read as a study of the micro-processes that generated the larger trends about which Greenbaum writes.

Sociologists of occupations have had comparatively more to say about how technologies undermine or "deskill" occupations (Braverman, 1974; Edwards, 1979; Rogers and Friedman, 1980; Wallace and Kalleberg, 1982; Burawoy, 1983). The argument, put most elegantly by Braverman (1974), is that technological advance progressively robs members of an occupation by embodying their skills in the technology itself. Braverman makes his case by describing the evolution of numerically controlled machine tools and their effect on machinists, an occupation whose status is now more akin to semi-skilled labor than to the craft it once was. Wallace and Kalleberg (1982) make a similar case for printing which has become progressively automated over the last 30 years. The argument has been extended to white collar work by claiming that computers have slowly devalued clerical and secretarial positions by fragmenting and mechanizing the more interesting aspects of office work. Haug (1975, 1977) carries the deskilling theme to the professions themselves. She predicts that advanced computer technologies like exper
programs will "deprofessionalize" the professions by widely disseminating knowledge to clients without the necessity of professional mediation.

Although there is little room to argue with the observation that certain occupations have been devalued by technological innovation, it is not clear that a given technology's occupational ramifications can be predicted ahead of time. Most of the empirical data on the phenomenon of deskilling is based on historical data and is retrospective in its orientation. The deskilling literature may gain its force from well chosen examples drawn paradigmatically from craft and trade occupations. From an occupation's perspective, technologies may be, but need not be, zero-sum games. It is plausible that a given technology could lead to occupational to contraction along some vectors of skill while opening up other opportunities for expansion. Results from the sociology of automation support such a multiplex view: some forms of advanced automation eliminate traditional manual skills but substitute in their place less obvious mental skills. In many instances net losses or gains will be difficult to predict without considering the total social context in which the occupation exists. The relentless historical determinism of current thought on technology and occupations may simply be too simplistic.

The Study of Technologies as Social Objects

Taken together, the five major genres of thought and research on the relationship between technology and work resemble an academic Tower of Babel. The five speak with different definitions of technology from
alternate stances towards technological determinism at different levels of analysis. One approach construes the work milieu as a collection of jobs, another as a polity of occupations, and the rest as an organizational context. Unless one wishes to work within one of the five perspectives, the critical question still remains: how should one conceptualize a technology and its ramifications for the social organization of work so as to get on with the empirical task of a sociology of technology? In the first chapter, I suggested that a sociology of technology needs to approach the multiplexity of technology in terms of social use. Such a mandate implies that before comparative work can begin, a number of sound, setting specific studies of particular technologies are needed from which to abstract an empirical typology of social use. Conducting such studies requires a conceptual framework attuned to technologies as situated objects. The remainder of this chapter outlines the conceptual framework that guides my study of radiological technologies. I would submit that the framework is sufficiently malleable to be appropriate for field studies of most technologies, and that it offers some hope of circumventing problems encountered by previous approaches, while at the same time incorporating insights that those approaches generate.

The Tangibility of Technology

There are times when pragmatism is useful, even for academics who would build theories. A case in point is the issue of what to count as an instance of technology: apparatus, technique, or organization. While technologies are many and are found everywhere, people aside from researchers have no trouble saying what they take a technology to be.
If you ask an individual in any work setting, "What technologies do you use to do your work", two responses are likely. After eyeing you somewhat askance, your informant will either show you a machine or describe a technique. In both cases, the technology will have a name and can, in principle, be pointed to. In the case of machines and techniques composed of physical action, the claim of ostensive definition should raise no hackles. However, even mental techniques must submit to some degree of description or documentation, for otherwise techniques could not be passed from one practitioner to another. Over the course of my research I put to technologists and radiologists the question posed above. While I learned of "under the table systems", "B-modes", "Seldinger techniques", "skinny needles" "CT scanners" and the like, never did I elicit a description of any aspect of the radiology department's organization with my question about technologies used in radiological work.

However, one need not submit to pragmatism and the wisdom of average individuals to arrive at the conclusion that "technology" refers most fruitfully to apparatus and technique. A similar conclusion can be drawn from scrutinizing investigations where researchers approach "technology" as a form of organization. Of the five approaches to the study of technology discussed in the last section, that which we called the study of "organizational technologies" is most prone to define technology as abstract patterns of workflow or as the organization of production processes. In reviewing the research on "organizational technologies," Stanfield (1976) and Gerwin (1979), caution that as they are defined and operationalized in the organizational technology literature, structure and technology are indistinct concepts. Rather,
the two terms' semantic domains overlap, leading to inconsistencies in choosing indicators for concepts. Stanfield cites numerous examples of indicators that stand for structure in one study and technology in another. For example, Mohr (1971) uses participatory management as a measure of structure, while Hage and Aiken (1969) use it to indicate technological differences. Similarly, Perrow (1967) speaks of managerial discretion as an aspect of structure, while Hickson et al. (1969) include it as an element of managerial technology. The problem is more fundamental than mere a disagreement over how to pigeon-hole measures consistently or a dispute over which attributes of multi-attribute phenomena are relevant for investigation (Comstock and Scott, 1977; Mohr, 1971). Rather the crux of the operational difficulty stems from framing technology in abstract organizational terms in hope of creating a theory presumably applicable to all organizations and all technologies. Let me be more precise about the upshots of the strategy.

Recall that researchers in the "organizational technology" tradition often portray technology in terms of routinization, predictability and uncertainty. Ratings on these "technological" attributes are then correlated to attributes of "structure" such as complexity, formalization, standardization, and centralization (often defined as the degree of participative decision making). Significant correlations are taken as evidence of a relation between technology and structure. Note also that theorists of bureaucracy from Weber (1968:1914) onward have described bureaucracy in terms of routinization, formalization, standardization, centralized control, and the search for procedural certainty and predictability. In other words, bureaucratic theory lumps together under one rubric precisely those attributes that
researchers have attributed to technology on one hand, and structure on the other. Viewed from the perspective of the theory of bureaucracy, significant correlations between technological (independent) variables and structural (dependent) variables are at best indications of the convergent validity of alternate measures of bureaucratic tendencies and at worst, a technically spurious.

If the tradition's inability to garner compelling evidence that technology influences the social organization of work is explained, in part, by an inappropriate level of abstraction that confounds technology with structure, then one would expect that a more concrete definition of technology would improve matters. Evidence from within the organizational technology literature itself supports such a hypothesis. For example, among those studies which have replicated and challenged Woodward's results, (Hickson, et al., 1969; Child and Mansfield, 1972), only the work of Blau et al. (1976) delivers significant relations between technology and organizational structure after controlling for size and non-linearity. These researchers find that technology is curvilinearly related to a host of structural attributes including horizontal and vertical differentiation, various spans of control, and the proportion of persons in numerous occupational categories. Blau and his associates depart significantly from earlier studies by restricting "technology" to "hardware": they assess the extent to which an organization employs automated machines and computers to carry out its work. Equally important is the fact that their measures of organizational structure are purely configurational, a stance towards the assessment of structure that bypasses perceptual ratings by respondents and the hobgoblins of complexity et al.
If generativity of useful empirical statements about the ramifications of technology for the social organization of work is inversely proportional to the seriousness of the foregoing problem, then the socio-technical school has arguably run aground on the same definitional reef. As socio-technical researchers moved towards a systems definition of technology and away from concrete statements about machines and techniques, they ceased to document naturalistic observations about how technologies changed social systems and instead, became entralled with the social systems themselves. Like the organizational technology research, the socio-technical school was drawn more heavily into defining technology in the abstract so as to propound an open systems approach to organizational theory. In later writings, the nature of the technical system as it is defined from one study to the next begins to sound the same, even though the studies pertain to incredibly diverse work settings. Said differently, the socio-technical school developed the notion of the social system at the expense of their understanding of the technical system. To put it boldly: one does not type a letter or treat a schizophrenic like one builds an automobile or mines a vein of coal regardless of what a series of boxes on a piece of paper might say to the opposite.

By comparison, the sociology of automation and the study of computers continue to produce coherent, if not always consistent, findings about technologies. Both approaches, interestingly enough, treat technology in concrete terms. When treating technology as a tangible, albeit socially constructed, entity, one does not yield to the temptation to confuse the technology with the surrounding social system. A technology may be shaped by its users to fit the system, but it is not
the system. Any study of a technology's implications for the social organization of work that fails to keep track of what is technology and what is social organization is untenable. No matter how illuminating such a study might be of the dynamics of organization, it is not a sociology of technology. If it is wise to separate technology from organization, the most expedient way to do so is to keep a firm eye on apparatus and technique.

Technologies as Social Objects

If technologies are for the most part tangible physical objects and actions, what is the nature of their relationship to the social world in which they are embedded? Does a technology actually cause certain social orders to come into existence? Or, is technology, as socio-technical theorists and some students of computers suggest, a neutral object whose implications for the social order arise solely from how it is interpreted by those who would use and study it? In short, how deterministic shall we be?

It would require particularly strong ideological fervor or some other form of denial, to argue that technologies have no direct implications for the social organization of the work, particularly when we are talking about machines. Take an assembly line for example. The mechanical pace of the conveyors directly determines the speed at which the worker must work in order to complete a task before the part being worked on is literally out of the worker's reach. While speeds are variable and are matters for negotiation between representatives of management and union, once set to reflect some fusion of social priorities, the machine takes over. Machine noise represents another
example. Most of us would agree that cohesive interpersonal relationships require interaction, especially verbal interaction. Yet while operating a pneumatic stamping machine it is unlikely that one could easily converse with someone nearby no matter how close the other person might stand. If social relations are to develop in this context, they are likely to arise out of breaks, breakdowns, and other moments of quiet.

The strength of the sociology of automation is its recognition that technologies induce social constraints and opportunities. While human beings are certainly adaptable enough to take advantage of opportunities, to circumvent constraints, and to define both in a number of plausible ways, the fact remains that machines pose constraints and opportunities to be confronted and interpreted. By grounding their study of the social implications of technology in the "man-machine" relationship, sociologists of automation acknowledge explicitly what existential philosophers term the "facticity" of situations: the notion that some things are inexorable and that one simply must make one's peace with them. As the study of automation suggests, the inexorable ramifications of a technology are likely to be strongest in the environment most proximal to the technology: that is at the interface between the technology and its user.

However, as the qualifications in the two preceding paragraphs imply, it is equally untenable to claim that the social ramifications of technology are all reducible to properties of the technology's design and the constraints these place on users. Because technologies exist in social space, their facticity is made plastic by interpretation: that is, people imbue machines and techniques with meaning. A Mazda GLC, a 1959
Stingray, and Rolls Royce all require much the same thing of a driver and perform an identical physical task, getting people from one place to another. But those who know anything at all about automobiles would never be so foolish as to claim that one car is as good another, that all three belong to strictly utilitarian commuters, or that given the option, any of the three would yield an equally satisfying drive. Technologies are social objects as well as tangibles, and as social objects, they attain symbolic value. Technologies are, in short, expressive as well as instrumental: they are understood at the same time that they are used.

Each of the genres of research on technology and work at one point or another confronts the symbolic or social aspects of technology. Some approaches, such as the evolving "web-models" of computer use, take the symbolic and interpretive nature of technology as their focus. Others, the organizational technology school for example, see the social aspect of technology as a worrisome mediating variable. Nevertheless, it would appear that technologies should be treated as symbolic, interpreted, social objects from at least three perspectives, each of which shapes a technology's use in particular settings.

**Signals:** First, technologies can be used to signal. In one of the earliest studies of industrial automation, Bright (1958) noted that "pride" was often a significant aspect of management's decision to automate. By pride, Bright meant that managers spoke openly about the technology's value as a signal: by automating the managers aimed to convince themselves as well as their competitors that their company was at the forefront of the industry. Mann and Hoffman (1960) observed a similar phenomenon in the two power plants they studied. The
technological sophistication of the automated plant bestowed upon the plant a certain aura of prestige within the industry. The prestige not only shaped management's attitude toward the plant, but the "pride" filtered down to the workers themselves. Operators in the automated power plant thought their work was more socially important than did operators in the less technologically sophisticated plant even though both plants produced the same commodity, electrical power. Referring to his study of computer systems in welfare agencies, Kling (1980) notes that the signal value of a technology may even outweigh the value of the technology's "intended" use:

Often the staff of an organization will point to 'technical benefits' such as labor reduction, internal efficiencies, and increased managerial control to justify the adoption and use of computing technologies. However, careful studies of the actual payoffs of computing within organizations indicate that other more private rationales often dominate the decisions to adopt or sustain computer based systems. Concerns for increasing administrative attractiveness, rather than internal administrative efficiencies, helped sustain an otherwise relatively useless client tracking system in Riverville. The welfare agencies using UMIS appeared more efficient to federal auditors; they were able to maintain a steady flow of funds because the presence of computing enhanced their image of effective administration.

The signaling potential of technology has concerned officials who seek to regulate the spread of expensive medical technologies like the CT-scanner. Regulators fear that hospitals will seek to purchase CT scanners, not because their patient load "justifies" the purchase, but because the hospital wishes to appear to be an "up to date" institution capable of the highest quality care (OTA 1978).
Theories of use: Signalling presumes that the technology is interpreted similarly by insiders as well as outsiders, or at least that insiders think they know what outsiders are likely to make of the technology. More specific understandings of the technology accrue among those who use them on a daily basis. By and large the interpretive systems that grow up around the day to day use of a technology have been little investigated. Nevertheless, setting specific understandings of machines and techniques are likely to influence the social pattern of their use. As a group of people gain experience with a technology, a shared interpretation of its nature and idiosyncracies will accumulate as the byproduct of a history of ongoing incidents. These bits of social knowledge eventually evolve into a particularistic theory that influences how people attempt to solve problems posed by technology and how they organize themselves to use the technology. Moreover, since technologies have different constituencies of users, it is possible that each constituency will develop a slightly different understanding of the technology and therefore on occasion find themselves in conflict (Kling and Gerson, 1978).

Cultural Shaping: Most technologies are introduced into work settings with a past. For this reason a technology becomes embedded in an ongoing cultural and historical context that also shapes the meaning of the technology as a social object and influences the social order that grows up around its use. It is certainly no fluke of sampling method that the most successful introductions of new technologies occur in those instances where new plants have been constructed to house and new staffs have been hired to operate a new technology (Mann and Hoffman, 1960). In such cases no previous cultures or histories shape
the technology's meaning to give rise to what is often called "resistance". The importance of existing cultural and historical contexts for molding technologies into social objects has received far more attention than any other interpretive force that contributes to a technology's meaning.

Fensham and Hooper (1964) found that as weavers switched from manual looms to automatic looms they had difficulty adapting to the requirements of running a larger number of looms. The authors suggest that the weavers continued to view machines from a "loom centered" point of view rather than from the "sett centered" perspective more appropriate for tending the automatic machinery. The crux of the difficulty was that within weaver culture, active intervention in the weaving process was defined as "skill," but monitoring machines was not so defined. Thus weavers approached the new technologies as they did the old. Herbst (1962) also noted the phenomenon that Van Mannen (1982) calls "learning new things in old ways" in his study of a group of coal miners experimenting with composite longwalling. By tracking the ongoing formation of subgroups over the course of 17 mining cycles, Herbst found that the miners organized themselves by transformations always reducible to groups of pairs, a pattern carried over from traditional mining.

As a rule the organizational technology approach has conceived of technology as having direct, causal implications for elements of social structure. Several investigators even go so far as to use the term "technological imperative" to describe the phenomena they study (Kandawalla, 1974; Grimes and Klein, 1973). Yet, investigations within the paradigm suggest that the lack of consistent findings may result
from failure to appreciate how ongoing historical and cultural patterns shape peoples' understandings of and decisions about the use of a technology. From the beginning, Perrow argued that his dimensions for assessing technology reflected people's perceptions and not intrinsic properties of machines and techniques. Child (1972) concluded his replication of the Aston studies by reminding researchers that managerial choices influence the structural arrangements surrounding any technology. Independently echoing Child's caution at the group level of analysis, Hrebinak (1974) found that he could not document relations between technology and structure until he had controlled for the behavior of work group supervisors.

An empirical sociology of technology and work must be prepared to deal with technology's dual nature. On one hand, the investigation focuses on tangibles that constrain the social organization of work. On the other hand, technologies are also social objects whose meanings are actively constructed by the people who use them. The social ramifications of any technology are therefore likely to be predicated on a tangle of forces which yield to no easy separation. Strongly deterministic or strongly interpretive approaches are both likely to miss the mark by over simplification. I would propose an attitude, which for the lack of a better term, I shall call "interpretive materialism". The term juxtaposes the contradictory aspects of tangibles embedded in social contexts. The task of the interpretive materialist approach to technology is to outline how specific technologies create constraints that fuse with social practice and an evolving definition of the situation to become social objects that influence the organization of work. Said differently, an interpretive
materialism would constantly tack back and forth between how
technologies shape and are shaped by the context of their use.

Technologies Ramify by Reverberation

Having settled on taking technologies as tangible social objects,
we are left with deciding what level of analysis is appropriate for
studying technologies in work settings and the related question of
whether effects at different levels are discrete and distinct or
interconnected. Given a choice between conceiving of a technology's
impact at the level of the individual, the group, or the organization,
the results of previous research seem to press downward. The sociology
of automation, which casts its lot at the individual level of analysis
is the only body of research on technology and work to yield
consistently corroborated findings. Moreover, as was discussed in
detail in literature review, patterns of results from studies in the
"organizational technology" tradition suggest return to at least the
group level of analysis. Finally, the inability of students of
computers to derive consistent principles about the computer's
implications for centralization or other organizational variables and
the subsequent shift to more political and interpretive stances that
assume a social world composed of overlapping interest groups (Kling and
Gerson, 1978) leads to much the same conclusion. Consequently, a rule
of thumb for the study of technology in the workplace can probably be
formulated: a technology is likely to most strongly and consistently
affect the social organization of work at the level of its most proximal
users.
Yet, despite the fact that studies which set out to find technology's ramifications at organizational levels of analysis generally turn up empty handed, one has difficulty ignoring the broader ramifications of technical change observed by those have intended to study the phenomenon at the individual and group level. As the textile mill studied by Fensham and Hooper (1964) converted to automatic looms, the researchers noted a number of changes beyond the restructuring of individual tasks. Before the automatic looms arrived weavers often helped each other and socialized on the job, but rarely interacted with mechanics, except to summon them to a broken loom. Likewise the mechanics rarely sought contact with weavers. After the automatic looms arrived, each weaver was assigned a larger "sett" of looms and thus had little time to socialize with weavers on adjacent setts. Instead weavers found themselves interacting more frequently with the mechanic and other operatives assigned to their sett. Fensham and Hooper argue that the new technology gradually transformed the basis of social organization on the shop floor. Whereas manual looms encouraged what they call "role groups", the automatic looms reinforced relations that created "task groups". Said differently, manual weaving contributed to occupational solidarity while automatic weaving encouraged solidarity between members of different occupations. Similar changes in role set observed in automatic process industries (Susman, 1970; Blauner, 1964) and coal mining (Trist and Bamforth, 1951, Herbst, 1962) suggest that changes in technology result in new ways of cleaving the organization of work.

Fensham and Hooper (1964) also argue that automation shifted structural arrangements even further removed from the on-going operation
of the looms. Whereas, the wefting and warping departments were formerly rather autonomous units, as more automatic looms went into production the preparatory departments and the weaving operation became more tightly linked. Wefting and warping eventually found themselves responding to the needs of weaving on an on-going basis. Perhaps a more striking example of the larger change that automation brought to the textile mill was the gradual alteration of the production coordinator's role. Under the manual system, the production coordinator had filled a rather unimportant staff position. With automation, the man suddenly became integral to the operation and was ultimately looked to as third in command even though his changed status was formally reflected neither by the organization chart nor by his continued absence from management meetings.

Other investigations suggest that technologies may even ramify beyond the organization itself. Mann and Hoffman (1960) note that automation is usually accompanied by the institution of shift work since automated technologies represent large capital investments that can not be allowed to sit idle. Shift work, in turn, not only changes the life pattern of workers, but also the routines of their families. Moreover, Mann and Hoffman observe that the decision to build an automated plant had the unintended consequence of lowering morale and satisfaction in the company's other plants where workers felt the company was showing undue favoritism towards workers in the new plant. Herbst (1962) observed much the same phenomenon in the mining operation he studied. Although both management and team members were clearly enthusiastic about the use of autonomous, composite mining teams, the experiment was
discontinued because other miners became jealous of the experimental face and forced management to back off of the experiment. 

Even though it would appear that technologies have their strongest influence on the social organization of work most proximal to their use, changes at this level may eventually spread to sectors of the social system at progressively greater distances from the locus of the technology. Consequently, it would be remiss to conclude that new technologies leave the larger organization and its environment untouched. However, as the examples cited above suggest, the nature of the changes may be quite different from those envisioned by theorists of organizational technology and researchers who have been interested in the organizational implications of computers. Rather than bring about greater centralization, decentralization, wider spans of control and the like, it would appear that changes are likely to involve organizational cleavages that shift as new role sets and new interdependencies are created. Hence if change in the organizational structure stems from change at lower levels of analysis, it may be inappropriate to assume that technical change is a distinct phenomenon at different levels of analysis. A second rule of thumb for investigating technology in the workplace can therefore be formulated: If the larger social organization of work is restructured by technology, then the restructuring can be traced to changes in the social organization of those individuals and groups that populate the technology's immediate social milieu.

If the foregoing argument is accurate then one might conceptualize a technology's implications for the social organization of work as a series of reverberations that begin in the social system nearest the technology and spread progressively further outward. Changes in realms
more distant from the technology grow out of changes in realms more proximal. Such a model is attractive because it simultaneously adapts to the observation that technological change is most potent at lower levels of analysis while not ignoring the fact that technology's effects gradually spread outwards to reorder society as a whole. Technological change is then more like so many pebbles dropped on the surface of a still lake. Any one pebble perceptually disturbs only a small area, but if many pebbles are dropped the whole lake will eventually seethe, but seethe in a way that can be traced back to the individual points of impact.

Figure 1 depicts the reverberation model that underlies the research to follow. By creating new man-machine relationships, a new technology alters the social organization of the work setting by first shaping the tasks of people who operate the technology by creating new man-machine relationships. At the same time, those who work with the technology begin to construct an image of the technology as a social object, and their evolving understandings contribute to the way the technology is used. Their construction of the technology as a social object draws on traditions derived from the historical and cultural context of the organization and occupations involved, as well as their daily experience with the machines and techniques.

In turn, altered tasks and evolving understandings of the technology bring about changes in the roles and role relationships of those who work directly with the technology. As tasks are divided up, as the parameters of the daily routine solidify, and as patterns sediment out of a stream of interpersonal interaction, a normative system develops to capture behavioral regularities in the form of role
FIGURE 1

A Technology's Social Ramifications as a Series of Successive Reverberations From Proximal to Distal Realms
expectations. The new roles are understood in both relational and non-relational terms. The former is linked primarily to what might be called the "work role", while the latter are defined by interactions between people holding the same or different occupational or organizational positions. One upshot of the evolving interactional order may be an altered role set.

Role sets may shift two ways. First, membership itself may change as the incumbents of a focal role find themselves having relations with incumbents of roles with whom they had no previous interaction. Equivalently, former bonds between incumbents of different roles may be severed. Second, even if membership remains constant, the quality and quantity of role relations may shift dramatically as a new interaction order redefines role obligations and expectations. In either case, changes in the overall pattern of role relations begin gradually to give rise to a new structural configuration by redefining patterns of interaction. Since patterns of interaction are synonymous with the boundaries of groups or cliques, the cleavages and coalitions within the organization may change thereby changing the organization's structure. These structural alterations in the boundaries of groups set the stage for further evolution of the technology as a social object, for now the lines of potential interest groups will have formed and each may project onto the technology a somewhat different understanding as it evolves into a different subculture. For example, structural and subcultural cleavages may ultimately generate conflict within the organization.

Finally, the internal and external ecology of the organization may be altered. By the internal ecology I mean to refer to such aspects of organizational life as the organization's culture and climate. By the
external ecology I have in mind the structure and quality of the relations between members of the focal organization and other persons beyond the organizations formal boundary. Such external actors may be suppliers, clients, family, or individuals filling a host of other roles.

The reverberation model provides the conceptual foundation of the research to follow. However, in and of itself, the framework is insufficient for formulating an investigation of the social implications of new radiological technologies. In addition, a methodological strategy appropriate to the study of technologies as social objects is required. Together the theoretical framework and the empirical strategy define the flow of the remainder of this monograph. Therefore, before moving headlong into the research results, I shall pause by one more waystation to discuss briefly my empirical strategy for studying technologies and the social organization of work.

FOOTNOTES

1. In this regard, the real marvel of Kidder's (1980) award winning account of Data General's development of the Eclipse is not so much his excellent description of the social process of technological development, but the mere fact that he was allowed to observe the process so closely.

2. James Bright (1958:5) attributes the term to D. S. Harder. In 1946 as the Vice President of Manufacturing for the Ford Motor Company, Harder is reputed to have said during a meeting called to review the layout and equipment plans for a new plant: "Let's see some mechanical handling between the transfer machines. Give us some more of that automatic business...some more of that -- that -- automation".

3. As regards the specific negative aspects of automation, Mann and Hoffman found, among other things, (1) that automation is associated with rotating shift work that disrupts family life,
(2) that the complexity of the technology places workers under greater stress, and (3) that breakdowns affect the whole plant rather than sections of the plant.

4. Of all the formal scales and typologies, only Amber and Amber's scale has received extensive use by other authors hoping to assess extent of automation (Hickson, et al. 1969; Blau, et al. 1976; Hull et. al. 1982). Bright's and Meissner's formal systems do not lead to easy quantification since they require greater familiarity with technologies before they can be used. Said differently, Bright's and Meissner's work presume rather particularistic knowledge of technologies. While the three systems are useful for more traditional technologies, almost any computer technology would fall into the same category, so their schemes would fail to distinguish between different uses of the computer. One fruitful line of work might be to build man-machine assessment systems which would distinguish between different uses of computers and computer based technologies.

5. One interpretation of the automation literature has been that advanced automation is positive for workers because it reawakens workers' involvement in their work and counteracts the instrumental orientation characteristic of workers in industries with lower levels of mechanization (e.g. the automobile industry). European sociologists have taken issue with this interpretation and have claimed that the sociology of automation overlooks the fact that workers' attitudes are determined more by the social environment from which they come than by the technology with which they work. Goldthorpe et al. (1967) argue that an instrumental attitude towards work is a predominant characteristic of the working class who value their private lives more than their work. Gallie's (1976) research on automated process plants in France indicates that even process workers are not allowed tremendous amounts of control over their work and that they too are instrumentally oriented to their work. While later researchers in the tradition of the sociology of automation were less likely to address the issue of how the larger social ecology affects a worker's behavior at work, Blauner (1964) and Mann and Hoffman (1960) were quite explicit about the interaction. Blauner notes that textile workers in the South do not evidence the alienation of textile workers in the North even though they use the same technology primarily because of Southern value systems, the paternalistic attitudes of Southern textile companies, and the caste system that exists in Southern textile communities. Mann and Hoffman note that an important aspect of the automated power plant they studied was the fact that workers were drawn from rural rather than an urban area. However, Cotgrove's (1972) data puts the disagreement into perspective. He finds that workers in process control industries are indeed inclined to derive their greatest enjoyment from leisure and family activities and to approach work instrumentally, but that they also find their work
involving and responsible. Cotgrove's point is this: Worker's in process plants aren't dupes, they know that one works for money, but at the same time working for money does not preclude becoming involved in work that one perceives as being worthwhile.

6. As will be discussed more fully in the next section, when sociologists of automation have conducted field studies and have turned their attention to the larger social ecology of the work setting, they readily admit that factors other than the technology influence the technology's ramifications on the social structure of work settings. However, at the individual level, the approach is at least paradigmatically deterministic.

7. Woodward's typology of technologies seems to resemble Blauner's (1964) ranking of the printing (craft), textile (machine tending), automobile (assembly line), and chemical (process) industries. Although Woodward's work predates Blauner's, he gives no indication of having read Woodward. Moreover, there are crucial differences between the two schemes. Blauner explicitly claims that he is concerned with increasing automation and that he has selected his examples accordingly. If Blauner's data tells on a level of analysis larger than the work group, it is the industry and not the organization. Woodward does not focus on industries but rather on organizations, and proposes to rank technologies on a dimension whose exact meaning is a matter of debate. Although Woodward called her scheme "technical complexity", others claim that the dimension might be better understood as a measure of "smoothness" (Starbuck, 1965:503), "continuity" (Hickson, et al. 1969:389), or "diffuseness" (Harvey, 1968:249). As Blau et al. (1976:24) note, her dimension is also correlated with extent of mechanization or automation. Blauner cautions that it is sometimes difficult to separate technology from industry since the firms in an industry tend to adopt the same technology.


9. The organizational school is in fact a convenient fiction. There is much diversity even among those who have studied the computer's social implications for the workplace. Kling and Sacchi (1980) identify six perspectives within what Marcus would call the "Organizational School": rational, structural, human relations, interactionist, organizational politics, and class politics. The first three group together under what Kling and Sacchi call "systems rationalism" and the later under the rubric of "segmented institutionalism". Note that the six perspectives would yield points of departure for any sociology. While this is not the place to review in detail distinctions between the perspectives, one point needs to be made: the wide divergence of perspectives suggests that there
is no core approach to the study of computers such as the "sociology of automation" or the "socio-technical" school. In the long run the diversity probably bodes well for the study of computing.

10. Kling (1980) attributes the period of declining interest to the discovery that workers were not being put out of work, which as discussed earlier, was a prominent concern in the early 1960's. Kling claims that the management of organizations recognized that technologically induced unemployment was a hot issue and that they purposefully avoided layoffs in order to increase the likelihood that employees, in particular, and the public in general would accept computing. Kling then states that in the 1970's, when computing had become more of a fact of life, employers were less concerned with layoffs and, in fact, that many organizations have adopted computers so as to reduce personnel costs.

11. The idea that technologies have value as signals corresponds to the notion that organizations adopt certain structures so as to appear to be responsible, credible, and modern members of whatever class of organizations they happen to be part of. See Meyer and Rowan (1977) on organizational structures as myth and ceremony.
I might not be right, but I've never been wrong
Things seldom turn out the way the do in the song.
But one in a while you get shown the light in the strangest of places if you look at it right.

Robert Hunter and Jerry Garcia
"Scarlet Begonias"

Research Questions and Design

To ask whether new imaging technologies change the social organization of radiology departments is to invoke three distinct, but interrelated empirical question. In fact, some variant of each is likely to be relevant whenever one investigates how any technology alters a workplace. First is the question of whether the new modalities are embedded in similar social contexts that differ from those enveloping traditional technologies. If an affirmative answer is obtained, one may then ask why such differences exists? Finally, the issue of plausibility requires that the distinctions be shown to hold, at least in modified form, for more than one radiology department. The resolution of each question requires a separate comparative stance that demands its own data. I shall call these comparative stances the synchronic, the diachronic, and the parallel.¹
Synchronic Analysis

Any social setting may be read as a historical document of itself shelved momentarily between past and future. Whatever the social order at present, we know it became so from what it once was. To wherever the social order evolves, we know it will arrive there by metamorphosis of what it is now. While all social settings so summarize their past and sire their future, some register their history more visibly than others. Most prior social orders leave behind few relics of their reign, and those traces that do remain are often mere forms of long forgotten substance. What existed and the reasons for its existence can be culled only from the memories of those who lived the period or from written records that survive the time. In other cases, rare by comparison, a previous order continues to exist side by side with what has come since and is likely to come in the near future. When living traces of a former order reside alongside vestiges of a new, it is possible to compare the two simultaneously. Such situations are a boon for those who would study social change.

A sociology of technology and work is perhaps blessed for this reason. In periods of technological change a workplace often becomes, at least for a span of time, an admixture of old and new technologies operated concurrently. Associated with each technology is the social order that has grown up around its use. Since the admixture occurs in the same setting, one may, in effect, hold constant variations brought about by the cultural, historical, environmental, and social idiosyncrasies of the setting as a whole, so as to see more clearly the ramifications of each technology. At present, radiology departments are precisely such living, Janus-like documents of their own social and
technical evolution. The "main department" with its x-ray and fluoroscopy equipment stands simultaneously juxtaposed to the newer equipment and techniques of ultrasound, CT, and special procedures.\textsuperscript{3}

The temporal concurrence of multiple radiological technologies in a specific department favors a synchronic comparison of their social use. To take a synchronic approach is to pretend that each technology's context is static or fixed in time. In terms of the framework set forth in the previous chapter, one assumes that the social reverberations set off by each technology have ceased, and that stable social orders have evolved. This fiction promotes an eye for comparing the various technologies and for discovering dimensions of social use that separate one technology from another. With such a comparison in hand, one can assess whether the social contexts of new modalities are similar, and whether they differ from those of older modalities.

In synchronic analysis, the social order most proximal to the technology's use is of primary concern, for at any point in time, it is difficult to untangle a given technology's responsibility for more distant realms of social organization (eg. structure and ecology). The substantive interest of synchronic analysis therefore properly centers on the inner concentric circles of the reverberation framework in an effort to distinguish the social contours of tasks, work roles, and role relationships. I shall use the term, "task", to cover the actual work that people perform, while "work role" will refer to more abstract characterizations of these regular duties. By "role relationship", I mean the patterns and qualities of dyadic interaction between incumbents of different roles. Taken together, the parameters of the work role combine with the parameters of role relationships to define the "total
role" of a focal person such as a "CT tech", an "x-ray tech", or "a radiologist working angio". A total role is therefore composed of two parts, a relational aspect that requires interaction between people (role relationship), and a non-relational aspect which is built out of the work itself (work role).  

Assuming that radiological technologies most strongly influence those actors associated with their immediate use (radiologists, technologists, and patients), the broader question regarding the social order surrounding the various modalities reduces to a number of more specific questions that guide the research to follow:

1. What are the tasks and work roles of the technologist in each of the modalities?

2. What are the tasks and work roles of the radiologist in each of the modalities?

3. What role relationships exist between technologists and radiologists in each of the modalities?

4. What role relationships exist between patients and technologists in each of the modalities?

5. What role relationships exist between patients and radiologists in each of the modalities?

Diachronic Analysis

If a synchronic comparison of the various technologies in terms of these substantive questions suggests that the new modalities are socially similar and simultaneously different from the older modalites, then we have reason to claim that they alter the social order of radiology departments in a consistent direction. However, the analysis
will only partially explain why different orders evolve. To state how and why technologies give rise to certain social orders, one must chart the reverberations they occasion. Since time is critical to the notion of reverberation, a diachronic analysis is required. Where a synchronic perspective freezes time and looks across the whole radiology department, a diachronic perspective seizes time to look vertically down the developmental path of a particular technology's use. A synchronic analysis compares technologies with each other; diachronic analysis contrasts each technology with its earlier and later self.

A diachronic approach is consistent with the perspective that social orders sediment out of a history of events, acts, interactions and interpretations that gradually define the contours of tasks, roles, role relationships and the nature of a technology as a social object. Since individual incidents, interpretations, and actions are often quite mundane and fade quickly into the continuous flow of daily work, participants themselves may not notice their cumulative importance. Changes may indeed be recognized when looking backwards, but no one may remember how or why the changes came to be. Therefore, to understand how a technology becomes a social object embedded in a particular social order, one must attend to the detailed history of ongoing, patterned, social processes that generate order through time. A diachronic analyst of a radiological technology would therefore ask: how does the social order surrounding a new radiological modality take shape, and why does it assume the shape it does?

The problem that confronts a diachronic analysis is that once a technology has been in place for some period of time, its use and the surrounding social order become more or less institutionalized. Change
becomes less frequent and the negotiated is taken for granted as fact. Therefore, if one seeks to understand how and why a new modality is associated with a particular social organization, it behooves one to follow the technology's use from the moment it arrives on the scene. Of the new imaging modalities mentioned in the first chapter, only the body scanner is currently at a stage of development where it is still being widely adopted by community hospitals. The other technologies are either well diffused among radiology departments, or else, are used only as prototypes in medical centers. Consequently, to enable a diachronic analysis, the research was designed to focus exclusively on hospitals receiving their first body scanner. With this fact in mind, the research sought answers to two more specific questions:

6. How do the roles of technologists and radiologists evolve after the introduction of a CT scanner?

7. How do technologists and radiologists understand the CT scanner and by what processes do these understandings develop?

An orientation to detailed social process is appropriate for charting dynamics proximal to a technology's use, but constant attention to a flow of events is a less viable strategy for studying more distant changes. For example, changes in the the structural articulation of a radiology department are likely to reflect lower order adaptations, but are also likely to take longer to congeal. While structural change is surely a diachronic phenomena, its characteristics are best seen by standing back from the flow of events and by chunking time into larger segments so that contrasts become visible. In effect, the diachronic
study of structural change involves comparing successive synchronic
snapshots of a department's overall social organization. This second
diachronic perspective is reflected by the eighth research question:

8. How do computer based imaging modalities in
general and the CT scanner in particular alter the
organizational structure of a radiology
department?

Parallel Analysis

Diachronic and synchronic strategies for analyzing the social use
of various technologies in a radiology department are necessary if one
is to claim that new modalities alter the social organization of
radiological work and explain how such change occurs. However, even in
combination the two are insufficient for making strong claims. As
discussed in the previous chapter, the culture and history of a
radiology department will shape the social use of any technology the
department adopts. The dynamic is of more than passing interest for
here lies a doorway into the substance of the organization's larger
culture. But to distinguish between setting specific aspects of the
social order and those keyed to the technology itself, one needs to
complement synchronic and diachronic analysis with a third axis of
comparison: the parallel.

By conducting identical synchronic and diachronic research in more
than one organization, one throws into relief the cultural and
structural differences between the organizations so as to sift out what
commonalities might exist in their use of similar technologies. From
the parallel perspective, cultural elements will cut across the use of
all modalities in a given site, but appear site specific when compared to elements common in other departments. At the same time, a parallel analysis points to similar differences between technologies in each department and therefore brackets what may be construed as the social ramifications of the technology itself.

Under the presumption that all three comparative axes are critical for documenting how new imaging technologies alter the social contours of radiological work, I designed the research with a triple comparative focus. Synchronic differences would be assessed by documenting the day to day use of various radiological technologies. Almost any radiology department would have provided adequate synchronic data. However, the diachronic agenda restricted potential sites to those departments that would receive CT scanners during the course of the project. The diachronic agenda also dictated that the project begin before the scanners were brought on-line so that the social organization of the departments could be assessed prior to the scanner's intervention. Finally, the concerns of parallel analysis required choosing at least two sites, each of which would satisfy the diachronic criteria.

Figure 2 portrays in schematic form this triple comparative research design. The present document speaks exclusively to the synchronic data. Later monographs will detail the diachronic development of the two CT operations. The parallel perspective flows through all of the four chapters as of patterns and dynamics at the two sites are compared and contrasted.
FIGURE 2

Triple Comparative Design
Entry and Research Sites

Since the research design targets radiology departments about to adopt their first body scanner, since the number of hospitals purchasing scanners is limited by the Determination of Need process (see Chapter 1), and since I had no funding to support distant travel, the population of potential sites was severely restricted. Only four Massachusetts hospitals were permitted to purchase their first body scanner during 1982, the year in which the study was to begin. In late January 1982, I obtained the identities of the four hospitals from the Massachusetts Public Health Council. Of the four, one was too distant to afford frequent access. In early February, I contacted the three remaining hospitals in hope of persuading at least two of the three to participate in the research. From that point forward negotiations proceeded fitfully for four months, driven by dynamics of which I had no understanding and of which I am probably still but dimly aware.

Knowing no one at the time who could arrange formal introductions, I began by placing telephone calls directly to the Chief of Radiology at each potential site. In the first hospital, I was referred to the administrator in charge of the department. As with the other hospitals, I arranged a face to face meeting, and acknowledged the telephone conversation with a brief cover letter and research proposal addressed to the hospital's designated contact. After meeting with the departmental administrator, I was informed quite firmly that the radiologists had discussed the proposal and concluded that they had no desire to participate in the study. Although the project was officially rejected because of potential disruption to daily routine, I learned
much later from a relatively credible source that the hospital in
question had a year earlier attempted to finesse the Determination of
Need process, was discovered, and reprimanded for the attempt. It is
quite plausible that my research purpose met with suspicion, a
hypothesis whose viability seems less fanciful given events at the
second hospital.

There, I began by negotiating directly with the radiologists as
well as the department's administrator. The proposal was relatively
well received within the department, but encountered snags at higher
administrative levels. Unbeknownst to me, during the previous year, a
journalist had entered the hospital posing as a researcher. The
individual later published, in a public forum, an article critical of
the high cost of medical care in which he cited physicians' names and
annual salaries. The incident left the higher administration somewhat
hesitant to open their doors to unknown social scientists.
Additionally, former members of the hospital's staff had been recently
indicted for illegal activities involving the use of hospital property
and it is likely that my investigative motives were suspect for this
reason as well.

At the third hospital, I was referred by the Radiology department's
administration to the hospital's second in command. While the Assistant
Chief Administrator was enthusiastic about the research, his enthusiasm
apparently did not extend to the radiology department's staff. After
meeting with me, the Chief Administrator left final approval to the
radiology department. Although I eventually arranged to present my
case to the department's administration, I was unable to meet with the
Chief Radiologist. In fact, it is unlikely that I would have ever
gained entry had I not begun to observe scanner operations at a local medical school so that I could familiarize myself with CT scanning before the scanners arrived at the primary research sites. The radiologist in charge of CT operations at the university hospital intervened on my behalf with the chief radiologist at the third hospital. Within three days of the intervention I was granted access to the third hospital. Later that same week, the second hospital also cleared the study. Thus, by the beginning of June, the proposal had been accepted at Urban and Suburban hospitals.

Urban Hospital was located on the edge of one of Boston's more depressed neighborhoods. The hospital was Church supported and, while not the principal affiliate of a nearby medical school, acted as a training site for some of the school's interns. Urban's staff also included residents, but offered no residency in radiology. In contrast, Suburban hospital was situated in a community on the outer fringes of the Boston metropolitan area, had no religious affiliation, accepted no interns, and took few residents. Because of the different locations and affiliations of the two hospitals, the patient populations at the two sites differed. While no statistics are available, based on a year's worth of observation I would hypothesize that Urban hospital's constituency was composed of a higher proportion of individuals from minority groups, the elderly, the indigent, and the foreign born. At the time of the study, both hospitals had a capacity of approximately 300 beds, and both had begun construction to expand their capacity.

The radiology departments of both hospitals were similarly staffed. When the study began, each had five radiologists. In July, Suburban hired one and Urban two new radiologists in anticipation of the scanner
operations. Each of the newly hired individuals had previous experience with body scanning. One of Urban's new radiologists left at the end of six months so that for the remainder of the study each department was staffed by six doctors. Both departments employed on their day shift approximately 50 other persons including technologists, clerks, secretaries, and orderlies. Since, all observation was done during the day when the bulk of a department's work takes place, the research pertains only to these individuals and is not likely to be representative of night shifts when the radiology departments were run solely by technologists.

While each department offered the full range of routine radiological studies and conducted special procedures and ultrasound examinations, there were a number of differences between the two sites. At Urban, the radiology department performed few cardiac or obstetric ultrasounds since the cardiologists maintained their own ultrasound equipment and since a nearby sister hospital handled obstetrics. In contrast, Suburban's sonographers routinely executed cardiac and obstetric exams along with pelvic and abdominal studies. Initially, neither department had jurisdiction over the hospital's nuclear medicine operation. Near the end of the study however, Urban's radiology department took control of nuclear medicine. Since nuclear medicine could not be compared across the two sites and since incorporation of the modality did not seem to significantly alter Urban's daily operation, observation of nuclear medicine was not attempted. Suburban on the other hand, purchased and began to operate digital subtraction equipment at the same time that it began to run its CT scanner. Since the digital equipment was among the first in the area and since it was
integral to special procedures at Suburban, the research does incorporate Suburban's use of its digital equipment.

That Urban had been operating a second generation head scanner since 1978, is potentially the most relevant distinction between the two sites. Although Urban's familiarity with head scanning poses a critical imbalance between the sites, the problem is not as catastrophic as it might first appear. Although similar in principle, head scanning and body scanning are quite different in practice. The body scanner requires radiologists to learn a new language of images: familiarity with cross-sectional images of the brain does not assist one in interpreting cross-sectional images of the body. Since the body scanner's hardware and software are quite different from the head scanner's, technologists who are experienced on the latter may have (and in fact did have) difficulty with the newer technology. Finally a number of inexperienced technologists were brought into Urban's body scanning operation so that familiarity with head scanning became even less of a research problem.

Propitiously, both radiology departments purchased the same type of body scanner: a Technicare 2060. Since CT-scanners differ substantially from one another, the ability to hold technological variation constant increased the comparability of the scanner operations. At the time the study began, both departments were in the process of constructing facilities for the scanners. Construction was completed at approximately the same time, and the two departments began to use the scanners within two weeks of each other in the early Fall.
Methods

Observational strategy

Like any social order, the social organization of a radiology department consists of ongoing patterns of human activity and shared cognition that smooth the vagaries and varieties of daily experience by establishing the consistency and coherence necessary for sustained action. Without such patterns radiologists, technologists, and patients would not know how to behave or what to think. The organized activity of radiological work would crumble against the rush of ongoing experience and be washed aside by the complexity of novelty. By this token, if technologies change the social organization of a radiology department, they must do so by altering old patterns or by creating new ones. The notion that technology shapes the context of work by reverberating outward from the social milieu of its most proximal use explicitly countenances an investigation of patterns. Tasks, roles, role-relationships, structures, and the larger ecology are nothing if not a series of ever more expansive regularities linked to one another at critical points so as to generate an overall gestalt.

If a radiology department is a myriad of patterns, and technological change a shift in those patterns, then the study of a technology's implications for the social organization of radiology is fundamentally a task for sustained observation. To speak of patterns is to speak of recurrent acts and consistent interpretations. Unless one observes, one is unlikely to know of what behaviors and what interpretations a pattern consists. Unless observation is sustained over multiple incidents, one can not document recurrence and
consistency. Although sustained observation is crucial for delimiting institutionalized and relatively stable patterns, it is even more critical for understanding how social patterns evolve. New social orders do not arise full blown. Rather they gel slowly out of a history of events, actions, incidents, and prior typifications that subtly shape a new normative order. Definitions of reality, particularly those that pertain to pragmatic activity, accrue as problems and incidents demand interpretation and action. But once the interpretation is posed, the act executed, and the result deemed sufficient, all fade into the past to become taken for granted aspects of the present. Genesis in mundane events is forgotten and the forces that shaped the pattern become obscure. Since this study aims to understand the creation and maintenance of behavioral and cognitive patterns in radiological work, as well as their link to technology, sustained observation became the method of choice.

In the second week of June, 1982, I began a year-long stint as a participant observer at Urban and Suburban hospitals' radiology departments. With the exception of a seven week hiatus from the field in the middle of the year, an average of three days a week were spent in observation. I logged sixty-three days of observation at Urban hospital and sixty-seven at Suburban. The typical routine was to arrive at the site between 8 AM and 9 AM, spend six to seven hours accompanying a technologist or radiologist as he or she went about the day's work, and leave by 3:30 PM when the day shift was about to end. In the evening after each day's observation, I expanded the day's field notes at a typewriter. On the average day I compiled twenty pages of single
spaced, typed field notes yeilding a total corpus of slightly over 2,500 pages for the entire project.

Like most field researchers who choose the stance of a participant observer, I cite the volume of field notes as evidence of sustained observation and as a not-so-subtle indicator that real work was done. Yet sustained observation and copious notes, while necessary conditions of adequate fieldwork, are not in and of themselves sufficient. In addition, to be methodical, observational research must also be systematic and explicit. While a field researcher may not know upon entering the setting how observation will become structured, as knowledge of the setting accumulates, its internal logic will suggest possible avenues for structuring inquiry.

Since I forayed into the radiology departments intending to discover how the organization of radiological work gels around the social use of different technologies, I required observational tactics that would systematically yield data on the use of each technology conducive for charting patterns of tasks, roles, and role relationships. Ideally, the unit of observation would mesh with the internal logic of the day to day round of work. Radiological work is parsed by insiders into what are variously known as "procedures," "studies," "tests," or examinations." A procedure is understood as an examination that employs a particular imaging technology in a specific way to render data about specific anatomical regions. Therefore the daily flow of work around a modality consists of a stream of procedures, each of which has a discrete beginning and end. Likewise the work day of a technologist or radiologist revolves around the series of procedures he or she conducts or interprets. Since most interaction between radiologists,
technologists, and patients occurs during the course of a study, and since studies are geared to technologies, the technology becomes the center of gravity around which roles and role relations are enacted. Procedures therefore offered an ecologically natural unit of observation for studying the social order that surrounds the use of a radiological technology. As soon as I discovered that days were parsed by procedures, they became the obvious candidate for systematically structuring each day's observation.

By cross-classifying procedures by roles and role relationships, I created an analytic matrix to guide the collection of data (See Figure 3). My research strategy was to collect multiple instances of the prominent procedures conducted with each technology so as to fill in the cells of the matrix. Using such a data matrix, procedures could be compared to one another or, all procedures under each technology could be collapsed so as to contrast the social use of different modalities. Moreover, the strategy was appropriate for collecting data to support diachronic comparisons: not only could technologies be compared to one another, but the later use of a technology could be contrasted to its earlier use by focusing on how data in each cell evolved over time.

The scheme not only structured my thinking, it also guided the pragmatics of observation. Since technologists and radiologists are usually assigned to one (or at most two) modalities each day, I developed the habit of attaching myself to a radiologist or technologist in the morning and following that person over the course of the day. Whom I chose to observe on a given day depended largely on two considerations: whether I needed to collect more data on a particular procedure or technology, and whether by choosing a potential informant I
FIGURE 3

ROLE/ROLE RELATION BY PROCEDURE MATRIX

PROCEDURES BY TECHNOLOGY

<table>
<thead>
<tr>
<th>ROLE RELATIONS</th>
<th>WORK ROLES</th>
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<td>TECHNOLOGISTS</td>
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<td>TECHNOLOGIST-RADIOLOGIST</td>
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<td>TECHNOLOGIST-PATIENT</td>
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<td>RADIOLOGIST-PATIENT</td>
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<tr>
<th>RADIOGRAPHY</th>
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<th>SPECIAL PROCEDURES</th>
<th>ULTRASOUND</th>
<th>CT SCANNING</th>
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<td>I.V.P.'s</td>
<td>Barium Enemas</td>
<td>Upper G.i.'s</td>
<td>Angiography</td>
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could watch the procedure being executed by someone whom I had not yet observed perform the procedure. As the second criterion makes clear, in choosing a daily companion I attempted to maximize the number of radiologists and technologists observed in the context of each technology so that I could separate social regularities from individual habits. Moreover, the observational strategy allowed me to understand what typical work days were like for individuals working various stations.

Phases of Observation

Over the course of the year, my substantive orientation changed in such a way that discrete phases of observation developed. These phases reflect the arrival of the CT scanners, alternations between collecting synchronic and diachronic data, and variations in my attention to the work worlds of technologists and radiologists. Figure 4 arrays these phases schematically along a timeline representing the duration of the fieldwork. From mid-June until late September, 1982, I devoted myself to collecting data for the synchronic analysis. During that time observation shifted on a daily basis between radiography, fluoroscopy, ultrasound, and special procedures. I attached myself exclusively to technologists and observed the department from their vantage point.

By late September, the CT scanners had been assembled at each site and by the first of October both radiology departments were operating the scanner on a daily basis. From the end of September to the end of

* At Urban, I also spent a number of days in the head scanner operation.
FIGURE 4

PHASES OF OBSERVATION

ASPECTS OF OBSERVATION

Comparative Focus

Primary Attachment

Technologies Observed

TIME

<table>
<thead>
<tr>
<th>June 1982</th>
<th>Jul</th>
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December, I attended almost exclusively the body scanner operations and their day to day development. The exception to this rule occurred at Suburban where I continued to observe special procedures in order to document the new Digital Subtraction equipment. During this period my focus shifted from the synchronic to the diachronic. Although I was able to observe radiologists throughout the period as they interacted with the CT techs and the scanner, I remained attached to the technologists and the flow of their daily work.

From Christmas to Valentine’s day I withdrew from the field to spend time with the data I had collected since June. During that period, at three week intervals I spent a day at each site to maintain connections, to provide assurances that I would return, and to catch up on major developments. In February, I returned to regular observation and continued to scrutinize the scanners, but now from the point of view of the radiologists whom I began to follow over the course of their days. By the end of March, I had gradually shifted from exclusively observing the CT scanners to observing radiologists as they worked other areas of the department. From the first of April to the end of May, I adopted once again a synchronic orientation, observing the variety of procedures performed in the departments. However, rather than attach myself primarily to either technologists or radiologists, I alternated back and forth between their company. While most of my time was spent outside the CT area, I continued to spend an hour or more a day with the scanners’ personnel so that I could continue to chart developments.
Evolving Explicitness

Too often, rigid distinctions are drawn between qualitative field research and studies shaped by quantitative designs. The former are extolled for the richness of their data, while the latter are preferred for explicitness and presumed replicability. While explicitness is perhaps easier to attain in survey or experimental research, there is no reason to conclude _a priori_ that explicitness is inimical to essentially qualitative studies.

The value of sustained observation is not simply the ability to reveal the patterned richness of a social setting, but through one's intimate knowledge of the setting to uncover what might be taken as indicators of that patterned order. After all, if participant observers become attuned to particularistic patterns of human activity and interpretation, they must do so by attending to repetitive cues. While it is not possible to document specifically all the facets of a multiplex setting that lead to ethnographic insight, some facets can be systematically isolated. In such instances, the power of setting specific measures can be enlisted to make more explicit the grounds on which one draws one's conclusions. By carefully documenting setting specific indicators of the phenomena one observes, one can not only _describe what happens_ in a setting, but also _document that it does happen._

The potential richness of an interplay between description and documentation in qualitative research is occasionally discussed but rarely performed, perhaps because the synthesis of the two requires something of a leap of faith on the part of the researcher. By definition, one can not know ahead of time what will count as a setting
specific indicator of the social patterns one discovers while in the setting. Hence, at least at the beginning of the study one can only arm oneself with an intention to synthesize and hope to develop tactics as the study progresses. Over the course of the research, I employed two primary tactics for enhancing the probability of augmenting my descriptive research with explicit indicators of the patterned phenomena I observed: the development of behavioral records and the use of non-observational sources of setting specific data to triangulate on hypotheses suggested by observation of ongoing events.

**Behavioral Records:** Fortuitously, radiological work is in large measure composed of physical and verbal actions that take place in time and space. The execution of a procedure involves visible human behaviors and the mechanical or electronic responses of machines. Even the interpretation of films by radiologists more than occasionally involves open conversations among radiologists or between radiologists and physicians. Given the wealth of observable behaviors, after my second week in the field, I settled on a stance towards notetaking: to capture to the best of my ability, the chronological stream of events, behaviors, and conversations that occurred over the course of an examination. In essence, I attempted to become a human camera. If a participant's interpretations of events were not spontaneously forthcoming, they were elicited between procedures or when action was otherwise in a lull, but never as the action proceeded.

From the beginning of the study I made no secret of the fact that I would be taking notes on what was going on around me. However, to reduce the intrusion of my notetaking, I employed small, spiral bound memo pads that fit easily in the palm of my hand. Over the course of a
procedure I attempted to jot down a continuous running record of as many
actions and bits of conversations as I could record. As part of my
notetaking regimen, I recorded the times at which the study began and
ended, as well as the time at which actors entered and left the scene.
Since all radiographic procedures take place in examination rooms,
entrances and exits were easily distinguished. In order to record times
unobtrusively, I wore my watch on my left wrist with the face below the
palm. Since I also held the memo pad in my left hand, I could easily
record the timing of events without obvious time watching gestures. When
the timing of beginnings, ends, exits, and entrances became habitual, I
expanded my time noting so that I could eventually document duration of
a procedure's phases. In addition to keeping time, I regularly recorded
who was in the scene, what they did, and where the scene took place. As
the repetitive aspects of doing a procedure became routine for me (as
they are for technologists and radiologists), I developed a shorthand to
document more parsimoniously the actions that reoccurred across all
procedures of a given type.

Since my notes took the form of a behavioral record, the
documentation of each procedure was sufficiently specific to support a
number of explicit analyses. Here I shall cite but several examples to
be more fully explained in the chapters where they appear. It was
possible, for example, to calculate the proportion of a procedure's
duration during which radiologists, technologists, and patients were in
face to face contact. These measures of "interaction time" are used to
substantiate observations about the nature of role relationships. Since
I had records of who made what decisions during the course of a CT scan,
I could plot when and under what circumstances decisions shifted from
the domain of radiologist's work to the domain of technologist's work as the scanner operations evolved. Finally, since a behavioral record is a chronological account of events, I found that chains of actions and events were critical for explaining the temporal structure that led technologists and radiologists to construe their work world as they did.

Non-Observational Data

In addition to culling explicit indicators and counts from behavioral records of procedures, I attempted to augment observational data with a number of observationally independent sources of information. The most problematic aspect of creating a behavioral record was chronicaling conversations. After several months of practice, I felt reasonably adept at recording the stream of physical action, but I was never convinced that I could record conversations accurately. While I felt I captured conversational jists, I had no means of capturing their complexity. In part to redress this problem, I secured permission to tape record procedures in the final months of the study. Tape recording was done with a small micro-recorder that fits in the palm of a hand. I held the recorder under my memo-pad to decrease its obtrusiveness. I have used transcripts of the tapes to document the verbal parameters of roles and role relations between radiologists, technologists and patients. The transcripts not only capture the verbal ploys that technologists and radiologists use when dealing with patients and each other, but they are amenable to a content analysis of the topics that individuals talk about during different procedures.\textsuperscript{8}
Although the data will not be presented here, the single most important source of observationally independent data were identical sociometric questionnaires distributed first in August and again in May to every member of both departments who worked the day shift. The sociometric data serve two purposes. First, sociograms constructed from the data can be used to challenge or verify observations about role relationships between technologists and radiologists. But more importantly, social networks can be constructed from the sociometric data to represent the overall pattern of relationships within each radiology department. Such networks can be taken as measures of each department's social structure before and after the scanner's arrived. If new imaging technologies alter the social structure of radiology departments, then one would expect the pattern of relationships surrounding the CT scanner to resemble the pattern of relations that enveloped the other new technologies before the scanner began to operate and before CT techs were hired. Consequently, the sociometric questionnaires not only triangulate upon observed role relations, they provide a methodological analogue to the theoretical link between role relations and role sets at the group level of analysis and the characteristics of a department's structure at the organizational level of analysis.

Radiology departments also generate a wealth of documentation on their own. Over the course of the year I found myself with access to numerous records at both hospitals. As I discovered that particular records might shed light on patterns I thought I was observing, I began to accumulate whatever bits of data might test my hypotheses. For example, I found that duty assignment sheets were helpful in
documenting the scanner's implications for radiologists' work. Daily CT schedules with their penciled in cancellations and "add ons" became measures of workflow and workload. Other records allow testing hypotheses regarding the implication of the CT scanner for the use of alternate procedures such as myelograms. Parameters recorded by the scanner's computer on hard copies of images represent an unobtrusive measure of the rigidity or flexibility of standard operating procedures or protocols. Since CT techs film these images, the variance of the parameters across time can be taken as a small indication of the tech's autonomy over the particulars of their work.*

As with the sociometric questionnaires, the relevance of these records (and numerous others tangential to the particular topics of this document) only became clear as I gained familiarity with the day-to-day social organization of the radiology departments, and as I began to observe patterns for which I desired some form of independent verification. Just as the most celebrated network analyst could not determine ahead of time the content of interactions that would meaningfully tap the social structure of a radiology department, so an expert in unobtrusive measures could not prognosticate the relevance of records routinely produced in the setting. Ironically then, it would seem that if one wishes to be more explicit about the results of field observation, one may have to wait until one has been a participant

* The last three sources of data provide the basis for other reports and do not appear further in this monograph. I have mentioned these sources of data to illustrate how records can fit into the ongoing thinking and hypothesis building of a field research project. I would underscore the fact that their usefulness can not be known ahead of time.
observer for some period of time. Only, then will one realize what indicators are relevant for what questions. Such methodological betting or leaps of faith are not widely tolerated in empirical social science as it is practiced today. Perhaps that is why empiricists are a dying breed, and why models are replacing observation as the engine of social science.

Research Role

As a participant observer, I intended, among other things, to study the roles and role relationships of technologists, radiologists, and patients. However, by choosing to observe I created for the social ecology of the radiology departments at Urban and Suburban hospitals an additional role that had not existed before my arrival: my role as a researcher. It is therefore fitting that I provide some insight into my own role in the two departments before I proceed to discuss the roles of others. Ideally this section should be authored by the technologists and radiologists with whom I associated over the course of my year in the field, for like them in their roles, I am certain that I have come to take my own for granted. Because I became accustomed to what I did and felt comfortable with the routines I established, I am no doubt a victim of innumerable blind spots. Having placed the caveat squarely on the table, I shall try to be as explicit as possible so that one may access the degree to which my own role shaped the data I shall soon report.

At the end of the project, I brought a camera to both radiology departments to capture on film mementos of the previous year. The
taking of pictures became something of an instantaneous farewell rite between myself and a number of the technologists with whom I had worked most closely. In these final days, several technologists offered to take my picture after I took theirs. I accepted the offer under the condition that they would pose me in the stance they thought was typical of my observing. As the technologists directed me on where to stand and how to hold my body, I was acutely aware that the poses felt familiar. Moreover, their attention to detail was alarmingly accurate. The specials techs at Suburban for example would not take my picture until I had taken the cap off the top of my pen and placed it in my mouth. They realized, and I did not, that when observing I would often pull the cap off my felt tip pen with my teeth and hold it there while I scribbled notes.

The photographs that the technologists produced show me standing in a corner of an examination room or directly behind the chairs of technologists seated at a CT-scanner's console holding a pen in my right hand and my note pad in my left. Always, I was instructed to write. What then can I say about my research stance, which appears to me, as I look at these photographs, so incongruent with my surroundings? After all there can be no doubt that I was the only person who took notes in the rooms I frequented.

Although I made no secret of my intention to take notes, I am certain that my behavior, at least at first, was more than a little suspicious and alien. Early on, a few of the bolder technologists ventured to ask what I was writing down. (Radiologists were rarely so direct.) On these occasions, I decided that I ought not hide what I had written and handed my notebook to any technologist or radiologist who
expressed the least interest in seeing what I wrote. Since most of what
I wrote pertained to the flow of events, those who accepted my offer to
examine the notebook without exception expressed surprise at finding the
notes recorded the obvious. A second common response was puzzlement
about how such mundane matters could be interesting. With this cue, I
explained my view of myself as a chronicler of what typically occurs in
the course of a procedure.

During the first few months, technologists were quite
self-conscious whenever something slightly embarrassing happened and
which they feared would find its way into my notes. On these
occasions, jokes would be made ("Steve, did you get all that down") and
nervous laughter would follow, of which the most nervous was probably my
own. When events turned towards the embarrassing or when I suspected
that something compromising had just happened, I ceased to take notes
immediately. While I might later jot down a summary of these events as
the routine returned (or when I decided I could unsuspiciously sneak
away to the bathroom), I was acutely aware that it was important that I
not be seen as someone who was after "dirt". As I have said, over time,
I came to feel quite comfortable with my notetaking behavior. I suspect
that most technologists and radiologists also made peace with my
notebook even if they did not completely forget its presence. In fact,
on more than one occasion technologists took the pad from my hand and
wrote down events that I had not taken notes on myself. Interestingly
enough, in all cases this behavior immediately followed what I thought
were untoward happenings that I was studiously appearing to ignore.
Similarly, technologists would frequently call my attention to
occurrences that I had not witnessed, but which they thought would interest me.

It stands to reason that with enough time, my presence as observer might become routine for technologists and radiologists with whom I had a history of interaction. What then of the patients whom I rarely encountered twice? Both radiology departments accepted student technologists from local training programs. Medical students and interns were common at Urban and, from the average patient's point of view, would not be out of place at Suburban. Without planning it to be so, from the very beginning my implicit cover became that of "student," even though neither I nor anyone else ever mentioned what kind of student I might be. Without solicitation, techs and radiologists gave me a situational identity so that I could blend into the setting as a plausible anomaly. At Suburban, I was given a white lab coat identical to those that male technologist's wore. Techs always introduced me to patients in a manner that suggested my right to be in the situation. If patients directly questioned my identity, technologists would usually respond before I had a chance: "He's trying to learn what we do"; "That's just Steve, he's learning the CAT scanner with us". In point of fact however, patients rarely questioned my identity, at least verbally.

Most patients assume that they have no grounds to question the authority of medical personnel even though they may not understand what is happening to them. Since techs and radiologists treated me as if I belonged in the setting, patients did to. I was more than willing to take advantage of propitious definitions of the situation. Prevalent definitions of the situation were, however at times embarrassing. Since I was a male, strange nurses and doctors as well as patients would
occasionally assume that I was a physician and ask me questions appropriate for a physician. I was obliged to explain that I didn’t know the answer to their questions, but that I would direct them to someone who did. If the person did not relieve me of the obligation, I brought in a radiologist or a technologist to bail me out.

Field researchers often harp on the necessity of gaining the trust of one’s informants. In my experience, trust and acceptance are only partially contingent on familiarity. In addition the researcher’s status is also determined by events and perceptions out of his or her control. I found acceptance more difficult to obtain at Urban because of a long history of conflict between the technologists and the radiologists and the administration. The atmosphere of the department was decidedly more tense than the climate at Suburban and technologists initially regarded me with intense suspicion. Some techs initially hypothesized that I had been sent to spy on them, a perception never voiced even indirectly at Suburban. In fact, Urban’s administrator had indeed made several overtures to me about consulting with him on managerial issues. Consequently, during the first month I had considerable difficulty in getting some technologists to speak with me unless I asked direct questions. At times I found the strain unbearable and would leave the site earlier than I had planned.

Although I cannot pinpoint exactly when relations began to unfreeze, I suspect that four factors led the x-ray techs to lower their guard. First, I studiously avoided the department’s administrator and made certain that if we spoke it was on public turf so that witnesses could hear the conversation. Second, from the beginning I had developed good relations with the CT techs working the head scanner. In early
July, the CT techs worked briefly in the main department during which time their willingness to talk to me may have worked to my advantage. Third, several situations gave me the opportunity to express verbal solidarity with the technologists' point of view. But most important, in my mind, was my relationship with the ultrasound tech, who was well respected among members of the dominant clique of x-ray techs in the main department. I suspect that the sonographer vouched for me with his friends. Once these individuals became more open, most others followed suit. Nevertheless, while I eventually developed easy relations with the CT techs, the specials techs, and the sonographers at Urban, I never felt completely a part of the main department.

My role in both settings was also influenced by the phase of the research. Since I began studying the department from the technologist's vantage point, I found switching to the radiologists difficult. The difficulty sprang from several sources. First, the radiologists and I needed to establish the same sort of working understanding of each other that I had much earlier established with the technologists. Second, when a setting contains multiple groups, despite one's own orientation, after a period of time one is eventually perceived as being aligned with one group rather than another. Thus in switching to the radiologist's point of view, I needed to overcome their perceptions of me as primarily interested in technologists. A similar transition occurred when I returned to the synchronic strategy at the end of the year. X-ray techs were somewhat suspicious that I had spent so much time with the CT-techs and the radiologists. However, by this time I knew the technologists well enough to confront the situation head on and explain my position both as a researcher and as a person. The stance appeared to work, in
that during the last two months I easily moved from one group to another without any apparent ill feelings.

Over the course of the year, as I gained more familiarity with the people at each site and as I learned more about the technologies I became more active in the day-to-day routine of the department. While I was legally constrained not to run technologies for technologists or to put myself in positions where I might unwittingly harm patients by trying to be helpful, I was nevertheless able to devise small measures of usefulness for myself by helping technologists with their "grunt work". I helped lift patients off gurneys and onto tables; held urinals for feeble males; carried messages back and forth between techs and radiologists, and lugged countless numbers of film cassettes and other paraphernalia for technologists who needed them. Over several months of observation, I had learned the scanner's software fairly well from observing technologists interact with the terminal. When techs and radiologists eventually discovered that they could use me as "walking-talking" documentation, they did not hesitate to do so. My ability to be of assistance grew out of the fact that I had observed computer problems encountered at both sites by a variety of techs. Therefore, my acquaintance with the range of potential problems and how to handle them was larger than some technologists' who knew how to cope with only those glitches they has seen before.

Finally, I perceived that with time I was seen as a neutral individual without factional loyalties. From the beginning I suspected that technologists and radiologists would test me by watching to see if I would pass information to other individuals in the department. Therefore, I was careful never to repeat what technologists or
radiologists told me unless I was told to carry a message or unless the information was obviously meant to be public knowledge (Eg. "Don't use room two because the film changer is jammed"). I can remember only one occasion on which I broke my self-imposed vow of confidentiality. At Suburban, the cardiologists made a move in the late spring to usurp cardiac ultrasound. I had been informed of the cardiologist's intentions by sonographers and radiologists alike. However, several radiologists did not know I knew about the turf battle even though I thought that my knowing was common knowledge. Under this assumption, I asked two radiologists a rather pointed question regarding the the progress of the conflict. One of the radiologists immediately demanded to know how I knew about the situation. Taken aback, I immediately mentioned another radiologist's name as the person who had informed me about the situation. At first, I thought that I had betrayed my confidant. However, it turned out that the radiologist was glad to hear that one of his colleagues had told me and not someone else. Afterwards the radiologist became more open with me than he had been up to that point in time. That openness led to the discovery that he had known my father-in-law while he was a resident. My fax thus ironically led our relationship onto firmer ground that it had ever been before.

However, my claimed neutrality is best substantiated by actions of the technologists themselves. After Christmas at Suburban, several technologists came to me to speak about difficulties they were having with several of their colleagues. They stated that they had decided to talk with me because it was well known that I was the only one in the department that "didn't talk". A far more dramatic incident occurred at Urban to elicit the technologist's perception that I was inherently
neutral. For reasons unknown to me, I had for almost a year been spared being asked to take sides in a conflict. Opening oneself to possible compromise is a risk of participant observation, especially when one observes in settings latent with conflict between persons of different status and authority. Near the end of my tenure at Urban, I witnessed an instance of hostility between a technologist and a radiologist. The technologist, who felt that she had accumulated a long history of reasonable grievances against the department, was quick to recognize that my presence meant that an outsider had seen an event that could clinch a formal grievance if I were willing to testify on her behalf. She lost no time in asking me to do so. After a moment of psychological agony, I told her that I could not assist her because she had asked me to attribute malicious intent when I had no access to the radiologist's motivation. The technologist became immediately indignant towards me. I feared that my action would forever compromise my relationships with the technologists. However, to my surprise upon returning to the department four days later, I was told by several technologists that the issue of how I should have responded had been discussed among the techs in my absence. While one or two felt I should have sided with the technologist in the dispute, the consensus I was told, was that I had all along been a neutral party and that I should not be expected to sacrifice that status now. To do so, my informant told me they had decided, would jeopardize my work.
Overview of the Rest

Taken together, the reverberation framework discussed in the last chapter and the triple comparative focus described in this chapter, provide respectively, the theoretical and empirical girders around which this research was constructed. However the data themselves are simply too voluminous to be reasonably presented in the confines of one monograph. Since, as I pointed out in the beginning of the chapter, the project's first task was to show whether, and if so how, new radiological techniques alter the social order of radiology departments, I shall concentrate here on the synchronic data and the inner two rings of the reverberation model. The diachronic data and the broader ramifications of the technologies will be reported in later documents. The next chapter should be read as an orientation to how each of the technologies in a radiology department are used. The chapter is largely a descriptive portrayal of how routine x-rays, IVP's, barium enemas, ultrasounds, special procedures, and CT-scans were performed at Suburban and Urban hospitals. Chapter 5 compares, along a number of dimensions, the tasks and work roles of the technologists and radiologists who used the various radiological technologies to perform examinations. The goal of the chapter is to muster data to show how the social orders surrounding the new modalities are similar to one another and at the same time different from those in which the older technologies are embedded. While Chapter 4 and Chapter 5 pertain primarily to in innermost circle of the reverberation framework, Chapter 6 moves squarely into the second concentric circle to discuss how role relations between patients, technologists and radiologists vary by technology.
Chapter 7 concludes the synchronic analysis by summarizing the previous three chapters to yield a total gestalt, a picture of what the new technologies have meant for the two radiology departments and, by implication, what knowledge processors may mean for professional settings in general.

FOOTNOTES

1. I have adopted the terms "diachronic" and "synchronic" from the study of linguistics. "Parallel" is to the best of my knowledge my own creation. All three are adequately defined in the text. However, I feel some need to make clear why I have chosen not to use the more hackneyed terms: "cross-sectional", "longitudinal" and "comparative". The reasons are simple. Cross-sectional would apply equally well to what I call "synchronic" and "parallel" analysis. Comparative covers all three. While longitudinal maps onto diachronic, it does not carry the evolutionary connotation associated with diachronic. This connotation is important, for it is an evolutionary perspective that underlies the reverberation model presented in the last chapter.

2. A number of studies reviewed in the last chapter made use of the concurrence of old and new technologies to tell on the social implications of the new technology for a work milieu. The most notable of these are Fensham and Hooper's (1964) and Rice's (1958) study of manual and automatic looms in the textile plants, Mann and Hoffman's (1960) investigation of automated power plants, Mann and William's (1961) study of a switchover to data processing, Trist and Bamforth's (1951) experiment with conventional and composite longwalling, and Malvey's (1982) study of computer use in hospitals.

3. See Chapter 4 for a discussion of the linguistic significance of the of the term, "main department".

4. The formulation draws on the work of Siegfried Nadel (1957) who argued that some roles are defined by relations (mother-daughter) while others are basically non-relational (carpenter). I would argue that all roles have both aspects even though the relative balance of the two may vary from role to role.
5. This perspective on the development of a social order reflects the stance that structures and realities are socially constructed. The study of "structuration" pertains to how behavioral regularities sediment out of histories of human action and events (Giddens, 1979; Ransom et al. 1980; Riley, 1983). The notion that members or radiology departments transform technologies into social objects by devising interpretive systems that subsume and explain the technology is drawn from the literature on the "social construction of reality". (Berger and Luckmann, 1967; Strauss, 19; Strauss et al. 1964; Van Maanen, 1978a 1978b).

6. Throughout this period of time I found myself placing repeated calls to the rafterology department only to be told that the chief tech or the chief radiologist was unavailable. My telephone calls were never returned. In retrospect the situation seems quite natural however at the time I was convinced that I was being given a not too subtle "brush off". Now that I am familiar with the site, my viewpoint has been modified. Because of their personal style and duties, the Chief technologist and the Chief Radiologist are rarely in their offices. Moreover, telephone calls placed to the main department are answered either by secretaries distant from the radiologists' and administrator's offices or by technologists in the main darkroom. Neither the secretaries nor the technologists typically know where radiologists or administrators might be and have little incentive to chase them down. Technologists who answer the phone usually do so because they happen to be nearby when the phone rings. In most cases the techs are in the middle of an exam and are waiting for films to be developed. Under such conditions techs often forget to give messages to each other. Consequently when I was told on one occasion by a technologist that she didn't know where the administrator was because it "wasn't her turn to watch him", I took offense at what I now would take to be a humorous and understandable response to an aggravation in the midst of what must have already been an aggravating day.

7. A number of researchers talk about "triangulation", the use of several methods to make findings from any one more explicit and believable (Webb et al. 1966, Jick, 1979). But fewer researchers actively attempt to triangulate. Meyer's (1982) study of hospitals facing an anesthesiologist's strike is one example. On tactics for making qualitative and ethnographic observations explicit, I have found the work of Michael Agar, (1980, 1981) and Roger Barker (1963, 1978) extremely useful. Barker's notion of the "stream of behavior" and methods for documenting it is a rare classic of qualitative empiricism in psychology too often overlooked by sociologists.

8. To preserve the anonymity and privacy of participants, transcripts of each tape have been made using a consistent coding scheme that identifies individuals by alphanumeric
symbols (eg. T1, T2 etc). Once the transcripts' codings were checked for consistency, sheets that mapped individuals onto codes were destroyed. The tapes were also destroyed after transcriptions were checked. Verbal references to individuals' identities within transcripts have also been eliminated and replaced by codes.
CHAPTER 4
DOING RADIOLOGICAL WORK: A DESCRIPTIVE OVERVIEW

Radiologists and technologists partitioned the social and technological space of the radiology departments into sectors. Radiography and fluoroscopy took place in the "main department", an area also known as "x-ray" or "diagnostics". The main department subsumed the largest proportion of the space allocated to radiology and included not only examination rooms but also the film library, the waiting room, the main darkroom, the "desk" and most of the department's offices and reading rooms. In contrast to the "main department", no single term covered the rest of radiology's territory. Rather, the remainder was broken into areas known by specific technologies: "special procedures", "CT", and "ultrasound". The term "department" was often appended to "CT" (CT department) and "ultrasound" (ultrasound department), but never to special procedures.

In daily parlance, "main" connotes the notions of "most prevalent", "central", and "most important". If one area of a radiology department was "main", the others were, at least tacitly, "peripheral". By implication, the peripheral sectors of a radiology department were those devoted to the new technologies that had been added, one by one, over the last decade. At the time the term was first coined, the three connotations undoubtedly coincided. But as the newer technologies became more numerous, more central to medical diagnosis, and increasingly important to the radiology departments' profitability, the connotations uncoupled. While the main department continued to employ
the most staff and to produce more studies, any financial, diagnostic or social connotations of greater importance had become a bit anachronistic. In fact, the "central-peripheral" distinction rested almost exclusively on physical location and size.

Specials, CT, and ultrasound were spatially as well as linguistically distinct from the main department. At Suburban, special procedures were conducted in an "angio suite" located on a hallway parallel to the main department (See Figure 5 for Suburban's floor plan). The CT department was even further away in an area built specifically to house the scanner. Though initially located near CT, Suburban's ultrasound temporarily moved to the main department in the middle of the year to await construction of new accommodations. At Urban hospital special procedures, the CT scanners, and ultrasound were all located on the same hallway. However, the hallway marked an unique space separated from the main department by the waiting room, the desk, and the "main office". (See Figure 6 for Urban's floor plan.)

Technologists are known by the area of the radiology department in which they work: "x-ray techs" staffed the main department, "specials techs" assisted with special procedures, "sonographers" or "ultrasound techs" conducted ultrasound studies, and "CT techs" ran the scanners. As Table 1 indicates, x-ray techs were the largest of the four groups at both hospitals. Moreover, as is typical of most hospitals, over 90 percent of the x-ray techs were women. Older technologists claimed that radiological technology was once a haven where a woman interested in science could pursue that interest without obtaining an advanced degree. Moreover, since males had more opportunities that paid better wages, men ceased to enter the occupation in great numbers and, over time,
Figure 5
Suburban's Radiology Department

KEY

- Bathroom
- Dressing Room
- Passboxes
- Film Processors
- R.R. Reading Room/
  Radiologist Office
- CB Control Booth
- WR Waiting Room
- Trans Transcriptionists
FIGURE 6

Urban's Radiology Department

KEY

- Bathroom
- Dressing Room
- Film Processor
- Passboxes
- Radiologist Office/Reading Room
- Waiting Area

[Diagram of Urban's Radiology Department with labels and symbols for different rooms and facilities]
### TABLE 1

Personnel at Each Radiology Department at Beginning and End of Study

#### Summer 1982

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<th>URBAN</th>
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<td></td>
<td>N</td>
<td>%Female</td>
<td>%Male</td>
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<td>Radiologists</td>
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<td>100%</td>
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<td>12</td>
<td>92%</td>
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<td>3</td>
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<td>33%</td>
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<td>4</td>
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<tr>
<td>Specials Techs</td>
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<td>67%</td>
<td>33%</td>
<td>3</td>
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<td>Administrators</td>
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<td>75%</td>
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<td>Nurses</td>
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<td>0</td>
<td>1</td>
</tr>
<tr>
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<td>.</td>
<td>1</td>
</tr>
<tr>
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<td>86%</td>
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<tr>
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<td><strong>57</strong></td>
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#### Sprin 1983

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<td>6</td>
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<td>19%</td>
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<td>Sonographers</td>
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<tr>
<td>CT Techs</td>
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<td>20%</td>
<td>80%</td>
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<td>33%</td>
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<td>75%</td>
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<tr>
<td>Fluoro Aide</td>
<td>.</td>
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<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54</strong></td>
<td></td>
<td></td>
<td><strong>60</strong></td>
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radiological technology gradually became predominantly female work. The few males that remained were most likely to be found staffing the newer modalities. At Suburban and Urban hospitals respectively, 67 percent and 80 percent of the male technologists were, at the end of the study, either a specials tech, a CT tech, or a sonographer.

Specials techs and CT techs were always former radiological technologists who had been promoted. Often the same was true of sonographers, however exceptions were more common in ultrasound. The first sonographers included nurses, individuals with bachelor's degrees in biology, and persons who learned the technology by apprenticeship. In the late 1970's sonographers moved to gain occupational recognition from the American Medical Association by requiring formal training and certified registry. The movement was successful. As of May 1983, only graduates of accredited training programs in ultrasound could become registered sonographers. However, with the exception of the sonographer who worked at Urban hospital during the first half of the study, none of the sonographers I observed had trained in formal programs, and all but two were former x-ray techs. Consequently, most specials techs, CT techs, and sonographers could, and at times did, double as x-ray techs, but the opposite exchange was impossible.

Unlike technologists, radiologists were not formally associated with technologies. In theory, radiologists could use all technologies, or at least interpret the images they created. However, as will be discussed in a later chapter, a technologically driven informal division of labor existed among the radiologists even though no formal division was recognized. Radiologists at both hospitals rotated through the various areas on a daily basis so that their tasks varied from day to
day. In contrast to the population of technologists, all radiologists in both departments were males.

In addition to radiologists and technologists, members of several other occupations rounded out the departments' rosters. Both departments began the study with one nurse and ended the study with two. Nurses assisted with special procedures, and at Urban they also administered injections for intravenous pyleograms and CT scans. Each department had a number of orderlies (called "couriers" at Urban) who transported inpatients to and from the radiology department and who performed a countless number of other odd and thankless jobs. A darkroom technician maintained the departments' film processors and developed films taken in the main department. Secretaries handled the main department's bookings and most of its paperwork with the exception of reports that radiologists dictated on the studies they read. Reports were typed by transcriptionists. Clerks maintained the film libraries, and at Urban hospital, sorted films into folders for radiologists to read. Suburban hospital employed an additional person who sorted and carried routine studies to radiologists when they were completed. Urban hospital differed from Suburban in that it also had a "fluoro aide" who assisted with fluoroscopy. Both departments were administered by x-ray techs who had been promoted to supervisory positions.

Having introduced from a distance the organization and actors of a radiology department, I shall now move in more closely to describe in detail the actions that defined the use of each technology. My intention is to foster a finely grained understanding of how each area of a radiology department executes its work and of what that work
consists. The following accounts of how particular procedures are performed form a background against which later analyses are set.

The Main Department

The daily round of work in a main department is partitioned by types of exams performed on particular machines in particular rooms during specific times of the day. Since barium enemas, upper gastro-intestinal studies, and gall bladder examinations (the bread and butter of fluoroscopy) all require patients to fast before they can be properly executed, both departments reserved mornings for "fluoro." To take advantage of the fact that people do not eat while sleeping and to relieve patients of having to fast beyond lunch on the day of the exam, fluoroscopic studies usually began by 7:30 AM, and continued non-stop until the day's schedule was complete. Although most studies were barium enemas and upper GI's, other less numerous fluoroscopic exams that did not require fasting were also scheduled during the morning hours, to take advantage of the radiologist's ready availability. Thus, in between barium enemas and upper GI's occurred the occasional "cardiac fluoro" or "t-tube". Since intravenous pyleograms (IVP's), contrast enhanced radiographic studies of the urinary tract, also require fasting, they too were morning work.

At Suburban all fluoroscopy occurred in Room 3 and Room 5 (see Figure 5). IVP's usually took place in Room 4 where the x-ray equipment was capable of "linear tomograms" (to be explained below). However, if the equipment in Room 4 malfunctioned, or if the day's fluoro schedule was light, IVP's could be shifted to Room 5, where linear tomograms
could also be produced. At Urban, Fluoro Room 2 and Fluoro Room 3 were
dedicated to the morning’s schedule of barium enemas and upper GI’s (see
Figure 6). Most of Urban's IVP's happened in Room 3, but when the
schedule was heavy, the polytome room next door was pressed into
service.

In both main departments afternoons were given to mammograms,
tomograms, and subspecials. Mammograms are radiographic studies of the
breast most often used to diagnose mammary cysts or cancers. Since
mammograms were held to be psychologically traumatic for patients and
since they also involved photography of women's breasts, males other
than radiologists were not allowed to observe. At Suburban, mammograms
were performed in Room 4, at Urban, in Room 1.

When physicians wished to scrutinize successive slices through an
anatomical structure, for instance the spine, they order tomograms. A
tomogram is an x-ray film that clearly images only structures lying on a
given plane through the body. By varying the point at which x-rays
converged (the "focal spot"), slices could be taken through the body at
different planes parallel to the top of the examination table. In
contrast to regular x-rays during which the tube remained stationary,
tomograms were created with the tube in motion. The motion obscured all
structures that did not lie on the designated plane. Linear tomograms
were produced when the tube moved lengthwise above the long axis of the
table. Other types of tomograms were created when the tube traced a
circular or elliptical path. Both departments had recently purchased
advanced tomographic devices, housed at Suburban in the "tomo" room and
at Urban in the "polytome" room.
The term "subspecial procedures" refers to a host of invasive studies which were neither as risky nor as complicated as angiography or other special procedures. Whereas specials typically involved catheterization, subspecials required no more than the injection of a contrast agent. Arthograms and venograms were by far the most frequent subspecials performed in either radiology department. Arthograms were used to diagnose damage to muscle and cartilage of the knee and elbow. During an arthrogram iodine dye and air were injected into the joint. The joint was then viewed on a fluoroscope while a radiologist or technologist "stressed", moved the arm or leg into a number of positions to open the joint for filming. Venograms were studies of the veins in the arms or legs that revealed venous occlusions characteristic of such diseases as flebitis. During a venogram the radiologist inserted a needle into a vein in the foot and injected iodine dye. The technologist then took x-rays of the leg as the dye coursed though the veins. Subspecials at Urban normally occurred in Fluoro Room 1 and were most often performed in Room 5 at Suburban.6

Of all the studies performed in the main department, only "routines" were scheduled for no particular time of the day. "Routines" covered a large number of studies that included most of what laymen mean by the term "x-ray". Routines required no contrast agents, involved no fluororscopy, and were known by the part of the body to be filmed: chests, toes, hands, ankles, spines, sinuses, etc. Each study was composed of a standard set of films taken from specified angles known as "views". Routines comprised the largest proportion of a main department's case load, and were performed round the clock, seven days a
week on a "first come, first serve" basis. Routines were the staple of Rooms 1 and 2 at Suburban and Rooms 2 and 3 at Urban.

X-ray techs rarely specialized in one particular type of study or worked consistently in one particular room. Rather, Suburban's techs rotated daily through various duty assignments, while Urban's rotation was biweekly. In both departments, the duty schedule was drawn up by the Assistant Chief, although individual techs could request particular days off or specific assignments if they had substantive reasons for their request. For example, if pregnant, a technologist would not have to work in fluoroscopy where exposure to radiation was greater than elsewhere in the main department. Techs also traded duties informally among themselves.

At Suburban, an x-ray tech could be assigned to the following stations: fluoroscopy, IVP's, mammograms, tomography, outpatients, the emergency room, the operating room, and portables. The first four stations have already been briefly mentioned. The last four referred to locations where routines were performed. The "outpatient" area was part of the main department. The term was, however, somewhat misleading. While all persons who came to the hospital exclusively for routine x-rays (eg. outpatients) were handled by techs working "outpatients", the outpatient area also x-rayed newly admitted patients requiring chest films as well as most other inpatients who could "travel".

In both hospitals, the emergency room and the operating room were equipped with x-ray machines. Techs assigned to the emergency room took films to support the diagnosis and treatment of trauma cases, for example, persons who had broken bones or suffered gunshot wounds. When assigned to the operating room, techs remained available in the "OR"
during surgery and produced films requested by surgeons as the operation progressed. Finally, "portables" referred to taking x-rays of bedridden patients confined to a ward. Each department owned several portable x-ray machines, mounted on motorized chassis. When doing portables, techs took the portable x-ray machine onto the floors and filmed patients as they lay in bed. Portables were known as "hard work" because of the patients' immobility, the likelihood of finding no one on the floor to assist with moving the patient, and the absence of technological aids common to most stationary machines.

For the most part, duties at Urban matched those at Suburban. However, Urban assigned particular techs to subspecial procedures when Suburban did not. Techs at Urban also rotated through a station known as the "MOB", the Medical Office Building. Techs assigned to the "MOB" spent the day working two x-ray rooms in an outpatient clinic attached to the hospital. No similar duty existed at Suburban since the medical office building with which Suburban's radiologists were associated was separate from the hospital. The radiologists hired technologists to work specifically in their private practice and drew on techs from the main department only when they need extra help.

Since it is neither possible nor necessary to discuss in greater detail the social organization of all the procedures performed by x-ray techs and radiologists in the main department, the remainder of this section concentrates on procedures that compose the bulk of the main department's work. Routines and IVP's represented the most frequent types of radiographic studies, while barium enemas and upper gastro-intestinal exams were by far the most numerous of the fluoroscopic procedures. Since the social organization of the barium
enema was similar to that of the upper GI, I shall omit discussion of the latter.\textsuperscript{8} Taken together, these three types of radiological work provide suitably representative samples of a main department's work.

Routines

When assigned to outpatients, technologists at Suburban stationed themselves in the film library adjacent to the main desk and across the hallway from Room 1 and Room 2 where routine x-rays were taken (see Figure 5). At Urban, techs waited in the alcove between the waiting room and the two examination rooms they used for routine x-rays (See Figure 6). Both locations placed the technologists near the scene of impending action, but strategically out of sight of patients seated in the waiting areas. In the morning, the outpatient area was staffed only by those technologists formally assigned to the area. However, after the morning's fluoro exams and IVP's were finished, technologists not assigned other duties usually migrated to the outpatient area to pick up work. In the afternoon, then, the film library at Suburban and the alcove at Urban became social centers of gravity. Later in the day it was not uncommon to find up to six technologists congregated in either location.

Routines were erratic work. Individual outpatients and new admissions arrived throughout the day for x-rays in no predictable pattern. At the same time, inpatients tended to come in spurts. Requisitions for studies ordered by doctors typically accumulated on the wards until collected and brought to the main department (usually by an orderly). Once the requisitions arrived, orderlies were sent to the
floors to retrieve patients. No one could predict whether an influx of inpatients would coincide with a rush of outpatients. Consequently, doing routines was a waiting game played across periods of idleness punctuated by briefer periods of frenetic activity. Given the number of techs who waited for patients in the outpatient areas, on a "slow afternoon" an individual technologist might perform no more than two or three studies in a four hour period.

As they arrived, outpatients were supposed to approach the desk and notify the secretaries of their presence. After supplying the secretary with personal information, the patient seated himself in the waiting area while the secretary typed a requisition and a "darkroom card". Techs would later use the card to label the patient's films. The requisition included information on the patient, the type of study requested, the number of films, and presumably a brief medical history recounting the reasons for the patient's referral. In practice, the history was usually missing or scant since physicians regularly neglected to provide much information on the forms that patients brought to the x-ray department.

Standard procedure at Suburban dictated that typed requisitions would be placed in one of five slots outside the door to the film library reserved for routines. To keep track of the queue of patients, an individual's requisition was to be moved down the row of slots as new patients arrived. Though the system was used occasionally during busy periods, techs typically intercepted requisitions hot off the typewriter by standing at an open window between the secretaries's office and the film library (See Figure 5). Except when couriers delivered a bundle of requisitions to the alcove directly from the floors, technologists at
Urban walked to the desk to pick up requisitions as soon as they were typed.

With requisition in hand, the tech began the procedure by summoning the patient. Outpatients were usually found seated in the waiting room while inpatients waited in wheelchairs or on stretchers along the wall of the corridor opposite the film library or alcove. Orderlies placed patients along these walls to signal technologists that they were waiting for an exam. When the study was complete, the technologist parked the patient along the opposite wall to signal the orderly that the patient was ready to "go back up."

Female outpatients having x-rays of the chest or abdomen would now be led to a dressing room to "slip into a johnny". Males, however, were not asked to wear johnnies unless a lower abdomen film was required. Rather, once inside the examination room men would remove their shirts and, if need be, unbuckle and lower their pants ever so slightly. Changes of garb were never necessary for inpatients who always wore johnnies or pajamas. However, because metal objects ruined films, the techs inspected pajamas for metal snaps or buttons. For similar reasons, techs asked patients to remove their jewelry before beginning a procedure.

After leading the patient into the examination room and shutting the door, the tech began immediately to position the patient for the first film. Only chest films were taken with the patient standing. Except for films of the hand or wrist which were taken with the patient resting his arm on the table while seated in a chair, most other studies required patients to lie on the table. If the patient was a "walkie-talkie", an "ambulatory" individual, getting the patient to
mount the table required no more than an appropriate instruction. However, patients traveling in wheelchairs or on stretchers presented greater difficulties, especially when infirm or incognizant.

Since it was hospital policy that all inpatients be moved from place to place in a wheelchair regardless of how nimble they might be, wheelchairs signaled that the patient could be infirm, but probably had power of self locomotion. However, the inference was not always accurate. For surgical patients, the elderly, and the seriously ill, moving from the chair to the table was a laborious chore. When patients appeared infirm, the tech readily assisted, coached and encouraged them out of the chair and onto the table. Techs moved stretchers next to the examination table, and adjusted their height so that the patient could slide onto the table. If the patient could not wiggle onto the table, the technologists summoned assistance by walking into the hallway and calling for "lifting help". On hearing the call, three or more technologists and orderlies entered the room and took up positions around the table and stretcher. On command, the group literally lifted the patient onto the table using the stretcher's sheet as a litter. Lifting inevitably elicited from patients in pain a barrage of protests, complaints, or curses. Once the patient had been moved, the help disappeared within seconds leaving the tech alone with the patient. In the process of lifting, technologists sometimes wrenched their back as occurred on several occasions during the research.

With the patient on the table (or immediately after entering the room in the case of a chest x-ray) the technologists began to position the patient, the first of two technical skills on which the occupation of radiological technology was founded. To position was to orient the
patient's body in relation to the x-ray tube so that the "area of interest" could be filmed from a prescribed point of view. When positioning a patient, the technologist first molded the patient's body into a particular stance or pose. For example, in a standing "lateral chest film", patients stood sideways in front of an "overhead tube" (an x-ray tube suspended from a track mounted on the ceiling) and placed their arms on top of their heads, or held onto an elevated bar to keep their arms out of the picture. A "right anterior oblique" film of the abdomen required patients to lie supine on an x-ray table, to turn slightly up on their right side, and to move their arms above their head. Positioning was often accomplished by much coaching and persuading, particularly when the patient was in pain. If patients had extensive difficulty assuming a positions on their own, techs physically shaped the patient's body into the pose they desired.

With the patient posed, technologists refined the position by "lining up" the film. All x-ray tubes have "field lights", lamps, which when turned on, project a rectangular area of illumination bisected by horizontal and vertical shadows that form a pattern resembling the cross-hairs of a rifle scope. The technologist adjusted the patient's position by orienting the shadows to anatomical features that serve as the position's landmarks. For example, in an "anterior-posterior" film of the lower abdomen, the vertical shadow traced the midline of the patient's torso and the horizontal shadow fell approximately one inch below the crest of the illium (the highest bone in the pelvic girdle). This placement increased the odds that the spinal column would bisect the film's longitudinal axis and that the lower abdomen would be squared to the edge of the film.
Lining up a patient to perfect a position often necessitated moving the patient's body so that the "area of interest" was properly "centered". Since obese or "uncooperative" patients were difficult to move even a distance of no more than an inch, techs preferred x-ray tables with "floating tops", a relatively new invention. With a floating top, the tech simply stepped on a foot pedal and shifted the table along the vertical and horizontal axes of its base. Hence films could be centered by moving the table rather than the patient. Both tables used for routines at Suburban and the table in Room 3 at Urban had floating tops.

With the patient positioned the technologist either "opened" or "coned down" the field by shifting the tube's "collimators," lead strips located in the tube's housing. Collimators blocked electrons and shaped the size of the field to the film. The position of the collimators and the size of the film were both determined by the area to be imaged. To continue an earlier example, an "A-P" of the lower abdomen that captured the ureters and bladder as well as the kidneys, required a 14 by 17 inch film and a field opened up to cover the entire pelvic area. If only the kidneys were of interest, the technologist coned down and used a smaller film.

Most x-ray tables used films housed in "cassettes": thin, rectangular, metal boxes slightly larger than the film itself. Before an x-ray could be taken, the technologist had to insert the sized cassette in the table's "bucky", a mechanical frame that moved the cassette in and out of position beneath the table. After laying the cassette in the bucky, the tech taped her "marker" to its lower right or left hand corner. Markers consisted of lead letters: the tech's
initials and either an "R" or an "L". The letters indicated which technologist produced the film as well as the right or left of the patient's body. After placing her marker, the tech pushed a button to withdraw the bucky to its position beneath the table. Tables were constructed so that the bucky moved in tandem with the tube thereby ensuring that the film lay directly in the path of the x-rays.

Techs had to lug their own cassettes to and from the darkroom. Since most cassettes were made of metal, it was difficult for techs to carry more than four or five at a time. However, newer x-ray machines were equipped with automatic film changers and processors. These tables stored quantities of films of various sizes. When the technologist selected a film by pushing a button on the side of the table, a vacuum sucked an unexposed film into position beneath the tube, and then automatically fed it into a film processor once it had been exposed. In less than a minute after exposure, a fully developed film appeared in the bin at the table's foot. Since the technology eliminated the need to "run cassettes" or wait for films, technologists preferred such equipment. The tables in both outpatient rooms and Room 3 at Urban were equipped with automatic processors and film changers.

While positioning, techs conversed more or less constantly with the patient about the pose the patient should assume. When satisfied with the position, the tech told the patient that she was about to take the film and that he should not move until the film was over. The technologist now walked quickly to the control panel located either in a leaded booth inside the examination room in the hallway outside. At the control panel, the technologist "set a technique."
Setting a technique, the second technical skill undergirding the technologist's occupation, essentially involved selecting three parameters of an x-ray tube's operation: kilovolts and milliamperes to define the electrical current applied to the tube's cathode as well as the number of seconds the tube would fire. Very loosely speaking, the technique determined how long the tube emitted how many electrons traveling at what speeds. Setting techniques was the technologist's art. "Too much technique" and the area of interest was "burned out", that is the film would be "too dark" for the structure to be seen clearly. Alternately, "too little technique" and films would be "too light" to read. In either case, films would have to be repeated.

In setting a technique, technologists weighed a number of variables: the part of the body to be imaged, the idiosyncracies of the particular machine, the type of film used, the patient's size and body weight, and in some instances, the likelihood that the patient would move or breathe during filming. While it is certainly possible to define equations that can pump out techniques given certain parameters and although techs learned such equations in school, in practice, technologists forgot the equations and learned to set techniques experientially by forming their own tacit theory of technique setting. As aids technologists developed "technique charts" that prescribed the range of settings found useful for particular studies on a specific machine. But even with technique charts, the grey areas were still numerous.

After setting a technique, technologists commanded: "hold your breath". The tech immediately shut the door to the control room (if there is a door to shut) and triggered the x-ray tube with a hand held
rotor. The tube whirred and the film was taken in a fraction of a second. On reentering the room, the tech told the patient to "breathe", walked quickly to the table, replaced the exposed cassette, transferred her marker, and began to position for the next film. From this point forward, each additional film followed much the same sequence of steps as the first.

When she completed the series of x-rays, the tech scrutinized each film to ensure that it was neither too light nor too dark, and that she had captured the area of interest. When using an automatic table, the tech needed merely to remove developed films from the bin at the end of the table and hold them to a light source.Films that were deemed inadequate were taken over. If all films passed muster, the technologist helped the patient off the table (or called for lifting help) and out into the hallway. If the technologist had been using cassettes, and if patients were waiting, she might allow the patient to leave the room at the end of the examination. However, the patient would not be "sent" until the tech had reviewed the films. If the outpatient area was not busy, the tech simply told that patient that she was going to develop the films and that she would return shortly. The technologist then carried the cassettes to the darkroom's passboxes.

Passboxes were metal boxes embedded in the wall of the darkroom. Each passbox had two doors, one that opened into a hallway and another that opened into the darkroom. At Suburban, technologists placed cassettes and the patient's darkroom card in the passbox and then alerted the darkroom technician by shouting through the passbox. The darkroom technician marked the films with the patient's darkroom card, opened the cassette, removed the film, put it into a processor, reloaded
the cassette, and returned the reloaded cassette to a passbox earmarked for unexposed films. At Urban, technologists marked their own films with the patient's card before passing cassettes to the darkroom. To identify films, techs placed the darkroom card in an appropriate slot at the top of an "ID camera" and slid the cassette's left hand corner into another slot at the camera's bottom. The camera automatically opened a panel on the face of the cassette. Light passed through the card to imprint its image on the lower corner of the film. After labeling the films, the technologists passed the cassettes to the darkroom technician.

At both sites technologists now waited for developed films to emerge from the film processor. Like passboxes, film processors were embedded in the darkroom's wall. The person in the darkroom placed an exposed film into the processor. A system of rollers drew the film through photographic chemicals and a drying process. After it had been developed, the film fell into a bin in the next room. Techs removed films from this bin, hung them on light boxes, checked their adequacy, and ensured that the area of interest was properly centered. If the films were adequate, Urban's techs simply initialed the requisition and turned the films over to a clerk in the sorting room who placed them in a plastic folder along with the patient's requisition. The folders would be picked up by a radiologist to be read at some later time. At Suburban the technologist batched the films herself and left them in a designated pile for a clerk to take to a radiologist for reading.

If the tech had not already done so, she now returned to the examination room to take the patient off the table. If a radiologist needed to review the films before the patient could leave, the tech
asked the patient to wait outside. At Urban, patients were rarely held until a radiologist read the films, but the practice was more common at Suburban. After Suburban's clerk took the films to the radiologist for a reading, she either dismissed the patient or informed the technologist that the radiologist wanted additional films. Note that in either case, neither technologists nor patients interacted with radiologists during a routine.

Intravenous Pyleograms (IVP's)

Intravenous pyleograms, or IVP's, are radiographic studies of the urinary tract. Since the kidney, the ureters, and the bladder are soft tissue structures, they can not be seen distinctly on routine films. To more sharply distinguish the urinary system, during an IVP, radio-opaque iodine dye is injected into the blood stream. The iodine collects quickly in the kidneys which remove the dye from the blood and pass it through the ureters to the bladder for secretion. Since the physiological process is rapid, it is possible to film the flow of the dye through the whole urinary system in a relatively short period of time.

Patients suspected of having kidney stones, hydronephrosis, or other problems that might affect the operation of the urinary system were candidates for IVP's. Since most patients had scheduled appointments, when the morning's work began technologists knew roughly how many IVP's they would perform and approximately at what time exams would begin. "Add ons," last minute appointments, were not uncommon however, since patients suffering from the severe pain of kidney stones
often arrived at the emergency room in the morning after a night of intense agony.

As with most other examinations, the technologist first greeted the patient, then led him into the examination room and instructed him to lie supine on the table. Moving patients to the table from a wheelchair or stretcher was fraught with the same contingencies and problems encountered during routines and was handled in the same manner. Once the patient was on the table, the tech usually offered small tokens of hospitality aimed at making the patient comfortable: a pillow, a blanket, or a pad for beneath the knees.

After the opening amenities, the technologist oriented the patient in the center of the table so that his body was parallel to the table's sides and perpendicular to its foot. If the patient was unable to move, the tech centered him herself by pulling the sheets on which he lay. As technologists manipulated the patient's body into position they usually struck up conversations. Though they might discuss the patients' health, the restfulness of the patient's previous night's sleep, and a host of other incidental topics, within the first five minutes, techs always asked if the patient had previously experienced an IVP. The question served two purposes: it told technologists whether they would have to explain the exam and it began a line of questioning designed to find out if the patient was allergic to iodine.

Rapid ("bolus") injections of iodine had several typical side effects. As the iodine flowed through the blood stream, patients experienced intense warmth, sensed a "fishy" taste in their mouth, and became nauseous. All of these symptoms were understood by techs and radiologists to be minor, fleeting, and largely unimportant. However,
within a matter of seconds after the injection, patients allergic to 
iodine developed a severe case of hives and exhibited other symptoms of 
toxic shock. In extremely rare situations the dye could cause heart 
failure and even death.¹⁰

With these consequences in mind, when patients admitted to having 
had a previous IVP, techs nonchalantly asked, "How did it go?" or "Did 
it give you any problems?" In response, patients typically described 
common side effects. If the patient did not mention hives or another 
symptom indicative of a severe allergy, the tech assumed that the 
patient was safe, for a severe reaction was unlikely to be forgotten. 
Patients having their first IVP elicited a second string of questions 
aimed at uncovering the patient's allergies. Most important was whether 
the patient "could eat seafood." As natural sources of iodine, an 
allergic reaction to fish and shellfish indicated potential problems 
with the dye. Regardless of the patient's answers, technologists never 
mentioned what allergic reactions were like. If she had reason to 
expect that a reaction might occur, the tech informed the radiologist 
who in most cases decided to cancel the procedure and recommend 
ultrasound.¹¹

At this point, technologists at Suburban briefly explained the 
procedure to patients having their first IVP, while technologists at 
Urban usually waited until they had taken "scout films." At both sites, 
however, the script was much the same. If the patient had had a 
previous IVP, the tech merely noted, "then you know what its all about 
then." First timers received a quick precis such as the following 
explanation provided by a tech at Suburban:
This exam is for your kidneys. What we'll do is take a
couple of pictures and then the doctor will come in and
inject some contrast into your arm and then we'll take
some more pictures. The injection will help us see your
kidneys, ureter, and bladder better so that we can find
out why your having this pain. All you have to do is lie
there.

Some techs told patients that the dye might make them feel "a little
warm" or "a little flush" or that they might get a "fishy" or "metallic"
taste in their mouth. Other techs waited until the injection was about
to occur before clueing the patient to possible side effects. Techs
might also describe the exam as "simple" or "easy". When patients asked
how long the procedure would last, technologists usually gave an
estimate ranging between 20 and 30 minutes.

As they conversed, the technologist began to position the patient
for the first "scout film": an anterior-posterior view of the lower
abdomen known as a "KUB" a film that simultaneously captured the
"kidneys, ureters and bladder". Scouts allowed technologists to verify
their techniques and to ensure that the area of interest was centered
before the injection occurred. Scouts also provided radiologists with
an "unenhanced" or pre-contrast view of the urinary system. Since KUB's
were "plain" films, the tasks of positioning, setting a technique, and
filming were identical to those described in the last section.

Following the KUB, the technologist "set up for" a tomogram scout
by closing the tube's collimators until the top of the field light's
rectangle cut the patient horizontally at the level of the first rib and
its bottom fell across the crest of the ilium. Now, only the kidneys
would appear on the film. After perfecting the position and changing
the cassette, the technologist warned the patient: "During this next
picture, the tube will move above your head. Don't be alarmed, it won't hit you." Before leaving the patient's side, technologists set the level of the tomogram (e.g. the number of centimeters above the top of the table that defined the plane of the slice). Ideally, the level would be set for the precise center of the kidneys. Although devices existed to measure the appropriate level, most technologists estimated the level rather accurately by merely examining the patient's girth.

Having readied the patient and the tube for the tomogram, the technologist positioned herself at the control panel which was outside the IVP room at both sites. After setting a technique and switching controls to tomographic mode, the tech told the patient, "hold your breath," quickly shut the door to the room, and triggered the tube. The tube swung first toward the patient's head, then towards the patient's feet, and finally came to rest above the center of the table. As the tube's movement ceased, the tech opened the door and told the patient to "breathe." After replacing the cassette, the tech took leave of the patient ("I'm going to have these films developed and then I'll have the radiologist look at them before he comes in to give you the injection.") to carry the scouts to the passbox.

From the passbox, techs usually returned to the examination room to fill syringes and prepare other implements for the upcoming injection. Rule of thumb in both departments dictated that patients receive at least 50 cc's, but no more than 90 cc's of contrast, with the exact amount determined by the formula: half a cubic centimeter for every

* The tube, is mounted on a column attached to the table. The column's movement during a linear tomogram causes the tube to inscribe an arc above the patient's body.
pound the patient weighs. Since most patient's were adults and since 30 cc syringes were used, techs typically "drew up" three syringes of contrast. As they observed techs filling syringes, patients asked, with surprising regularity, how much contrast would be injected. With equal regularity the tech underestimated the amount by approximately 20 to 30 cc's and assured the patient that "it's really not that much". Once filled, the techs placed the syringes in a bed pan along with a "butterfly needle", an alcohol prep, a bandaid, and a tourniquet. The bed pan was then placed by the side of the table to await the radiologist.

After filling the syringes, the tech once again took leave of the patient to retrieve her scouts. By now, the films were usually waiting in the film processor's bin. As she took the films from the bin, the technologist held each to a light box to check her technique and to make sure that she had not "cut off the kidneys." Some imperfection might send the tech back to the examination room to repeat a scout before summoning a radiologist. If the films passed muster, the tech set out to find a radiologist who would review the films and inject the patient.

Although Suburban's radiologists were most often found in their office, techs had to search frequently enough that the task of finding a radiologist was reputed to be the most difficult aspect of the tech's job. Radiologists assigned to the main department could be involved with a barium enema or another activity at the time the tech went searching. Even if the radiologist was in his office, another tech might have already engaged him, or he could be in the process of consulting with a physician. On such occasions techs had to wait. Waits ranged from one minute to twenty minutes depending on what the
radiologist happened to be doing and on the number of radiologists in the department.

The radiologist working Urban's fluoro area injected IVP's. Since the radiologist remained in the fluoro area through most of the morning, techs doing IVP's usually had no difficulty finding a radiologist. However, since he was likely to be involved with a BE or an upper GI at the time the tech arrived, she might have to wait up to 20 minutes before the radiologist could review the scout.12 Moreover, since the radiologist's presence in the fluoro area was no secret, physicians also knew they could have films read between examinations. If a physician arrived, the tech would have to wait even longer, for the radiologist would attend to the physician before turning to the IVP.

Once the technologist secured a radiologist, their interaction usually lasted no longer than a minute. The tech gave the radiologist the films or hung them on a light box for him to read. While the radiologist examined the films, the tech reviewed the patient's symptoms and whatever other facts she deemed pertinent. On occasion, the radiologist might call the tech's attention to a structural abnormality such as a kidney stone. But more frequently, the radiologist critiqued the technologist's choice of technique and passed judgement on the accuracy of her positioning. If the radiologist thought that the quality of the film was unsatisfactory, he requested another scout before assenting to the injection. The encounter usually ended with the radiologist telling the technologist at what levels he wanted future tomograms taken.

The radiologist now accompanied the tech back to the examination room, where he introduced himself and inquired briefly about the
patient's symptoms. As the radiologist spoke, he tied a tourniquet around the patient's upper right arm and rubbed or patted the inside of the patient's elbow to raise veins at the site of injection. In the meantime, the technologist stood beside the radiologist and assumed the role of silent assistant who passed alcohol preps, butterfly needles and syringes to the radiologist as they were needed. Just before he inserted the needle, the radiologist warned the patient, "Ok, you're going to feel the needle now," "a little pinch," or more simply, "Here we go". If inserted correctly, blood backed up into the tube attached to the butterfly. Upon seeing the blood, the tech handed the radiologist the first syringe which he attached to the tube. As the radiologist began to inject, the tech taped the needle to the patient's arm and the doctor usually told the patient, "you might feel a little warm". When radiologists forgot to issue the warning, the technologist did. The injection continued until all syringes were emptied. After injecting the final syringe, the radiologist remarked that the tech would now take a few more films and that he would leave the needle in the patient's arm while the films were being taken. At this point the radiologist typically left the room having been with the patient no more than three minutes.

The radiologist's departure triggered a flurry of activity. Almost immediately the technologist took the "zero minute films". At Suburban, zero minute films consisted of three (later in the year, two) tomograms taken through three successive levels of the kidney. Only one tomogram was usually taken at Urban, however, the rule of thumb depended on which radiologist was on duty. Some radiologists demanded other zero minute films including a KUB. Five minutes after the injection, the techs at
Suburban took a KUB, while the techs at Urban took Left and Right Posterior Obliques (see section on Routines for a description).

Finally, ten minutes after the injection, techs at both sites filmed a second KUB. Throughout this series of films, the techs worked quickly to change cassettes, transfer markers, and set techniques so that the films would occur at appropriate intervals. Since patients were most likely to experience the side effects of the dye immediately after the injection, between films techs repeatedly asked patients how they "were doing" and reassured them that the sensations were normal as well as brief. By the time the ten minute film had been taken, most patients admitted to "feeling much better". At this point, the technologist usually removed the needle which had remained in the patient's arm during the filming. When she was sure that the patient was in no serious difficulty, the tech took leave of the patient and carried the films to the passbox.

Most techs now waited by the processor until the films were developed rather than return to the examination room. After checking the developed films for technical flaws, the tech once again sought the radiologist. Depending upon what the films revealed, the radiologist might ask for additional, "follow-up films" or else tell the technologist that she could conclude the exam. Follow up films were most often requested when the bladder was not visible in the 10 minute film and were taken to gauge the severity of a ureter's blockage. The technologist continued to take follow-up films and show them to the radiologist until he told her that she could allow the patient to leave.

Once the radiologist had deemed the examination over, the technologist returned to the examination room to take a "pre-void" film:
a coned down "anterior-posterior" or "posterior-anterior" view of the bladder (depending upon which radiologist happened to be doing the study). After the "pre-void" film, the technologist helped the patient off the table and into the bathroom where the patient was told to "void". Infirn patients were given a urinal or bed pan and told to void on the table. While the patient was in the bathroom, the tech carried the pre-void film to the passbox. When patients left the bathroom, the techs helped them mount the table once again for a "Post-void" film, a coned down, A-P view of the bladder. Patients were told that the post-void was to see "how well you emptied out". Following the post-void, the technologist helped the patient off the table, and if necessary into a wheelchair or gurney. Outpatients were simply directed back towards the dressing rooms.

Barium Enema

Of all the procedures a technologist could be called upon to perform, the barium enema (BE) was least preferred. Barium enemas were, quite literally, the x-ray tech's "dirty work". Not only did the examination frequently result in patients defecating on the table or the floor, but since BE's involved fluoroscopy, they exposed the technologist to more radiation than routines, IVP's, or other studies consisting solely of static films and tomograms. Moreover, barium enemas were reputed to be an elderly patient's examination since the elderly were more likely to suffer from intestinal maladies such as diverticulitis or polyps, two common problems diagnosed by the enema. From the technologist's point of view, the elderly were difficult to
manage not only because they might be senile and infirm, but more importantly, because they were thought to have less control over their sphincter muscles and therefore, more likely to "evacuate" on the table.

Regardless of whether the elderly represented a high proportion of fluoro patients and whether the problems of doing a barium enema on an elderly patient were as real as technologists believed, it was clear that few techs relished the procedure. Technologists referred to the procedure by epithets such as the "poop-o-gram," and claimed that administrators assigned techs to BE's as punishment. Beside the door to Urban's Fluoro Room 3 hung a sign attesting to the technologist's sentiments about the work:

Nobody Loves THE ENEMA

No one recalled who created the neatly printed sign, but for several years the memento had greeted all who passed through the portal.

Although the actual execution of a barium enema was similar at both sites, since Urban and Suburban organized fluoroscopic work differently the work role of techs in the two departments differed. At Suburban, techs were assigned to one of the two fluoro rooms. The person "on films" allocated patients to the two rooms as they arrived for their scheduled appointments. As with IVP's, this individual also ensured that outpatients had changed into johnnies and that all patients were waiting outside the assigned room by the time the previous exam ended. Radiologists on fluoro duty worked out of their offices. When techs
required the radiologist's assistance they needed to summon him. Techs assigned to fluoroscopy worked individually and beyond the allocation of patients to rooms, no attempt was made to coordinate exams. The two fluoro rooms operated as independent entities.

Fluoroscopy at Urban took place in two rooms located side by side at the far end of the radiology department (See Figure 6). Each morning a radiologist assumed responsibility for fluoroscopy and remained in the area until lunch, or until the morning's schedule was complete. Although techs were nominally assigned to one of the two rooms, in practice, the two fluoro techs shared the work of both rooms. On arrival, patients were sent by secretaries to the waiting area near the fluoro rooms. The techs called the patients from the waiting area and made sure they are wearing johnnies by the time the exam was ready to begin. Because the radiologist was readily available and because the technologists collaborated, the two rooms operated in tandem. On the ideal, but admittedly rare, day when no unexpected lags were encountered, the pace of work was extremely rapid. As fluoroscopy in one room ended, the other began. Since Urban's daily fluoro schedule was twice as heavy as Suburban's and since the pace was quick, the fluoro area had the hectic aura of non-stop patient processing."

In addition, Urban employed a "fluoroscopy aide", a woman in her mid-forties, who assisted technologists and radiologists on fluoro duty. Urban's more finely divided system of labor instanced E. C. Hughes'__________________

" During the month of April 1983, Suburban performed, on average, 4 BE's and 4 UGI's daily. During the same period, Urban averaged 7 BE's and 9 GI's daily. Since both departments used two rooms and attempted to finish all fluoro by noon, the pace at Urban was roughly twice as fast. (The data are taken from daily schedule sheets).
(1958) contention that occupational prestige is reckoned by pecking orders created as one occupational group passes its "dirty work" on to a more subservient position. Just as technologists performed work that radiologists would avoid, so the aide played subordinate to the techs. The aide assumed the more unpleasant aspects of enema work that Suburban's technologists performed for themselves. She prepared the enema bags, inserted enema tips into patients' rectums, cleaned when patients evacuated on the table and, more often than not, assisted the radiologist during fluoroscopy.

Because of the fluoro aide, Urban's techs were free to devote themselves solely to coordinating patients, taking scouts and overhead films, developing films, and monitoring machines and supplies. Whereas Suburban's technologists followed the patient through the whole exam, Urban's techs frequently came into contact with particular patients only when films were needed. Of course, the division of labor was not absolute, and in times of increased activity, or when the aide was absent, the techs performed duties otherwise left for the aide. Tech's at Urban had clear ideas of what constituted "aide's work". Many of Urban's techs were adept at finding other work, until the aide was free to clean a patient who had evacuated on the table or to attend to a patient waiting to be "plugged".

Barium enemas (or any fluoroscopic exam) were also shaped by the type of technology found in fluoro rooms. With older fluoroscopic equipment, the x-ray tube was often mounted beneath the table and the intensifier was attached to a mechanical arm suspended from the ceiling. When fluoroscopy was to be performed, the intensifier was swung over the table and locked in place. During fluoroscopy, the radiologist stood by
the side of the table and moved the intensifier along the patient's body. Depending upon the machine, he might view the fluoroscopic images on a free standing TV monitor, or through a series of mirrors embedded in the intensifier's housing.

Newer fluoroscopic equipment was "remote controled". A "remote control" room featured a control booth in one corner from which the technologist or, more commonly, the radiologist manipulated the equipment. The control booth was surrounded by walls, one of which contained a leaded glass window for viewing the patient during the procedure. The walls and the leaded glass protected the radiologist and technologist from radiation -- protection absent in a tablesidem system. Below the window, inside the control booth was a control panel. Using the buttons, dials, knobs, and joysticks of the panel, a radiologist or tech could move the tube and intensifier (or alternately the top of the table), open and close the tube's collimators, and take films whenever desired. Fluoroscopic images were viewed on a TV monitor also mounted inside the booth. If the person at the controls wished to speak to the patient, he or she could do so by means of a microphone. If the x-ray table was equipped with a 105 mm camera -- a camera that uses rolls of film similar to those found in any other camera -- then the technologist need not change cassettes during fluoroscopy. Consequently, with the most sophisticated remote controls, neither the radiologist nor the technologist needed to leave the booth during the procedure unless the patient ran into difficulty.

Both of the fluoro rooms at Suburban were remote control rooms. However, since Room 3's intensifier was mounted above the table (rather than below, as was the case in Room 5 and in Urban's remote room),
radiologists could conduct tableside exams if they so desired. Urban's two fluoro rooms were extreme contrasts. Room 2 housed a remote control booth far more sophisticated than either of Suburban's. However, equipment in the adjacent room was considered a relic of the past. Thus, only tableside procedures could be performed and images were viewed through a series of mirrors. In the remainder of this section I shall confine discussion to the use of remote control rooms since these accounted for three of the four rooms I observed. I shall also presume in the following discussion that the technologist assists with all aspects of the procedure. This was always the case at Suburban, but only so at Urban when the aide was absent. Therefore, the reader should keep firmly in mind that Urban's fluoroscopy aide would perform all of the technologist's work except the taking of films.

If the patient was not the first of the morning and if the previous examination was also a barium enema, before bringing the patient into the room the technologist would wash the table with water or alcohol to remove any barium that might have spashed onto the table during the last procedure. The tech might also spray the table with a scented disinfectant. After being cleaned, the table was covered with "chucks", disposable paper towels of considerable absorbancy. If the patient was elderly and the tech anticipated that the patient would not be able to "hold the enema", she might also inflate a "bed ring" into which the patient's buttocks would be placed. Bed rings resembled a child's toy life preserver with plastic stretched across floor of the opening.

With the room ready, the patient was met, greeted, brought into the room and asked to lie supine on the examination table. As in any other procedure, if the patient had difficulty moving the technologist
assisted and if necessary, called for lifting help. Once the patient was on the table, the tech might offer a pillow, sheet, or blanket for the patient's comfort. Next, the tech began to position the patient for scout films. Occasionally, patients and technologists engaged in cursory small talk about the weather, the patient's operation (if one had been or was going to be performed), where the patient lived and so forth. However, as a rule, conversation was minimal and focused almost exclusively on the exam.

In almost all cases techs asked patients if they had "had the exam before". If the patient replied affirmatively, the tech offered no explanation, but would rather comment, "then you know what's going to happen" or would ask if the patient had any questions. At this point, knowledgable patients occasionally made jokes: "The only thing I want to know is where is the nearest bathroom". Should the patient claim to have never had a BE, the tech would either launch into an abbreviated explanation of the exam or inquire if patient's doctor had explained the procedure. Some patient's said the exam had been explained, but then indicated that they are expecting to ingest the barium orally. On such occassions, techs countered the misunderstanding immediately: "No that's the other exam (eg. UGI). This is an enema."

If the patient evidenced no familiarity with the procedure, the tech offered a one to three sentence summary of events. The patient was told that he would receive an enema, that a radiologist would come in and take some films, and that afterwards the patient would be allowed to go to the bathroom. Techs assumed that patients understood the implications of the word "enema", and rarely offer detailed explanations
unless the patient inquired further. The following are examples of how technologists explained barium enemas:

We're gonna put some barium into your bowels so that your bowels will show up on our films. That is what your doctor has requested that we do.

T: We're going to take one picture and then we're going to have you lie on this table and we'll put a tube in you and put some barium in through your rectum. Then the doctor will come in and take some more pictures. When he's done, we'll take the tube out and have you go to the bathroom and then we'll take one more picture and you'll be done.

P: Will this be like an enema?
T: Yes, it is an enema.

We'll put barium in and fill up your colon. Then we'll stand you up and let the barium drain out. Afterwards we then put air in and take a few more pictures.

Techs often concluded explanations by asking patients if they had questions. Few did. Techs typically assured patients that the exam "moves quickly" and expressed the importance of "holding it in". Usually the technologist would also inquire about the patient's symptoms or why the doctor ordered the test.

After positioning the patient for the scout, an anterior-posterior view of the entire lower abdomen, the technologist told the patient that she would now take a "preliminary" film. Sometimes techs added the qualifier, "to see if you're cleaned out". All patients were supposed to have been given laxatives or a "cleansing enemas" prior to the BE. However, not infrequently, the scout films revealed that the patient was "full of shit". Since feces in the intestines decreased the odds that
the BE would be "diagnostic", patients who were not suitably prepared were considered undesirable. Unprepared patients not only experienced more pain from a barium enema, they were also more likely to evacuate on the table. Radiologists occasionally cancelled or cut short barium enemas when patients were "not well prepared", though they never did so as frequently as techs would have preferred.

In remote control rooms, technologists rarely centered patients as precisely as when doing routines or IVP's. Rather, technologists almost always positioned patients only approximately. They then went to the control booth where they set a technique and activated the fluoroscope. With the fluoroscope turned on, the technologist could view the patient's internal anatomy on the fluoro monitor. By watching the monitor and moving the tube or table with the booth's controls, techs centered the patient by placing specific anatomical structures in appropriate locations on the screen. After centering the patient, the tech switched the equipment to static mode and filmed the scout after telling the patient, "hold your breath." Technologists preferred remote rooms, in part, because fluoroscopic positioning increased the odds that the area of interest would be captured on the first try.

After taking the scout, the tech replaced the cassette and informed the patient that she would return after developing the film. While out of the room, the technologist left the door to the hallway open so that someone would be likely to hear if the patient called for assistance. The tech carried the scout to the passboxes and waited at the processor for the film to be developed. In theory, technologists were supposed to wait until a radiologist had seen the film and the patient's requisition before going further with the examination. Two types of barium enemas
were performed in radiology departments: "routines" and "air contrasts". As the names suggest, the former are more prevalent while the latter occur only when patients exhibited particular symptoms such as intestinal bleeding. Routine BE's required "thin barium", air contrast's "thick barium". Since the procedure to be performed was formally the radiologist's decision, the technologist presumably did not know what kind of barium to prepare until the radiologist had told her.

However, in practice, technologists only awaited instructions from radiologists about half the time. Based on their experience with BE's, their knowledge of the patient's history written on the requisition, and the symptoms that the patient had provided, techs could predict the radiologist's decision with great accuracy. Consequently, technologists often sought to save time by preparing the enema bag while the scouts were being developed. However, regardless of whether or not the tech filled the enema bag before consulting a radiologist, she would not insert the enema tip until a radiologist had seen the scouts. At Suburban either the technologist herself or the person "on films" showed scouts to radiologists after they had been developed. At Urban, scouts were hung on the light boxes in the hallway for the radiologist to examine at his first opportunity. Once the radiologist had decided, the technologist could officially prepare the enema bag and "plug the patient".

Barium bags were prepared at Suburban in an area known as the "barium kitchen" and in Fluoro Room 3 at Urban. Both locations offered the crucial resource for preparing barium: a sink. Barium for regular enemas comes prepackaged as a powder inside a plastic enema bag. In the side of the bag is an opening covered by a plastic cap. To prepare for
regular enemas techs opened the cap, filled the bag with water, closed the cap, and mixed the barium by shaking the bag vigorously. Thick barium is a liquid bottled in half-gallon jugs and must be poured from the jug into an empty enema bag. After preparing the barium, the tech placed a clamp on the long plastic tube manufactured into the bottom of the bag and attached an enema tip to the tube's distal end. Enema tips were phallic in shape. Below the tip's head was a balloon which was inflated after inserting the tip to guard against the patient expelling the device.

With the bag prepared, the technologist returned to the examination table where she hung the bag from an IV pole near the foot of the table. As patients watched the technologist, many inevitably asked if the technologist intended to infuse the whole bag (approximately 1-1.5 liters). The technologist responded with assurances such as "you probably won't get the whole thing" or "it's not as much as it seems". After hanging the bag, the technologist donned a pair of surgical gloves and lubricated the enema tip with a gel known as "lubrafax". In a very business-like and authoritative voice, the technologist now asked patients to turn to the left and bend their right knee. The maneuver exposed the patient's rectum. The technologist then politely warned the patient of the impending insertion: "I'd like for you to take a deep breath in and let it out". As techs inserted the tip, patients were likely to flinch, whimper, and on occasion shout or complain verbally. If the tip did not enter smoothly, the tech apologized for inflicting pain and reminded the patient to "take deep breaths" and to "relax". In such instances, it was surprisingly common for patient's to relieve techs of responding by the excuse, "probably my hemorrhoids".
After inserting the tip, the technologist attached a "puffer", a four inch plastic square filled with a sponge, to the haft of the tip, and warned the patient, "you're going to feel some pressure now, this is just the balloon to keep it from coming out". By squeezing the puffer several times the tech inflated the balloon. The patient was now ready for the exam. The technologist bid the patient return to a supine position, explained that she would summon the doctor and left the exam room.

The tech was not likely to return to the patient's side before finding a radiologist unless an unreasonable amount of time elapsed. Finding a radiologist to attend a barium enema was fraught with the same difficulties as finding a radiologist to inject an IVP. The radiologist might be speaking to a physician, be engaged with another procedure, or out of the department completely. Although techs did not usually have to wait more than five minutes, on some occasions a twenty minute interlude occurred between the time the tech finished preparing the patient and the time the radiologist entered the examination room to begin the procedure. Techs at Suburban often passed such periods in the coffee room off the main darkroom or in the hallway socializing with their colleagues. At Urban, techs waited in the hallway outside the fluoro rooms.

When a radiologist was ready to perform the fluoroscopy, the technologist returned to the examination room in the doctor's company. Upon entering the examination room, most radiologists stopped momentarily beside the examination table to introduce themselves and inquire about the patient's symptoms. After a brief exchange of words, the radiologist entered the control booth and seated himself at the
controls. Unless the room was equipped with an automatic barium dispenser, the technologist now donned a lead apron.¹³ Techs wore lead aprons even in remote control rooms since they were likely to be in the examination room when the radiologist turned the fluoroscope on. Since radiologists were unlikely to leave the booth until fluoroscopy ended, they did not wear aprons unless conducting a tablesine procedure.

As the examination was about to begin, the radiologist or the technologist warned the patient of impending events: "Here we go" or "OK, you're going to feel it go in now." While warning the patient, the radiologist activated the fluoroscope with a foot pedal located beneath the control panel. The radiologist now moved the table, the tube, or both until the enema tip could be seen in the lower middle of the TV monitor. Having located the tip, the radiologist ordered the technologist to "start the barium" or "open it up."

If the tech was using an automatic dispenser, she merely stepped on the foot pedal to break the clamp's electromagnetic field so that the barium flowed through the tube into the patient's intestines. However, without an automatic dispenser, the technologist had to leave the control booth, walk over to the IV pole and loosen a clamp by hand. After loosening the clamp, the tech returned to the control booth by walking backwards. Although radiologists usually turned the fluoroscope off when the tech was in the room, some radiologists began fluoroscopy before the technologist was safely inside the booth. Since lead aprons are open in the back, by walking backwards techs guarded against "being fried" should the radiologist activate the fluoros prematurely.

Once the tech returned to the control booth, the radiologist switched the fluoros on and began to follow the barium on the TV monitor
as it snaked its way haltingly into the intestines. Since barium is radio-opaque, its movement on the screen was a black flowing mass that gradually filled the translucent folds of the intestines. As the examination proceeded, the patient was asked to assume numerous positions so that the radiologist could view the intestines from various angles. Communication with the patient was usually one-sided and phrased in commands: "Turn up on your left side...a little more," "Roll towards me," and so forth. Some radiologists spoke directly to the patient through the microphone. Others told the technologist how they wanted the patient positioned and waited for the tech to relay the message to the patient. In the latter case technologists simply reiterated from the booth's doorway at a volume loud enough for the patient to hear what the radiologist had said:

Rad: (to tech) A little LPO.
Tech: (to patient) Turn up on your left hip.
Rad: (to tech) A little more.
Tech: (to patient) Turn up a little more.
Rad: (to tech) That's enough. Little to the right.
Tech: (to patient) Could you turn to your right a little?
Rad: (to tech) You have to push her.
Tech: (to patient as she enters exam room) Slide away from me.
Rad: (calling to tech) No, the other way.
Tech: (to patient) Lie flat on your back. Now tip up the other way.

As the radiologist observed the barium flow into the intestines, he moved the table and the tube to keep the barium's coursing centered on the TV screen. When he saw an area of the intestines that he wished to record on film, he ordered the "Barium off". The tech either removed
her foot from the automatic dispenser's pedal or walked out into the room to manually clamp the tube. When the barium's flow ceased, the radiologist or technologist asked the patient to hold his breath. As patients stopped breathing, their intestines ceased undulating so that the radiologist could take a spot film by pressing a button on the console. The number of spots taken during an exam depended on the radiologist and the appearance of the patient's intestines. With a 105 mm camera mounted on the side of the tube for spot films, the technologist did not have to change films during fluoroscopy. However, when cassettes were used, the technologist periodically entered the examination room to replace exposed cassettes.

Although most patients suffered the Barium Enema silently, some complained vociferously. Patients were heard to say, "I can't take it any more", "It's coming out, I'm sorry," "Stop," or simply groan in pain. When the patient protested, the radiologist or technologist instructed the patient to breathe deeply and relax amid reassurances that the exam was almost over. If the patient seemed to be in extreme pain, the radiologist would perhaps limit the number of spots, but examinations were rarely ended before the barium had traversed its full course.

The radiologist signaled the end of fluoroscopy by telling the technologist to do the "overheads". At the same time, the patient was told that no more barium would enter and that he or she could go to the bathroom as soon as the tech took a "few more films". Overheads were regular x-rays designed to capture specific areas of the large intestines. At Suburban, five overheads were taken, while at Urban techs routinely produced four films after fluoroscopy. When takeing
overhead, technologists worked at a feverish rate and constantly assured the patients that they were "doing fine" and that the procedure was almost over.

With the last overhead complete, the technologist announced the examination's end and that the time had come to remove the barium. The tech suggested that she be allowed to drain some of the barium into the bag before removing the enema tip out and leading the patient to the bathroom. From the technologist's point of view, the more barium that drained back into the bag, the less the patient could expel on the way to the bathroom. To "drain a patient," techs dropped the barium bag to the floor. In most instances, the force of gravity immediately began to siphon the barium into the bag.

While draining the barium, the technologist carried the films to the passboxes. On returning to the examination room, the technologist put on rubber gloves or wrapped one hand in a chucks. She then asked the patient to turn on on his side so that she could remove the tip. After removing the tip and depositing the barium bag in the trash, the tech helped the patient off the table and to the bathroom. On the way, the technologist reminded the patient that when he finished in the bathroom, she would have to take one more film "just to be sure you're cleaned out". (If the patient was infirm and unable to walk to the bathroom, the technologist placed a bed ring under the patient's buttocks).

Patients were allowed to take as much time as necessary in the bathroom. Meanwhile, the technologist checked her films or smoked a cigarette in a common area. If the tech believed that the patient had been too long in the bathroom, from the bathroom's door she inquired if
the patient "was alright". After the patient left the bathroom, the technologist bid him to climb back on the table to take an anterior-posterior film of the lower abdomen. After the film the technologist reminded the patient to take a laxative. Inpatients were told to badger nurses for a laxative. As several technologists explained to me, the barium "turns to cement" after a period of hours. Rarely were techs so graphic with patients.

Ultrasound

Suburban hospital employed three sonographers, one male and two female. The male had been a sonographer since the early 1970's and had trained the two women. Each day two of the sonographers staffed the ultrasound operation while the third assisted in the main department. Since the male was considered to be the department's full-time sonographer, it was the two women who rotated between ultrasound and x-ray. At the beginning of the study, Urban's radiology department employed one full time sonographer, a male who also had learned the technology early. Since one of the department's x-ray techs had trained in ultrasound under a former employer, she ran the department when the regular sonographer had a day off. When at Christmas, the trained x-ray tech left the department to have a child, the radiologists decided to train a second x-ray tech to handle studies in the sonographer's absense. In early spring, the male sonographer accepted a job with an ultrasound manufacturer. Shortly thereafter, the radiology department hired a full-time replacement, a woman who had a number of years experience at a local medical center. When the new sonographer arrived,
the trainee who had performed ultrasound studies over the intervening month, returned to main department and the status of part time sonographer.

As outpatients arrived for ultrasound studies, they were sent directly to the ultrasound area at Suburban and sat in chairs outside the ultrasound room until the sonographer called for them. At Urban, outpatients waited for their appointments in the radiology department's waiting from whence they were summoned by the sonographer. At both sites, orderlies delivered inpatient's directly to ultrasound's door. When sonographers are ready to begin procedures, they greeted the patient, introduced themselves, and led the patient to the ultrasound room. Most ultrasound studies did not require patients to wear johnnies. In fact, johnnies were used only when females had cardiac studies. If the cardiac patient was male, the sonographer asked the patient to remove his shirt. All other patients were simply asked to lie supine on the examination table. If a johnny was required, the sonographer either waited in the hall while the patient changed clothes, ushered the patient to a bathroom, or drew a curtain around the table to form a temporary dressing room.

Unlike the heavy, mechanical tables of an x-ray room, an ultrasound room's examination table was a light stretcher mounted on wheels. Moreover, the table itself was not integral to the technology as were tables associated with radiography, fluoroscopy, specials, and CT-scanning. Consequently, when an inpatient arrived on a gurney, the sonographer did not need to lift the patient onto the examination table before performing the study. Rather, the examination table was simply wheeled out of the way so that the patient's stretcher could take the
table's former place. Of course, if an inpatient traveled in a
wheelchair, the sonographer might assist the patient's move to the
table.

Once the patient had mounted the table, sonographers offered a
pillow and covered the patient's lowering body with a blanket, less to
shield the patient from the cold than to guard the patient's "decency".
Having placed the blanket, the sonographer instructed patients to expose
their abdomen by lower their pants or skirt and by raising their shirt,
blouse, or dress. If the patient was female and having a cardiac study,
the technologist discretely opened the mid-line of the patient's johnny
to reveal her sternum without exposing her breasts.

While patients arranged themselves on the table, sonographers
always struck up conversations marked by the exchange of pleasantries,
small jokes appropriate to ultrasound ("Did they give you enough to
drink on the floor", "So we're gonna see how your ticker tocks") and
other forms of friendly small talk. Inevitably, however, sonographers
led patients into rather extensive discussions of their symptoms.
Sonographers probed patients for specific locations of pain, previous
diagnoses provided by physicians, and an historical account of the
malady that brought the patient to the study. If the patient was an
inpatient, the sonographer might glance through the patient's chart.
Sonographers were adamant that without assessing the patient's symptoms
they could not conduct a study competently. The symptoms were clues to
the patient's potential problem and consequently, to which organs and
what type of lesions the sonographer should be alert.

After patients had exposed the area of the body to be examined,
sonographers stated, "I'm going to put some jelly on your (stomach,
abdomen, etc)." Urban's sonographers alway added the warning, "and it may be a little cold". However since Suburban's sonographers heated bottles of gel in an electric device much like the home appliances that warm cans of shaving cream, they were unconcerned about shocking patients with the gel. The gel created a liquid interface between the head of the transducer and the skin to improve the transfer of sound from the transducer to the patient's body. If the patient was having a cardiac ultrasound, the sonographer attached EKG pads to the patient's chest and linked the pads to an EKG monitor before proceeding with the gel's application.

A bank of real-time ultrasound equipment stood to the side of the examination talbe. Real-time equipment was extremely compact. The computer, keyboard, video monitor, camera, and video tape recorder were all embedded in a metal cabinet that stood no more than five feet high and three and a half feet wide. Since the system was mounted on wheels ultrasound was a portable modality. After applying the gel, the sonographer turned to the keyboard and typed the patient's name, hospital number, age, sex, and the perspective of the first series of images into the computer. The information immediately appeared in the upper right and left corners of the video monitor. After entering the data, the sonographer dimed the room's lights so that the monitor could be more easily observed.

During an ultrasound examination, sonographers stood next to the patient and held the transducer against the patient's body. Since sonographers had to watch the monitor to conduct a routine study, they faced the bank of equipment and used their free hand to adjust dials and change labels on the monitor. The examination progressed as the
sonographer shifted from one perspective to another or from one organ to another by moving the transducer along the patient's body and by rotating the transducer against the skin. What the sonographers saw and wished to see on the monitor dictated their manipulation of the transducer from one instant to the next.

To preserve an image, the sonographer first froze the picture on the video monitor by stepping on a foot pedal and then triggered the shutter of a camera to record the image by stepping on a second pedal. Films were contained in thin, rectangular, plastic cassettes that had compartments on either side for a sheet of film. The cameras were designed so that nine images, arrayed as a three by three matrix, can be recorded on each film. Although there were standard protocols that determined which organs and which perspectives a sonographer had to film during any procedure, the actual number of images recorded was left to the sonographer's discretion and varied with the pathology that the sonographer discovered.

Throughout the examination sonographers asked patients to assume different positions that allowed various organs to be imaged from alternate perspectives. Moreover, by having patients move onto their sides at angles of different degrees, the sonographer could skirt pockets of bowel gas (with high acoustical impedance) or use one organ (such as the liver) to push another organ (such as the stomach) out of the field of view. Before taking films, sonographers asked patients to hold their breath. When patients stopped breathing, motion on the screen decreased before the frame was frozen. Organs were usually imaged both longitudinally and transversely. Sonographers argued that it was their responsibility to capture enough data so that the films
convincingly showed the radiologist that a particular problem did or did not exist. Consequently, sonographers attempted to triangulate onto areas of interest from multiple perspectives.

With the exception of cardiac studies, all ultrasounds conducted at both hospitals proceeded as described. For cardiac studies, sonographers at Suburban first performed an "m-mode" examination of the heart.\textsuperscript{15} M-mode output did not appear on a video-monitor, but rather on a strip of paper that resembled a graph. To produce an m-mode, sonographers used a "B-scanner", the type of ultrasound equipment used in the early 1970's before real-time scanners were perfected. The real time scanner imaged all areas of a field simultaneously and continuously as if one were taking a movie of the area. In real-time, the computer stored no information until the sonographer "froze the image" before taking a film. The "B-scanner" was far more primitive.

The field of a B-scanner's transducer was much narrower than the field of a real-time transducer. Consequently, the tech had to move the transducer through an arc on the patient's skin in order to capture the same area imaged instantaneously with a real-time transducer. Whereas the real-time transducer was held in the palm of the hand, the B-scanner's transducer was attached to a mechanical arm with a number of joints that allow the transducer to be moved through various angles. Unlike real-time, the B-scanner's computer stored information and displayed this information on a video monitor as the technologist moved the transducer through the arc. If one were to watch the monitor as the image appeared, it would seem as if the image was constructed by an imaginary line that swept across the screen leaving behind bits of an image in its wake. The final image was a static representation of one
swath through the body. The data on the screen had to be destroyed before another area or perspective could be recorded. Hence, motion studies were impossible with the B-scanner's video monitor.

However, the B-scanner could record motion when operating in m-mode (where "m" stands for motion). Rather than display the heart, for example, on a video monitor, the m-mode displayed echos of the heart's beating on a strip of chemically coated paper. The paper was wound on a roll housed inside the scanner's cabinet. When activated, the paper moved over a device that recorded continuously, echos rebounding off the heart's structures. The output of an m-mode appeared as a series of parallel graphs. In fact, each area of the m-mode output corresponded to a particular structure of the heart and should be read as an abstract representation of juxtaposed anatomical structures over time. By holding the B-scanner's transducer in an appropriate location, the sonographer could image the heart's valves, ventriculars and atriums simultaneously on the output. Hence, the m-mode yielded abstract cross sectional data. By studying the shapes of the various sub-graphs within the m-mode output, the functioning of valves and other cardiac structures was ascertained. At Suburban, only the m-mode part of a cardiac study was performed before the radiologist arrived.

Near the end of all filming sessions, sonographers at Suburban summoned the radiologist on ultrasound duty to the ultrasound department. Although sonographers occasionally sought radiologists in person as did x-ray techs in the main department, more often sonographers simply called the radiologist on the telephone or over an intercom system. If the radiologist did not appear within a reasonable period of time (an outside limit of 5 minutes), the sonographer either
called a second time, or left the area to find the radiologist. Since two sonographers worked Suburban's department at all times, patients were never left alone.

Once the radiologist arrived, he assumed a position beside the sonographer in front of the video monitor. In most cases, the sonographer now provided the radiologist with a real-time "tour of the anatomy and pathology." Sonographers oriented the radiologist to the particular anatomy on the monitor by stating that the image was either transverse or longitudinal and by naming specific structures visible on the screen. The sonographer focused the radiologist's attention on abnormalities by naming sectors of particular organs (eg. upper pole of the kidney). The radiologist often directed the sonographer to image certain organs or to provide views from certain perspectives.

Radiologists who were more competent at ultrasound occasionally manipulated the transducer themselves.

Conversations between the sonographer and radiologist as they viewed the real-time images transpired in the hushed tones of whispers. Often, the two held short debates about the nature of what they saw on the screen and were as likely to discuss pathology as anatomy. In cardiac studies, the radiologist's viewing of the real time images represented the first real-time imaging of the heart. For other studies, the radiologists reviewed what the sonographer had already photographed. In both cases however, additional films were sometimes taken.

At the end of a cardiac, the radiologist also examined the m-mode output. In preparation for the radiologist's viewing, the technologist cut the output into strips and circled problem areas in red ink. Some
radiologists took the m-mode data with them, others left the data with the sonographer so that he or she could calculate various measures and ratios of the heart's functioning.

At Urban, radiologists did not attend ultrasound examinations unless the sonographer was inexperienced. Rather, when the filming was complete, sonographers took leave of the patient by saying that they were going to develop the films and that they would return in a few minutes. After developing the films, the sonographer might or might not take the films to the radiologist to view. The decision depended largely upon which radiologist was on duty and which sonographer was performing the exam.16 If the sonographer decided to have a radiologist view the films, then the sonographer carried the films to the radiologist's office and hung them on the radiologist's view box. After hanging the films the sonographer gave the radiologist only enough information to orient him to the films and the patient's problem. The radiologist then read the films and as he read, asked the sonographer questions. If the sonographer agreed with the radiologist's interpretation he or she said "umhum" or "that's what I thought too". If sonographers disagreed, they called the radiologist's attention to other data they thought incompatible with the radiologist's hypothesis. In the same manner, radiologists challenged the sonographer's hypotheses. If the two could not reach agreement, they might return to the ultrasound room and conduct jointly a second real-time study. When sonographers did not immediately take films to the radiologists they noted on the requisition what they thought the films revealed.

Once the radiologist had seen the real time at Suburban and once the sonographer returned to the ultrasound room at Urban, patients were
dismissed. The sonographer announced that the exam was over and wiped the gel from the patient's body with a "chucks". Usually the sonographer told the patient that the gel did not stain clothing. With the gel removed, the patients reclothed themselves and left the examination room.

Special Procedures

Without doubt, special procedures were the most glamorous and prestigious work that took place in a radiology department. Special procedures refers to a group of radiological examinations held to be more intricate and risky than any other performed in a radiology department. Each involved the insertion of catheters, tubes, or needles into a patient's body under semi-sterile conditions and were considered minor. It was the mystique of surgery that lent the work its prestige. As a specials tech at Urban put it, "Specials is as close to the operating room as you can get in radiology without being sent to the O.R."

Most of a radiologist's daily work as mental work, the interpretation of films. When performing special procedures, however, the radiologist assumed a stance akin to that of a surgeon. Special procedures were active interventions requiring manual dexterity as well as mental acuity: the radiologist had to enter the patient's body with a scalpel and manipulate needles and catheters though the patient's vascular system. Only radiologists with appropriate training, typically the department's younger doctors, could perform special procedures.
For a radiological technologist, to be tapped as a "specials tech" was to advance in one's career. Persons so designated were paid more than x-ray techs, were provided with additional training, and were accorded higher status by technologists and radiologists alike. Common wisdom had it that only the most skilled and the least perturbable x-ray techs were chosen for special procedures. In both radiology departments, specials techs were viewed by all as sources of expertise in radiological technology. Specials techs were also, from time to time, given administrative duties and responsibility for coordinating work in the main department.

There were three major types of special procedures performed in a radiology department. First were angiograms (or arteriograms) during which a catheter was placed in an artery. Iodine dye was then injected through the catheter while taking a rapid series of x-rays to chart the contrast as it surged though the vascular system. Angiograms were used to diagnose occlusions of blood vessels and to locate tumors. That the preponderance of special procedures were angiograms was evidenced by the fact that the work and its location were often referred to as "angio."

A second type of special procedure involved inserting a catheter or tube into an organ to provide drainage. For example, in a "transhepatic biliary drainage" the radiologist placed a catheter in the common bile duct to remove bile from a jaundiced patient whose liver has malfunctioned. Finally, biopsies constituted a third type of special procedure. In a biopsy, the radiologist inserted a needle into an organ or abscess to collect fluid or tissue samples for pathological analysis.
Regular Angiography

Although individual special procedures at both hospitals were similar in broad contour, their details varied considerably. The differences arose, in part, because Suburban and Urban employed different machines to execute special procedures. In short, Urban's equipment was older and far less sophisticated than Suburban's. Urban's angio room was equipped with a standard x-ray table with a "beneath-the-table" tube and an intensifier suspended from a track in the ceiling. When fluoroscopy was needed, the intensifier was swung over the patient's body and locked into position. Urban's rapid film changers, the *sine qua non* of angiography, were stand alone devices known as Cubixes or Schonanders. These box-like machines stood at the head of the angio table. When the catheter was in position and it was time to do a "run" (a rapid series of films), the technologist pulled the patient toward the film changers using a "body board" that lay between the patient and the table. X-ray tubes suspended from tracks mounted in the ceiling were then positioned so that they projected their beams through the patient and onto the screens of the film changers.

Figure 7, shows in schematic form how Urban's equipment would appear during a "bi-planar cerebral angiogram" if one were standing at the head of the table looking towards the patient. One film changer was positioned beneath and the other to the left of the patient's head. One x-ray tube projecting downward was placed above the patient's face, while a second tube projecting sideways was positioned to the right. Bi-planar refers to the fact that two views of the patient's brain were filmed simultaneously: a lateral view taken from the side and an anterior-posterior view taken from above.
FIGURE 7

Bi-planar Cerebral Angiogram Set-up
In contrast, Suburban's angio room was dominated by its relatively new and technologically sophisticated Seiman's "C-arm". The C-arm obtained its name from the C-shaped brace or "arm" at whose opposite ends were mounted an x-ray tube and a "tower". The tower was cylindrical in shape. On one end of the tower was a "Puck" or automatic film changer that held up to twenty films. At other end of the tower was the face of the fluoroscope's intensifier. By activating a switch on a control panel, the puck and the intensifier could be inverted, that is, one could be exchanged for the other by rotating the tower so that x-ray tube projected alternately onto the puck or intensifier. In addition to using the intensifier for fluoroscopic work, its images could be routed to either a 100 mm camera for making spot films or to a digital camera, the input device for the digital subtraction equipment. Both of these cameras were also mounted on the tower.

Suburban's angio table had a "floating top" so that patients could be moved easily right or left across the table's horizontal axis, and up or down along the table's longitudinal axis. Three hydraulically powered mechanical joints allowed the C-arm to assume an almost limitless array of positions vis à vis the patient and the table. One joint rotated the C-arm through a complete circle around the patient when the table's top was extended beyond the head of its base. Consequently, the technologist could place either the tube or the tower at any point around the patient's head. The flexibility of the C-arm's movement allowed a large variety of views of the patient's anatomy, whereas Urban's stationary bi-planar system restricted the number of views that could be produced. Figure 8A schematically portrays the action of the C-arm's first joint as it would appear if one were
Figure 8A
C-arm's Movement Around Patient's Head

POSTERIOR-ANTERIOR VIEW

LATERAL VIEW

ANTERIOR-POSTERIOR VIEW

(TIME)

FIGURE 8B
Angular Movement of C-arm's Second Joint

(TIME)
standing at the head of the table looking towards the patient. A second hydraulic joint, positioned the tube and tower so that x-rays would strike the area of interest at various angles along the longitudinal axis of the patient's body. (See Figure 8b). A third joint allowed the C-arm to move up and down the length of the table so that the equipment could be positioned over various sections of the patient's body. If the C-arm was not needed, the same mechanism allowed the whole device to be swung completely out of the way of the table. The C-arm's movements were controlled from a mobile control panel that could be positioned anywhere in the angio room.

Aside from technological differences, special procedures at Urban and Suburban were distinguished by different social organizations that arose from the role that nurses played at each site. At Suburban, the nurse monitored the patient's condition during the procedure. But, aside from injecting valium or other sedatives, monitoring EKG's, recording data, and comforting the patient, the nurse took no active part in the procedure itself. Rather, a technologist assisted the radiologist as he placed the catheter. At Urban however, the nurse not only performed the duties just outlined, she also assisted the radiologist during the procedure. Thus, if there was an auxiliary role among the members of a specials team, it was the nurse's at Suburban and the technologist's at Urban. In the nurse's absence, however, Urban's specials techs readily and ably assumed the nurse's role. Two specials techs worked every procedure at Suburban, while special procedures at Urban involved only one tech.

Since it is unnecessary to describe each type of special procedure to gain a sense of how special's work was organized, I shall limit
further discussion to angiograms. A number of different angiograms, named for different areas of interest, were performed in both radiology departments. For example, "carotid angiograms" focused on the carotid arteries, "four vessels" imaged the ventribral arteries as well as the carotids, "renals" examined the arteries of the kidneys, "pulminaries" traced the vascular system of the lungs, and "femorals" explored the arteries of the legs. Although the various angiograms differed in the catheter's placement and the number of runs taken, the structure of each was quite similar.

Angiograms typically began before the patient arrived, when the specials tech decided that it was time to "set up" for the procedure. Like minor operations, specials required a number of sterile instruments. "Setting up" meant unpacking and arranging the instruments on a surgical tray. The first step in setting up was to unwrap the "surgical kit". A surgical kit was a bundle of implements that had been cleaned, sterilized, and wrapped in sterile towels. The kits were assembled in each hospital's "Central Supply" and were ordered on a daily basis in a quantity sufficient for the next day's schedule. After placing a kit on the surgical tray or table, the technologist loosened the adhesive tape that fastened the surgical towel in which the implements were wrapped. When unfolding the towel, which became a table cloth, the tech carefully touched only that portion of the towel that had already been exposed to air.

Before proceeding further, the technologist donned a pair of sterile surgical gloves to avoid contaminating the implements. Having gloved up, the tech unwrapped and arranged the implements in specific locations and neat piles. Surgical kits contained glass syringes of various
sizes, clamps, a scalpel, sterilized towels and drapes, guaze pads (called "4 by 4's") a metal stopcock, and stainless steel crucibles. At Urban, the specials tech's involvement in setting up the tray ceased at this point if the nurse was on duty. The remainder of the task would be performed by the nurse and the radiologist as soon as the radiologist arrived in the area. At Suburban however, the technologists completed the task.

With the kit unpacked, individually packaged, disposable implements used during the procedure were opened: plastic syringes, needles, dialators, catheters, and guide wires. Once all implements were arranged, the technologists filled the crucibles: one with betadine (a redish liquid disinfectant containing iodine) and one with alcohol. At this point, the tech might empty several bottles of contrast into a sterile bowl and fill a second bowl with saline solution. However, at Suburban, techs often delayed filling bowls with contrast and saline until after prepping the patient. In either case, the contrast and saline was always poured after the prepping solutions to ensure that no deadly liquids splashed into those that would be injected into the patient's body. Finally the techs drew up syringes of contrast, saline, and "xylocaine", a local anesthetic.

At both sites, patient's usually arrived in the angio area before the technologists finished setting up the surgical tray or shortly thereafter. In fact, at Urban, the patient was always on the table at the time that the nurse and radiologist opened cathethers and drew up syringes. Except for patients having digital subtractions, all angio patients traveled on stretchers since regular angiograms required hospitalization. The patient was met at the door by the technologists
and the nurse. If the patient seemed too weak to move himself, he was transferred from the stretcher to the table with the orderly's help. From the moment of arrival, techs and nurses engaged patients in conversation about any number of topics. At Suburban, the techs always made sure that the patient understood the procedure and explained the examination if the patient was uninformed. Explanations were left to the radiologist at Urban who typically arrived shortly after the patient.

With the patient on the table, techs began to strap the patient's legs, arms, and head to the table (or body board) using webbed belts and velcro fasteners. Techs always explained the purpose of the straps before applying them, but treated them incidentals about which the patient should not be alarmed. The following remarks were quite typical:

I'm going to put straps across your knees. It's important to us that you keep your knees down. I'm just telling you this to remind you that your knees are strapped in case you fall asleep and wake up and feel yourself bound.

At both radiology departments, the specials techs took scout films after securing the patient to the table or board. In order to take a scout at Urban, the technologist had to slide the patient over the film changers by moving the body board. At Suburban, the top of the table was simply moved towards the C-arm. When examining the cerebral vascular system, masks were placed over the face of the x-ray tubes. Masks were lead plates lead circular areas removed from their centers. The masks allowed only the head to be imaged and cut down on scatter
radiation that might mar the film. At Urban, specials techs positioned patients for scouts using the x-ray tube's field lights. When the tech judged the position adequate, he ensured that he could duplicate the view on later runs by marking with a magic marker those points on the patient's body the field light's shadows fell. After taking and developing the scouts, the technologist slid the patient and the body board back onto the table.

As Suburban, specials techs used the fluoroscope to position patients for scouts. The technologist activated the fluoroscope and watched the video monitor that stood beside the table to determine when the position was adequate. A scale on the side of the tower recorded the intensifier's distance from the patient's body. The technologist noted the distance, inverted the intensifier and the puck, and moved the C-arm until the puck was at the same distance from the patient's head as the intensifier had been. The maneuver assured that the film would capture the same image that was seen on the monitor. The scout was now taken.

Once the scouts were complete, the patient was passed to the nurse. The nurse's preliminary tasks were threefold. First, she took the patient's blood pressure and recorded the data on a chart that she was responsible for keeping. The nurse's second task was to connect the patient to an EKG monitor. During the course of the procedure the nurse would monitor the EKG to detect potential heart failures or "arrythmia". Finally, the nurse started a saline I.V. that contained heparin, an anticoagulate, by inserting a needle into the patient's wrist. As nurses worked, they typically carried on non-stop conversations with patients who were willing and able to talk. Nurses attempted to
reassure patients and take their minds off the procedure by steering the conversation towards the humorous. While the nurse performed her preliminary tasks, the specials techs developed the scouts and loaded the film changer's magazines. At Suburban, technologists routinely waited in the control room until the nurse had finished her duties. They used the time to read the patient's chart, to converse, and to smoke a final cigarette. At Urban, while the nurse readied the patient, the radiologist finished preparing the surgical tray and shaped the tip of the catheter over a flask of steaming water.\textsuperscript{17}

When the nurse's tasks were complete, the patient was "prepped". At Urban, prepping was the radiologist's job. At Suburban technologists prepped patients before summoning the radiologist to the angio suite. "Prepping" refers to washing the patient's body in the area where the catheter was inserted. In most regular angiograms, the point of insertion was the right femoral artery just below the point where the artery branched off from the abdominal aorta. Since the point of insertion was located near the patient's groin, prepping required that the patient be naked from the waist down.

Recognizing that prepping placed the patient in an exposed and undignified position, the techs at Suburban routinely divided the prepping task among themselves so that the female techs prepped female patients and the male techs prepped male patients. In most cases, the technologist who prepped the patient also assisted the radiologist during the procedure. At Urban no sexual distinctions were made since a radiologist prepped all patients and all radiologists were males.

Before prepping, technologists and radiologists "suited up", that is they donned lead aprons, surgical gowns and surgical gloves. To
begin prepping, the patient's johnny was raised to expose the pelvic area. Prior to washing the patient's groin twice with betadine soaked "4 by 4's" (or cotton balls), the techs or the radiologist warned the patient that the liquids would be cold. After applying the betadine, the area was again washed twice with alcohol. The person prepping the patient always preaced the alcohol with the warning: "it might sting". Potential stinging resulted from the patient's groin having been recently shaved by personnel on the floor.* After the alcohol, the patient's lower body was covered with green surgical drapes. The last drape was placed so that only the area of the incision remained visible.

After the prep, the implements were carried to the table and placed on the drapes. At Urban the procedure was now ready to begin since the radiologist had been in the room since shortly after the patient arrived. However, at Suburban, the techs had to await the radiologist's arrival. To hasten the procedure, Suburban's techs usually summoned the radiologist during the last few minutes of the prep. In most instances the radiologist arrived at about the same time that the tech finished prepping. On their arrival most radiologists entered the angio room, spoke momentarily to the patient, and then retired to the control room to suit up. While suiting up, the technologists were likely to provide the radiologist with a summary of the patient's chart and to pass on any useful information they had learned while talking with the patient (eg. the patient was sensitive, allergic, anxious or had this or that

* When the patient had not been shaved before their arrival, the techs removed the patient's pubic hair before beginning the prep. Shaving the patient was the only aspect of the prep that Urban's radiologists did not perform. They delegated the task to the nurse or the technologist.
operation). When the radiologist was suitably garbed, the team entered
the angio room.

Radiologists often began each procedure by asking the patient how
he or she felt. More often than not, the radiologist told the patient
that the nurse would administer "something to help you relax", and
requested that the nurse inject the patient with valium. Usually three
to five cubic centimeters of valium were requested, but if the patient
was extremely nervous the radiologist might call for higher dosages or
for demerol, a heavier sedative. As the nurse injected the valium, she
told the patient that the "medicine" would "sting a little," a warning
often repeated by a technologist or the radiologist. Although nurses
sometimes injected the valium directly into the patient's arm, they were
more likely to avoid unnecessarily sticking the patient with an
additional needle by injecting into a shunt on the IV line.

The radiologist's first move was to numb the area around the
incision site with xylocaine. At Urban, the radiologist retrieved the
syringe from the surgical tray himself. At Suburban, the assisting
technologist handed the radiologist the syringe. Before injecting, the
radiologist warned the patient that he was about to insert a needle.
Warnings followed standard scripts: "You're going to feel a little pinch
(stick, mosquito bite) now. It will sting a little bit. It's just some
novocaine". Radiologists always used the generic term "novocaine"
rather than the more specific "xylocaine" or "lidocaine" which patients
were not likely to recognize. Occasionally radiologists forgot to warn
the patient before injecting the anesthetic. In such instances, a tech
or nurse offered the warning as the radiologist was about to insert the
needle. Rather than inject at one site, the radiologist distributed the
anesthetic around the the insertion area, often asking the patient if later injections were felt. An answer of "no" suggested that the anesthetic had taken effect.

With the warning, "You're going to feel a little pressure now", the radiologist made a small incision with a scalpel. Next, the radiologist widened the mouth of the incision with a pair of forceps. After widening the incision, the radiologist inserted a Seldinger needle into the incision with the goal of piercing the femoral artery. A Seldinger needle was a two part device approximately six inches long. A metal rod or stylus fit inside the haft of the needle and could be inserted or withdrawn much like a sword in a scabbard. The stylus closed the bore of the needle to reduce the loss of blood.

When insertions proceeded smoothly and the radiologist located the artery on the first try, no more than two minutes would have passed since the procedure began. However, locating the femoral artery was not always an easy task. The difficulty of locating the artery was not only affected by the radiologist's skill, but also by the patient's attributes. Formerly obese patients often had loose and folded skin which made locating the artery more difficult. Moreover, each individual's internal anatomy was as idiosyncratic as their external anatomy. If radiologists could not locate the artery on the first try, they removed the needle and began again. When the artery was finally punctured, blood shot out the haft of the needle dousing the drapes and occasionally splattering the radiologist, the assisting technologist, and the floor. After the initial puncture, the procedure became relatively bloodless.
After entering the artery with the needle, the radiologist removed the stylus and the assisting technologist or nurse handed him the tip of a guide wire. The radiologist threaded the wire through the needle's haft and into the artery as the assistant fed the radiologist more wire. The guide wire had to pass into the femoral artery, into the aorta, and up to the aortic arch where the radiologist chose the artery (carotid, pulminary) to be the catheter's final location. As radiologists moved the wire into the arteries they usually asked for "fluoro".

On request, the technologist moved the patient under the intensifier (at Suburban) or locked the intensifier in place over the patient (Urban). With the patient under the intensifier, the radiologist activated the fluoroscope with a foot pedal and located the tip of the guide wire on the video monitor standing beside the examination table. Using the fluoro monitor, the radiologist continued to move the guide wire until it was positioned where he desired. With the guide wire positioned, the fluoro was turned off and the patient was moved from beneath the intensifier so that the radiologist could work more freely.

The radiologist now removed the needle by passing it along the guide wire to the assisting technologist or nurse, who continued to pass the needle along the length of the wire until it was completely removed. The assistant wiped the wire with a guaze to remove blood that the needle had deposited as it passed by. Next, the assistant threaded a catheter onto the end of the guide wire. After the catheter was threaded halfway down the wire, the radiologist took over and continued to move the catheter along the wire's length. Before passing the catheter into the artery the radiologist warned the patient that he
would soon feel "some pressure". Having administered the admonition, the radiologist proceeded to thread the catheter into the vascular system. The catheter followed the guide wire to its terminal location. When the radiologist deemed that he has inserted the catheter a sufficient distance, he once again called for "fluoro". After the radiologist located the catheter on the monitor he moved it further into the aortic arch.

At this point, the radiologist had to finesse the catheter into an artery, such as the carotid, that branched off the arch. The task required skill and could consume a considerable amount of time if the arterial system was oddly shaped. The radiologist removed the guide wire from the bore of the catheter and passed it to the assistant. Next he attached a stopcock to the end of the catheter and then a syringe of saline to the stopcock to "flush the catheter". After flushing, a contrast syringe replaced the saline syringe. As the radiologist injected the contrast, he activated the fluoro and watched its course on monitor.

As the dye left the catheter's tip, it appeared as a dark swirl that was soon washed out of the monitors field of view by the coursing of the patient's blood. As the contrast was carried away, it marked the contours of the patient's arteries. By observing the path taken by the contrast, the radiologist moved the catheter into its final location by jiggling and rotating the catheter further into the artery while viewing his progress on the fluoro monitor. Often, radiologists injected contrast several times before attaining a final position. Adequate placement of the catheter was crucial. If the catheter was not far enough into the artery of choice, the catheter could jerk out of the
artery as the pressure injector began to operate. At best, such a mishap could result in the need to do the run over and at worst, the patient's artery could be "stripped" or a piece of plaque could be dislodged causing an infarct and a stroke.

With the catheter in place, the patient was positioned for the first run. At Urban, the special's tech, who had been patiently standing at the foot of the table sprang into action. After retiring the intensifier, he moved the patient into position much as was described in the discussion of scout films. At Suburban, the technologist who had not been assisting the radiologist positioned the patient for the first run. To set up the C-arm the tech inverted the puck and intensifier, if the run required large films. If smaller films could adequately capture the run, the 100 mm camera was used and the intensifier was left in position. Techs worked quickly when setting up for a run. Speed was most pronounced at Suburban where the technology eliminated the need to manually position the patient and where the machinery responded to automatic controls. All of Suburban's techs had mastered the C-arm's controls to the point where they could maneuver several hydraulic joints simultaneously. The upshot was that the massive piece of equipment seemed to whirl around the patient's head with only several inches of clearance.

While the technologist positioned the patient, the nurse or tech who had been assisting the radiologist filled the pressure injector with the radiologist's help. Pressure injectors were hydraulic syringes that used large (100 cc) disposable plastic syringes. Contrast was drawn into the syringe by placing a tube attached to the syringe's tip in a bowl of iodine contrast. The injector filled the syringe mechanically.
After consulting with the radiologist, the tech or nurse set a rate at which the contrast was to be injected, the length of time the injector would operate, and the maximum PSI after which the injector would cut itself off. With the injector filled and set, the radiologist linked the free end of the tube attached to the syringe to the catheter. Once the radiologist finished with the pressure injector, he usually walked to the patient's side and told the patient that he or she would soon feel the injection. The contrast was said to occasion a "hot flash" that would pass in a few seconds. Patients were admonished not to breathe or move during the injection.

After double checking the equipment, the technologists, the nurse and the radiologist now left the angio room for the control room. The radiologist assumed a position at the door to the angio room and a technologist went to the control panel to quickly set a technique. At Urban, the technologist warned patients that runs were about to begin. At Suburban, the radiologist usually shouted the warning. In either case, after warning the patient, the tech triggered the pressure injector and the x-ray equipment. The equipment came alive and the control panel began beeping to signal the number of films taken and the rate at which they occurred. Runs usually took no more than 30 seconds to complete.

As soon as the run was over the technologists and radiologists returned to the angio room. Almost immediately one or more members of the team asked the patient how he fared and offered assurances: "you did fine," "that hot feeling will go away in a minute," et cetera. At Suburban the technologists began immediately to position the patient for a second run while at Urban, the next run was not decided until the
radiologist had viewed the films from the first. In part this
difference reflected the fact that at Urban, two views were often taken
simultaneously while Suburban's C-arm could only capture one view at a
time.

A variable number of runs were taken during angiograms with the
exact number depending on the type of angiogram being performed, and the
number of runs that had to be repeated. Runs were repeated if the
catheter slipped out of the artery or if the films did not appear as
expected. If more than one artery and its branching system were
examined (as in a 4-vessel), the catheter would ultimately be moved.
Moving a catheter followed much the same line of action described above
for the final stages of the catheter's placement.

After films were developed they were hung on view boxes for the
radiologist to peruse. The radiologist chose the best films from each
run as "selects", which were placed in a separate envelope. In the case
of a 4-vessel angiogram as many as ten runs might be performed at
Suburban. Other angios required fewer runs. Fewer runs were also taken
at Urban because the bi-planar system could image two views at once.

Once the procedure was deemed complete by the radiologist, the
technologists continued to develop films and began to clean up the angio
room. Meanwhile, the nurse and the radiologist removed the catheter
from the patient's arteries. At Suburban, the radiologist stood beside
the patient applying pressure to the wound for 5 to 10 minutes so that
the incision would clot. At Urban, a compression clamp was used to stop
the flow of blood, and the radiologist was free to return to the view
boxes to examine the films. When the wound was deemed sufficiently
cotted, patients were moved back onto their stretcher and were taken to
the recovery room for several hours before being taken back to the ward. After the patient left, the techs and the nurse cleaned the angio room in preparation for the next procedure. At this time, the techs and the nurses also completed their required paperwork.

Digital Subtraction

Digital subtraction angiography at Suburban was organized differently than routine angiography in a number of significant ways. Because the digital subtraction equipment was sensitive to small amounts of contrast, the radiologist could now enter the vascular system though a brachial vein rather than the femoral artery. Since a venous entry site posed fewer risks for the patient, digital subtractions could be performed on an outpatient basis. Specials techs met digital patients in the waiting area, led them to the angio suite, and had them change into a johnny in the bathroom off the angio suite's control room. After the patient had changed, the techs brought him into the angio room where they explained the digital procedure in detail. After elaborating the risks involved, the techs asked the patient to sign a "consent form" that relieved the radiology department from legal responsibility should complications develop during the procedure. With regular angiograms, a radiologist had visited patients in their hospital rooms prior to their study to explain the risks and to pursue the patient to sign the waiver.

After the patient signed the waiver, the technologists interviewed the patient about his or her medical history and filled in a medical questionnaire. The techs then tied a tourniquet around the patient's
arm to check possible entry sites. If the patient had "bad veins," the technologist mentioned that the radiologist would try to enter though the arm, but if he was unable to do so he would probably decide to use the femoral artery. After checking the patient's veins, the techs secured the patient to the table and left the angio room so that the nurse could start an I.V. No scout films were necessary at the beginning of a digital study since every digital run required its own scout.

Placement of the catheter in a digital subtraction followed the same series of steps as a regular angiogram with two exceptions. Since entry was through the brachial vein, the radiologists did not need to move the catheter as far into the vascular system. Moreover, because digitals were less risky and presumably less painful, valium was not used unless the patient was extremely anxious. Since a digital entry was less complicated, placing a catheter required less time than a regular angiogram. Once the catheter was in place, technologists positioned the patient and filled the pressure injector as before. However, less contrast needed to be injected.

After the patient was positioned, everyone adjourned to the control room where one technologist took command of the digital's console. If the tech had not already done so, she entered the patient into the computer, programmed the number of films per minute, and set several other parameters that defined the equipment's functioning. After setting a technique the tech took a scout film by pressing a button on the console. Within a matter of seconds the scout appeared on the video monitor. The tech checked the technique by changing the computers "window" and "center" settings. Windows referred to the range of values
of a grey scale assigned to the image, while center referenced the range's midpoint. If the technique was adequate, the image would "white out" and "black out" at predetermined center settings, that is, the screen would become completely white or completely black. When techs thought that the technique was poor, they set a new technique and took a second scout. The scouting process continued until the techs were satisfied.

When the techs were ready, the radiologist warned the patient to expect the contrast's hot flash and the technologists triggered the run. As the run progressed, each individual image flashed momentarily on the console's video monitor. During each run the technologists and the radiologist crowded around the console, critiqued the images, and noted potential findings. When the run ceased, the nurse went to the patient's side where one technologist began to set up for the next run. The radiologist remained with the other technologist at the console. Together these two examined the run more closely while the technologist attempted to refine the images' quality by fine tuning display parameters.

After the procedure was complete, the patient was led to the bathroom to change back into his street clothes. Meanwhile, one of the technologists sat at the console "post-processing the images". More often than not, the radiologist was also at the console during this time. Post-processing refers to changing parameters to optimize the quality of the films. For example, the technologist might improve an image by changing the "mask". "Masks" were films taken early in a run which were then subtracted from later films. "Pixal shifting" also improved an image. When shifting pixals, the computer essentially moved
the position of the mask vis a vis the target film to eliminate fuzzy boundaries. Post-processing also involved labeling major arteries in the film. The tech accomplished each of these manipulations by engaging specific software routines.

As the techs post-processed images, they and the radiologist often discussed the patient's problem as revealed by the films and spoke about the quality of the images. When the techs had perfected the image, they transferred it to film using a camera similar to those used in ultrasound and CT. If the radiologist remained for the post-processing he usually indicated what images to transfer. However, the techs made the choice if the radiologist had left.

After patients finished changing clothes, the techs or the nurse offer them donuts and glass of juice. If the patient accepted, he remained in the control room conversing with the technologists, the nurse, and occasionally the radiologist for several additional minutes.

CT-Scanning

Since the CT-scanners represented a rather large financial investment for both departments and since the technology was not available at all hospitals in the region, the scanners operated on a schedule different from other technologies. Whereas special procedures and ultrasound examinations were rarely scheduled after 5:00 PM, the CT scanner routinely worked into the evening hours. Urban's radiology department booked CT scans until 9:00 PM and Suburban's scanner remained open until 10:00 PM. Even the main departments which performed routine x-rays throughout the night scheduled few patients after 5:00 PM.
Rather, the main departments' evening work consisted largely of emergencies and unscheduled outpatients. Like the main department both scanner operations also maintained Saturday hours, but only emergency ultrasounds and special procedures were conducted on weekends.

Most patients having x-rays, fluoroscopy, ultrasound or special procedures were either ambulatory outpatients referred by individual physicians or the hospital's own inpatients. In addition to these persons, both CT departments also scanned patients from hospitals that did not own a scanner. In fact, Urban and Suburban both actively sought to arrange regular referring relationships with local hospitals, a practice encouraged by the Determination of Need process. Under DON guidelines hospitals are often allowed to purchase a scanner only if they can show that their scanner will be of service to neighboring hospitals who can not afford or who have not been allowed to purchase their own. Approximately one third of all persons scanned at Suburban and Urban were patients of other hospitals. The individual arrived by ambulance and were accompanied by Emergency Medical Technicians.

The scanner operations at both research sites also differed from ultrasound and special procedures in that each had two secretaries who coordinated the CT schedule, maintained CT records, and greeted patients as they arrived for scans. Sonographers and specials techs at Suburban handled their own bookings while all bookings other than CT were made though the main desk at Urban. Moreover, both CT departments maintained a separate film library while films from all other procedures were kept in the departments' main film library with one exception: sonographers at Suburban also maintained their own films.
To staff the scanner, Suburban hospital hired two experienced CT techs from one of the region's first body scanning installations and promoted two x-ray techs from the main department. By contrast, Urban hired no outsiders experienced in body scanning. Rather, to create a CT staff large enough to run two scanners simultaneously, Urban brought the specials techs and an x-ray tech from the main department to the CT area. These individuals along with the techs who had been operating the the head scanner were trained to run both scanners.

When patients arrived for a CT scan, they reported first to the CT secretary and then waited in the CT area's waiting room where patients having abdominal scans were soon greeted by a technologist who bid them several cups of Gastrographin, a weak iodine solution. Like all iodine dyes, "gastro" was radio-opaque and therefore enhanced the radiologist's ability to distinguish the stomach and small intestines from other anatomical or pathological structures. At both sites, the gastrographin was mixed with fruit juice to mask, however poorly, the contrast's taste. Hence, "gastro" was called "juice" and the act of administering "gastro" was termed "giving the patient juice". As might be expected, patients rarely enjoyed the "juice" and many complained about it's taste, but the concoction caused surprisingly few patients to vomit.

When ready to begin the scan, a CT tech summoned the patient from the waiting area. Ambulatory patients having abdominal or spinal studies were ushered into a dressing room and asked to slip into a johnny. When dressed for the procedure, the tech led the patient to the gantry and, if the patient was infirm, helped him to mount the scanner's table. As in other areas of the radiology department, CT techs lifted patients traveling by stretcher onto the table if they were unable to
move under their own power. However, they needed to do so less frequently since they usually convinced emergency medical technicians to lift patients from other hospitals onto the table. If the scan was of the patient's abdomen, the technologist might now ask the patient to drink a final cup of gastrographin to ensure that the stomach was filled with contrast.

Depending on the pathology under investigation, a scan might be of one of three types: plain (unenhanced), contrast (enhanced), or both. Plain studies required no intravenous contrast so that the patient could be immediately positioned in the gantry. In a contrast study, iodine dye (Rhenographin) was injected or infused into the patients arm before he was placed in the gantry. If both types were to be performed, a plain scan was executed first, an injection was then administered, and the area was scanned again. In body scanning, intravenous contrast differentiated blood vessels from other structures and highlighted certain structural abnormalities of the brain during head scans.

At Suburban, contrast was almost always injected by syringe. Moreover, after the first month and a half of the scanner's operation the CT techs administered almost all injections. At Urban, contrast was usually infused rather than injected. In an infusion, a butterfly needle was inserted into a vein in the patient's wrist and the needle was attached to a tube running to a 300 ml bottle of contrast hung in an inverted position from an I.V. pole. The height of the bottle controlled the flow of the contrast into the vein: the higher the bottle, the faster the contrast entered under the force of gravity. Only when radiologists desired a "bolus" study were injections performed at Urban. A bolus was a rapid injection performed in the middle of a procedure to
highlight blood vessels in a specific area where pathology had been hypothesized to exist on earlier scans. Urban's technologists never administered injections or started infusions. In theory, the radiology department's nurses were to administer the needles. In practice, the radiologist assigned to CT often started infusions and always injected boluses.

Many patients scheduled for head scans, had histories of behavioral and psychological problems. Scans were ordered in such cases to rule out structural abnormalities, such as brain tumors, that might explain the patient's state. Moreover, elderly patient's suffering from severe senile dementia were also frequent head scan patients. Because Urban had been operating a head scanner for a number of years and because the radiology department had referral arrangements with several local mental hospitals, the number of such patients at Urban was greater than at Suburban. Patients whose symptoms were associated with mental illness or who exhibited bizarre behavior patterns often posed difficulties for the scanner's operation. Such patients were frequently anxious and occasionally violent. At a minimum they, were likely to be "uncooperative", a term most often applied to patients unable to remain still while being scanned. Movement during a CT scan creates artifacts that rendered the scans uninterpretable. To avoid such problems, when it appeared that a patient was exceedingly anxious or likely to be "uncooperative", Urban's radiologists administered injections of valium before positioning the patient in the gantry. Valium was rarely used at Suburban and then only when patients began to "act out".

Soon after the patient was on the table for a plain study or after the contrast was administered in a enhanced study, the technologists
positioned the patient for the scan. To keep the patient from falling off the table and to reduce the patient's freedom of movement, the techs bound the patient with webbed straps. At the start of a head scan, the patient's head was be placed in a plastic head rest and secured by straps or adhesive tape to reduce motion.*

After securing the patient to the table, by pressing buttons on a hand held control device attached to the gantry by an electrical cable, the tech moved the patient into the gantry. The device controlled the table's height and fed the table's top, and hence the patient, in and out of the gantry's circular opening. When the patient was sufficiently far inside the gantry, the technologist pressed another button on the control device to activate the gantry's lasers. The lasers struck the patient's body and provided the technologists reference points for adjusting the patient's position. For example, in a head scan, technologists moved patients into the gantry until the lasers struck the occipital bone. Similarly the starting points of every other scan were associated with an anatomical landmark.

Having positioned the patient, the technologist walked to the rear of the gantry to demonstrate the breathing lights. Red and green lights were mounted on the gantry's inner surface. The green light shone when no scans were being taken, but when scans were imminant the lights changed from green to red. Patients were told to hold their breath whenever the red light came on. After providing breathing instructions,

* Cloth packings were also wrapped around a patient's forehead and eyes to "round out the head" when being scanned on Urban's head scanner. Early scanners like Urban's EMI generate artifacts when the object being scanned is not perfectly circular in cross-section. The packing created a circular object.
the technologist informed the patient that the study would soon commence and that if at any point during the scan the patient desired assistance he or she need only speak. The technologist, would be in the control room next door would be able to hear the patient over the intercom embedded in the gantry.

While one tech positioned the patient, another programmed the scanner for the study. Programming consisted of entering the patient into the scanner's computer and selecting parameters for the scan. To enter a patient, the technologist pushed a button labeled "new patient". The computer terminal then provided the technologist with a series of prompts. When prompted, the tech typed the patient's name, hospital number and other bits of data into the computer. In addition, the computer prompted the technologist for the values of certain technical parameters such as which matrix would be used to construct the images, which filters would be used, whether or not images would be stored immediately on magnetic tape, and what labels would be applied to the images.

After going through the new patient routine, the technologist set a technique. As in radiography, setting a technique on a CT scanner involved selecting the kilovolts, milliamperes, and seconds at which the x-ray tube would operate. In addition, a CT technique also included the scan diameter (eg, the diameter of an imaginary circle inside the gantry's opening that envelops the patient's body), the number of millimeters the table was to move between scans, the number of scans desired, and a choice of two additional filters. Techniques were set by pushing touch sensitive buttons arrayed along the scanner's console.
Once the technique was set, the scanner would begin a series of scans as soon as the tech touched the "start scan" button.

As soon as the technologist who positioned the patient returned to the control room, the tech at the console started the scanner and the first scan was taken. As the computer displayed the first scan on the video monitor, the techs examined the image to ensure that the patient was positioned properly and that the area of interest would be captured. If the patient had to be repositioned, one of the technologists entered the gantry room to alter the patient's position. One the patient was appropriately positioned and the tech had left the gantry room, the "pause" button was released. From this point forward, the scanner operated automatically: one scan was taken, the table moved outwards the specified distance, and another scan was taken. The sequence continued repetitively until the programmed number of scans was executed or until the scanner's x-ray tube reached a temperature high enough for the machine to cut itself off so that the tube could cool. While scans were being taken technologists read the patient's chart, watched images for indications of pathology, took care of other tasks, or simply sat and talked to one another.

When scanning ceased, for whatever reason, the computer began to "reconstruct" and display images on the video monitor. Reconstruction referred to the process by which the computer converted raw data into pictures. Technologists usually photographed the images as they appeared on the monitor by pressing a foot pedal or a button on a device that sat beside the console. Either trigger operated a shutter in a special camera known as a "Matrix" after its manufacturer. Like similar cameras used in ultrasound and digital subtraction, a Matrix camera
transferred the picture on the video monitor to film. The size of the pictures and the number of scans per film could be varied, but at both sites it was standard to array nine scans on each film in a three by three matrix.

When the tube's heat fell sufficiently low, the techs reactivated the scanner and scanning continued until the study was complete. Once the technologists assured themselves that the area of interest had been scanned they summoned the radiologist to view the images. The radiologist now entered the control room and sat beside the techs at the console. One of the techs commanded the computer to display the scans sequentially on the console's video monitor so that the radiologist might view each. While observing the scans, technologists and the radiologists often discussed the anatomical or pathological information contained in the scans as well as the scan's quality and what additional work needed to be done. If the study was a simple enhanced or plain scan, the patient was dismissed after the radiologist viewed the images. If the scan called for both a plain and contrast scan, or if the radiologist decided to bolus the patient to determine whether a structure was vascular or pathological, the techs or the radiologist administered an injection at this point in time, and the area was scanned again. After the contrast scan, which followed much the same pattern as the first, the patient was taken out of the gantry, assisted off the table and dismissed.

The preceding descriptions of how radiologists and technologists performed selected radiological procedures with the various technologies found in a radiology department by necessity oversimplifies the daily
round of radiological work. Nevertheless, the portrayals set an adequate stage for addressing the question, "have the new technologies spawned social organizations that differ from those surrounding work in the main department." In the next two chapters each technology's use is analysed in greater detail to discover first how the work roles of technologists were altered by new imaging technologies and second, how the technologies changed role relations among patients, radiologists, and technologists. In the process, I shall embroider more refined distinctions into the cloth of basic description that I have attempted to weave.

FOOTNOTES

1. Throughout the remainder of this monograph I will occasionally refer to "radiology departments" to denote phenomena that were common to both Urban and Suburban. This linguistic convention eliminates the need to clutter the prose with such phrases as "at both sites", "at both Urban and Suburban", etc. Although the language carries the implication of even wider applicability, the reader needs to hold firmly in mind that commonalties cover explicitly only the sites I observed. Where the organization of radiological work at Urban and Suburban differed should be clear from the text.

2. Radiologists and administrators have their own offices. In addition, one or more offices are shared by the secretaries, clerks, and transcriptionists. In the main darkroom, the darkroom technician develops the main department's films which are, in turn, archived in the film library. Reading rooms are where radiologists interpret films and dictate reports. These rooms might or might not double as radiologist's offices. Patients report to the main desk when they arrive at the radiology department and are told to be seated in the waiting room.

3. The main departments of both radiology departments are clearly responsible for the largest proportion of the studies produced at each site. However, as one of the administrators was careful to point out, routine radiography did not make the
department much money. Since most routines were conducted on inpatients or outpatients referred by physicians, only 80% of the costs were paid by insurers. The administrator estimated that if an inpatient were to have more than two studies done, then the department would actually begin to loose money. On the other hand, since many CT scans were referred by other hospitals, the radiology department charged the referring hospital directly. In most instances the referring hospital pays 100% of the charge and it is up to the referring hospital to the collect from patients and their insurers.

4. As mentioned in the last chapter, Suburban was building a new addition to the hospital. The radiology department was slated to move into the new building once it was completed. At that time ultrasound was to regain its own distinct area. Special procedures would also move to its own area of the new building, but there was some debate over whether CT would remain in its current location or accompany the rest of the department next door. As the project neared its close it appeared that CT would remain where it began.

5. For this reason, I have never seen a mammogram performed. The issues of sex and modesty form an interesting undercurrent in the daily life of a radiology department. While most technologists will state that they are not bothered by a patient's sex and deny that they typically treat patients of the opposite sex differently, their actions often belie their words. For example, since most techs are females below the age of 30, they often attempt to avoid preparing young males for barium enemas. When confronted with a male their own age or younger, they either ask a male technologist to prepare the patient or else enlist the assistance of an older female technologist. Interestingly enough, technologists show no hesitancy to prepare males for barium enemas if they perceive the patient as being beyond a certain age. Note that perceived age and not chronological age is important. The implication is that technologists are able to create sexually neutral definitions of the situation only when males appear to have passed what is taken in the larger culture to be their sexual prime. Older female technologists are not subject to the same hesitancies of the younger technologists. Because of these social dynamics (which also occur in other examinations), it would seem that radiology departments would provide an excellent setting for field experiments on the interaction effects of perceived age and the attribution of sexuality.

6. Myelograms, the injection of a radio-opaque dye into the spinal column to diagnose ruptured disks and other spinal diseases are also considered subspecial procedures. At both sites, myelograms were performed by neurosurgeons who used the radiology department's equipment. Myelograms were morning procedures.
7. One of Suburban's technologists who worked only during the mornings specialized in fluoroscopy and claimed room 5 as her territory. Near the end of the study, it appeared as if another technologist had also been more or less permanently assigned to fluoroscopy. Portables were originally the province of one of the male techs who was later promoted to the CT department. After that time, portables were shared by all of Suburban's technologists. At Urban, the practice of assigning technologists to areas on a regular basis was discontinued shortly after the study began. While the demise of the practice pleased most technologists, those who claimed the emergency room as their domain were disgruntled.

8. One should merely keep in mind that the Upper GI requires the patient to swallow barium so that the esophagus, stomach, and small bowels can be observed. If the course of the barium is to be traced throughout the small bowels the procedure is called a "small bowel follow through". If only the esophagus is of interest then the term is "barium swallow".

9. The cassette contained phosphorescent "screens" that emit light when struck by electrons as well as "grids" that absorb scatter radiation. The light emitted by the phosphorescent screens actually produces the photographs. The electrons from the x-ray tube cause the screens to glow, and photons from the screens strike the films creating the picture. Scatter radiation refers to electrons that have bounded of an object at an angle. Since true images are best produced by electrons whose path has not been deflected, the film can be made clearer by reducing "scatter".

10. Over the course of the year I spent in these hospitals no patients died from IVP's or any other procedure. In fact, I attempted to find out how likely death might be by polling older technologists and radiologists about whether they had ever seen a patient die during an IVP. Only one technologist with a 15 year tenure admitted to having witnessed such a death. The frequency of the experience among radiologists was equally rare and limited to radiologists with considerable years of tenure in the profession.

11. Radiologists and technologists are faced with the problem of determining whether patient's are lying when they claim to be allergic to iodine. Patients hear from other people that IVP's can cause side effects and reactions. To avoid the procedure, some patients will claim to be allergic when they are in fact not. To make the determination, techs and radiologists use the patient's medical history was well as the accuracy of their discriptions. If radiologists think the patient is lying they will inject anyway. I never saw a radiologist's disregard for a patient's claim result in a reaction. This would lead me to suggest that over a number of years of practice, radiologists and techs learn to sort out the "crock".
12. Near the end of the study, the nurses at Urban assumed responsibility for injecting IVP's therefore eliminating the need for the technologist to summon a radiologist to the injection. This discription therefore applies only to how the procedure was conducted up until that point in time when the radiologist's role in the IVP was reduced.

13. An automatic dispenser is a pole with an electromagnetic clamp attached. The tube from the enema bag runs through the clamp and the clamp is activated by a foot pedal placed on the floor of the control booth. Automatic dispensers are called "E-Z EM Automatic Flow Controls". "E-Z EM" is a trade name used by a company that makes a number of barium enema supplies.

14. Of all materials, liquids offer the least acoustical impedance and gasses the most. Thus, ultrasound images liquid filled structures most clearly whereas gas obstructs ultrasound's view.

15. Cardiac studies were not performed by sonographer's in Urban's radiology department since the cardiologists at Urban operated their own cardiac echo unit. Although the sonographers had a D-scanner, I never saw them use it.

16. Only the experienced sonographer who worked at Urban until the last few months of the project routinely waited to show radiologist's films. This sonographer was highly trusted by the radiologists.

17. The shape of a catheter's tip helps the radiologist maneuver the arterial system and holds the catheter in place. In the past, all radiologists shaped their own catheters. However, companies now supply preshaped catheters. The radiologist needs only to provide the company with a prototype. Preshaped catheters were used by both departments, but Suburban relied almost extensively on them. Rarely did radiologists at Suburban shape their own catheters.

18. CT techs are often paid at a higher salary than x-ray techs as are sonographers and specials techs. This was the case at Suburban but not at Urban. That CT techs were the same pay grade as x-ray techs was a bone of contention among Urban's CT techs.
THE PROFESSIONAL, THE SEMI-PROFESSIONAL, AND THE MACHINES:
THE SOCIAL RAMIFICATIONS OF COMPUTER BASED IMAGING IN RADIOLOGY

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DOCTOR OF PHILOSOPHY

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 1984

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Vol 2

Signature of Author

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MAY 22 1984
CHAPTER 5

TECHNOLOGISTS' TASKS AND WORK ROLES

When introducing the notion that technologies engender social change by reverberation, I proposed that a technology most strongly affects the social organization of work at the level of its most proximal users. From the foregoing descriptions of how actual radiological procedures are performed, one fact should stand in relief: no person in a radiology department is closer to the technology than the technologist. Although a radiologist may actually operate certain machines during phases of particular exams and although his work may be decisively altered by the images that new technologies produce, only the technologists' involvement with the technology can be aptly construed as a "man-machine" relationship. Not only are techs the sole operators of most machines during most procedures, but all of their work takes place in the context of a machine's use. In contrast, the radiologist spends the bulk of his time in an office or reading room interpreting rather than producing studies. Given the division of labor and the relative proximity of radiologists and technologists to the machines, if new imaging technologies change the social organization of radiology departments by altering new man-machine relationships, they are likely to do so by affecting technologists' work. Accordingly, in this chapter I focus on how the technologist's task and work role varies across the procedures and technologies previously described.

Of concern, then is the following question: Do new radiological technologies alter the technologist's work milieu, and if so, do they
consistently create differences that distinguish the roles of specials techs, CT-techs, and sonographers from those of x-ray techs in the main department? I shall proceed to answer this question by systematically comparing each technology's social organization along a number of dimensions to show where similarities and differences lie.

Following the lead of Blauner (1964) and other sociologists of automation who also adopt a synchronic stance, if the empirical similarities and differences fall along expected lines, and if there is no reason to suspect that the patterns can be otherwise explained, I shall propose that the differences be attributed to the technology. This is not to say that the technologies are sufficient causes for the differences, but merely that their existence generates constraints and opportunities that give rise to different forms of social organization. Some constraints and opportunities may indeed be directly linked to technical attributes of the machines, others arise wholly or in part from social evaluations. Over the course of the analysis, I shall note the mixtures of technical and social forces relevant to the topic at hand.

Interpretation

The medical specialty of radiology stands on the radiologist's ability to interpret medical images and on the profession's historical success at securing for radiologists the exclusionary right to provide such interpretations. While other physicians are certainly able to read films (orthopedic surgeons for instance) and while scattered practitioners have always attempted to circumvent the radiologist by
purchasing and installing their own equipment, by and large, the medical community has accepted the radiologist's professional mandate. As I mentioned in the first chapter, to secure this mandate radiology not only had to carve itself a niche among physicians, but also bar members of other occupations, most notably the technologists, from providing competitive services. Radiologists were ultimately able to keep technologists from interpreting by gradually gaining control of the institutions by which technologists are trained, certified, and hired. Today, only duly registered graduates of A.M.A. accredited training programs can be employed as radiological technologists. Graduates of such programs are taught anatomy and skills necessary for producing quality radiographs, but are not tutored in sign systems that might allow them to interpret films.

However, to say that techs are not supposed to interpret and that they have not been trained to interpret, is quite different from saying that they can't and that they don't. Throughout their careers radiological technologists work with medical images. Moreover, interpretive consultations and comments occur frequently and spontaneously in hallways, reading rooms, darkrooms, and wherever else radiologists corner each other, find themselves cornered by physicians, or talk out loud. Given that they work in an environment thick with diagnostic interpretation, it stands to reason that techs might learn informally what they have not been taught systematically. Consequently, I set out to learn whether technologists could and in fact, did read the films they produced.

At the end of radiological procedures, patients commonly asked technologists, "what do I have," "what do the films show," or some other
variant of "can you look at the pictures and tell me if I'm OK".
Regardless of the technology that the technologist happened to be
operating or the procedure that had just been performed, the
technologist almost always replied, "I don't know, you'll have to ask
your doctor. The radiologist will talk to him once he's had a chance to
read the films." Other techs deflected the question by briefly
explicating the established division of labor, "I don't know how to read
them. They don't train us to do that. Only the radiologist can read
these things." What was surprising about such situations was the
linguistic invariance of the technologists' reply. It was as if all
technologists had memorized a script at some point in their career. As
one might expect, the gulf between the tech's espoused ignorance and his
or her actual knowledge was often quite wide. The truth of the techs'
response depended on who they happened to be, but more importantly for
our purposes, on what technology they happened to operate.

To determine whether x-ray techs could read the films they
produced, as they were in the act of taking a film out of a processor or
placing it in a reading packet, I made a practice of asking what the
film revealed. The question was contextually appropriate, for on such
occasions techs were likely to hold films to a light box to check the
adequacy of their techniques. Moreover, both acts occurred well out of
the sight and hearing of patients. With the exception of those few
technologists with years of experience most x-ray techs named a variety
of anatomical structures, but mentioned few signs of pathology. When
techs did note pathologies, the problems were usually either structural
in nature, or else those frequently found in often repeated exams.
Thus, technologists could rather easily identify broken bones or
spondelectesis, whether an IVP revealed a kidney stone or a blocked ureter, and whether a barium enema indicated diverticulitis or polyps. The techs might also say that they thought an area looked "funny," or that it "didn't look normal", but why the appearance was "not right" they could not say.

Suspecting that the technologists might withhold their knowledge from researchers as well as patients, I also listened closely to what x-ray techs said to each other about the films they developed. By and large, the techs rarely spoke of pathology. Instead, they most often talked of the technical attributes of the image: its technique and the adequacy of its centering. When techs did proclaim that their patient "had something", that "something" was most often a kidney stone, a gall stone, a ureter that wasn't draining, a polyp, or a broken bone. X-ray techs did not often see, or at least say they saw, hydronephrotic kidneys, tumors or masses, enlarged hearts, adelexis, pneumonia, pneumothroax, or any of a host of other exotic sounding maladies that radiologists read in the same films. In fact, if a tech recognized that such problems existed it was then that they claimed something "looked funny". With sufficient experience, x-ray techs sometimes realized that something out of the ordinary was going on, but were usually unable to name what they saw.

When x-ray techs did discuss cases in detail, the cases invariably embodied an element of the unusual or the bizarre. One famous case involved a twenty year old male who came to Suburban to have his wisdom teeth removed. A radiologist discovered in the boy's routine chest film a tragic cancer that later claimed his life (the case became known because the radiologists spoke of it to technologists and showed them
films). Bullets and other foreign bodies embedded in the body also spawned interest. Often such cases gained the status of legends or stories. From time to time techs told these tales to entertain themselves and their visitors, as occurs in the following extract from fieldnotes at Suburban:

Tech A: Steve, you didn't see our tapeworm did you?

S.B.: Tapeworm?

Tech A: Yeah. We had a patient two weeks ago who had a tapeworm. You could see it right on the x-rays.

Tech B: (Producing a film from a drawer below the light boxes) Steve, come here and look at this.

Tech C: See the tapeworm curled all up in the stomach?

(One could see the trapazoidal segments of the parasite in the duodenum)

Tech B: Where's the other film? I can't find it.

Tech C: Too bad. On the other film you can see the worm eating the barium.

Tech B: You know how they find out if you got a tapeworm? If you hold a piece of food in front of a person's mouth whose got a tapeworm, the worm will come out and try to get the food. (She wiggled her two fingers in front of her mouth.) You can see the worm's horny old head.

Thus, x-ray technologists were most likely to recognize three types of problems: the anatomical, the common, and the sensational.
The range of the x-ray techs' interpretive abilities reflected the distribution of knowledge and the organization of work in the main department. Since they were trained to recognize anatomy, structural oddities, such as broken bones or missing kidneys, easily stood out as abnormal. In contrast, since the technologist's training did not cover diagnosis, signs of more subtle pathologies had to be learned while on the job from persons already possessing such knowledge. It is telling therefore, that x-ray techs seemed to recognize most pathology in films from IVP's, and to a lesser degree, from Upper GI's and barium enemas. Not only were these procedures frequent, but each brought the technologists into contact with a radiologist at a point in time where the radiologist attended to diagnostic information. At such junctures, over time, wittingly and unwittingly, by mentioning their occurrence in the tech's presence, radiologists taught techs to recognize the maladies commonly diagnosed by the exams.

To test this hypothesis about how x-ray techs' interpretive skills became slanted, I reviewed the fieldnotes from each examination I observed and recorded whether, over the course of the exam, the technologist and the radiologist had discussed, however briefly, an anatomical or pathological attribute of the images that were produced. Table 2 presents for various procedures, the percentage of exams during which the meaning of a image became a topic of conversation. As the table suggests, in both main departments, meanings were most often mentioned during IVP's. One will recall from the last chapter that IVP's required technologists to repeatedly present a radiologist with films so that he might determine the future course of the exam. Upper
Table 2

Percentage of Examinations in which Radiologists and Technologists Spoke about the Meaning of a Film

<table>
<thead>
<tr>
<th>EXAMINATION</th>
<th>URBAN</th>
<th></th>
<th>SUBURBAN</th>
<th></th>
<th>COMBINED</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Routines</td>
<td>9</td>
<td>0%</td>
<td>10</td>
<td>0%</td>
<td>19</td>
<td>0%</td>
</tr>
<tr>
<td>I.V.P.'s</td>
<td>7</td>
<td>57%</td>
<td>24</td>
<td>29%</td>
<td>31</td>
<td>35%</td>
</tr>
<tr>
<td>Upper G.I.'s</td>
<td>20</td>
<td>30%</td>
<td>15</td>
<td>13%</td>
<td>35</td>
<td>23%</td>
</tr>
<tr>
<td>Barium Enemas</td>
<td>28</td>
<td>18%</td>
<td>25</td>
<td>4%</td>
<td>53</td>
<td>11%</td>
</tr>
<tr>
<td>CT Scans</td>
<td>42</td>
<td>64%</td>
<td>50</td>
<td>40%</td>
<td>92</td>
<td>51%</td>
</tr>
<tr>
<td>Specials</td>
<td>11</td>
<td>27%</td>
<td>27</td>
<td>85%</td>
<td>38</td>
<td>68%</td>
</tr>
<tr>
<td>Ultrasounds</td>
<td>16</td>
<td>100%</td>
<td>31</td>
<td>77%</td>
<td>47</td>
<td>85%</td>
</tr>
</tbody>
</table>
GI's were the second most likely exam to foster interpretive conversations not only because some Upper GI's, "small bowel follow throughs," were structured like IVP's, but because they were always conducted from a fluoroscopic control booth where the tech and the radiologist could converse in undertones without the patient overhearing. Since most barium enemas at Urban were conducted at tableside and since radiologists and technologists hurried through the exams to minimize the patient's discomfort, barium enemas were less likely to involve interpretive exchanges even when remote rooms were used. Moreover, the course of a barium enema did not depend on information contained in the films themselves. Finally, no interpretive conversations occurred during routines because when performing these studies technologists rarely saw radiologists. The pattern of results for both hospitals is consistent with the notion that techs knew most about the findings of exams whose structures conduced radiologists to provide interpretive information.²

In contrast to the x-ray techs in the main departments, CT techs, specials techs, and sonographers were better versed in the meaning of the images they created. When asked to explain an image, technologists in the newer modalites often went to great lengths to describe not only the immediate anatomy and pathology visible in the film, but also the likely causes of the problem and their implications for the patient. Such extensive involvement with the images was particularly true of the specials techs and the sonographers, most of whom had at least several years more experience with their technology than the relatively inexperienced CT techs who only began to operate body scanners during the course of the project.³
Whereas x-ray techs typically responded briefly to questions about a film's implications, technologists in the newer modalities occasionally gave lectures. During my first visit to Urban's head scanner in the first month of the study, a patient was being scanned for a subdural hemorrhage. I asked the technologist whether the scans suggested a positive finding. In response, the technologist pointed out areas of gross anatomy and then reviewed the signs of a subdural. Since the particular patient did not seem to have the problem, the technologist pulled a looseleaf notebook of prior scans from a shelf. The book was part of the CT department's "teaching files", a collection of scans used as exemplars of problems common in head scanning. The tech proceeded not only to point out cases of subdural hemorrhage, but also spent ten minutes showing me other common pathologies. In a similar vein, sonographers and specials techs at both sites enthusiastically hung studies on light boxes and meticulously pointed out signs of pathology and how one could differentiate normal from abnormal studies.

Like IVP's in the main department, CT scans, special procedures, and ultrasounds were structured so that a radiologist reviewed images in the tech's presence. At a minimum, radiologists viewed CT scans at the console in the presence of the technologists before the patient was sent. Suburban's radiologists and sonographers conducted a second real-time study before dismissing patients, while Urban's sonographers usually showed films to radiologists in their office after completing the real-time portion of the exam. Extensive contact occurred in special procedures where radiologists and technologists worked together over the course of the whole study. Consequently, as the data in Table
show, with the exception of special procedures at Urban, findings were more often a topic of conversation in the three newer technologies than in the main department (Urban's exception is explained below).

While greater structural opportunities to learn about the meaning of films may explain why CT techs, specials techs, and sonographers were more likely than x-ray techs to know what a film meant, opportunity to learn is insufficient for explaining either the breadth of their knowledge or the intensity of their interest. To account for these qualities, one must look to two attributes of the new technologies' use that distinguish them from the old. The first distinction is essentially social in nature while the second is technical. The social distinction is most clearly seen in the case of the body scanners.

As mentioned earlier, with the exception of the two experienced techs hired by Suburban, the newly appointed CT techs at both hospitals knew little about body scanning, cross-sectional anatomy, or pathological signs relevant to CT. However, the technologists' lack of familiarity with the scanner and its products was shared by most radiologists as well. At Suburban, only the radiologist who joined the staff during the summer of the project had extensive experience with CT scanning. The others had no more than passing acquaintance with either scanners or scans. While Urban's radiologists had operated a head scanner for seven years, as a group, they were only slightly more knowledgable about body scanning. One of Urban's new radiologists was hired specifically because he had specialized in body scanning during his residency. In addition, one of Urban's other radiologists had long been an advocate of CT scanning and had availed himself of opportunities to study both the technology and the diagnostics of body scanning before
the scanner arrived. Thus, while there were two or three persons at each site who knew the technology and its output, most techs and radiologists alike met the scanner with enthusiastic ignorance.

Given excitement that attended the scanners' arrival at both hospitals, the mystique and wonder that piqued everyone's interest, and the very real and pragmatic necessity for the radiologists to learn to interpret the scanner's images, it should come as no surprise that radiologists spent considerable time with the technologists in front of the console, especially during the early months of the scanners' operation. As the techs and the radiologists watched scans appear on the video monitor, discussions of the anatomy and pathology arose spontaneously. Since most of the people involved were inexperienced, the discussions bore a peculiar flavor. Radiologists not only debated with and educated each other, but they also went to great lengths to explain images to the techs. The techs, in turn, did not hesitate to ask radiologists about the meaning of a scan. Thus at both sites, a tradition of open discussion of diagnostic signs at the console developed early.4

A sense for the qualitative differences between these discussions and those that occurred between techs and radiologists in the main department can be obtained by comparing the following excerpts from transcripts of an IVP and a CT scan in which a radiologist speaks to a technologist about the meaning of an image. Although the examples are both from Urban, they are typical of the two technological contexts at both sites.
IVP

T: (Hanging a film on a light box) That ok?
R: Sure. (At this point the radiologist is looking at the table top in front of him)
T: You didn't even look!
R: (Laughs) I didn't even look! (Examines the film) Ooooop. There's a rock!
T: Oh yeah, where?
(The radiologist now points to a white speck of the the side of the spine as the edge of the left kidney)

CT SCAN

(The radiologist and the two CT techs are in front of the console looking at an abdomen scan. The radiologist is in the process of explaining how surgeons drain pseudocysts, a problem the current patient suffers)
R: They punch a hole through the side (of the cyst).....
T1: Uhhuh.
R: ...and right through the stomach.
T1: So it drains?
R: They sew the two together. They put sutures on the outside and then they cut a hole. They suture it together. All around the edges to that they join together. And then they poke a hole in the stomach and the pseudocyst. And they let the pseudocyst drain into the stomach. The pseudocyst drains and empties. The stomach's food evidently never bothers it. Eventually it closes off...
T: The stomach doesn't...
T2: (referring to image) Quite a bit of surgery I take it. (eg. the anatomy looks abnormal)
R: She had her gall bladder out?
T1: We got her x-rays.

(moments later)

R: (pointing to screen) Big spleen. These could be varicies here. Renal varices. She's probably got....These are probably more varices here. There's some more there. She's got 'em all over. Something's wrong! She's got hypertension and varicies. And that's usually from cirrhosis. But I mean she could have post necrotic cirrhosis...Why don't you just go ahead and do about two or three more cuts? Just, I want to take a look at those varicies.
Note that in the IVP example, the interpretive comment is made in passing without much elaboration. However, the radiologist in front of the CT scanner purposely and deliberately shows technologists both anatomical and pathological signs in detail. In the process he tells the technologists what the surgeons will do for the patient's pseudocyst and raises an additional hypothesis about the patient's condition (varicies) which he says are a sign of cirrhosis. In part, then, the technology's newness and the relatively more equal initial distribution of knowledge about CT scans fostered a social order characterized my more open exchange of information and the radiologist's willingness to treat the techs more like members of a team. However, a second, more technical aspect of the scanner's operation also differentiated the scanner from traditional radiological technologies and supported the CT tech's greater involvement with images.

An X-ray tech's ability to produce a radiograph, regardless of what study it might be a part of, is divorced from the image itself. In fact, techs rarely examine films from a routine study until the exam is completely over. Even in an IVP, where post-injection films are critical for determining what and how many follow-up films will be necessary, it is the radiologist and not the technologist who uses the x-rays' information to make a decision. In contrast, information from previous images is far more important in the course of a CT scan. At the start of each scan, CT techs examine the first image to determine whether the patient has been positioned correctly. If the scan is "too high" or "too low", the patient must be repositioned before the scan continues. Similarly, CT techs monitor ongoing scans to determine when the study should cease. Unless CT techs use the images to coordinate
the precise beginning and end of the scan, either too few or too many scans will be taken. In the first case, not enough information is obtained on the patient's problem; in the second, the patient is exposed to excessive radiation.

Similarly, if techs are to independently program scanners for bolus injections during which only areas of suspected pathology are rescanned, then the technologist must be able to recognize the pathology to judge the number of scans necessary. Otherwise, a radiologist must tell the technologist what area to repeat. Likewise some knowledge of anatomy and pathology are necessary when the tech "post-processed" images. Post-processing refers to measuring the size and density of structures thought to be pathological, enlarging the areas for a more detailed view, and labeling the areas for easy identification. To command the computer to execute any of these tasks the technologist must at least be able to recognize the particular structures of interest. Thus, to operate the scanner effectively, the CT techs needed to use anatomical and even pathological information contained in the scans.

As with a CT scan, anatomical and pathological information contained in images guided the course of special procedures and how the specials techs conducted runs. For example, in a carotid angiogram, the patient's position for all but the first run was partially dependent on results of the previous run. When vessels overlapped so that one could not be seen or when the dye appeared weak because the orientation of the patient's neck rather than an occlusion seemed to be constricting the flow, the techs adjusted the perspective accordingly to obtain better images. Thus in between runs radiologists and technologists examined films. While viewing the films the radiologists almost always discussed
what they saw in the images. However, the involvement of the special's
tech in these discussions differed dramatically between the two sites.

At Suburban, the conversations were more like those that occurred
in the CT areas. The radiologist and the technologist stood together in
front of the light boxes and as the technologist hung the films for the
radiologist (since he usually kept his surgical gloves on), the two
reviewed the films. While the radiologist generally led the
conversation, occasionally the tech was the first to mention an instance
of pathology. If the films seemed to call for adjustments in the next
run, the technologist might also be the first to suggest the corrective
action. Because Urban's radiologist's stood by the processor and hung
films for themselves as they emerged, the technologist was usually in
the darkroom when the radiologist began to examine the films. Instead
of discussing the films with the tech, the radiologists conversed with
the nurse. By the time the technologist emerged from the darkroom, the
radiologist had typically finished reviewing the run. The radiologist
simply told the technologist what new position and techniques were
needed and if he mentioned pathology, it was likely to be in the form of
a brief summary. Thus, the specials tech's involvement in interpretive
conversations was more akin to that of the x-ray tech performing an IVP
(and hence the lower score in Table 2). One should not presume,
however, that Urban's specials techs knew little about the films they
produced. Whenever I asked one of the techs to explain runs, they were
as adept as Suburban's techs at explaining the location and implication
of almost every patient's problem.

While CT techs and specials techs took interest in the meaning of
the films they produced and while they were often able to read
anatomical and pathological signs no technologist knew more about images than the sonographer. In ultrasound the cybernetic use of images reached a zenith. Unless sonographers continually responded to the images on the video monitor, they could not conduct the study. As they watched the monitor, they adjusted and readjusted the position of the transducer and the patient's body until the organ of interest appeared from a desired perspective. Only then would the sonographer transfer the image to film. To capture views of particular organs, the sonographer had to know where organs were located in the body from a longitudinal and cross-sectional perspective, as well as each organ's characteristic appearance in ultrasound. Moreover, if the study was to be "diagnostic", the sonographers also had to detect pathology as easily as anatomy.

In stark contrast to any other imaging technology, because the transducer was a probe with a narrow field of view, the sonographer could not rely on the machine to automatically capture evidence of the patient's malady. Instead, to capture signs of pathology or to prove that no signs existed sonographers had to actively search for the pathology. Moreover, since ultrasound images were far more ambiguous than those produced by any other technology, iatrogenesis was a problem the sonographer had to avoid. As one sonographer put it, "you can make anybody look sick if you hold the transducer right". Thus sonographers not only had to know how to differentiate the signs of different diseases, they also had to distinguish artifacts from the real thing. But, the sonographer's need to interpret images was even more complex. Since different pathologies can lead to similar structural manifestations, the sonographer had to keep in mind the various
potential causes of any given manifestation and then attempt to eliminate options by providing conclusive images. One sonographer provided the following example as an illustration:

There are two things that can cause a dilated common duct. A stone in the duct or a tumor in the head of the pancreas. So if you see a dilated duct, you had better check the whole duct for a stone and look at the head of the pancreas. Actually, there is a third possible cause, but it only occurs about one percent of the time. Anyway, if you look at the pancreas and you can see it and there's no tumor, then you have to try to see the whole duct. If you can't see the whole duct you can't discount the stone and you have to say the dilation is probably from a stone.

The nature of ultrasound technology and the skills required of a competent sonographer led some sonographers to proudly claim in private that they were the only technologists who knew how to diagnose. Consequently, they saw their work as the most interesting and challenging available to a technologist. However, sonographers clearly recognized the tenuousness of their position. While their skills made them invaluable to a radiology department, they at the same time placed the sonographer in social jeopardy. In order to do their work they had to do precisely that which technologists were not supposed to do: interpret and diagnose.  

In summary, when compared to x-ray techs in the main department, CT techs, specials techs and sonographers knew more about and were more involved in the images they created. In part, this distinction grew out of the social order that enveloped the technologies in their early days when the technologies were almost as mysterious to the radiologists as to the technologists. As a result, technological subcultures bearing
traditions of open communication about the meaning of films were established. But the differences were also grounded in technical distinctions. The flow of procedures conducted with the new technologies were more likely to depend on a cybernetic use of information contained in the images themselves. The importance of the technologists' ability to recognize anatomical and pathological signs in order to competently operate the technology was weakest in regular special procedures where the technologies were supercharged versions of more traditional machines. At the other extreme were sonographers who could not operate ultrasound without extensive knowledge of anatomical and pathological signs.

Variety, Routine, and Predictability

Main Department: When I asked x-ray techs at both hospitals what work they liked best, most said they preferred routines because of the "variety". The tech's definition of variety and the concept as used in the technology and job design literature overlap, but do not coincide. For example, Hackman and Oldham (1980) use the term "variety" to refer to the number of tasks a job involves, the heterogeneity of the work itself. While the technologist's usage would subsume Hackman and Oldham's they would find it a bit too narrow. For technologists, variety also connotes "not knowing what will happen next". It involves the likelihood that the next unit of work will be different from the last and the probability that events might turn unpredictable. "Variety," then, as the techs understood it was a handmaiden to chance that disrupted the tedium of the ordinary.
Doing routines did indeed have certain similarities to a game of fortune. As they waited in Urban's alcove and Suburban's films library, x-ray techs had no way of knowing which of a number of possible studies they would be asked to perform next. Since routine x-rays were rarely scheduled ahead of time, mystery shrouded the next patient's identity, his arrival time, what maladies he might suffer, and what problems he might pose. Thus, in outpatient work, task heterogeneity was amplified by surprise. Although techs did not wait on the edge of their seats anticipating the next study (after all, work is work), the flurry of activity and negotiation that often accompanied a patient's arrival did suggest brief currents of suspense.

As patient's walked up to the desk or arrived from the floor, the techs on outpatient duty turned their attention, however momentarily, from their present activitivities to the patient. The first tech to see the patient usually mentioned the patient's arrival. Some of the techs would then move to the front of the alcove at Urban or to the window between the film library and the secretaries' office at Suburban to discover what study the patient was to have. Depending on the nature of the study, techs might either try to avoid or embrace the opportunity to become involved. Uninteresting cases (a routine chest x-ray) or patients who seemed to promise hassles (a bag lady with a peculiar aroma) occasioned avoidance. On the other hand, accidents, the arrival of handcuffed prisoners, or the chance to do a rare exam might culminate in several techs deciding to do the procedure together.

The unpredictable range of work that flowed through both outpatient areas fostered concomitant variation in the skills that techs could flex. "Toes", "chests", "skulls", and "femurs" and other radiographic
studies all require different positions and techniques for their execution. Since the sequence of studies that techs performed while doing routines was more or less random, the odds were that over the course of the day they would employ more of their technical knowledge and training than in any other area of the main department. But perhaps more critical than the variety of technical challenges that the diversity afforded, was the heterogenity of the patients themselves and the problems they presented. With the exception of emergency room work, x-ray techs were likely to encounter the highest proportion of "interesting" cases while doing outpatients.

Interspersed between the frequent and relatively boring chest x-rays were patients whose situations were out of the ordinary. For example, all but the worst trauma cases (eg. serious head injuries, wounds requiring immediate surgery, etc.) were handled in the outpatient area at Suburban. Individuals who had sustained injuries such as might occur in a fall or an automobile accident posed problems that demanded special handling. Moreover, such people usually had more interesting stories to tell about their condition than did patients who were having appendectomies or who suffered from kidney stones or chronic constipation. The wider variety of medical problems that led to routine x-rays also amplified the variety of patients. Professional football players were occasionally brought to Suburban's x-ray rooms after being injured in practice, Urban frequently ministered to street people, and both departments saw their share of criminals with police escorts. Rarely were the personal circumstances of IVP or BE patients as intriguing.
A sense of the excitement that outpatient work could offer may be gleaned from an incident that occurred at Suburban. Two police officers, one dressed in the leather regalia of a motorcycle policeman, had brought a young male to be x-rayed before taking him to jail. The officers claimed that the teenager had stolen a car and, when cornered, had attempted to run over the motorcycle cop. The officer who's motorcycle was allegedly damaged in the altercation appeared in fine condition. The boy, however, was being x-rayed for broken ribs. Since there were no visible cuts on the boy's body, the techs were quite curious about how the prisoner might have broken his ribs especially since the policeman had emerged unscathed. Had the cop not been on the motorcycle and the boy in a car? Word of the patient's arrival spread rapidly throughout the main department and before long seven techs, the darkroom technician, and two administrators were in the outpatient area. Three technologists performed the study while the Assistant Chief Tech attempted to disperse the other technologists who were talking to the officers and, according the ACT, "gawking" at the patient.

**IVP's and Fluoroscopy:** In contrast to routines, when performing IVP's and fluoroscopy techs knew that the next study would be more or less exactly like the last. The morning's IVP and fluoro schedules were stacked so that one patient followed on the heels of another in a four to five hour stream of the same exams. Variations were introduced only by the severity of the patients' conditions, by their personality, and by mishaps that might occur over the course of the procedure. But, after one performed enough IVP's and BE's even the mishaps became routine. For example, technologists with several years experience had an uncanny ability to look at patients and predict with surprising
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accuracy whether they would or would not evacuate during a barium enema. Techs commonly complained that IVP's, BE's, and Upper GI's were "factory work". By the metaphor technologists not only meant that the work was routine, and that they could, as one tech put it, "plug them in your sleep", but also that patients were processed impersonally. Given the pace of the exams, techs felt that they could give patients little attention. A particularly cynical technologist summarized her experience in fluoroscopy with the following words: "It's good Morning. Then, bring them in, plug them, fill them up, and hope they don't shit before they leave."

Because each exam was identical, there was little variation in the films that techs took and hence, in the positions they used. Every tech knew that each IVP required a "KUB" and an "A-P tomo" as scouts. After the injection there was a "0-minute tomo", a "5-minute KUB" and so forth. Variations from one patient to the next were introduced only by the radiologist after looking at the films. But even when radiologists asked for additional films, the views rarely changed, the exam merely became longer. The same film was repeated at intervals until it was clear that the patient's bladder either would or would not fill. The likelihood of a radiologist requesting an out of the ordinary film in a Barium Enema or an Upper GI was even less than in an IVP. Since the radiologist conducted the fluoroscopy, he presumably captured on "spot" films whatever areas especially interested him. Because the number of views required in an IVP or BE were limited, the techniques that techs set were also circumscribed.

Even patients' maladies, symptoms, and complaints became somewhat stereotypical after a tech had seen a number of IVP's and barium enemas.
The technologist knew exactly when the patient would complain during an IVP and what those complaints were likely to be. In turn, the tech's responses were equally well scripted and varied little from patient to patient. When the patient complained about being hot and nauseous, the tech would automatically reply with a variant of, "I know, hon, it'll pass in a minute". Similarly, techs expected vociferous complaints during a barium enema and patients who would threaten to expel the barium. Techs also knew that they were to respond by assuring patients that they could indeed hold the barium in because, in fact, the exam was almost over. Ironically then, it would seem that so far as the bulk of the work of the main department is concerned, "routines" were misnamed: for x-ray techs routines were far less routine than procedures that went by other names.

**CT Scanning:** If a heterogeneous workflow fostered technical variation in technologists' work, then, CT scanning should afford techs at least more variety than IVP's or fluoroscopy. In the same period of time that an x-ray tech might perform four identical IVP's or barium enemas, CT techs operating a body scanner might complete four or five different types of scans: perhaps a head, a chest, an abdomen, a lumbar spine, and an auditory canal. Despite their greater heterogeneity, however, scans occasioned less technical variety than one might initially expect. In radiography and fluoroscopy, each study demanded an idiosyncratic set of films. Each film, in turn, required the technologist to position the patient uniquely and to set variable techniques in order to capture a specific view. In CT scanning, however, the notion of perspective or point of view was irrelevant since the technology's design guaranteed that all scans were complete
cross-sectional images. So long as the appropriate area of the body was inside the gantry, barring mechanical failure, the machine would always capture the necessary data. Consequently, CT techs did not need to coax or manipulate the patient's body into exotic contortions. If the patient lay supine and motionless, the machine did the rest. The nature of the CT scanner's technology therefore reduced positioning to deciding how far to move the patient into the gantry.

Like positioning, techniques were also less complex in CT. While CT techniques ostensibly involved a larger set of parameters than radiographic techniques, most were determined by protocol. If one knew the type of scan required and how to work the controls, then parameters could be read off a chart on the wall. Moreover, the number of options available for any given parameter was limited. On standard x-ray devices, kilovolts, milliamperes, and seconds were continuous scales. But on the CT scanners, the value of each parameter was restricted to a small number of discrete options: for example, three kilovolt, six milliamphere, and three second settings were possible. Since the choices were fewer, even without protocols the number of possible techniques would be less in CT scanning. Finally, once the scanner is programmed, the whole study is executed more or less automatically with little intervention by the tech. It would seem then that the CT scanner eliminated most of the art and technical variety that distinguished traditional x-ray work and thereby mitigated the variation that heterogeneity might infuse into the work.

However, at the same time that scanners limited traditional sources of technical variation, they introduced new forms of variety uncommon in the main department. Because scanners revealed anatomical and
pathological structures that other technologies could not capture, because their images were more precise, and because persons did not have to be contorted into positions, the scanners were extremely suitable for trauma patients. For example, both hospital's scanners were used to assess structural brain damage when persons sustained severe head injuries. Patients felled by acute and sudden organic maladies such as cerebral vascular accidents or severe aortic aneurisms were also candidates for immediate CT scans. The importance of the CT scanners for emergency medicine meant that CT techs were likely to have their daily routine disrupted at any moment by an "emergency scan".

When emergency scans occurred, the otherwise sedate CT department erupted with activity as the techs were suddenly immersed in the suspense of a life and death situation. Emergency patients were often unconscious, linked to a number of life support systems (heart monitors, respiratory devices, etc.), and accompanied by a bevy of nurses and technicians as well as a doctor. The retinue invaded the CT department suddenly with only a few minutes prior warning. For the duration of the scan, the scanner's images became the center of attention, and the techs, crucial members of an emergency medical team. The attending physician usually stood beside the tech at the console and discussed the case with the tech as the images appeared. As one might expect, CT techs found emergencies exciting and involving.7

A second, more frequent source of variety that disrupted the CT tech's routine was more directly tied to the technology itself: the sudden and unpredictable advent of technical malfunctions. As complex concatenations of interrelated technical subsystems, the CT scanners were vulnerable to a seeming infinity of problems that originated from
multiple loci. Since the various subsystems were tightly coupled, any malfunction was likely to disrupt the whole scanner and bring the CT operation to a complete halt. Problems were occasionally mechanical (as when a tube blew, or when the table ceased to move), but in most instances they were computer related and occurred at the interface of the scanner's software and hardware, or in the software systems themselves. The nature and severity of such problems were unknown in the main department where devices were largely mechanical.

X-ray techs could afford to treat technical problems as minor irritants. When machines broke down they rarely ceased to function completely, and if they did, other machines could be used as back-ups. CT techs, however, took technical problems quite seriously. In comparison to most other technologies in the radiology department, the scanners broke down with greater frequency and posed more cryptic problems. When the scanners malfunctioned, the normally placid technologists grew animated and scurried about the control room attempting to assess the nature and extent of the problem. CT techs did not have the option of finishing a study on another machine and were rarely able to limp along with a crippled scanner. Until the problem was solved or deemed insoluable work backed up and patients were inconvenienced. If the problem could not be solved, then the patient would have to be taken out of out of the gantry and rebooked while other patient's appointments would be cancelled.

In the absence of technical problems and emergencies, however, the CT technologist's daily round of work became rather routine. In fact, when the scanners were working correctly and when there were no emergencies, CT techs often complained of boredom. After programming
the scanner and initiating the scan, the technologist had little to do until the images were photographed. In the afternoon, as one sat in front of the console after a morning's work and a heavy lunch, the dark of the control room and the quiet but hypnotic regularity of the scanner's various sounds easily enticed one to "nod off". It was this aspect of CT scanning that x-ray techs were most likely to notice and use to justify the common sentiment that to be a CT tech was to be reduced to a "button pusher".

Special Procedures: Excluding emergencies and technical problems, CT techs could predict accurately the course of almost any scan. In contrast, specials techs never knew exactly what would transpire from the time the patient entered the angio suite until the procedure was over and the patient had left. Depending on the patient's physical condition and the structure of the patient's vascular system, the placement of a catheter varied from a quick, routine act to an arduous ordeal. Moreover, the particular views, techniques, and positions that a specials tech used over the course of a procedure varied not only by the type of study and the patient's size, but by the idiosyncracies of the patient's problem. For example, when patients had high blood pressure or a "fast flow", specials techs would alter their technique and the timing of runs. Often the precise parameters of a run were not determined until the tech and the radiologist scrutinized the results of an earlier run. Consequently, even though two special procedures were of the same type, and their general contours were identical, the particular technical aspects of each study were idiosyncratic.

Yet, all sources of technical variety in special procedures paled before the variety introduced by omnipresent risk and danger. Because
special procedures were invasive and the patients were often chronically ill, specials could, at a moment's notice, totter on the brink of routine and emergency, or even on the line between life and death. The act of placing a catheter and injecting contrast with a pressure injector could dislodge arterial plaque and cause a patient to stroke. Since many patients who had angiograms suffered from heart conditions, it was possible for them to have mild to severe heart attacks during an exam.9 Though mildly sedated, patients typical remained conscious, nervous, and apprehensive over the course of a special procedure. Sedated patients occasionally became "hysterical" in the middle of a procedure and behaved so as to endanger themselves. For example, I witnessed several patients instinctually grab for the catheter as the radiologist moved it through the arterial system. By such actions, patients could strip their own arteries. Finally, as with any procedure that involved the injection of iodine dyes, there was also the possibility of severe allergic reactions.

Aside from more routine technical variations and the potential for serious medical situations, the predictable course of a special procedure could be ruptured by a radiologist's decision to proceed along an unanticipated path. During one particularly difficult carotid angiogram, the radiologist could not move the catheter into a "tortuous" carotid artery -- an artery with many twists and turns. After trying for forty minutes, the radiologist turned to the specials tech and said quite calmly, "Discretion is the biggest part of valour. Let's stick him in the neck, Harry". Within a matter of minutes the technologist had rearranged the equipment, prepared the necessary implements, and stood beside the radiologist as he placed a needle directly in the
patient's carotid artery. The "direct stick" was a more dangerous method of performing a carotid angiogram and a common practice before plastic catheters and the Seldinger technique were widely disseminated. When the procedure was safely over, the participants, including the patient, treated the radiologist's decision as an act of heroism. Specials had once again proven to be an exciting place to work.

While the foregoing sources of variety were present across all special procedures performed in both hospitals, digital subtraction brought to specials the technological uncertainties that epitomized CT scanning. Like the scanner, digital subtraction equipment was a complex, computerized technology composed of interrelated and tightly coupled subsystems. In comparison to the Seiman's C-arm, the DSA equipment was far more fickle and subject to unpredictable crashes and software problems. Moreover, although the DSA and the C-arm needed to operate in tandem, the two technologies were manufactured by different companies. The links between the two systems caused a number of recurrent problems. As one will recall, no scouts were taken at the start of a DSA. Consequently, it was typical for technical malfunctions to become apparent only after the patient was catheterized. As in CT, if the problem could not be solved, the patient would have to be taken off the table and the exam rescheduled.

**Ultrasound:** Unlike special procedures, ultrasound posed few risks to the patient, and hence was not tinged by the omnipresence of danger. Moreover, since ultrasound employed a smaller computer, involved fewer subsystems, and had less flexible software, sonographers experienced fewer instances of equipment failure than CT techs or specials techs working with DSA. In fact, to the best of my knowledge sonographers at
neither site experienced equipment troubles during the course of the
study. Finally, the types of ultrasound exams were fewer than types of
routines or special procedures, and as will be discussed more fully a
later section, since sonographers either explicitly or implicitly
controled appointments they knew precisely when what exams were
scheduled. Nevertheless it would be a serious mistake to view
sonographer's work as routine, for beneath the deceptively placid
exterior of ultrasound work lay a variety and complexity perhaps
surpassed by no other task that a technologist might perform.

Ultrasound differed substantially from all other technologies in a
radiology department in that there were no standard positions or
techniques by which the sonographer could capture the area of interest
on film. This is not to say that sonographers did not have rules of
thumb and and practical tactics, but rather that sonographers literally
tailored every procedure to the patient. While viewing the video
monitor, sonographers worked the transducer across the patient's body to
locate, explore, and film organs of interest.

Since the sonographer had to locate and image anatomy and pathology
in order to take a film, every examination became a unique event, an
interactive contest between the sonographer and the patient's body in
which the sonographer attempted to find valid signs of pathology's
presence or absence. Patients having similar studies often presented
dissimilar complaints. Moreover, each patient's anatomy varied, and the
variety generated slightly different images and posed slightly different
problems for the sonographer to solve. For example, when doing an exam
sonographers might need to decide how to handle an ill placed pocket of
gas that obstructed a clear view of the gall bladder. Similarly,
sonographers might have to decide when a recalcitrant ovary was simply hidden or actually atrophied. If the first were true and the latter pronounced, the patient could be in serious trouble.

In the sonographer's mind, the variability of the work was a direct outgrowth of the craft-like use of the small transducer. One of Urban's sonographers noted that unlike an x-ray tech, the sonographer could not simply "point and shoot" and be sure of capturing the problem. Suburban's sonographers attested to the same fact by the phrase, "the machine doesn't do the work for you." If capturing evidence of anatomical and pathological structures on film were cast in the language of warfare (a metaphor common in the medical literature—e.g. "battling disease"), ultrasound was the technological equivalent of hand to hand combat. In contrast, radiography and flouroscopy were diagnostic shotguns, while the CT scanner was the radiological analogue of a nuclear bomb.

In sum, the variety of a technologist's work was contingent on a number of factors. First was the heterogeneity of the studies a tech performed over the course of a day's work. However, if heterogeneity was to engender variety, each study had to be linked to a corresponding and more or less unique set of technical actions so that the range of studies was matched by concomitant technical diversity. Otherwise variety was a purely nominal phenomenon: two studies might be called by different names, but all practical purposes involve the same tasks. Because of the linkage, a heterogeneous workflow led to greater task variety in routine outpatient work than in CT.10

The technologist's work also became more diverse as it became more unpredictable. Variety spawned by uncertainty had many sources in
radiological work. The variety of routine x-rays in the outpatient area was amplified by the random arrival of patients whose studies could not feasibly be scheduled. Emergencies broke the routine of CT work, but reached their pinnacle of importance in specials where emergencies developed out of the omnipresence of risk and danger. While CT techs handled emergencies that other people defined, specials techs often witnessed their genesis and were in a position to actively assist with their control. As technologies became more complex and automatic, technical problems became more frequent, more consequential, and less well understood. Without doubt, technical uncertainties were the greatest source of variation in the daily routine in the CT department and, with the arrival of digital subtraction, became increasingly important in special procedures. Finally, when technologists must understand each patient as a unique case in order to use the technology effectively, even ostensibly similar studies are tinged with the potential of the unpredictable. Such a craft-like source of variation characterized the work of the sonographer and set sonographer's work apart for the work performed by other technologists.

If one were to rank the various technologies by the variety of work they afforded, ultrasound and special procedures would surely rank highest, since variety was a daily experience for specials techs and sonographers and since its source arose from the work itself. The variety of routine x-ray work was also substantial. However, the source of variety in routines was lodged in the workflow and was hence external to the work itself. At the opposite end of the continuum from ultrasound and special procedures fell fluoroscopy and IVP's. Not only was the work organized to drive out heterogeneity, but the unpredictable
was rare regardless of its source. Even techs claimed that IVP's and fluoro were the epitome of more of the same. Although CT work was disrupted by the advent of emergencies and technical problems, the first were extraneous to the daily operation of the scanner itself. Moreover, if there had been no emergencies and no technical problems, CT work might have become as routine as fluroscopy. Consequently the work of CT techs was characterized only by a moderate amount of variety when juxtaposed to the work of other technologists.

Closeness of Supervision: Autonomy at Work

Routines: If "variety" was the first reason x-ray techs gave for preferring routines, freedom "to be your own boss" was certainly the second. Technologists repeatedly proclaimed that the outpatient area was the only place in the main department where the "bosses don't breathe down your neck".1 By "bosses," the techs meant the Chief Technologist, the Assistant Chief Technologist, and less frequently, the radiologists. At neither Suburban nor Urban did the department's administrators or radiologists pay close attention to the work that went on in the alcove or the film library. Only on the rarest of occasions would radiologists visit either area, and even then, their presence had little to do with the routines that were being performed. For example, a radiologist might enter Suburban's film library to retrieve a patient's folder, but under most circumstances he would send a clerk instead. Administrators were more likely to visit the outpatient areas, but since they usually had other duties to attend to, they rarely stayed. Given the uncertainty of patient arrivals and the brevity of
routine studies, any attempt by administrators to closely coordinate routine x-rays would be undercut by the randomness of the work environment.

The fate of "quality control" efforts at Suburban testified to the x-ray technologists' protectiveness of their freedom from supervision in routines. On two separate occasions over the course of the research, Suburban hired x-ray techs from the outside to fill the position of "quality control" person. Among other duties, the quality control person monitored the quality of films taken in the main department and asked technologists to repeat films that did not pass muster. The technologists were quite resentful of the position and argued openly that the department could save money by allowing techs to continue to monitor their own films. As expressions of their discontent, technologists treated the quality control persons with studied coolness. Some went so far as to ignore their presence in a room. Technologists were also quick to point to whatever mistakes a quality control person might make, to undercut her accomplishments, and to question her competence ("How do you expect her to tell us what to do when she hasn't bothered to learn how to run half the machines in the department?").

At least once each year, radiology departments conduct a "repeat analysis", a two week study of how many films are repeated and for what reasons: inadequate technique, poor centering, misplaced markers, and the like. The first person hired for quality control was saddled with a repeat analysis two months after her arrival. At the end of the study she posted the following notice on a bulletin board in the film library: "THE REPEAT ANALYSIS IS OVER. THE OVERALL PERCENTAGE WAS 3%. THE % IS BELOW NATIONAL AVERAGE. LET'S KEEP IT UP!!!" A day later a second note
appeared on the bulletin board, printed in pencil and placed directly below the first: "IT ONLY PROVES WE HIDE OUR FILMS REAL GOOD." The second note raised the distinct likelihood that the positive statistics had more to do with the technologists' ability to protect themselves from scrutiny than with the quality control person's ability to lower the repeat rate. Given that administrators would at least suspect that the techs might manipulate the results in their favor, the note effectively cast doubt on whether the department had anything to cheer about. Faced with an inhospitable environment, both quality control persons left the department within two months of their hiring.13

Despite their freedom from immediate supervision when doing routines, the techs' discretion over the particulars of their work was severely curtailed by bureaucratic mechanisms. Once the nature of the study was defined, standard operating procedures, known as protocols, completely determined the type and number of films to be taken. The type of study was dictated by the requisition itself, and techs could not alter the requisition's instructions regardless of what patient's might say, unless they first consulted a radiologist. In September, a memo appeared on Suburban's bulletin board to remind technologists that under no circumstances, were they to take films not explicitly sanctioned by the requisition. At the time, a technologist commented cynically, "But its my right arm that's broken. That's OK, we'll take a picture of your left anyway".

Several months later, I observed unexpectedly, an incident related to the ruling and the technologist's cynical remark. A radiologist was reading films in his office when a technologist from the outpatient area entered and announced that she was x-raying a child who had swallowed
the glass top of a soda bottle. The technologist explained that the requisition called for a stomach film, that the films had shown no foreign objects, and that the child said the glass was stuck in his throat. The technologist then asked sarcastically if she could take an x-ray of the patient's neck. The radiologist, who was known among the technologists as the most competent and compassionate, gave the technologist a look that implied she had no reason to even question the action's propriety and told her to go ahead. Pressing the issue, the technologist shot back, "You mean we don't have to call his doctor first?" The radiologist assured her that he would take full responsibility.¹⁴

Although x-ray techs had little leeway during the course of the study itself, they did enjoy a fair degree of discretion when reviewing the quality of the films they had taken. When working routines, Urban's technologists critiqued their own films to make sure that their technique was satisfactory and that the area of interest had been captured and centered correctly. If in their opinion, the film's quality was adequate, they could dismiss the patient without consulting a radiologist or an administrator. At Suburban, films were supposed to be reviewed by a radiologist, or by the person "on films" before the patient could be dismissed. In practice however, technologists usually checked their own films before a clerk shuttled them to the radiologist on duty. Only on rare occasions did radiologists request additional films, and in most cases the additional films were supplementary views to assist diagnosis rather than repeats. That the radiologists requested few repeats may be explained, in part, by the fact that a clerk rather than the technologist herself took the films to the
radiologist. Radiologists were more likely to criticize a film if the film's creator was also its bearer (see discussion of IVP's below).

**IVP's and Fluoroscopy:** Although administrators and radiologists receded to the background of outpatient work, their presence as a supervisory force was far more immediate when technologists worked IVP's and fluoroscopy. At Suburban, the Chief or Assistant Chief Technologist usually assumed the role of the person "on films". In this capacity, the administrators allocated IVP and fluoroscopy patients to rooms, monitored the progress of exams, checked films, and often collated films packets for the radiologists. Although Urban's administrators ensured that inpatients were brought down to the floors in time for their appointments and informed techs when their patients had arrived, they were far less visible than administrators at Suburban. However, in their stead stood the radiologists. Throughout the morning, one of Urban's radiologists worked along side the techs assigned to fluoro duty. If anything, Urban's fluoro techs were therefore under more constant scrutiny than their counterparts at Suburban. When on fluoro a radiologist was always at hand to issue orders, critique films, and monitor the workflow.

At both hospitals, techs performed IVP's rather independently until they approached a radiologist with scout films to request an injection. At that point in time, control of the IVP shifted from the technologist's adherence to protocols to the radiologist's discretion. After the injection, the technologist was bound to show successive films to the radiologist who reviewed the images to decide whether additional films were needed. Unlike routines, where the tech was usually the sole arbiter of quality control, by showing each film to the radiologist,
techs doing IVP's had to submit to the radiologist's critique. Being
told that one's films were unacceptable was an inherent aspect of IVP's.
When reviewing an IVP, radiologists often took issue with the
technologist's choice of technique or the adequacy of the film's field:
"bring it down a little," "open it up a bit," "it's a little burnt isn't it," "looks like you lost the lower pole", and so forth. Radiologists
criticized one or more films in 50 percent of the IVP's I observed,
while no radiologist offered a compliment on a film well taken.  

Since techs always reviewed their films before taking them to a
radiologist, they could, if they saw reason, repeat a film without
waiting to be told. However, given the inevitable scrutiny of the
radiologist, techs often decided to wait to see what the radiologist
said. As they pulled their films from a processor, techs explicitly
noted when films were "too dark" or "too light" and would add "he's not
going to like this". Nevertheless, on such occasions the tech was
likely to carry the presumably marred film directly to the radiologist.
Nor was the strategy irrational if the goal was to avoid additional work
and decrease the patient's exposure to radiation, for radiologists were
more likely to criticize than to ask for repeats. In 35 percent of the
IVP's (9 out of 26), a technologist explicitly told me that something
was unsatisfactory with one of the films. In a third of these cases
(3), the tech decided to repeat the film on her own, while two thirds of
the time (6) the tech presented the film regardless of her reservations.
In only one third of the latter instances (2) did a radiologist ask for
a repeat film. Thus by refraining from taking the films over, techs
correctly surmised that they would repeat fewer films than if they took
responsibility themselves. Moreover, since the techs felt that
criticism was inevitable, they might as well give the radiologist something to criticize. Such behavior was less likely when techs perceived that they were the sole judge of their work's quality. On the three occasions when technologist's thought films from a routine were inadequate, they immediately took another film.

When working fluoroscopy techs were subject to similar direction and critique from radiologists. After taking scouts for a barium enema, technologists at both hospitals had to wait for a radiologist to review the scouts and decide whether the patient should have a regular or an air contrast study. A technologist might, as the techs at Suburban often did, second guess the radiologist and fill the enema bag before obtaining confirmation from the radiologist. However, under no circumstances would a technologist actually hang the bag and insert the tip without first receiving the radiologist's blessing. To do so would be to break with protocol, but rule infraction was not the technologist's worry. Rather, from their point of view, the real risk was that the radiologist might reach a decision discrepant with their own and therefore place them in the position of having to replace the tip in the patient's rectum before the exam could begin. Such an act would not only waste earlier work and cause the patient unnecessary discomfort, but represent an embarrassing atonement for a mistake.

In a barium enema and most other fluoroscopic exams the type and number of films were completely set by standard procedures. The only exception was the "small bowel follow through" were follow-up films were required as orally injected barium treks its way through the patient's small intestines. Consequently, aside from the small bowel, fluoro techs did not need to repeatedly show their films to a radiologist.
Nevertheless, their films still came under scrutiny. At Urban, the technologists hung the results of each study on light boxes outside the fluoro rooms for the radiologists to examine between procedures. Since the radiologist saw the films in the technologist's presence criticisms were common. At the beginning of the study, Suburban's fluoro techs were less likely to have their films scrutinized at end of the exam. They simply reviewed the films themselves and placed them in reading packets for the radiologist's later digestion. However, as the year wore on, the person on films began gradually to take over the task of collating films from fluoroscopic studies. When the Chief or Assistant Chief performed the duties of the person on films they would pull films from the processor and hang them on light boxes before placing them in folders. If the person on films noted problems with a film they would usually request the technologist to repeat the film. All else being equal, the technologists preferred for one of their own to assume film duty (a specials tech for instance) since techs were less likely to ask other techs to repeat.

CT Scanning: In stark contrast to technologists in the main department, CT techs were almost completely free of the watchful eye of administrators. In fact, one benefit that Suburban's CT techs consistently cited when asked why they liked working with the scanner was that in CT, "you don't have to put up with the bosses telling you what to do all the time". On only eleven occasions over the course of the year did I observe the Chief Technologist or Assistant Chief Technologist in Suburban's scanner area. Of the eleven visits, all but two lasted less than 15 minutes. At Urban, the administrators' absence was even more dramatic. My field notes record that the Chief or
Assistant Chief visited Urban's scanner on a total of three separate occasions. By comparison, no day passed in the main department that I did not see the administrators on more occasions than I could count.¹⁶

The administrator's absence should not be taken to mean that the CT techs were left completely on their own to orchestrate their work as they deemed fit. Rather, the bulk of the tech's immediate supervision came from radiologists, a situation the precise reverse of any found in the main departments with the exception of fluoroscopy at Urban. When assigned to CT duty, radiologists at both departments worked out of the radiologist's office in the CT area rather than offices in the main department. In fact, the only time the radiologists based themselves outside the main department was when they were assigned to CT. Even when performing special procedures, radiologists typically returned to the main department between patients. Since the radiologists left the CT area only to attend to occasional tasks (such as ultrasound exams which were coupled to CT rotation at Suburban), a radiologist was, in principle, available to observe the detailed goings-on of almost all scans. However, the role that radiologists played in the minute by minute coordination of the scanners varied dramatically between the two departments.

During the first three weeks after the scanner was first brought on line, Suburban's radiologists spent considerable time in the control room with the CT techs observing scans in progress. But by the end of the fourth week the radiologists ceased to involve themselves with the conduct of the scans. Instead of sitting in the control room with the technologists, the radiologists remained in the office where they interpreted scans the techs produced, studied CT atlases or articles on
CT diagnostics, and attended to other tasks they might have before them. Thus, after the first month Suburban's CT techs were left alone in the control room to conduct individual scans more or less independently with the exception that they were still subject to a radiologist's decision about whether particular patients should receive contrast injections. But even the decision to inject rarely required interaction unless the injection was a bolus. Typically, one of the radiologists reviewed the CT schedule each morning and noted on paper who would and would not be given enhanced studies. Only when the scan was complete would techs summon the radiologist from his office to review the images on the console. Aside from these occasions, radiologists did not visit the control room for more than several minutes at a time.

Circumstances were far different with Urban's body scanner. There the radiologists assigned to CT not only spent most of their time in the CT area, but were likely to remain in the control room while techs conducted the scans. Table 3A analyzes the percentage of a scan's duration that radiologists and CT techs were in each other's presence in the control room. One might expect that as the scanners became less novel and as both techs and radiologists became more familiar with the machine's operation, the radiologists would spend progressively less time in the tech's company. In terms of the first regression equation in Table 3A, accounting for the number of days since the scanner's began operating explains only 9 percent of the variance in the duration of contact. Nor does it seem that duration decayed as curvilinearly as one would expect if a learning phenomenon was involved (Hall, 1971). Adding the square of the number of days since the scanner's inception raises the multiple correlation coefficient in the second equation by only two
Table 3A

Explaining the Percentage of Contact Between Radiologists and CT Techs During CT Scans

(COMBINED ANALYSIS) *

<table>
<thead>
<tr>
<th>Model</th>
<th>Intercept</th>
<th>Day</th>
<th>Day²</th>
<th>Hospital</th>
<th>R²</th>
<th>Df</th>
<th>F</th>
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<td>-.001</td>
<td></td>
<td></td>
<td>.09</td>
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<tr>
<td></td>
<td>(8.45)**</td>
<td>(-2.57)**</td>
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<tr>
<td>Curvilinear</td>
<td>.52</td>
<td>-.004</td>
<td>1.3 (10^{-5})</td>
<td></td>
<td>.11</td>
<td>(1,65)</td>
<td>1.46</td>
</tr>
<tr>
<td></td>
<td>(6.62)**</td>
<td>(-1.78)</td>
<td>(1.63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curvilinear Plus Site</td>
<td>.75</td>
<td>-.004</td>
<td>1.3 (10^{-5})</td>
<td>-.39</td>
<td>.50</td>
<td>(1,64)</td>
<td>48.94**</td>
</tr>
<tr>
<td></td>
<td>(11.01)**</td>
<td>(-2.40)*</td>
<td>(1.63)</td>
<td>(-6.97)**</td>
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<td></td>
</tr>
</tbody>
</table>

** p ≤ .01

* p ≤ .05

+ Numbers in parentheses are t-statistics for the corresponding parameter
Table 3B

Explaining the Percentage of Contact Between Radiologists and CT Techs During CT Scans

(HOSPITAL SPECIFIC ANALYSES) +

Suburban:

<table>
<thead>
<tr>
<th>Model</th>
<th>Intercept</th>
<th>Day</th>
<th>Day $^2$</th>
<th>$R^2$</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
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<tr>
<td>Linear</td>
<td>.29</td>
<td>-.001</td>
<td></td>
<td>.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.77)**</td>
<td>(-3.39)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curvilinear</td>
<td>.41</td>
<td>-.007</td>
<td>2.6(10$^{-5}$)</td>
<td>.35</td>
<td>(1,36)</td>
<td>5.88**</td>
</tr>
<tr>
<td></td>
<td>(6.50)**</td>
<td>(-3.07)**</td>
<td>(2.45)*</td>
<td></td>
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</tr>
</tbody>
</table>

Urban:

<table>
<thead>
<tr>
<th>Model</th>
<th>Intercept</th>
<th>Day</th>
<th>Day $^2$</th>
<th>$R^2$</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>.68</td>
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<td>.13</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(8.79)**</td>
<td>(-1.99)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Curvilinear</td>
<td>.73</td>
<td>-.003</td>
<td>7.8(10$^{-5}$)</td>
<td>.14</td>
<td>(1,26)</td>
<td>.32</td>
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<tr>
<td></td>
<td>(6.06)**</td>
<td>(-1.00)</td>
<td>(0.58)</td>
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</tr>
</tbody>
</table>

* p .05
** p .01

+ Numbers in parentheses are t-statistics for the corresponding parameter
Table 3C
Percentage of Contact Between Radiologists and CT Techs During CT Scans

Percent Contact

Day of Operation
percentage points. However, one can explain a significant proportion of the radiologist's contact with CT techs by knowing the department they worked in. Adding a dummy variable representing Suburban and Urban increases the value of the multiple correlation coefficient by 39 percent. ($R^2$ equals .11 in the second and .50 in the third equation of Table 3A, an increment that is clearly significant. The F ratio for the difference is: $F = 48.94$ df=$(1,64)$ $p<.01$.)

Given the incredible difference between hospitals, I repeated the regression analysis for each hospital separately. Table 3B reports the regression equations for Suburban and Urban hospitals respectively. Note that the radiologists' contact with CT techs differs markedly between the two sites. Suburban's data conforms to the expected curvilinear relationship indicative of decreased contact as the scanner became less novel (The increment in the multiple correlation coefficient between first and second equations is 11 percent, a significant difference $F=5.88$, df=$(1,36)$, $p<.05$). At Urban, however, the extent of contact between radiologists and CT techs does not appear to decay. The beta weights for the number of days the scanner was in operation or its square are both insignificant.

Figure 3C plots the the actual percentage of contact between technologists and radiologists for each scan I observed. In addition, the graph portrays regression lines for each hospital's data regressed separately on the number of days the scanner had been in operation on the day the scan was done (and the square of that value). Without doubt, Urban's radiologists spent much more time in the control room. Urban's regression line is consistently above Suburban's. Moreover, Suburban's scores cluster near the bottom of the graph and eventually
fall to zero, while Urban's exhibit much wider variance and are best represented by the average duration since no temporal trends were significant. Considering only those scans conducted before the 80th day of operation, only 11% (3 out of 27 data points) of the time did Suburban's radiologists spend more than fifty percent of the exam in the technologist's company. In contrast, in sixty-two (62%) of the cases (13 out of 21) Urban's radiologists spent over half the scan in the control room. After the 80th day, no radiologist at Suburban spent more than half an exam with the techs, while at Urban radiologists did so thirty-eight percent (38%) of the time (3 of 8 data points above 50%).

As Urban's radiologists stood behind or sat beside the tech at the keyboard and watched the progress of the scan, they frequently told the technologist that the patient needed to be positioned more adequately, that another technique should be used, and even what commands to type into the computer. On occasion, the radiologist would lean over the technologist's shoulder and type entries into the computer himself. Such behaviors were extremely uncommon at Suburban. Even when radiologists were in Suburban's control room they rarely told the techs how to conduct the details of a scan or deigned to set the scanner themselves. The differences in supervision at the two sites can be seen clearly by considering who made what decisions over time.

Regardless of type or purpose, all CT scans were clearly punctuated by nine similar points of decision. The beginning of each study was marked by an explicit decision to bring the patient to the gantry. Although scans were supposed to occur at scheduled times, in practice, patients were rarely received punctually. The precise timing of a study
depended on a host of factors including equipment malfunctions, the technologist's backlog of adjunct tasks, the difficulty of previous scans, unexpected requirements stipulated by a radiologist, the technologists' need for a break, and their desire to get ahead of schedule. Consequently, when techs and radiologists wanted to start the next patient they usually said so.

Before the patient was placed on the table a decision regarding the administration of contrast was made. Even when the radiologists left written instructions, the decision was occasionally reaffirmed or redefined in the process of setting up for the study. Once the patient was on the table and initial injections were complete a third decision occurred: where to position the patient for the first slice. After the patient was positioned and the techs had returned to the control room, techniques were set. The choice of technique represented the fourth decision common to all scans. A fifth choice involved the distance to be scanned or the number of scans to be taken. (While the decision began with the initial scanning distance, it was not completed until someone recognized that the area of interest was passed.)

As the first image appeared on the monitor, its adequacy was always evaluated. If the scan was neither too high nor too low in the body for capturing the the area of interest then the scan continued. If the positioning was deemed inadequate, then the patient was repositioned. Determining the adequacy of the first slice was the sixth decision point. After the images had been obtained and they were about to be transferred to film, windows and centers were chosen. When the techs were finished with the images a decision was made about whether the radiologist would review the images before the patient was dismissed.
Finally, the ninth decision was to deem the study complete and to dismiss the patient.

The question of who made each of the nine decisions was an open one. At times the radiologist might decide. At other times, the technologist chose. In some cases, the decision was reached jointly. While the decision to administer contrast was always officially the radiologist's, at least at Suburban, the decision was occasionally usurped by the technologist. Also, in theory, a number of the nine decisions were determined by standard operating procedures. However, in practice, scans were individualized to the degree that protocols only approximated the course of action that was actually taken. Because of this variation, the nine decision points can be used to assess the degree of discretion enjoyed by the CT techs at each site. At one extreme, a radiologist might make all the decisions all the time. At the other extreme, the technologists could take complete control. In the first case, techs would have less autonomy and could be said to be closely supervised.

Over the course of the year that I spent in the two hospitals, I was able to document 99 scans (50 from Suburban and 44 from Urban) with sufficient detail to be able to determine from field notes who had made what decisions. When ever a radiologist was at all involved in making a decision I coded that choice as a "1". If the choice was made solely by the technologists, I coded the decision "0". Figure 9 arranges each CT Scan from Suburban and Urban in chronological order and present the data for each decision point as a horizontal vector of zeros and ones. Note that with the exception of the decision to administer contrast, Suburban's radiologists became progressively less involved

with the particulars of the scans (eg. 1's tend to fall out of the table). In contrast, Urban's radiologists remained quite involved with particulars throughout the whole year.

The distinction between the two hospitals lodges in the relation of the radiologists to the machines and the technologists. After the fourth week of the scanner's operation, radiologists at Suburban began a regular system of rotation through the CT area. Up until that point in time, the newly hired radiologist who had previous experience with CT scanning had spent most of his time in the scanner with the techs and other radiologists. In contrast, the two radiologists who had experience with body scanning shared responsibility for Urban's scanner until the eighth week of their scanner's operation. Rotation changed the social milieu of CT scanning at Suburban, but not at Urban. As I have discussed in detail elsewhere (Barley, 1983a), when the inexperienced radiologists began to rotate through the scanner, they were met by technologists who had greater knowledge of the technology than they. The interactional dynamics spawned by the difference led the radiologists to withdraw from the day to day details of the scanner's operation where as they were subtly but consistently shown to be less knowledgeable than the techs.

At Urban, the inexperienced radiologists began to work with techs who had no more than two months prior acquaintance with body scanning. Neither the techs' knowledge nor demeanor threatened the status system. The techs were accustomed to the radiologists controlling the details of the scans and expected them to continue to do so. Although the inexperienced radiologists tended to grant the techs more leeway than the experienced radiologists, the techs themselves were unwilling to
make decisions on their own (Barley, 1983a). Consequently, the techs at Urban did not act to usurp autonomy as did their counterparts at Suburban. To cite an example, if the radiologist was absent from the office when the scan was completed, techs at Suburban dismissed the patient without bothering to summon the radiologist. Techs at Urban either waited for the radiologist to return or searched the department so that he might review the scans or sanction the patient's dismissal.

Table 4 lends credence to the interpretation. To test the importance of the presence and absence of the experienced radiologists in the two scanner operations, I calculated for each scan the percentage of the nine decisions that were made by a radiologist. For each hospital, I then regressed the percentage on the number of days since the scanner started operating (and the square of the value) as well as on whether or not a CT experienced radiologist was involved in the study. As the equations in Table 4 suggest, with time, radiologists in both departments became less involved as they and the techs learned more about the scanner. (The $R^2$ values for the curvilinear equations are .32 ($p=.0004$) and .36 ($p=.0001$) respectively for Urban and Suburban). However, as the third equation for each hospital clearly indicates, the presence of an expert was important only at Suburban. (By including a dummy variable for the presence of the "expert", the multiple correlation coefficient jumps from .36 or .64 for Suburban, a highly significant increment $F=38.11$ df=$(1,46)$ $p<.01$). Radiologists at Urban were equally likely to become actively involved in the details of the scan regardless of whether they had prior experience with body scanning or not.
Table 4

Percentage of CT Decisions Involving Radiologists *

<table>
<thead>
<tr>
<th>Model</th>
<th>Intercept</th>
<th>Day</th>
<th>Day^2</th>
<th>Expert</th>
<th>R^2</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban Hospital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>.77</td>
<td>-.002</td>
<td></td>
<td></td>
<td>.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(15.79)**</td>
<td>(-3.49)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curvilinear</td>
<td>.88</td>
<td>-.005</td>
<td>1.9(10^-5)</td>
<td></td>
<td>.32</td>
<td>(1,41)</td>
<td>5.88*</td>
</tr>
<tr>
<td></td>
<td>(13.13)**</td>
<td>(-3.20)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curvilinear + Expert</td>
<td>.72</td>
<td>-.005</td>
<td>1.5(10^-5)</td>
<td>.14</td>
<td>.35</td>
<td>(1,40)</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>(5.36)**</td>
<td>(-2.21)*</td>
<td>(1.79)</td>
<td>(1.44)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Suburban Hospital**  |           |           |         |        |     |    |      |
| Linear                 | .40       | -.001     |         |        | .26 |    |      |
|                        | (9.13)**  | (-4.13)** |         |        |     |    |      |
| Curvilinear            | .51       | -.006     | 1.99(10^-5) |        | .36 | (1,47) | 7.18** |
|                        | (8.79)**  | (-3.45)   | (2.67)** |        |     |    |      |
|                       |           |           |         |        |     |    |      |
| Curvilinear + Expert   | .44       | -.007     | 2.38(10^-5) | .27    | .65 | (1,46) | 38.11** |
|                        | (9.87)**  | (-5.38)** | (4.22)** | (6.15)** |     |    |      |

+ Numbers in parentheses are t-statistic for corresponding parameters
* p ≤ .05
** p ≤ .01
It would seem then that the closeness of supervision in the two CT departments depended on the relative distribution of CT-relevant knowledge. The scanners' upset established definitions of what techs should know and what radiologist's should know and brought about some leveling of the two group's experience. When techs were relatively more experienced compared to radiologists, the radiologists were willing to grant the techs undisputed control over the daily operation of the machine. However, when techs had less experience than radiologists or when their experiences were equivalent, then the radiologists would provide closer supervision. The former situation challenged the traditional distribution of authority and control by inverting the expertise hierarchy that governs medical settings. Since the second situation offered no such challenge, traditional patterns could transplant themselves more readily in the new technological setting.

**Special Procedures:** Like CT techs, specials techs were largely immune from the scrutiny of the Chief or Assistant Chief Technologist in their daily work. On only one occasion did I observe an administrator to enter the special procedures area at Urban and then, to deliver a message to the nurse. Similarly, administrators at Suburban explicitly visited the specials techs only to spread information. They were, however, more often in the area than Urban's administrators since they often checked up on x-ray techs performing tomograms in the room that adjoined the angio suite. Nevertheless, even when administrators were nearby, they never told the specials techs how to perform aspects of a procedure or showed any desire to shape the organization of specials work. In fact, if anything, the specials techs were more likely to tell the administrators how they wanted "things done". This was particularly
true at Suburban where the whole department respected the angio suite as the specials techs' turf and recognized that they had final say over its use. For example, on a number of occasions the specials techs felt that too many people were using the tomography room and that the level of noise was inappropriate for an angio area. On each of these occasions they compelled the administrator to reduce the number of people working tomography.

The fact that administrators remained in the background of the specials techs' world did not mean that the specials techs disregarded the administrators' authority. Rather they, as the CT techs, felt that the administrator's role was properly limited to issues of policy. On such topics as call, pay, overtime policy, and departmental rules, specials techs abdicated to administrators, albeit not always without voicing disagreement. In the world of special procedures, as in the CT department, legitimate supervision over the details of work came only from the radiologists.

Just as there were site specific differences in the degree to which CT techs controlled the details of a scan, so were there marked differences in the specials techs' breadth of discretion. In the last chapter, I noted that Urban's radiologists arrived in the area earlier than their counterparts at Suburban, and that they performed tasks carried out by Suburban's techs. Similarly, Urban's nurses executed duties that were tech's work at Suburban. The differences in the technical role of the nurse and the radiologist meant that Suburban's techs controlled aspects of the procedure that were not within a technologist's jurisdiction at Urban.
Until the radiologist arrived in the angio suite, there was no
doubt that Suburban's technologists orchestrated events. Nurses would
not link the patient to EKG leads or I.V.'s until the techs had finished
their preparations and had explicitly suggested that the nurse begin.
The techs were also allowed, *de facto*, to choose the catheter for the
procedure since on most occasions catheters were laid out for the
radiologist when he arrived. Although radiologists would request a
different catheter if the technologists had predicted his preference
wrongly, in most procedures the radiologists employed what the techs
offered. Since Urban's radiologist entered the angio room shortly after
the patient, the specials techs rarely had an opportunity to coordinate
preparations. Nor, given the relatively higher status of nurses at
Urban, was it clear that if the radiologist was delayed would the right
of coordination shift to the tech. No catheters were opened at Urban
until the radiologist made his specific preference known. At that point
in time, the nurse retrieved the catheter since the technologist was by
that time taking scout films.

During the placement of the catheter, the radiologist became the
coordinator of events. At both sites, whatever the radiologist
requested, he received. Nurse and tech alike became additional hands
for the radiologist. However, the role of "maker of suggestions" was
differently distributed at the two sites. At Suburban, nurses remained
silent during the procedure unless they spoke to the patient. Techs, on
the other hand, chattered constantly with the radiologist, made comments
on the progress of the exam, and often asked in an anticipatory fashion
if the radiologist desired additional implements or intended to take
alternate courses of action. At Urban the roles of the nurse and
technologist were precisely reversed. The technologist stood at the foot of the table and spoke only when spoken too. The nurse chattered and attempted to anticipate the radiologist's needs. While Suburban's techs told the nurse what to do, the Urban's nurses directed the techs.

At both sites, technologists always asked radiologists how many films they wished for each run, at what speed the runs were to occur, and what settings to use for the pressure injector. At Urban, some radiologists told the specials tech what technique to use, however Suburban's radiologists usually allowed the techs to set the technique without intervention. When it came to actually setting up for and executing a run, radiologists at both sites abdicated to the technologist's expertise. While techs were positioning the patient and preparing the machines, radiologists stayed out of the technologist's way. If the radiologist finished his work before the technologist completed the positioning, the radiologist would either leave the room or stand patiently to the side with his arms folded.

**Ultrasound:** That one of Urban's sonographers could seriously propose that ultrasound become its own department and that sonographers act as an independent diagnostic service providing information to radiologists and referring physicians alike, gave testimony to the sonographers' independence. No other technologist in the radiology department would dare utter such a radical idea since most would consider themselves incapable of performing diagnostics without a radiologist. Nor was Urban's sonographer alone in his perception that ultrasound was distinct from the remainder of the department. When patient's asked Suburban's sonographers if they worked for the radiology department, the sonographers always replied "we are a peninsula of
radiology". As often occurs on peninsulas, the inhabitants of the ultrasound department cherished their separation. As ultrasound was then organized at both sites, unless the sonographers were indeed to become independent agents free of the radiology department it would be difficult to imagine how they might gain more autonomy.

Only when a sonographer was a trainee, did radiologists actively supervise the sonographer's work. Urban's radiologists rarely attended ultrasound examinations unless the procedure was a biopsy (in which case the radiologist performed the biopsy after the sonographer located the organ or abscess) or the sonographer's first pass yielded ambiguous data. In the latter case, the radiologist would repeat the examination, not as an affront to the sonographer's ability, but to vary operator bias in capturing a second set of data to compare to the first. Although Suburban's radiologists viewed real-time images after the sonographer had explored and filmed the area of interest, they rarely told the sonographer how to proceed. Rather, the radiologist's viewing was more of a formality, a second pass during which the sonographers, in their own terms, "led the radiologist on a tour of the area". The expressed purpose of the review was dual: to inform the radiologists, since they were legally responsible for the interpretation, and to provide a second opportunity to discover or confirm pathology. If discrepancies of interpretation occurred, they were resolved not by the sonographer's abdication to the radiologist, but rather by discussion referencing the data in the image itself.¹⁷

Unlike other radiological procedures, radiologists could not easily criticize the sonographer's work without repeating the exam themselves. The parameters of transducer frequency, "gain", and "slope" were like a
technique in radiography in that they altered the quality of the image and the visibility of anatomical structures and were chosen in response to variations in the patient's anatomy. However, their values were set more by the sonographer's tacit feel for the images than by established protocol. Moreover the relation of the parameters to the quality of the image was not obvious from films. As one sonographer put it, "They can't look at my films and tell me to raise my KV".

Moreover, in direct contrast to other technologies, the number of films that sonographers took and the organs that they imaged depended on what the they found as they conducted the exams. Because the technology's use was so ambiguous, prescriptions about what to film could only be outlined in the most general terms (eg. be sure to look at the gall bladder). The ultimate decision had to be left to the sonographer. Note that no other technologist was free to determine what to image. In fact, as mentioned at the beginning of the section, x-ray techs were forbidden to vary standard views unless they first consulted a radiologist. Thus, for all intents and purposes, the particulars of ultrasound lay squarely in the sonographer's control.

In review, patterns of supervision distinguished the main department from CT, special procedures, and ultrasound at both hospitals. Administrators and radiologists alike subjected the x-ray tech's daily work to scrutiny, except when the techs performed routines. However, even in routines, protocols and bureaucratic rules limited the x-ray tech's autonomy. In contrast, technologists who operated new technologies were free of the administrator's watchful eye in their daily round of work. Only radiologists could rightfully supervise the work of a CT tech, a specials tech, or a sonographer.
Whether or not the radiologists actively supervised the particulars of CT, specials and ultrasound work was, in part, determined by the culture of the radiology department. Urban's radiologists were consistently more likely than Suburban's radiologists to provide close supervision. Not only did Urban's CT techs and specials techs have less autonomy in their daily work, but x-ray techs performing fluoroscopy at Urban were more closely supervised than their counterparts at Suburban. However, that Urban's sonographers were as autonomous as Suburban's, points to a second distinction that separates new technologies from old. The distinction explains the demise of the administration, while at the same time transcending the cultural differences between the two departments.

When new imaging technologies first enter a radiology department they introduce novelty and uncertainty into a well ordered work setting. From a technological standpoint, few persons will know ahead of time how to operate the machines. Moreover, few radiologists will know how to interpret the images that the new technologies create. In a world where authority is based on differences in knowledge and where an occupational group's identity and power are defined by differential distributions of expertise, a new imaging technology poses an inherent threat. By leveling distinctions in expertise, the new technology can potentially upset the status quo.

If the technology's design allows routinization and if the traditional direction of the differences in knowledge still exists, then the former social order of the radiology department can reassert itself. However, if the technology does not allow routinization of skill or if differences in knowledge are sufficiently leveled or even reversed in
the technology's early days, then a new social order will arise since older patterns of supervision and control grounded in expertise are no longer viable. Unless an administrator has himself or herself been a CT tech, a specials tech, or a sonographer, over time, the techs who operate the technology will develop more expertise with the technology than the administrator can ever hope to gain. Consequently, when administrators do not already understand the particulars of a new technology, they have little option but to grant technologists discretion. We have seen that administrators were largely absent from the social milieu of the three new technologies, but that the most intervention occurred in Suburban's CT department. Interestingly enough, the variation fits the explanation perfectly. Suburban's Chief Technologist was a former CT tech who understood the technology.

At Suburban, the experienced CT techs initially knew more about the technology than most of the radiologists. Consequently, when rotation began the radiologists were placed in a situation where by abdicating control over the daily operation of the scanner they could avoid social situations that instantiated the technologist's greater familiarity with the technology and its images. At Urban, where no experienced technologists were hired, the reversal of expertise did not occur and the traditional pattern of supervision could reaffirm itself. Special procedures were more likely to follow the cultural patterns of the departments since no radically new imaging technologies were involved in special procedures. However, in both departments sonographers enjoyed extreme independence of both radiologists and administrators in their daily work. The nature of ultrasound technology is such that the difference between the radiologist's knowledge of the technology and its
products is not radically different from the sonographer's. In fact, sonographers were likely to know more about the technology and its images than radiologists who had not trained in the modality. Close supervision of the particulars of ultrasound was therefore mitigated not only by an initial leveling of expertise, but by a technological configuration that maintained relative equality. Only by conducting all ultrasounds themselves could the radiologists bring about the demise of the sonographer's autonomy and discretion.

Interactions with Physicians

The radiologist's role in a hospital is essentially that of a consultant, the diagnostic expert to whom other physicians turn for information. The department itself, with its machines and film libraries, is a clearing house and repository for medical images. Given that a radiology department forms a nexus of diagnostic information and expertise, physicians from all specialties frequent the world of radiology in search of expert opinion and the opportunity to view their patients' films. This was certainly the case at Suburban and Urban hospitals were physicians wandered in and out of the department with impunity seeking studies and radiologists to read those studies.

The social and physical terrain of Suburban's main department was so ordered that a physician was extremely likely to encounter technologists when foraging for diagnostic information. The film library was inhabited by technologists performing routines, and the radiologists' offices were either directly off the main corridor or required the physician to pass through the main darkroom where
technologists idled. At Urban, physicians in search of a radiologist were less likely to encounter x-ray techs since the radiologists' offices and the film library were less centrally located and could be reached by paths that did not pass through the heart of the main department. Nevertheless, despite the different frequencies of mutual sightings, actual interactions between x-ray techs and physicians varied little between the two departments. In both hospitals, communication between a physician and an x-ray technologist was rare, and when conversations did occur they were almost always brief.

When physicians walked through a corridor, into the film library, or through Suburban's main darkroom they often ignored technologists, especially when they spied a radiologist or a film clerk. In return, technologists ignored physicians. Even social amenities as trite as, "How are you today" rarely passed between a technologist and physician unless the technologist had worked at the hospital long enough to make the physician's acquaintance and become known as a familiar face. A few technologists who had been at Urban or Suburban for over a decade knew a large number of physicians and occasionally conversed with doctors. But, such incidents were infrequent. For the most part, doctors only spoke to x-ray techs when they needed information they could not otherwise obtain.

In those instances when a doctor spoke to an x-ray technologist, one of three questions and its concomitant response were likely to constitute the complete content of the dialogue. The physician might ask, "Have you seen Doctor (insert radiologist's name)?" In which case the technologist would usually reply "yes" or "no" and direct the physician towards the radiologist's last known whereabouts. If one of
the physician's patients had been scheduled for an exam on a given day, the doctor might inquire, "Have you done the (IVP, Barium Enema, etc) on (patient's last name) yet?" When the tech knew about the procedure she provided the information immediately, otherwise, she either checked the schedule or directed the doctor to an administrator. Finally, if the doctor was in search of films, a third question was likely, "Can I see the films on (patient's last name)?" When a tech held the films in her hand she handed them over. But since doctors rarely timed their visits so serendipitously, the technologist typically referred the doctor to the film clerk. Under no circumstances did I ever observe a physician ask an x-ray tech about the results of a study even if the technologist had performed the exam. Nor, did I ever observe a technologist offer a physician information on how the patient had fared or what had been learned. In the main department, physicians only spoke substantively with radiologists.

A technologist's interactions with physicians were both quantitatively and qualitatively different in the CT department. Since CT techs were fewer in number than x-ray techs, physicians realized that any given CT tech was far more likely to know what had happened in the scanner over the course of the day and to know where the radiologists went when they left the CT area. Moreover, it was extremely likely that the technologist on duty had been the individual who scanned a specific patient. For these reasons doctors put the three previous questions more frequently to CT techs than they did to x-ray techs. However, such quantitative differences were insignificant in comparison to the qualitative differences that distinguished the CT techs' interaction with doctors from corresponding interactions in the main department.
Except for neurosurgeons, who had worked with CT scans for over a decade and who were often able to read scans for themselves, most referring physicians could not interpret scans without assistance. Moreover, like the public at large, many physicians found the scanner and its products somewhat mystifying and wonderous. Given these two conditions, if physicians could not find a radiologist in the CT area they often availed themselves of the second best source of information, the technologist. When doctors entered the control room to speak to a CT Tech, they often dallied at the scanner viewing the scans that were presently on the screen. Even when the scans did not belong to one of their own patients they were likely to ask the tech questions about the study. If the doctor sought information on a particular patient and discovered that the patient had been scanned, in stark contrast to norms of appropriate physician behavior in the main department, the doctor often asked the technologist what the scan had revealed. If the technologist was familiar with the study, he or she usually glossed the findings for the physician. The technologist might also call the scans to the computer's video monitor or give the doctor a folder of films. However, I never observed a CT tech hang films from a scan and review the films in detail as a radiologist might do. CT techs risked summaries, not full blown interpretations.

In the main department, or any other area of the radiology department for that matter, physicians did not attend studies performed on their own patients. But since doctors were interested in the scanner itself, they occasionally arrived in the CT area while their patient was on the table to watch the scanner in action. Even more frequently, physicians working the emergency room accompanied their referrals to the
CT area. If a radiologist was not available to stand beside the physician and narrate the action as the scan progressed, the doctor would question the techs at the console. In such situations barriers between technologist and physician were momentarily broken. The doctor might even sit beside the tech at the console. As the scans appeared on the video monitor discussion of the patient and the scans' information occurred spontaneously as the technologist and the radiologist exchanged questions, information, and opinion. For example, consider the following entry from field notes at Suburban:

Both Frieda and the radiologist had gone to lunch. Ted was manning the scanner by himself, when the emergency room called to say they were bringing a patient down for a scan. Before long, two nurses and a doctor wheeled a man attached to numerous monitors into the area. Ted helped the nurses lift the patient onto the table and quickly positioned him for a chest scan. The patient was suspected of having had a massive coronary. After positioning the patient, Ted returned to the control room, programmed the scanner, and began the scan. The doctor sat down at the console and began to ask Ted about how to run the scanner.

As the scans started to appear, the doctor and the technologist turned their attention to the screen. Ted asked about the patient's condition and the doctor began to fill in the details of the patient's circumstances. As the third scan came on the monitor, Ted blurted, "Jesus, look at that aneurism." On the image, the patient's aorta appeared as if it had been blown up like a balloon. The aorta was easily as large as a ventrical of the heart. "Boy that's the biggest one I've ever seen," Ted continued. The doctor wondered how large the aneurism actually was.

"Want to see," Ted asked. The doctor admitted that he'd be very interested. Ted activated the measuring subroutine and measured the diameter of the aorta at several places by moving the joystick to place dots on the aorta's circumference. He then calculated the aneurism's area by activating the measurement circle and expanding it until it coincided with the aneurism's perimeter. The doctor agreed that this was possibly the largest aneurism
he had ever seen. Ted asked if the doctor thought they'd operate. The physician replied that they probably would.

Although physicians did not attend special procedures, specials techs nevertheless had numerous opportunities to speak with physicians about their patients. Doctors realized they could obtain immediate information by calling the angio suite at Suburban shortly after the procedure was finished. If the radiologist was not available to speak with the physician, the techs did not hesitate to provide the caller with the patient's results. Usually the techs refrained from detailed information, but would merely provide the physician with an overview: "her right side was occluded," "it looked pretty clean," "she had a lot of disease," and so on. For more specific details, the doctor would need to talk with the radiologist and view the films personally. Although physicians also called Urban's angio room for information, they did so less frequently since Urban's specials techs did not remain in the specials room after examinations were completed. Moreover, having been socialized into a more restricted role, the techs at Urban were more likely to refer questions of interpretation to the radiologist who performed the study. Nevertheless, physicians knew that if the radiologist was not available and if they needed information they could press the specials tech into providing information about the exam.

Specials techs at both hospitals interacted with physicians around matters that did not concern films and results. When a special procedure went awry, specialists were often called to the angio room. A cardiologist might be summoned when a patient suffered arrhythmia. The services of an anesthesiologist were used when mild sedatives were deemed inappropriate either because of the patient's medical condition
or because the patient's anxiety was so great that the procedure could not be performed under normal conditions. On these occasions a doctor joined the specials team as a temporary member and interacted with the technologist as such. Thus there were times when specials techs worked along side physicians who were not radiologists.

Unlike the main department where technologists were completely divorced from scheduling decisions, specials techs took a direct hand in scheduling special procedures. At Suburban, the technologists had always attempted to monitor and rearrange special procedures to insure that the day's schedule was evenly distributed. However, after the digital equipment arrived and the volume of special procedures increased, the mandate for scheduling patients formally shifted from the department's secretaries to the techs themselves. The shift occurred after the secretaries scheduled eight digital subtractions in one day. The pace was so feverish that the radiologists soon realized that only technologists understood the requirements of the procedures well enough to book patients. Responsibility for scheduling meant that the specials techs interacted with doctors who called to book patients for procedures. When taking a call, the specials tech and the physicians briefly discussed the nature of the patient's case. Moreover, if a case had to be canceled because of equipment failure, it was the technologist who usually notified the patient's doctor. At Urban, specials techs also played point of contact and a source of information for physicians requesting bookings. However, since physicians were conditioned to call the main desk rather than the angio suite to schedule patients, Urban's techs had fewer opportunities than Suburban's.
Once again, the work of sonographers' exhibited in the extreme, characteristics that distinguished the situation of the specials tech and the CT tech from that of the x-ray tech in the main department. That sonographers had to understand the images they created in order to produce them was no secret hidden in the bowels of the radiology department. Physicians realized that the sonographer was as good a source of diagnostic information as most radiologists. Since the sonographers were easier to locate than radiologists, many physicians habitually contacted the ultrasound department with the expressed purpose of discussing their patient's study with a sonographer.

When physicians called by phone for the results of a recently completed study, the sonographer simply dredged the information from memory. When exams were several days past, the sonographer pulled the patient's folder from files kept in the ultrasound department and read the radiologist's report verbatim. Even if the physician came in person the sonographer usually chose to communicate information from recall or to show the physician a written report. However, physicians occasionally pressed the sonographer to hang the study on a view box and review the images in detail. To read a physician a report was perfectly legitimate since the report documented the radiologist's word and reading simply relayed. A secretary could do the same. To provide results from recall stretched accepted practice to its limits. However, to hang and review films was to step across a boundary trespassed by no other group of technologists in the radiology department. Even the CT tech who spontaneously discussed scans on a video monitor with a physician present in the console room could technically claim to have not assumed the radiologist's role. But, the act of hanging and
discussing films was precisely what radiologists' did when physicians approached them for consultation.

Since radiologists at both hospitals had castigated their sonographers for reading films for physicians, the sonographers were wary of the practice. They never offered to show physicians films and would only do so if pressed. Perhaps to ease the bind that doctors created when they asked for a reading, the sonographers discussed films in a manner different from a radiologist. Where a radiologist would say, "She has a cyst here in her left ovary and a large fibrous uterus," the sonographer would point to the signs themselves and speak in the language of ultrasound. As a result, the sonographers structured readings as if they were teaching the physician how to see what they saw. In the same situation the sonographer would say, "Now see this black area, here. It's liquid filled because fluid transmits sound and looks like that. Now this is the reflection of the sound as it hits the back wall of the fluid filled cavity...." (If, however the physician had simply called on the phone the sonographer would say, "She's got a cyst in her left ovary and a large fibrous uterus."

Sonographer's claimed that physicians did not understand what ultrasound could and could not do. The quintessential examples of a doctor's ignorance cited by sonographers at both hospitals were requisitions for lung studies. (Remember, ultrasound can not image through gas.) Older sonographers in both departments said that they had personally seen such requisitions. Unlike other technologists who might simply laugh at the physician's ignorance, the sonographers argued that their duty was to educate physicians about the technology's proper use. The sense of mission led sonographers to contact physicians when they
suspected ultrasound might not be appropriate or to recommend ultrasound when they thought they could help.

If, in the middle of an exam, sonographers suspected that the patient's symptoms suggested a problem other than the one for which the patient was referred, they would call the physician, explain their rationale and say, "why don't I go ahead and look at her (x) while we have her down here. It may save a trip later." Sonographers labeled such situations, "training" the physician. In short, the technologist tells the physician in a tactful and appropriately unassuming manner that the physician may have made a mistaken initial diagnosis and ordered the wrong exam. No other technologist has such leeway with physicians. It is easy to see how, over a period of time, a sonographer gains a reputation for diagnostic expertise if a large number of alternative hypotheses and exams that a sonographer proposes turn out to be correct.

Supplies and Equipment Repairs

Over the course of each working day both radiology departments consumed a vast array of supplies. Every radiological study required at least two photographic films of certain sizes, shapes, and "speeds." The developers that processed the films were linked to five gallon tanks of chemicals that were replaced several times a week. For every IVP three disposable syringes, two or more needles, three bottles of Rhenographin 60, an alcohol prep and a bandaid were used. Barium enemas relied on the availability of barium, enema bags, tips, bed rings, and a plentiful supply of "chucks". Each outpatient was given a clean
"johnny" to wear, and blankets, pillowcases, or sheets used for one exam were rarely used for another. In short, without these and a seemingly endless list of other disposable and reusable, but eventually replaceable items, technologists would have been unable to perform their work.

While x-ray techs consumed supplies, they had little responsibility for and worried even less about maintaining the inventory. When a technologist discovered that some item was low or completely out of stock, she generally told the Assistant Chief Technologist. In turn, the Assistant Chief compiled and submitted orders to suppliers. Aside from reporting scarcities, x-ray techs rarely talked about supplies unless in the course of a procedure they discovered that a needed item was not available. Decisions about what supplies to order and which vendors to use were also the administrator's responsibility. Over the course the research, I never heard an x-ray tech voice an opinion on the quality of supplies or suggest that an alternate supplier might provide superior or inferior products.

Outside the main department, the technologists' involvement with supplies and vendors was often quite different. At Suburban, CT techs monitored their own inventories and were responsible for seeing that supplies were replenished in sufficient quantities. In the second week of the scanner's operation, the CT techs divided among themselves duties for monitoring specific items. One technologist was to track the use of linen, inform the laundry of evolving needs, and make sure that daily deliveries arrived on time. Another assumed responsibility for preparing sufficient stocks of gastrographin. A third monitored syringes, contrast agents, and so forth. To keep track of their needs, the CT techs took weekly inventories. For some items, the techs dealt
directly with the source of supply, the laundry for instance. If the item was also used by the main department (syringes, rhenographin, etc.), then the tech submitted an order to the administrators who combined CT's order with the main department's. Urban's CT techs also gauged their own use of supplies and combined orders with specials and ultrasound through one of the specials techs became coordinator of the three areas when the body scanner first arrived.

Suburban's specials techs not only kept inventories and dealt with in house sources of supply (the laundry, central supply), they also submitted orders directly to manufacturers of catheters and other equipment used only in special procedures. Moreover, specials techs were included in decisions regarding new purchases and even suggested purchases themselves. When Suburban began to perform digital subtractions, the specials techs convinced the radiologists that the department should order "disposable kits" since the volume of procedures would expand. Compared to standard surgical kits prepared by central supply, disposable kits would save preparation time. After securing the radiologist's blessing, the technologists negotiated with salesmen to compile a kit that would contain items necessary for digital subtractions: catheters, aluminum crucibles, plastic forceps, foam applicators, and so forth. On several occasions I observed radiologists pass salesmen off to the specials techs who examined the products being sold and passed judgment on their utility. After evaluating the product, the techs advised the radiologist as to whether the item ought or ought not be bought. Although I never observed a radiologist at Urban refer a salesman to one of the specials techs, the techs claimed that they too had say over supplies needed and purchased.
At both sites, sonographers controlled the few supplies they needed. Suburban's sonographers ordered their supplies directly until the end of the year when a hospital-wide budgetary crisis led the department to decide to consolidate orders through the administration. Since the sonographers used few supplies that differed from those also used in the main department (gel being the major exception), Suburban's sonographers began to submit requisitions to the Assistant Chief much as the CT techs did. At Urban, ultrasound supplies were handled similarly.

A parallel distribution of responsibility distinguished the different technologists' roles in the maintenance of the machines themselves. As was mentioned earlier, when an x-ray machine malfunctioned, x-ray techs were only momentarily inconvenienced. Since it was possible to perform radiographic and fluoroscopic exams in more than one room, an equipment failure never precluded doing one's work or created backlogs that lasted for more than a day. Consequently, when an x-ray tube or table developed a problem, techs in the main department first checked the machine to make sure the trouble was real and then notified the Assistant Chief Technologist. The Assistant Chief or an experienced tech could sometimes correct the malfunction, but more often than not, a repairman would be called. Summoning the repairman was the Assistant Chief's responsibility. After the machine was officially deemed "down", the technologist spread the word among the other techs and ceased to be concerned with the situation.¹⁹ Repairmen who arrived to work on the equipment were typically unmolested by technologists curious to discover the nature of the problem.
In contrast, specials techs, CT techs, and sonographers remained close to repair efforts and took an active stance toward equipment maintenance. Because the older technologies in the main department were relatively well understood by administrators and radiologists alike, the x-ray tech's knowledge of the machine was unlikely to be considered valuable unless the tech had shown uncommon mechanical skill. Precisely the reverse situation occurred with the newer technologies, where technologists were assumed to understand the machines better than anyone else. Because the technologies were so recent, few radiologists and fewer administrators had extensive experience with the machines. Consequently, only the technologists who operated the machines could describe their use in sufficiently precise detail to communicate with the manufacturer's "engineers".20

A particularly telling incident occurred at Suburban to underscore the cultural assumption that technologists who worked with advanced technologies understood them best. One afternoon the digital subtraction equipment crashed in the middle of an angiogram. The Chief Technologist happened to enter the angio suite moments later and insisted upon talking to the engineer. Although the Chief Technologist had been a CT tech and had more experience with computer technologies than any of the specials techs, the radiologist performing the special procedure ordered the Chief to relinquish the phone so that a specials tech could explain the problem's specifics to the engineer.

In special procedures and CT scanning, an equipment malfunction could shut the operation down completely, inconvenience patients, and create lengthy backlogs of work. Since sonographers could substitute the b-scanner for real time ultrasound, sonographers were less
critically hampered by breakdowns. However, if the b-scanner malfunctioned cardiac studies became impossible at Suburban. Moreover, since CT scans, special procedures, and ultrasounds were more costly than the average radiographic or fluoroscopic procedure, their cessation signified substantial revenue loss for the department. For these reasons, sonographers, specials techs, and CT techs always dealt directly with the manufacturer's representatives and never needed to justify calling an engineer before placing the call. In fact, a radiologist or administrator would only know of problems before they were reported if they happened to be in the area while the techs were conducting a preliminary assessment of the situation.

The novelty and complexity of the new technologies combined with the severity of a malfunction's consequences to catapult technological expertise to a central position in the technological subcultures that surrounded the machines. Whereas few x-ray techs (the exceptions were several older males) took interest in the machines as machines, CT techs, sonographers, and ultrasound techs prided themselves on their command of the technology itself. The phenomenon was particularly strong among specials techs where the machines were in many ways similar to those used in the main department. To diagnose machine problems, and if possible, either repair or skirt machine failures was a mark of competence that brought the specials technologist status and reputational clout. The specials techs' reputation for mechanical aplomb was so well accepted that x-ray techs and administrators in both hospitals often enlisted the assistance of one of the specials techs when they encountered machine problems in the main department.
Even younger, less experienced specials techs felt the an
obligation to fix machines. Upon arriving in Suburban's specials area
one morning, the most recently hired tech proudly told me the following
story about her exploits with the film changer on the previous evening:

He scheduled a carotid at the last minute for 4:30 and I
was the only one here. When I was taking the scouts, the
Puck jammed. I tried to get the cover off, but couldn't
so I called Seiman's. Then I saw Jack walk down the
hallway and I remembered that he had trained as a specials
tech before he went over to nuclear medicine, so I had him
come in and take the cover off. As soon as he got it off,
I took the film out and unjammed the machine myself. By
the time the Seiman's guy got here I had everything fixed.
But, I couldn't get the cover on. So I pretended I had
just finished and had him put the cover on for me. I was
real proud of myself. I showed him that I might be a
woman, but I'm not helpless.

When specials equipment broke down with a catheterized patient lying on
the table, the prospect of calling off the study meant sending the
patient back to the floor and doing a second catheterization at a later
date. Since many specials procedures were preliminaries to surgery,
surgery itself might have to be postponed. Given the relatively grave
consequences of a breakdown, specials techs not only placed calls to
engineers, they began to search for the problem themselves and, if
possible, repaired it themselves, as in the story above. One several
occasions I observed specials techs repair film changers, developers,
and other mechanical pieces of equipment while the radiologist continued
with whatever aspect of the procedure he could in the meantime perform.
The tech's boldness with the technology led them to take actions and
make claims that even they were uncertain of:
Sam led me over to the controls, "Have you ever looked inside of one of these control panels?" He lifted the top of the panel. "Nothing but a bunch of wires. I don't know what the fuck's going on in there. Well, we were in the middle of a pulmonary and the damn thing stopped working. Couldn't even get the lights to come on. Jones and Smith (radiologists) were both in here and they were playing with the dials trying to get the thing to work. So finally I just said, 'Excuse me,' walked over, lifted the lid and let it slam back down. I swear to God, it started to work. I didn't know what the fuck I was do'in. But boy were they impressed.

Because their machines were largely mechanical rather than electronic, the specials techs had an edge over the CT techs. While electronics, in general, and computers, in specific, were a mystery to most techs, mechanical principles were more familiar and techs learned the principles of an X-ray tube's operation in school. For these reasons techs could assess and repair mechanical problems more easily than electronic difficulties. Nevertheless, CT techs always plunged headlong into technological problems regardless of whether they were mechanical or whether they originated with the scanner's computer. Before calling an engineer, the CT techs tried numerous avenues of action to diagnose and correct the problem themselves. To enlarge their understanding of the scanner, CT techs would often observe the scanner's engineer at work and would question him about problems. Over time, the CT techs began to build a theory of the scanner's operation that combined bits of information learned from the engineers with conceptions spun by the techs themselves (Barley, 1983c). While the homespun theories were at many points technically inaccurate, they allowed the techs to cope with the scanner and reinforced the perception that the CT techs knew the machines better than most anyone else.
Of the three groups, sonographers were less troubled by equipment malfunctions since ultrasound was more reliable and less complies than the scanners. Unlike the other groups of technologists however, sonographers were more likely to have a theoretical grasp of the technology's functioning. Sonographers discussed for extended periods of time, the principles by which the equipment converted sound into images and the precise effects of manipulating characteristics such as frequency and amplitude. Sonographers took satisfaction from knowing that they understood the technology and that its principles differed from other technologies in the department.

Group Work and Call

Although x-ray techs occasionally teamed up to perform particular procedures, they usually did so only when mechanical problems incapacitated one or more of the examination rooms, when one of the technologists was uncertain of himself or herself, or when boredom became chronic. For example, if one of the fluoro rooms ceased working during the morning, the techs assigned to each room would work together in the remaining room to hasten each procedure. Student technologists always worked with a seasoned technologist in the early period of their training. Later, after students gained more experience, they might themselves form teams to carry out exams. Finally, in the afternoon when work was slow two x-ray technologists might jointly conduct a routine in the outpatient area or work together on an arthrogram or other subspecial procedure. Aside from these situations, the work of an
x-ray technologist was designed as an individualistic enterprise and, for the most part, remained so.

In contrast, CT scanning, special procedures, and sonography were more likely to be shared endeavors. CT techs at both hospitals always worked as dyads or trios. By sharing the component tasks of running a scanner, patients could be scanned more perfunctorially. Only when one technologist went to lunch or left the area for other reasons did a CT Tech become solely responsible for the scanner's operation. At Suburban, specials techs usually worked in pairs, but occasionally all three technologists cooperated on a particular study. While Urban's specials techs worked singly whenever a nurse was on duty, in the nurse's absence, a second specials tech assumed her role. Before Urban hired its second nurse, specials techs were more likely than x-ray techs to work as teams. However, after the second nurse was hired and the specials techs began to double as CT techs, teamwork in specials declined. Ultrasounds at the two departments were also conducted differently. While Urban's sonographers usually worked individually, two sonographers staffed Suburban's ultrasound operation each day.

The differences between the patterns at the two hospitals were situation specific adaptations. At Suburban, the radiology department's sonographers conducted all ultrasounds performed in the hospital. Urban's sonographer, in contrast, performed no cardiac, no obstetrical, and few gynecological examinations. Cardiac studies were handled by a cardiac ultrasound department staffed by a second sonographer employed by the hospital's cardiologists. Obstetrical and gynecological examinations were referred to a sister hospital several blocks away. The division of labor resulted in part from political maneuvers by the
cardiologists several years earlier. Prior to that time, cardiac studies had been performed by the sonographers in the radiology department. By the time this research began, the radiology department's caseload was not sufficient to justify a team of sonographers.

Similarly, the fact that Urban's specials techs worked singly rather than in pairs was a situationally specific adaptation to the broader role of the nurse in Urban's special procedures. A nurse was only needed at Suburban to monitor EKG's, to take blood pressures, to start I.V.'s and to administer injections of valium -- tasks that technologists are legally barred from performing. But, since Urban's nurse also performed these duties as well as other work, a second tech would have been redundant. The specials techs at Urban recognized that their situation was not the norm at most hospitals and privately lamented the fact that they did not have the breadth of responsibility that specials techs elsewhere enjoyed. However, the techs informed me that they had once questioned the discrepancy and were told to drop the topic. The specials techs complied. Since two of the specials techs were unregistered technologists, they felt they had little choice but to accept the situation as it existed if they wished to remain in their line of work.

Hence, once one considers the reasons for why specials and ultrasound were organized differently at Suburban and Urban, it would appear that Suburban's pattern was more typical and that Urban's was something of a historical and situational anomalie. Regardless of the differences, it was still the case that technologists were only organized as teams or groups around the operation of the newer technologies. X-ray work was an individual affair at both sites.
The work of techs staffing the newer technologies was distinguished not only by potentially different interactional structures, but also by different temporal structures as well. While both main departments operated around the clock they were staffed by three progressively smaller shifts of technologists. The day shift began at 7:30 AM and ran until 3:30 PM when the evening shift started. The evening shift ended at 11:00 PM when the night shift began. While twelve to sixteen techs staffed the day shifts, only three or four technologists worked the night shift. At neither hospital did technologists rotate through shifts: the day shift always worked days, the evening shift always worked evenings, and nights were exclusive property of techs assigned to the night shift. The staffing structure meant that the main department was always open for emergencies, and that technologists could count on an eight hour day and a regular schedule of hours that did not change. When x-ray techs went home at the end of a shift, they did not return until the next day.

The temporal structure and staffing of the scanners, the angio areas, and ultrasound were quite different. Neither special procedures nor ultrasound maintained regular hours after 4:00 PM at either hospital. While the scanners operated into the evening hours and were staffed by CT techs on staggered shifts, both scanners closed their doors by 11:00 PM. Therefore, between 11:00 PM and 7:30 AM, the new technologies were generally inactive. However, as I mentioned when discussing variety in CT work, a CT scanner is a critical diagnostic tool in certain emergency medical situations. Similarly, angiograms and ultrasounds are also used for emergency medical diagnosis, though less frequently than the scanners. Since medical emergencies did not confine
themselves to daylight hours, and since the newer technologies were not operational twenty-four hours a day, emergencies needing an immediate CT scan, angiogram, or ultrasound often occurred when the areas were closed. To handle such situations, CT techs, specials techs, and sonographers went "on call."

When "on call," the technologist carried a pager at all times. If an emergency occurred, personnel at the hospital would summon the technologist by dialing a telephone number that caused the pager to sound an alarm. When the alarm went off, the technologist was to call the hospital, ascertain that the summons was not a mistake, and then hurry to the hospital to perform the study. Each evening and over each weekend one CT tech, one specials tech, and a sonographer from each department carried a pager. The techs within each area rotated the duty among themselves. Although I was unable to obtain precise records of the number of emergency calls placed during the year, without doubt CT techs were more likely be called in than specials techs, and specials techs were more likely to be summoned than sonographers. Hardly a week went by when the CT techs did not have at least one evening emergency during the week and one or more weekend emergencies.

Being "on call" placed certain restrictions on the technologist carrying the pager. Techs were supposed to remain within thirty to forty-five minutes driving time of the hospital, so that they could respond quickly to life and death situations. Persons carrying a pager were also expected to remain sober during the designated hours that they were on call. These restrictions plus the random nature of emergencies meant that calls were likely to occur when they were least wanted, that a good night's sleep was never a certainty, and that technologists
occasionally sacrificed attending events that they would have attended under other conditions. Conversations about the details of emergencies and the exingencies of being interrupted from sleep and other activities were common among CT techs, specials techs, and sonographers at both hospitals. In compensation for the inconvenience of call duty, techs were paid approximately a dollar an hour for carrying an activated pager and a minimum number of overtime hours (3 or 4) for any trip they had to make. Call meant that CT techs, specials techs, and sonographers could not separate their work lives from their leisure lives as easily as could an x-ray technologist.

Conclusion: Towards Technologically Induced Occupational Identities

The traditional, formal division of labor in a radiology department is clear cut. Strictly defined, the technologist's role is twofold: to manage patients and to produce films for radiologists. In turn, the radiologist interprets the films and provides referring physicians with "readings". Administrators coordinate the day to day work of the department and manage the department's transactions with actors in the larger environment who are not physicians: suppliers of goods and services and representative of other units within the hospital. Secretaries and clerks make appointments and handle paperwork, while orderlies fetch patients.

As I have attempted to make clear over the course of this chapter (and in Figure 10 which summarizes the preceding discussion in tabular form), traditional descriptions of radiological work roles may be glibly accurate for the main department, but they may misrepresent the nature
Figure 10

Characteristics of Technologist's Work: A Summary

| Variety: level source | Main Department | | | | | |
|-----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                       | Routines        | I.V.P.'s        | Fluoro          | C.T.            | Specials        | Ultrasound      |
|                       | high external   | low external    | low external    | medium internal | high internal   | high internal   |
| Supervision: Admin.   | distant         | close           | close           | distant         | distant         | distant         |
| Rad.                  | distant         | close           | close           | S: distant U: Close | S: medium U: close | distant         |
| Interpretive Ability  | slight          | slight          | slight          | moderate        | extensive       | extensive       |
| Interaction w/ Dr.'s  | infrequent      | infrequent      | infrequent      | moderate        | moderate        | extensive       |
| Supplies              | no              | no              | no              | yes             | yes             | yes             |
| Equipment             | no              | no              | no              | yes             | yes             | yes             |
| Group/Individual Work | individual      | individual      | individual      | group           | S: group U: individual | S: group U: individual |
| Call                  | no              | no              | no              | yes             | yes             | yes             |
of work performed by technologists who staff the newer imaging technologies. There we find technological subworlds in which the technologist's work is not quite as routine, and where variability arises less from external factors (such as an unpredictable workflow), than from attributes of the technology and the work itself. These realms are ones into which administrators rarely venture and where daily supervision, if it does occur, comes directly from a radiologist. Here even the basic structure of work is often different. Technologists may work together in teams and the separation between work and leisure is harder to maintain. But perhaps most importantly, we find technologists whose work roles have expanded in scope. Not only do the techs assume part of the administrator's work by managing supplies and by becoming more actively involved in the maintenance of the technology, but they may even encroach, ever so slightly, on the radiologist's prerogatives. For example, the new technologists may know something about and even use information in the images they create. In addition, the CT tech, the specials tech, and the sonographer may find themselves interacting with physicians in ways prohibited for x-ray techs and reminiscent of traditional interactions between radiologists and doctors.

The roots of these differences lie in the technical attributes of the new technologies and in the social situations that surround their incipient use. In increasing degrees, regular special procedures, digital subtraction, CT scanners, and ultrasound each demand that technologists employ the information they create to guide the technology's course. As the cybernetic use of images for technical purposes becomes more important, the chasm between execution and conception that undergirds traditional role distinctions in radiology
becomes less viable. Moreover, the newest of the new imaging technologies are increasingly complex and are built up out of multiple technical subsystems integrated and controlled by computers. Integrated complexity amplifies both the likelihood and the severity of technical problems, while the computer introduces a form of technology still foreign to most people who work in radiological settings. Thus, the technology is not likely to be well understood even by those who set out to use it. Finally, and perhaps most important in the long run, each new modality introduces a completely new system of diagnostic signs, a new language of medical images. Like all languages, the visual language of a radiological technology must be learned to be used and must be used to be learned. In short, the information in the images are, at first, likely to be opaque.

With these attributes, the technologies enter the social world of the radiology department. There, they are met by a mixture of enthusiasm, excitement, and apprehension. While everyone believes that the technology's potential is great and that its procurement signals a medical and perhaps a financial red letter day, few people know what to do with either the machine or its images. Most radiologists and the technologists who have been selected to staff the technology will have had no experience with the technology. They in turn must rely on the one or two techs and radiologists who do. Similarly, most physicians who refer patients will not understand the technology and its images and count of the radiology department's ability to create and interpret the information. Thus the technology's use is likely to be born in an environment where knowledge differentials between radiologists and
technologists are leveled. If experienced techs have been hired, the differentials can be reversed.

The relative distribution of knowledge about the technology and its images combine with the staffing scheme to influence the supervisory structure that arises around the technology's use. If experienced techs are hired, and if inexperienced radiologists feel uncomfortable working with techs who appear to know more than they and who are clearly competent to coordinate the details of the technology's use, then the technologist's may grant the techs far reaching autonomy almost immediately. If the technologists are inexperienced, more traditional supervisory patterns may reestablish themselves, at least initially. With time however, supervision is likely to become less close as radiologists grow confident in the technologist's knowledge, as the techs begin to assert autonomy, and as the radiologists become bored with the machine itself.

Over time, the technologists' experience becomes increasingly differentiated from that of other techs in the department and from the administrators as well. Since the technologists are often the only persons who work constantly with the machine they become the local experts on its use. Since they understand both the technology and the work, while the administrators do not, the administrators can lay no claim on supervising the techs' daily work. Moreover, the technologist is also more attuned to the supplies and equipment needed to operate the technology and is in a better position to transact business with the manufacturer's engineers when technical problems occur. Only the technologist can speak in detail about the specifics of a technical
problem. Thus the coordinating roles that administrators play in the main department fall to the techs.

Because only a few technologists are trained in the technology, aside from the radiologists, they are the only persons who know the technology. If a radiologist is not available, the technologist become a second best source of information. Consequently, physicians may turn to techs as informational resources, particularly when it becomes known that the techs understand the images they create. The situation is less likely in the main department where all radiologists know how to read traditional studies more or less equally well and where technologists do not.

As the technologist's work world becomes progressively differentiated from the world of the main department, the techs may devise nascent occupational identities around their association with the technology. By an occupational identity I mean a sense of uniqueness drawn from the perception that one's work is somehow different from the work of others. The probability new imaging technologies will foster the formation of occupational identities is likely to be enhanced by the group work structure associated with the newer technologies and the physical distances that tend to separate CT departments, ultrasound departments, and angio suites, from the main department. The former reinforces the perception of a common situation among techs who operate the same technology, while the latter isolates the work group from others. Initial indications of such occupational identities should not be consistent from site to site since each will grow in isolation. Cross department commonalities should not arise until a technologist's specific job gains broad recognition as an accepted occupational
subsidiarity and until interaction between techs at different radiology departments begins to occur. (Van Mannen and Barley, 1984). Instead, nascent occupational identities should first appear as outgrowths of incipient technological subcultures.

Evidence of occupational identities and subcultures linked to the new imaging technologies existed at both Urban and Suburban. Sonographers at both sites knew of sonographers at other hospitals and could talk about how ultrasound was organized in different radiology departments. Moreover, the sonographers in both hospitals regularly subscribed to several ultrasound journals which they kept in the ultrasound department. If other technologists subscribed to similar journals they did not display them prominently as an occupational accoutrement. However, the dawnings of an occupational and even professional sense of self were also evident among CT techs and specials techs. Both radiology departments sent CT techs to a conference in Texas sponsored by the scanner's manufacturer. These techs returned full of stories about how CT scanners were run elsewhere. Suburban's specials techs attended annual conferences on angiographic techniques held by a local medical school. One of Suburban's specials techs even delivered a paper at a regional conference. Although there were regional conferences devoted to x-ray technology, it appeared that x-ray techs from neither hospital attended.

At Suburban, the technologists who worked the new technologies dressed differently from x-ray techs. The sonographer wore a short white smock quite unlike any uniform worn by anyone else at Suburban. The CT techs wore street clothes beneath long lab coats. The male specials tech often wore a sports shirt and a pair of slacks and no
insignia of his occupation. In contrast, x-ray techs wore white dresses or white pants. Male x-ray techs usually wore short lab coats. At Urban, only the sonographers dressed distinctively. They wore white lab coats while all other technologists wore blue smocks.

Specials culture was most elaborate at Suburban where the technologists promulgated a particular value system congruent with their work situation. The specials techs valued highly the ability to maintain calm in the midst of havoc. It was, in their minds, unprofessional to become visibly disturbed in the face of emergencies or unforeseen events. Rather, the professional specials tech thought and acted quickly, but pretended that everything was proceeding normally. Their term for failure to maintain such a sense of distanced cool was "spazzing out." To be told by a special's tech that you had "spazzed out" was a serious insult. CT techs at Suburban also began to develop a distinctive normative system over the first eight months of the scanner's operation. Here the system centered on efficient management of the workflow. CT techs went out of their way to invent methods for regulating the flow of work so that they could speed up or slow down the pace at will. At the same time, the CT techs devised a number of verbal games that only they played. Most involved sexual innuendos. In contrast, evidence of distinctive technological subcultures were rarer at Urban. Early on, the specials techs made a habit of eating together at lunch in a location not frequented by other technologists. However the tradition died soon after the specials techs began to work the CT scanner.

As one might expect, the identities and subcultures were more fully formed in ultrasound and special procedures which had been in
existence for a number of years. Moreover, technologically defined subcultures were stronger at Suburban than at Urban since the organization of work at Suburban consistently posed more favorable conditions for the dual perceptions of similarity and difference. For instance, as discussed earlier, Suburban's radiologists tended to grant specials techs and CT techs more autonomy than did the radiologists at Urban. Moreover, Suburban's new technologies were not only physically separate from the main department, but they were distant from each other. In contrast, ultrasound, CT, and special procedures were located on the same hallway at Urban. The proximity of the new technologies to each other worked against the development of distinct subcultures. However, most important was that by allowing specials techs to run the CT scanner, the department diffused the occupational identities of the CT techs as well as the specials techs.

FOOTNOTES

1. There is, of course a second moral to this story relevant for would be fieldworkers: caveat emptor.

2. Curious readers may wonder why the percentages for Urban's main department are higher than Suburban's. I suspect that the higher scores for the fluoro exams represent the fact that Urban's radiologists remained in the fluoro area throughout the morning. This is consistent with the opportunity thesis detailed in the text. Urban's high IVP score is suspect. Two of the four IVP's involved Urban's part-time sonographer. I consistently found that when CT-techs, sonographers, and special techs worked the main department, they were far more likely than x-ray techs to discuss films with the radiologists.

3. However, two experienced CT techs hired by Suburban were quite knowledgeable about CT scans and on occasion became resources for those radiologists at Suburban who had no experience with the technology (See Chapter 6).
4. As one might expect, there were differences between the two departments that derived from the fact that some of Suburban's techs were more familiar than some of the radiologists with the scanner. These differences are discussed in a latter section of this chapter as well as in Chapter 6 and Chapter 7. Also see Barley (1983a).

5. Although it is tempting to launch into a discription of how sonographers manage their knowledge with patients and radiologists, that is part of the topic of the next chapter.

6. Combining data from both sites, the average durations of a barium enema, an IVP, and a CT scan were respectively 43 (N=48), 56 (N=28), and 47 (N=88) minutes. Thus in the same time that it would take to do four average barium enemas or four average IVP's, 3.7 or 4.8 average CT scans could be completed.

7. As some testimony to the seriousness of the emergencies that CT techs are likely to encounter, the only patient who to my knowledge died in either of the radiology departments did so while having an emergency head scan. The patient was brought to the scanner after having suffered a massive cerebral hemorrhage.

8. Neither the radiologists nor the technologists were well trained in computer technology and were religously shielded from learning much about the software routines that could be used to correct common problems. Elsewhere, I have discussed in detail how techs and radiologists reacted to and attempted to solve technical problems in CT scanning, as well as the role of the engineer. See Barley (1983b).

9. Out of the 38 special procedures that I witnessed over the course of the study, I observed three instances of arrhythmia during an angiogram. Since I can find no reasons that suggest I unwittingly sampled for complications, if these cases are taken as representative, then cardiac problems would seem to occur in about 8% of the special procedures performed in a radiology department.

10. For this reason a strategy of simply counting the number of different tasks that people are said to perform can be misleading as a measure of task variety. Nominal heterogeneity is a little discussed pitfall that looms wide when researchers attempt to quantify aspects of settings by counts of types of events or entities whose content they little understand. A similar problem can be encountered with highly differentiated job hierarchies in which two jobs have different names but, in fact, vary little from one another.

11. Techs could also escape close supervision by working "portables" or the "OR", where then would never be likely to see either an administrator or a radiologist. In fact, some
technologists suggested that others used the duty assignments as ways to avoid work. When assigned to the duties techs would simply stay out on the floors, rather than return to the department as soon as their jobs were completed. However, working the OR carried certain pressures of its own. Many techs claimed that it was extremely stressful to work for surgeons during an operation and hence preferred to avoid the OR. Female technologists also usually detested portables since it required them to move heavy pieces of equipment around the hospital and to deal with patients who were bedridden and therefore required more lifting in order to get adequate films.

12. By intimating that the quality control position wasted money, the technologists fueled their indignation at the hospital which had recently said it was in a financial crisis pursuant to new reimbursement legislation passed by the Massachusetts legislature. The ruling set a cap on hospital reimbursement by third party payers. As one response to the new regulatory environment, the administration had announced that annual salary increases would be less than usual.

13. In the case of the first quality control person, talk among the technologists suggested that the individual had been asked to leave. Although I do not know for certain whether this was indeed the case, I do know that of the two she was the most resented because she was also widely disliked as a person. If the insinuations were accurate, it would seem that the techs' campaign to point out the quality control person's weaknesses was rather successful since many of their complaints appeared to be grounded in fact. On several occasions I had tried to get the quality control person to tell me about differences between the various pieces of x-ray equipment in the department. The individual was unable to explain the room's idiosyncracies and how these might influence a technologists job and the likelihood of having problems with films. In comparison, most technologists could tick of idiosyncracies on a moment's notice. The second individual left citing person circumstances, however, I was privy to several discussions in which the individual openly discussed with trusted others, her perception that the technologists did not like her and that this was causing her great upset.

14. Because of the technologist's tone of voice and her reputation for competence in the department, it was clear that she was using the encounter to make comment on the stupidity of the rule. I sensed also that the radiologist was somewhat embarrassed by the situation. However, I have no data to suggest that technologist only chose to inquire because she knew that I would be an audience to the scene and that under other circumstances she would have acted on her own judgement. Nevertheless, the possibility remains that if she knew I was with the radiologist then she may have realized that her point
could be made even more poignant by my observation of the interchange.

15. Of 31 IVP's, the field notes on 26 were complete enough for the purpose of coding radiologist's critiques. (The other 5 lacked information on one or more follow-up films.) Of these, 13 evidenced negative critiques. The proportions were similar for both departments: 47% for Suburban (9 out of 19) and 57% for Urban (4 out of 7).

16. The greater tendency for Suburban's administrators to visit the CT area reflects the fact that the Chief Tech was herself a former CT tech and had in fact worked with the two experienced techs before coming to Suburban. Given the Chief's interest in CT and her friendship with the techs, it is surprising that she did not frequent the area more often.

17. The review undoubtedly served a third, latent purpose, that of symbolically maintaining the radiologist's authority as the expert at interpreting diagnostic images. The reviews were repetitive reminders of who was really the boss. Radiologists and sonographers alike recognize the thin line they tread. The issue of whether or not sonographers "should" or "do" interpret is one that resounds throughout the journals of both professions and is said to arise at almost any professional meeting.

18. Only the two CT departments and the two ultrasound departments maintained their own separate film libraries. That a separate film library was a mark of status and distinction was given credence by the specials techs at Suburban who explicitly suggested that they too should be allowed to keep their own films now that they had begun to perform digital subtractions. A separate film library was a sure sign of one less link to the main department and represents one reason why CT and Ultrasound were called departments while special procedures was not.

19. At Suburban, the technologists were also supposed to record current machine problems on a blackboard beside the film processor in the main darkroom so that techs who had not received word of the problem could check the board to update themselves on the status of mechanical difficulties. That techs often unwittingly made problems worse by using a machine known to have malfunctioned was testimony to the system's failure as a communications device and the relative lack of importance that x-ray techs attached to equipment problems.

20. Repairmen were called "repairmen" in the main department. However, persons who repaired CT scanners, ultrasound equipment, and special procedures equipment (excluding the equipment in Urban's specials area) were called "engineers" by the companies and the technologists alike. None of the "engineers" had degrees in engineering and were graduates of
company sponsored training programs. The difference in language attests to the difference in status that that a few electronic components can make in the world of machinery.
CHAPTER 6

TECHNOLOGICAL SHAPING OF ROLE RELATIONS

In his treatise, *The Theory of Social Structure*, Siegfried Nadel (1957) argued that roles are essentially of two basic types, "relational" and "non-relational". According to Nadel, relational roles cannot be played without a second individual in a specific companion or complementary role. Thus, there can be no "son" without a "mother", no "debtor" without a "creditor", and no "subordinate" without a "superior". In contrast, "non-relational" roles require no specific alter egos. Rather, actors in non-relational roles need only engage in the bundle of behaviors deemed by members of society to be the defining characteristics of those roles. There are then, no specific alter egos for the "butcher", the "baker" and the "candlestick maker". To assume these occupational roles it is sufficient if the first bakes, the second butchers, and the third makes candles. Relational roles are said to require interactional partners, non-relational roles do not.

While Nadel's dichotomy captures an important distinction between conditions necessary for assuming particular roles, it would be a mistake to presume that roles are, other than linguistically, so easily typed. A butcher's occupational role surely depends on how he treats animals for money. But without customers, the butcher's work would certainly earn him another name, as well as another place, in society. Most roles then, are best understood as mixtures of the relational and non-relational that can only be analytically separated. The previous chapter focused primarily on the non-relational characteristics of
technologists' roles, their tasks and the organization of those tasks. But even in the discussion of tasks and work organization, the importance of the interactional substrate was, at times, far from implicit. For example, a technologist's autonomy was clearly predicated on her interactions with administrators and radiologists or the lack thereof. In this chapter, I focus directly on the interactional substrate to ask whether and how radiological technologies shape role relationships in a radiology department. The shift brings the discussion squarely into the second concentric circle of the reverberation framework.

Three actors are critical to any radiological procedure: the technologist, the radiologist, and the patient. Other members of a radiology department play roles that support the central triad. While orderlies, administrators, and secretaries are important to the work of a radiology department, their absence would not bring to demise the production of diagnostic studies. In contrast, if patients, technologists, or radiologists were to disappear, medical imaging as it is currently practiced would also cease to exist. Corresponding to the three central actors then, are three role relationships that inscribe the interactional context of radiological work: relations between technologists and patients, relations between radiologists and patients, and finally relations between technologists and radiologists themselves. I shall consider each in turn.
Relations Between Technologists and Patients

Regardless of the study performed or the technology used, a patient's interaction with a technologist was usually confined to a brief, one-time encounter. Even patients subjected to multiple radiological studies over a long period of hospitalization rarely met the same technologist twice. Consequently, any relationship between patient and technologist was more or less completely bound by the temporal span of a procedure. Table 5 presents the mean, minimum and maximum duration of various examinations observed over the course of the study. As the table suggests, most radiological exams lasted less than an hour. Routine x-rays were, by far, the briefest, averaging six minutes in duration. Special procedures were generally the longest with an average duration of ninety minutes. However, even at the extreme, a complicated special procedure created interaction space of little more than three and a half hours (216 minutes).

As if an examination was not brief enough, actual interaction time could be even more tightly circumscribed. For interactions to occur between a technologist and a patient, each had to be in the other's company, but not all procedures fostered constant companionship between technologist and patient. As Table 6 demonstrates, the percentage of an examination's duration during which the technologist and patient were face to face depended on the type of procedure being performed.¹ Routines brought technologists and patients together throughout the whole course of the study. Since most routines were performed on machines with automatic film processors, the techs did not even need to
Table 5
Mean, Minimum, and Maximum Duration of Specific Types of Radiological Procedures
(in Minutes)

<table>
<thead>
<tr>
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<th>N</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>Routines</td>
<td>11</td>
<td>6</td>
<td>1</td>
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<tr>
<td>I.V.P.'s</td>
<td>28</td>
<td>56</td>
<td>27</td>
<td>127</td>
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<td>Barium Enemas</td>
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<td>43</td>
<td>18</td>
<td>76</td>
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<tr>
<td>Special Procedures</td>
<td>52</td>
<td>90</td>
<td>30</td>
<td>217</td>
</tr>
<tr>
<td>Ultrasounds</td>
<td>48</td>
<td>16</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>CT Scans</td>
<td>88</td>
<td>48</td>
<td>19</td>
<td>126</td>
</tr>
</tbody>
</table>
## Table 6

A: Average Percentage of Various Procedures' Duration that Technologists were with Patients

<table>
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<tr>
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<th>Urban</th>
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<tr>
<td></td>
<td>N Mean %</td>
<td>N Mean %</td>
<td>N Mean %</td>
</tr>
<tr>
<td>Routines</td>
<td>5 100%</td>
<td>6 100%</td>
<td>11 100%</td>
</tr>
<tr>
<td>I.V.P's</td>
<td>20 46%</td>
<td>6 57%</td>
<td>26 49%</td>
</tr>
<tr>
<td>Barium Enemas</td>
<td>19 67%</td>
<td>24 39%</td>
<td>43 51%</td>
</tr>
<tr>
<td>Specials</td>
<td>44 99%</td>
<td>8 100%</td>
<td>52 99%</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>29 98%</td>
<td>18 72%</td>
<td>47 88%</td>
</tr>
<tr>
<td>CT Scans</td>
<td>41 26%</td>
<td>43 30%</td>
<td>84 28%</td>
</tr>
</tbody>
</table>

B: Analyses of Variance

### I. Technologies Grouped by Traditonal/Non-Traditional:

<table>
<thead>
<tr>
<th>Source</th>
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<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F</th>
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<tr>
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<td>1</td>
<td>2.38</td>
<td>2.38</td>
<td>23.60**</td>
</tr>
<tr>
<td>New vs. Traditional</td>
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<td>.15</td>
<td>.15</td>
<td>1.51</td>
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<tr>
<td>Residual</td>
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### II. Technologies considered individually:

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** p ≤ .01
leave the patient's side to develop films. In contrast, I.V.P.'s and barium enemas required technologists to run films, locate radiologists and fill barium bags. Consequently, techs and patients were less continually in contact than in the outpatient area even though they might actually interact for longer periods of time. At both hospitals, average patient contact was least during CT scans where technologists and patients spent most of every study in separate rooms. Sonographers and specials techs however, kept patients company almost as constantly as x-ray techs performing routines. Both technologies required close proximity to the patient.

Thus, while each technology appeared to influence the amount of interaction between patient and technologist, no consistent distinctions could be made between radiography and fluoroscopy on one hand, and the newer technologies on the other. The analyses of variance in Table 6B substantiate the point. While the the percentage of patient contact varied between the two departments (F=23.66, df=(1,160) p<.01), whether or not the technology was traditional or recent was unrelated to the amount of time that technologists spent with patients (F=1.15, df=(1,160) p=.22). Yet, the examinations themselves, taken as proxies for each technology, did significantly alter the time that patients and techs spent together (F=187.68, df=(5,256) p<.01). However, the duration of a study and the amount of actual contact during an examination are but broad parameters that only condition interaction. While their pattern of variation suggests that each technology created a somewhat different interactional milieu for technologists and patients, neither tells much about the nature of the interaction itself. To better understand how the technologies shaped relations between patients
and technologists, each technology must be examined individually. I shall begin by describing a few general strategies that most techs used to manage patients so that we might then see how each technology altered these strategies.

General Strategies for Interacting with Patients

**Distancing:** The brevity of the typical radiological procedure, the large number of patients that flowed through a department, the need to conduct exams expediently, and the low probability of prior or future contact with any patient joined forces to create the technologists' dilemma: how to distance oneself from individuals for whose condition one had no primary responsibility while at the same time showing sufficient concern to maintain the patient's dignity and cooperation. To strike the appropriate professional stance technologists could not afford to become personally involved with patients. Nor, could they afford to be cold.

Linguistic strategies were important resources that assisted all technologists in resolving the dilemma. To distance themselves from patients technologists tended to refer to patients by the study that brought them to the department. Only to their faces were patients known as "Mr. X" or "Mrs. Y". In conversations between technologists, patients became "toes", "spines", "sinuses", "skulls", "gall bladders," and so forth. Consequently, if technologists were to refer to an earlier patient they were more likely to say "Remember that spine..." than, "When I was doing Mr. X". Several technologists who entered the occupation in the late sixties found the linguistic practice abhorrent
and suggested that it contributed to the "treating of patients like meat". But by and large even those techs who in their more reflective moments condemned the habit were oblivious to its practice.³

A second linguistic practice served not only to distance the technologist from the patient, but to create a semantic environment of concern as well, thereby bridging the horns of the tech's dilemma in one act. Techs employed terms of endearment and diminutives when speaking to patients, especially when the person was elderly or in pain. "Hon," "sweetheart," and "dear," were omnipresent in the x-ray tech's lexical toolkit. At the slightest sign of difficulty the terms were brought to the fore, seemingly to preface or qualify almost every order or question the tech directed at the patient: "OK, hon, can you roll over for me?" "It's ok dear, it'll pass in a minute." "Take in slow deep breaths, sweetheart. I'm right here." Similarly, when the patient's requisition suggested that he or she was known by a diminutive nickname such as "Bessie," "Gertie," or "Teddy," techs picked up the name and used it in place of global endearments. If the practice bothered patients, they did not say so. Never did I hear a patient say, "I'm not your sweetheart," or "It's Mrs. Smith, to you".

Shows of concern that prefaces the procedure also allowed techs to define themselves as persons with compassion for the patient. Techs often began an exam by offering patients accoutrements of comfort: a pillow, a blanket, or a pad for under their legs "to relieve the pressure on the back." In some instances, technologists would underscore the portent of their offer by stating explicitly how the prop would make the experience more bearable. Several technologists even went so far as to keep a bigger, fluffier pillow beside the exam table.
As soon as a patient reclined, the tech offered to replace the smaller pillow already on the table with the more comfortable one, "Would you like a bigger pillow for your head?" Although offers of comfort were well rehearsed, they were convincingly made. Their routine nature was only obvious when one observed multiple exams, a form of knowledge not open to most patients.

Explanations: A surprisingly large number of patients had no idea what particular procedures consisted of, or even why they were having a test performed. Radiologists and technologists alike habitually complained that the physician's reluctance to explain the nature and purpose of diagnostic tests combined with the patient's failure to understand or listen, to create a situation where most patients were in the dark about what would happen to them in the radiology department. Situational ignorance was particularly common when procedures required injections, ingestions, or infusions. Ignorance came in several varieties. On one hand, patients might simply not know why they were asked to have the test or what the test actually involved. On the other hand, some patients appeared to believe they were having one exam, when in fact, they were scheduled for another. The latter problem was most common among barium enema patients as the following excerpts from fieldnotes on three BE's suggest:

T: Have you ever had this examination before?
P: About two years ago.
T: What did they do to you?
P: They gave me something to drink.
T: No, that's the other exam. This is like an enema. We'll put some barium in and then have you move from side to side while we take some pictures.
P: Does it make any difference if I have allergies?
T: No, because there is no intravenous injection in this test.

T: Why are we doing this exam? What problems are you having?
P: I don't know.
T: Are you having any pain? Any blood in your stools?
P: No. They want to see what's wrong. I'm swallowing something and they want pictures.
T: No, you're not going to swallow anything. This is an enema. We put it through your rectum. We'll do it quickly but it's very important that you try to hold it in, OK?

T: Have you ever had one of these before?
P: (looking around and in a meek voice) Is this were they use a light? You know put a light up?
T: No, it's like an enema.
P: (knowingly) Oh!

Since patients could misunderstand or even be misinformed about what would occur to them, techs began most procedures by asking patients if they understood or had experienced the exam before. When patients claimed knowledge, technologists typically decided that they need not explain further unless the patient subsequently revealed ignorance: an uncontradicted assertion of knowledge eased the technologist's job. If mutual understanding could be presumed, the tech could avoid explicitly mentioning unpleasant information that might disrupt the social fabric of the encounter. The assumption and its importance for the interactional context was actually made explicit during the preliminaries to a barium enema where technologists often granted knowledgable patients insider status by following the patient's claim to knowledge with a statement like, "then you don't need me to tell you what this is all about". In reply, patients frequently accepted the
techs' invitation to collude: "Of them all, this is the one I hate the most" or "All I want to know is, where's the bathroom?"

When the patient did not understand the procedure or had not had the exam before, the technologist briefly summarized upcoming events in a few sentences. Summaries were always short, and objectionable information was always glossed or delivered at a rapid rate. Rather than lay out the procedure's course in detail, the technologists adopted a strategy of incremental or ad hoc explanation. The patient was told little about the details of events until they were about to occur. At that point, the technologist's comments took on the flavor of announcements: "You're going to feel some pressure now," "I'm opening the flow," "The tube's going to move above your head on the next one," and so forth. The warnings' immediacy satisfactorily informed the patient while at the same time catching him off guard. By so doing, technologists met their obligation of providing information, but in such a way that the event was over before the patient could meditate on its occurrence. Without time to ruminate, patients had less time to worry.

Under the presumption that certain words and phrases might increase a patient's anxiety and reduce a patient's cooperativeness, x-ray techs employed euphemisms when explaining procedures or and when referencing potentially objectionable events. Since techs knew that patients could be afraid of radiation, they often avoided direct references to, "x-rays". Instead of saying, "I'm going to take an x-ray of your stomach," techs would say, "I'm going to take some pictures of your belly." Similarly, talk about an injection might be phrased as "a little ole needle" or "the doctor will put some contrast in your arm". Inflating the balloon at the end of the enema tip was noted as, "you're
going to feel some pressure now." Even the barium itself might be called "water" as in the phrase, "You're going to feel the water come in now."

In addition, to using euphemisms, techs took advantage of the indexicality of the situation. Words like "rectum", "barium," "feces," or "enema tip" and any of their more colloquial synonyms were easily replaced in situ by the versatile pronoun "it". In the main department, the use of euphemisms and indexical references progressively increased as techs moved from routines to IVP's and on to barium enemas. Consequently, these strategies seemed directly tied to the potential trauma or untoward nature of an exam. While techs usually called an IVP by it's rightful name, barium enemas were frequently referred to only as "this exam". In fact, "enema" was rarely mentioned unless the patient misunderstood the exam.

Controlling Complaints and Gaining Compliance: Over the course of radiological exams patients were likely to complain about multiple inconveniences and discomforts. The danger of such complaints was that they might escalate to the point where they obstructed the tech's work. To diffuse complaints immediately, techs often simply granted their legitimacy and veracity. By granting legitimacy to a patient's objections, the techs showed a form of empathy, while subtly suggesting that the problem was not serious enough to discontinue the action. Techs usually granted a complaint's legitimacy when they deemed the problem to be nothing more than a minor irritation:
P: This table's hard!!
T: Yes, the table is hard.

P: I'm sticking to the table.
T: (Good humoredly) Isn't it wicked how skin sticks to these tables.

P: (as the tech inflates an enema tip) I don't like that.
T: I know it's uncomfortable, but it has to be there so you won't loose it.

P: I feel like I've got to throw up!
T: I know. I'll let you throw up in a minute.

At first glance the final example might be interpreted as a rather callous use of a granting tactic. In this case, however, the technologist granted the patient's complaint so that she could finish taking a scout for an IVP. Since the patient had not been injected, the tech thought the complaint inconsequential. True to her word, as soon as she finished taking the film, the tech brought the patient a bed pan. The patient responded, "What's that for?" The tech replied, "In case you get sick." To which, the patient returned, "I don't have to throw up!" Complaints could, as this example suggests, become a game between patient and technologist. Astute technologists learned quickly to recognize a ploy when they saw one. In this case, the patient lacked the sense of urgency of persons about to "be sick".

In direct contrast to granting the legitimacy of a complaint, technologists sometimes took the opposite tactic and negated the validity of the patient's statement. Negations often took the form of a technologist's explicit or implicit counter to a patient's prediction about the likelihood of a feared event or promised behavior. Negations carried the additional message that things were not exactly like the patient thought them to be. The technologist's invitation in a negation
was for the patient to redefine the situation in a way that would make it easier for both to endure and manage:

P: I feel like I have to go!
T: No you don't. You just feel the tip and the balloon.

Negation only worked when the technologist could offer a clear alternative to a patient's explanation for a presumed experience. However, if the patient's fear pertained to unpleasant experiences in degrees, technologists would seek much the same result by diminishing the extent to which the experience would be a problem. Concerns about the duration of the procedure were the most common topic amenable to diminishing. For example, if a patient asked how long an IVP or a barium enema would take, techs were likely to underestimate the average time by twenty to thirty minutes. During many procedures, technologists frequently promised patients that the remaining time to be spent on the table had grown short: "How do you feel? This (post-evac film) is an easy one. It's just to make sure you're cleaned out. It won't take a minute," or more commonly and succinctly, "Just hold on, we're almost through". The opportunity for diminishing negative stimuli also arose when techs were filling syringes or hanging barium bags for barium enemas. Upon seeing the tech work, some patients timorously asked how much iodine the tech intended to inject or whether the entire barium bag would be infused. In response to such questions techs invariably underestimated the dye by approximately twenty cubic centimeters and promised the barium enema patient that he or she would certainly not "get the whole thing".
After working a procedure for some period of time, techs grew to predict common responses to particular events. Technologists used their knowledge of stereotypical concerns to allay fears before they arose. The *prior countering* of disturbances was particularly useful when the source of anxiety had little basis in fact. Hence before raising or lowering a table to or from a 90 degree angle technologists said, "Don't worry, you're not going to fall". Similarly, when doing IVP's and other exams requiring tomograms techs assured patients that the tube would not hit them. Thinking it better to confront complaints before they occurred, some techs also found the tactic appropriate when they knew they would cause pain: "I'm gonna place this tube in. This is not the best to go through, but it's over quick". Note that the tech combines the prior counter with an indexical and euphemistic reference ("place this tube in") while diminishing the effect ("it's over quick") just before taking action.

Whereas the previous four tactics for managing a patient's fear or behavior attempted to counter anxiety, techs occasionally sought control by resorting to *threats* to instill anxiety. Threats were rarely used unless the patient was considered exceedingly "difficult". For example, I observed a routine in which the patient continually moved about on the table and refused to lay still. At one point in the exam, the patient cried out that she was afraid that she would fall off the table. The technologist, who had become exasperated with "what's a matter hon" and "please try to lie still", turned to the patient and threatened, "You're gonna fall if you don't get down off you hip like I want you too." The patient did as she was told.
Finally and perhaps most frequently technologists sought to manage patients by encouragement and concern. Throughout the examination technologists told patients profusely that they were doing "good" or "great," and that the exam was going splendidly. Techs repeatedly asked patients how they were feeling, especially after an injection. If the patient said "fine," the tech responded "good" and noted that matters were probably not as bad as the patient expected. If the patient replied negatively, the patient was told to "hold on" or "you can make it." If the patient appeared intensely ill or fearful, some technologists even stroked the patient's brow or held their hand.

Each of the foregoing strategies for managing patients were universal in the repertoires of all technologists. However, their frequency of use varied from procedure to procedure across the main department. In addition, every type of procedure shaped interactions between patients and technologists in its own characteristic direction. I shall consider in turn, routines, IVP's, and barium enemas.

Relations with Patients in the Main Department

Routines: Unless patients were severely ill or in intense pain when they arrived in the outpatient area, x-ray techs faced few patient management problems when doing routines. The procedures themselves caused little discomfort unless the patient could not assume the various required positions. For this reason, arthritic patients, post-surgical patients who moved stiffly, patients with broken bones, or the incognizant and feeble necessitated special handling. However, since there were no noxious stimuli to neutralize, techs could usually manage
even the most difficult patient by showing concern and empathy, by using terms of endearment, and by profusely encouraging the patient into a pose while physically moving the person's body.

When patients were relatively mobile and flexible, the encounter between the technologist and the patient was often amiable. Techs frequently joked with patients at the start of a routine. If the patient returned the tech's good humor, then a sheen of verbal banter might develop to cover the brief encounter. Small talk and joking behavior allowed both patient and technologist to treat the technical aspects of the procedure as if they were incidentals. Similarly, when patients had suffered an accident (a broken leg for instance) or were in the department under unusual circumstances, technologists focused the conversation on how the patient came to be in the hospital, interrupting the conversation only to direct the patient into position.

Although joking and verbal banter occurred during other procedures in the main department, the style of interaction was not as frequent. For instance, patients having IVP's were often experiencing the intense pain of a kidney stone and were less willing to treat the exam inconsequentially. Moreover, when procedures were known to be invasive, patient's were often preoccupied with premonitions of an unpleasant experience. Routine x-rays did not appear to be foreign to many patients and few seemed to expect a painful experience. X-ray techs held that most people had either had previous x-rays or had seen them mimicked on TV shows, and therefore expected a relatively benign encounter. For this reason, technologists rarely explained a routine study at its beginning, but simply provided ad hoc rationales as they went along.
The newer technologies in the outpatient rooms also shaped interactions. With "floating tops", technologists could move the table rather than the patient to position for films, thereby reducing the number of orders they had to give. As a result they were less likely to bother the patient and encounter resistance. Tables with automatic film processors, allowed the technologist to remain with the patient throughout the exam. By maintaining constant contact, x-ray techs could keep patients preoccupied. Since both innovations also eased the technologist's work, they speeded the procedure. Techs performing routines worked quickly under any technological circumstances, but automatic machines enhanced their proclivity to end encounters before they ran out of things to say and the patient had time to contemplate the experience.

I.V.P.'s: Although the machines used in an IVP were similar to those used in routines, the nature of the interaction between the patient and the technologist was quite different. Not only was the procedure more lengthily, but the technologist had to contend with an injection and the side effects of the iodine dye. In addition, there was always the slight chance that the injection would trigger a severe allergic reaction. As a result, when performing IVP's x-ray techs were more likely to employ the full range of patient management strategies discussed above.

In addition, the iodine's side effects occasioned interactional exchanges associated only with procedures that involved injections. IVP patients were never explicitly informed about the nature of allergic reactions in order to forestall undue anxiety over an unlikely event. Rather, patients were told only of the common side effects.
Nevertheless, even when patients had had an IVP before, they were unlikely to treat intense warmth, a metallic taste, and nausea as a "normal" experience. Only the technologist and radiologist understood the statistical sense in which the sensations were "normal". For patients, the sensations were decidedly abnormal and most reacted accordingly. In part, because the technologists looked for signs of a "real" reaction and, in part, because the patient's response to the side effects could disrupt the sequencing of post-injection films, techs repeatedly asked patients what and how they were feeling during the first five minutes following the injection. In most instances, patients replied by describing expected sensations. Upon such description, technologists immediately attempted to redefine or normalize the patient's experience by claiming that the patient's sensations were "usual," "typical," "not serious," and ones that "most people have." The more intense the patient's response to the sensations, the more persistent the technologist's attempt to redefine normality. When patients finally experienced the side effects' abatement, technologists might clinch their attempts to normalize the experience by saying, "Good, I told you that those feelings would go away in a few minutes."

The necessity of showing post-injection films to the radiologist at intervals placed the tech performing an IVP in a different position than techs performing other exams. Since techs took leave of the patient by stating that they had to show the films to a radiologist before proceeding further, patients knew that techs were likely to know what the follow-up films indicated. Consequently, patients having IVP's were more likely to ask the technologist what the radiologist had seen in the films. Most technologists took the standard line, claiming that they
couldn't read films and that the radiologist hadn't mentioned what he saw. However, when exams became lengthy, patient’s realistically began to expect trouble and might pressure techs to reveal information. In such instances, rather than be specific about the problem, techs usually said, "it doesn't look like you're draining too well". The comment left the patient to ponder the implication of "not draining too well," while absolving the technologist of guilt about keeping information from the patient.6 Acknowledging that the films were vaguely positive also reduced the patient's pressure on the tech to tell more.

**Barium Enemas:** The aura of interaction between patients and technologists during a barium enema was decidedly distinct. Whereas IVP's and routines were performed with standard radiographic equipment, barium enemas required a fluoroscope. The use of a fluoroscope always tended to bend interactions between patients and technologists in directions uncommon in radiographic work. At the same time, since the barium enema attracted a different patient population and since it required what in other settings was socially taboo, definitions of the situation as a medical encounter were more tenuously maintained. Consider first, the technology's ramifications on the encounter.

Until the radiologist entered the examination room and the enema actually began, the fluoroscopic technology little affected the tech's interaction with the patient. However, once fluoroscopy started, the nature of the technologist's exchanges with the patient shifted for the duration. The tenor of the shift depended upon whether the radiologist operated the fluoroscope at tableside or from a remote control booth. If a tableside system was used, the technologist essentially became an accessory to the procedure. The task of communicating with and managing
the patient became the radiologist's. While some technologists might attempt to comfort the patient during a tablesde procedure, most stood away from the table, said little, and only approached the patient to change cassettes or regulate the flow of the barium.

With a remote control booth, fluoroscopy assumed a totally different character. During all forms of fluoroscopy, radiologists issued patients a stream of orders regarding how to turn their bodies so that areas of interest could be seen more clearly on the fluoro monitor. At tablesde, the radiologist spoke directly to the patient, and if the patient did not hear or respond appropriately, he guided the patient into position with his hands. From a remote control booth, the radiologist could neither assist patients nor speak directly to them without using a microphone to project his voice into the room. These microphones, however, often boomed with enough distortion that a patient having his bowels filled with barium might not hear what the radiologist said. Distortion decreased when the volume was lowered, but then the patient, who was often elderly, had even greater difficulty making sense of the radiologist's instructions. The technical barrier, in turn, created a human barrier. The microphone could be perceived to make an already uncomfortable and potentially humiliating experience even more impersonal and ominous.

To overcome the technical and human liabilities of remote control, technologists often acted as the radiologist's conduit. When playing the role of a conduit, the technologist stood in the doorway of the control booth and relayed the radiologist's orders to the patient. If necessary, the tech entered the room to accomplish tasks that the radiologist would have performed had a tablesde system been used. The
following excerpt from a transcript of a barium enema conducted from a control booth depicts how the technologist became the radiologist's mouthpiece.\textsuperscript{7}

\begin{verbatim}
R:  (to tech) OK, have her roll to her left for me please.
T:  (to patient) Roll towards your left a little bit...Just a little bit. OK, that's fine.
R:  (to tech) Little more.
T:  (to patient) Little bit more.
R:  (to tech) That's good. Barium on.

(Seconds pass, the radiologist takes two spot films and, the technologist goes to the table to change cassettes.)

T:  (to patient) How you doin' Mrs. M____? Hold on, and take slow deep breaths through your mouth.

(Tech returns to booth)

R:  (to Tech) Now, have her turn around towards me a little bit.
T:  (to patient) OK, lie on your back...And roll up this way a little.
R:  Hold it! Hold it! Hold it!
T:  (To patient) Yes, that's fine. OK.
R:  (to Tech) On her back.
T:  (to patient) On your back.
R:  (to tech) A little bit to the left.
T:  (to patient) To your left again.
\end{verbatim}

Although in other procedures technologists often repeated a radiologist's commands when they thought a patient hadn't heard what the radiologist said, only in remote fluoroscopy were technologists habitually responsible for the radiologist's words.

The barium enema was unlike most other radiological procedures in that it required the technologist to perform what in most other circumstances would be considered perverse. Neither patient nor technologist found the experience pleasant, and both were protected from
embarrassment only to the degree that they cooperated to define the situation as a medical encounter. Since patients did not have the technologist's experience and professional identity to draw on as interactional resources, the technologist had to take primary responsibility for ensuring that the patient experienced a minimum of shame and fear. To assist in the endeavor and to manage the social violation of the patient's body, techs drew most extensively on the previously discussed patient management strategies when performing enemas. In particular, euphemisms and indexical references were fundamentally important in that they enabled the technologist to avoid or mollify references to objectionable objects and acts.

In addition to managing humiliation however, the technologist also needed on occasion to obscure procedure's potential sexual overtones. Unlike the BE's humiliating aspects, the sexual aspects of the enema only became important when the technologists themselves confronted the problem. At Suburban, where only female technologists performed barium enemas, the potential sexuality of the enema arose only when the patient was a young male and the technologist a young female. Apparently older males were not perceived by most techs as having sexuality and older female technologists seemed more or less steeled against the problem. When a technologist felt that a male patient "might be embarrassed" by the procedure, she typically recruited a male tech to insert the enema tip, after which, she would resume the exam. At Urban, where technologists of both sexes performed barium enemas the younger female techs not only recruited male techs when facing a young male patient, but they shielded young female patients from male technologists. Of course, if Urban's fluoro aide was available to "plug the patients", no
sexual issue ever phased the technologists. The aide herself was a middle aged woman who handled the barium enema with the clinical detachment of the older female technologists at Urban. Thus it would appear that the sexual issues were only important when the techs thought they were, that the issues were most salient for young female techs, and that they were linked to perceptions of patient's age which preconditioned the attribution of sexuality.

Aside from the technology and the untoward nature of the exam, the demographics of the patient population combined with the tech's distaste for the barium enema's dirty work to shade technologists' interactions with patients. Barium enemas were most frequently performed on elderly patients. The distribution's skew was particularly great at Urban where approximately two-thirds (13 of the 20 examinations for which age data was recorded) of the barium enemas were performed on patient's over fifty-five. The extremely elderly (70's and beyond) posed significant problems for technologists. Not only were these patients likely to be senile, but they were more likely to expel the enema tip and to resist the technologist.

Technologists had paradoxical attitudes towards elderly barium enema patients. On the one hand, techs held that most enemas were useless for the elderly and that they therefore constituted a form of cruel and unusual punishment:

I don't know why they want to give her a BE. She's just too old. They get these old patients in here and they give them the works. If I were her, I'd refuse. Sometimes they do refuse when we bring them down. But, they go back upstairs and they talk to their doctor, who's God or something, and he talks them back into it. Anything for an extra buck.
T1: They shouldn't be doing this to this patient. What good is the exam going to do her? Why'd they send her anyway? (Looks at requisition.) Distention.
SB: What's that?
T1: That means her bowels are stretched out of shape. So they're going to put some barium in and stretch them some more.
T2: If I get like that when I'm old, I hope they take me out back and shoot me.

The patient was not well prepared, and had just evacuated on the table. He was staring blankly at the ceiling. Louise turned to me and said, "This is pathetic. What are they going to do if they find a cancer in the colon of a 83 year old man? Operate?" Louise asked me if I knew why they were doing the exam. I said no. She walked over to the table and picked up the requisition. "This doctor is why."

As these excerpts from fieldnotes suggest, technologists empathized with the plight of the elderly patient and laid blame for the situation on the referring physician. Yet, their sympathy and anger did not negate the practical exigencies that elderly patients brought to enema work. At times, the combination of the techs' pity for the patient, their anger at the physician, and their distaste for the procedure's unpleasantries surfaced as hostility. In private, troublesome, senile patients were called "dooseys," "goobers" and other unflattering names. More often, techs directed their hostility towards the radiologist whom they faulted for not refusing to accept such patients. However, in extremely rare instances, some technologists allowed hostility to color their treatment of the patient.

In one examination I observed, the 82 year old patient was almost incognizant and screeched sounds comparable only to the noise made by a wounded animal. The patient alternately screeched and then moaned "Ohhh dear" in a pitched whine. These verbal behaviors were constant and repetitive even when the patient was lying on her stretcher in the
hallway. When the technologists attempted to move her or put her into position she intensified her cries and actively fought their manipulations by attempting to scratch the techs' arms. The patient was unable or unwilling to follow instructions. In addition, she defecated before the enema tip was inserted so that the techs had to clean both the table and the patient before they could begin the procedure.

Over the course of the exam all decorum broke down as the experience became increasingly onerous and difficult to manage. One of the technologists began to mimic the patient's screams and cries. Both ceased to employ euphemisms. "She's already shit", said one tech upon discovering that the patient had defecated herself. The technologists threatened the patient with falling off the table if she didn't lay still. By the end of the exam, the technologists had ceased telling the patient how they wanted her to move. They simply picked her up (she was a living skeleton) as if she were a doll and put her into the position they wanted her to be in. In effect then, the technologists ceased to treat the patient as human. However useful the attitude was at the time, when the procedure was finished the technologists reverted to righteous indignation and proclaimed loudly that no one should be positioned to treat another person in such a way. Lest the reader feel inclined to blame the situation on the technologist's personalities, one should know that on all other occasions both techs were models of professionalism. Their behavior can only be explained in the context of the situation, in this case, a situation that stretched to the limit the strains that seethed beneath the interactional order of a barium enema, strains that did not attend other procedures.
Relations with Patients In Special Procedures

To have a special procedure automatically meant that one suffered from maladies more severe than kidney stones or diverticulitis. Many specials patients had suffered strokes or were victims of advancing heart disease. Others had complete kidney shutdowns or tumors that constricted hepatic ducts causing intense jaundice. Even digital subtractions performed on outpatients implied, at minimum, cardio-vascular disease. Although patients may not know exactly why they were having the procedure or what precisely would be done, they knew its implications were serious and that risk was involved. Consequently, specials patients were always nervously apprehensive if not visibly terrified.

The cues surrounding a special procedure symbolized and amplified the perception of seriousness. Patients scheduled for any special procedure, other than a digital subtraction, were hospitalized. A radiologist came to the patient's room prior to the procedure to explain the exam's risks and to ask the patient to sign a consent form. By signing, the patient absolved the radiologist and the department of liability should complications arise. When wheeled into the angio room, the patient was enveloped in an environment that resembled an operating room. A tray of surgical instruments stood beside the table. The patient was strapped to the table, attached to a heart monitor and washed as if for surgery. Finally, the radiologist and technologists wore surgical gloves and gowns. The seriousness of the cues, the severity of the patient's problem, the intensity of the patient's apprehension, and the possibility of dangerous complications combined to shape interactions between patients and specials technologists.
Unlike other radiographic studies, the interactional context of a special procedure progressed through three distinct stages: the period of preparation, the procedure itself which included the insertion of the catheter and the execution of runs, and the post-procedure wrap-up during which the catheter was removed and the patient was readied to return to the floor. Each particular phase was characterized by a specific type of interaction. When phases and their corresponding interactional contexts were strung in sequence, the special procedure became a miniature drama whose intensity built to a plateau of suspense that was maintained until the exam was deemed over.  

During the preparation stage, technologists not only completed actual physical arrangements for the procedure, they also readied the patient psychologically. A well set social-psychological stage involved creating a personal atmosphere to reduce the patient's anxiety. In contrast to other radiological contexts, specials patients were always addressed by their first names. Moreover, special techs rarely used terms of endearment unless the patient entered a period of crisis. To further enhance the personal atmosphere, technologists not only introduced themselves by name, but sought openings to make slightly revealing remarks about each other's personalities. For example, female techs at Suburban took advantage of opportune moments to rib the male tech about his chauvinism.

As the preparations proceeded, the technologists ferreted out information about the patient's life and family: whether he had children, where he worked, where he lived, and so forth. Such information provided the techs with conversational ammunition unrelated to the procedure. When aspects of the patient's life paralleled their
own, techs made the links explicit and capitalized upon the similarities to create an atmosphere of familiarity. Links as tenuous as the patient's having a daughter who went by the same name as a technologist became interactional resources: "Well, you know you're in safe with anyone named Debbie."

During the preparation phase patients were also to be convinced that they were in good hands and that the procedure was less threatening than might first be presumed. Accordingly, specials techs created opportunities to downplay the seriousness of the exam and to amplify the patient's confidence in the specials team's competence. Like techs in other areas, specials techs always asked patients if they understood the exam and rarely reviewed the procedure when patients claimed to know what was going on. Also like x-ray techs, if an explanation was necessary specials techs provided a gloss. However, when curious patients asked directly about specific aspects of the exam, specials techs responded with very precise information often using medical jargon to connote knowledge and medical experience. Techs also dropped cues about the extensiveness of their experience. After several months of performing digital subtractions, Suburban's techs began to tell patient's that they had "done over 500 of these and we haven't lost anybody yet." The claim was usually offered whenever patients mentioned that their doctor told them that digitals were a "new" or "experimental" technology. Of course, the tech's assertion was only true if one counted regular angiograms as well as digitals, but if patients suspected the white lie they never let on. Similarly techs at both sites took opportunities to point out that they did "three or four of these a day" whenever patients asked about a procedure's frequency.
Finally, even if they questioned a radiologist's competence or style in private, techs often informed worried patients that they were "in luck" because the radiologist was "the best in the department".

Humor was the specials techs' special tool. Whereas x-ray techs joked with receptive patients, specials techs joked with all patients. Whenever possible techs and nurses treated events lightly. For example, if a female patient's johnny slipped over her shoulder, Urban's nurse might ask, "What you tying to do, get sexy with all these men? Let me tell you, they're all mine". Suburban's techs even went so far as to create and employ routine jokes and witty euphemisms. Thus, when about to bind the patient to the table, the techs usually said, "we're going to mummify you" or "now, we'll turn you into a mummy," rather than "now we'll strap you to the table". Similarly when checking a patient's arm for an injection site prior to a digital, techs would take the patient's arm in hand, momentarily glance downward, and say while looking the patient in the eay, "I hope you remembered to bring your veins with you", perhaps adding, "can't send you back for them you know." As the last examples suggests, with humor techs could supply patients with ongoing information about next acts without sounding threatening. In fact, the line about veins was designed to begin "cooling the patient out" in case it became necessary to enter the vascular system through the groin rather than the arm.

But perhaps more important than any other aspect of the preparatory phase was the opportunity to bring the patient backstage, to allow the patient to observe the informal workings of medicine in which technologists, doctors, and nurses were individuals doing routine jobs. While arranging the instruments, itself a backstage act, techs often
spoke of events that had occurred in the department and discussed their perceptions of those events and the people involved. So long as gripes did not directly pertain to the conduct of special procedures, preparations were times when it was acceptable for technologists to complain about their lots, for example, to lament working overtime or a new hospital policy. Moreover, techs treated preparatory tasks humorously, openly joking with each other and the patient about the work that was going on. In contrast to the more staid atmosphere of an IVP or a barium enema, during preparations specials techs often appeared to be acting for the patient's benefit:

T1: I'm waiting for you to uncover this, Ted. (Referring to the drape covering the surgical table and said with mock irritation signalling a jibe)
T2: (Calling from the control room) Wait a minute! (Several second's pass and the technologist enters the examination room.) You're just like my mother.
T1: Now I'm you're mother. (Winks at patient.) While ago I was your wife.
T2: You're my mother, my sister and my wife. When you nag, you're my wife. When you whine, you're my sister. And when you give me orders, you're my mother.

In point of fact however, such interactions were typical of how techs behaved in private. Thus techs invited patients to join them, however momentarily, in their work world, to assume the status of a visiting insider. By modeling the nonchalance of an insider, techs implicitly signaled, "no big deal".

The transition between preparation and procedure was demarked by the radiologist's entrance at Suburban and the end of prepping at Urban.
On both occasions, the radiologist usually asked the nurse to administer an injection of valium, "to take the edge off." From this point forward interactions became directive, clinical and routinely scripted. The radiologist preceded every act with a standard line of warning which the technologist might or might not repeat. Except for words of comfort and periodic questions about how the patient was feeling, little communication passed between patient and technologist unless an emergency developed. Because the situation was clearly defined as risky, when patients behaved in ways deemed unacceptable, unlike other technologists, specials techs would become quite authoritative and directive:

(The patient suddenly grabs the catheter with her right hand)

T1: (to patient) Don't! Don't!
RN: (to patient) Don't move your hands P____! Stop!
T1: (to patient) P____, put you hands down now! You're going to hurt yourself. What'sa matter?
RN: (to patient) What'sa matter?
T1: (to patient) What'sa matter?
RN: (to patient) Feel sick? Stop! You feel sick? Want to vomit?... Turn you head to the side.
T1: P____!! Let go of that thing right now!

(Tech reaches out and begins to pry patient's hand off the catheter)

On the other hand, when patients became ill or exceptionally frightened but did not act dangerously, the techs comforted the patient and provided regular assurances that the procedure was progressing smoothly. Specials techs and nurses might also hold the patient's hand or stroke her face. In no other radiological setting was comfort by touch as frequent or as important to technologist's interactions with patients.
Once the procedure was deemed complete, the austerity of interactions collapsed as rapidly as it began. Techs and nurses resumed their former joviality, as if to celebrate the successful end of the procedure. Patients were told that they did well, that the procedure was a success, and that they no longer had anything to worry about. The celebration of danger past was even symbolically instituted when Suburban began to perform digitals. At the end of each digital, the patient was brought into the control room and offered a muffin and orange juice. While patients ate, they and the nurse often reviewed the patient's experience on the table, providing a verbal outlet for release of tension. Apparently, techs at both hospitals were rather successful at creating a personalized interactional context of concern: as a rule, only specials patients expressed appreciation at the end of a procedure. No one thanked an x-ray tech for seeing them through an IVP or a barium enema.

Relations with Patients in Ultrasound

The interactional context of an ultrasound examination was on several counts antithetical to that found in special procedures. Whereas specials brought the technologist and the patient together for a relatively extended period of time, only routine x-rays and the occasional upper GI were likely to take less time than an ultrasound. If the shadow of danger and fear cast relations between specials techs and patients into their characteristic form, it was the absense of risk that marked corresponding interactions among sonographers and patients. In fact, no other procedure in the radiology department caused the
patient less physical discomfort or potential harm. Even routines x-rays exposed patients to radiation and necessitated that they contort themselves into position. But, ultrasound posed no known health hazards and the greatest physical inconvenience that sonographers ever asked of patients was that they roll from their back to their side.

The brevity of the exam and the benign nature of the technology eliminated the need for sonographers to employ interactional tactics typical of most other radiological encounters. As in routines, which were also short and comparatively painless, sonographers were rarely moved to ask patients if they understood the exam or if anyone had explained the procedure to them. From the sonographer's point of view, the minute the transducer touched the skin, the logic of the ultrasound exam became obvious. In fact, the only explanatory warning that sonographers regularly issued pertained to the gel, which even when warm, felt wet. On only one occasion during my observations did a sonographer provide any description of an ultrasound's course. In that instance the patient asked the sonographer if the exam would hurt. At the time of the inquiry, the exam had already begun and the sonographer was holding the transducer to the patient's side. In a reassuring voice the sonographer questioned, "Does it hurt now?" To which, the patient readily replied, "No". "That's all there is to it," said the sonographer laconically.

Since ultrasounds brought no discomfort or humiliation, sonographers called objects and events by their everyday names rather than by euphemisms. Similarly, because they experienced no pain and anticipated no risk, patients rarely complained during an ultrasound. Therefore, sonographers had little need for the patient management
strategies that x-ray techs used to control patients' behavior. Negation, prior countering, normalization, diminishing and even repetitive encouragements -- the primary interactional building blocks of all other radiological encounters -- simply served little purpose in ultrasound. Finally, sonographers rarely called patients "Hon," "Dear" or "Sweetheart". Instead, sonographers followed norms of address common in most other social contexts. If the patient was approximately the same age as the sonographer, then the patient's first name was used. Elderly patients, however, were almost always addressed as "Mr. Smith" or "Mrs. Jones".¹⁰

The critical distinction between encounters in ultrasound and encounters elsewhere in the department was perhaps most succinctly and poignantly captured by the different meanings that x-ray techs and sonographers attached to the word "difficult". X-ray techs and CT techs occasionally told me that particular exams would be or had been "difficult." In every case, the "difficulty" arose from the patient's behavior which, for one reason or another, had made the procedure troublesome to manage. I was therefore somewhat taken aback to first discover that a patient could be mild mannered and exceptionally pleasant even when a sonographer had cautioned me that the patient would be "difficult". At the end of the exam, I asked the sonographer where the difficulty lay. In response, the sonographer began to describe how a combination of extensive bowel gas and a recent surgical procedure had decreased the visibilty of the structures that needed to be observed. Where the x-ray techs' primary concern had been managing the patient's behavior, the sonographer's concern was managing information. This critical difference shaded all aspects of the ultrasound encounter and
led to a interaction context whose parameters were unlike any other in the department.

Once patients were on the table and ready for the exam, sonographers always interrogated them about their problem. While x-ray techs and specials techs frequently posed similar questions, their intentions and the sonographer's intentions were quite different. Whereas x-ray techs and even specials techs usually wanted to know why the patient was having the exam so that they could fill out a form, prepare the correct barium bag, or simply store the knowledge for their own reference, sonographers needed the information to conduct the exam. Consequently, whereas other techs accepted what the patient said without further question, sonographers explored. The sonographer probed symptoms, questioned circumstances of onset, inquired about scars and the nature of the prior surgery, and even on occasion, felt areas of the patient's body with their finger tips. Moreover, sonographers asked what the doctor said to the patient when requisitioning the exam and what any previous tests had shown. If available, sonographers sometimes consulted the patient's chart before beginning the study. The upshot of the interaction was that from the very start, sonographers gave the impression of being knowledgable about the process of medical diagnosis.

The ecology of the ultrasound procedure posed its own specific problems that also revolved around the management of diagnostic data. During an ultrasound, the patient lay on a table no more than arm's length from the sonographer. Unlike the hurrying to and fro of technologists performing other exams, the sonographer stood by the patient's side until the exam was over. As the exam progressed the sonographer constantly monitored the images on the screen, pausing only
to take films. However, the critical aspect of the encounter was that patients could not only see the sonographer watching the images, but they could usually see the monitor themselves. Under the circumstances, it became very difficult for sonographers to deny that they didn't understand what they were looking at for it was obvious from the context that sonographers "looked for" things. As one sonographer put it, "you can't hide behind the excuse that you haven't seen the films yet". The dilemma then, was how to manage an interactional context in which it is apparent one has information that another person wants when the rules are such that one needs to remain mute. In short, without the excuses and props that supported other technologist's denials, sonographers had to manage what E. C. Hughes (1958) called "guilty knowledge".

When patients became inquisitive about the images on the monitor, the sonographers' most frequent tactic for satisfying a person's curiosity without transgressing occupational role boundaries was to talk anatomy. The sonographer pointed to anatomical structures and engaged the patient in a conversation about the images without revealing information concerning pathology. On such occasions, the relationship between sonographer and patient resembled a off-hand teaching encounter:

P: (Looking at the screen) Where is my left ovary?
S1: (to patient) I'll show it to you when we get there. I'm on your right now. See, here's your uterus and here's your right ovary (pointing to screen). Really I haven't seen your left, so I can't tell you anything about it.

(Second sonographer pages radiologist)

P: Who did he call? The gynecologist?
S1: The radiologist, he's the one who reads the films. So you can ask him any question you might want to.
(Second sonographer approaches the first. Moments later.)

S1: (to S2) Want me to measure the uterus?
S2: Yes.
P: What's that dark thing?
S1: That's your uterus.
P: That's what it looks like?
S1: Yes, that's what it looks like.

Anatomical terms were also useful when sonographers wished to tell each other or a radiologist the nature and location of signs of disease without revealing information to the patient. When another person could be presumed to understand ultrasound images, it was often sufficient to simply call the second person's attention to a particular sector of the image where the sign in question resided. For example the sonographer might say, "left kidney, upper pole, right quadrant", to direct an insider towards a cystic structure in the kidney. During the radiologist's review of real time images at Suburban, conversations between sonographer and radiologist often consisted entirely of noun phrases referencing anatomical structures and locations.

Regardless of attempts to obscure information, patients sometimes followed the flow of the procedure and deciphered conversations between sonographers. On such occasions, patients could become involved in the procedure other than by simply asking for information and receiving an anatomy lesson. In the following excerpt from a transcript of a gynecological examination, the patient resolves the sonographers' problem of not being able to find the patient's left ovary:

(Finishing up the realtime)

S1: (to second sonographer) You can call for someone (eg. a radiologist).
S2: I have.
S1: On the right, alright?
S2: (of patient) This is J's sister-in-law. In the emergency room. When you get the chance, just push real hard on the bladder.
P: (Laughs. Prior to GYN's, patients force liquids.)
S1: (to patient) Could you move a bit towards the left?

(patient slides to her left)

S1: (to S2) There's the right ovary.
S2: Did you get the other one?
S1: Not yet. Wasn't sure.
S2: Left side.
P: I'm missing the stuff on the left side.
S1: Oh! You don't have an ovary on your left?
P: I don't know what, I had a tube taken out. I don't know what else.
S2: How come you had that done?
P: I had a tubular pregnancy and I lost it.
S2: OK.
S1: I haven't seen it. I haven't see the left ovary. So.
S2: Alright.

In no other radiological context would the patient be positioned to take such a spontaneous role in the procedure itself. From the patient's point of view, ultrasound provided the luxury of being a participant in and simultaneously an observer of one's own exam.

Finally, the close, interactional context of the ultrasound examination and the sonographers' difficulty in denying their knowledge at times created extremely sensitive interpersonal situations. On some occasions withholding or revealing information surpassed an occupational issue to take on broader moral overtones. Moral dilemmas were particularly likely during obstetrical exams on patients who, for one reason or another, feared for the life of their unborn child. Without doubt, such patients were more emotionally distressed than most other patients who visited ultrasound. While it may have been relatively easy to tell a cardiac patient with mitral stenosis that she would have to
talk to her doctor to learn the results of the study, sonographers found it more difficult to be detached from the expectant mother. In the sonographer's mind, to withhold positive information in such a case was cruel, to provide negative information was a necessary burden better left to the radiologist.

To resolve the dilemma, sonographers devised methods to communicate good news and to suppress bad. When sonographers discovered that a fetus was alive and well, they might enlarge the image to maximum magnification so that the patient could see the fetal heart beat and then call the patient's attention to the screen by smiling broadly. Alternately, the sonographer might comment in an off-hand, but obvious, manner about the image so as to leave little room for doubt: "That good ole baby's lying flat on his back. Sometimes, I think they do that on purpose. Say's, "Oh boy, am I gonna get that guy". If, however, the sonographer were to discover a dead fetus, he or she became extremely serious and professional in orientation. The sonographer engaged the patient in unrelated topics of conversation to distract her attention until the radiologist could be consulted on how he wanted to handle the situation. In short, unlike other techs, even when sonographers' needed to manage a patient's fear and anxiety, the root of their problem lay in the bearing of bad news, inflicting of emotional, rather than physical pain.

Relations with Patients in CT

For different reasons then, both ultrasound and specials technology enhanced or personalized relations between technolgists and patients.
In direct contrast, the CT scanners appeared to distance technologists from patients. The distinction was not obvious at the outset of a scan when interactions between patients and CT techs were no more distant than those found in the main department. In fact, CT techs managed an enhanced study using much the same tactics that x-ray techs used to control injections during an IVP. But where x-ray techs began immediately to take films after an IVP's injection, unless the scan involved a "rapid bolus", CT techs waited until the sensations of the dye's side effects began to wear off before beginning the scan. As the side effects abated, the techs moved the patient into the gantry and programmed the computer for the study. Thus by the time the study was actually ready to begin, the "worst part" of the procedure was often over, at least from the technologists' point of view.

Most CT techs held that aside from enhanced studies which required injections, CT scans were among the "easiest" radiological studies to endure. Unenhanced CT scans subjected patients to none of the obvious physical discomforts, risk, or humiliation that characterized other radiographic procedures. In fact, once the scan began, patients merely needed to lie still on a padded table, hold their breath occasionally, and allow the scanner to move them out of the gantry. The CT techs' conception of the scanner as a benign technology was revealed by the way they explained the course of a scan. Of all the technologists in the radiology department, CT techs were most likely to estimate the timing of an examination accurately. The technologists sensed that if patients were to lie still, they needed to be able to estimate the scan's actual duration so that they would not become prematurely restless. Technologists also often told patients that nothing would touch them
during the scan, that the scan was painless, and that all they would be aware of was the noise the scanner made when it went into operation. Most importantly, the technologists impressed upon the patients how critical it was for them to "just relax" and "lay still" during the scan.

Up until the technologist left the gantry room for the control room, the task of managing the encounter with the patient was intimately entwined with the performance of technical duties: an interaction context common to all other radiological technologies. However, once the techs retired to the control room and the scan began, the technology split the two elements of technologist's work into separate and more or less mutually exclusive realms of work. One could not simultaneously manage the patient and conduct the scan. To attend to either task one had, in effect, to cease doing the other.

The separation of the interactional and technical duties was predicated on physical separation: during the scan the patient remained in the gantry room while the technologist sat at a console in the control room. Unlike control booths in remote fluoroscopy which were closer to the patient and not completely enclosed, a scanner's control room was sufficiently isolated so that patients would not hear what a tech said even if the tech were to shout. The scanners' designers had realized that communication between patient and technologist could be a critical problem during a scan. Consequently the control rooms were equipped with a large, leaded, plate-glass window through which techs could observe patients. Moreover, an intercom system was built into the gantry itself so that techs and patients could speak to each other.
However adequate the intercom system may have appeared in theory, in practice it was at best the window's aural analogue. Both devices helped techs detect when patients were in distress, when they wished assistance, and when they had merely become restless, but neither provided the technologist an effective medium of control. Early in each scanner's history, technologists at both sites attempted to use the intercom to query patients and caution them against moving. In all cases, the intercom proved to be ineffective for obtaining compliance, and in some instances, the disembodied voice appeared to excite further an already restless patient. Consequently, within the first two weeks all CT techs had discovered that when a patient appeared to need assistance or when it became necessary to chastize a patient about moving, the only option was to cease scanning and enter the gantry room to talk with the patient face to face. Given that the window proved an equally reliable signalling medium, most techs turned the intercom off so that the scanner's mechanical sounds would not be annoyingly broadcast into the control room.

The actual physical distance between the patient and the technologist was translated into social distance, and perhaps even psychological distance, by two additional attributes of the technology. When running a CT scanner, technologists needed to monitor simultaneously a number of streams of information. For example, techs could scan one patient, photograph the films of a second, and store the images of a third on magnetic tape during the same segment of time. No other radiological technology had the capacity to generate a multichanneled work environment. Since all other technologies, including the computer based ultrasound, fostered a linear flow of work
the problems of simultaneously monitoring multiple tasks never arose. Most of the time, multiple channels of information were not a problem in CT either. However, on occasion CT techs became so absorbed in what was going on in the control room that they did not immediately notice when a patient appeared to need help.

The tendency to lose touch with the patient became more of a problem when technical difficulties arose. Particularly in the early months, both scanners were prone to mechanical and electronic breakdowns. In most cases, technical problems disrupted scanning completely. Thus when technical problems occurred, the first matter of concern was to bring the scanner back on-line or, at least, to discover that immediate repairs were impossible. While attending to technical breakdowns it was common for techs to work for fifteen or twenty minutes on the problem before someone remembered to check on the patient or inform him about the situation.

Motion was inimical to the scanner's ability to create diagnostically useful scans. If a patient moved or breathed during a scan, streaks or "artifacts" appeared to obscure anatomical structures in the images. It was therefore ironical that patients referred for CT scans were likely to suffer from problems that made them less capable of lying quietly during the scan. Abdominal scans were often conducted on patients who had or who were suspected of having cancer. Since cancer's association with the body scanner was well known, many patients were extremely anxious about their scans and some actually bordered on hysteria. Given the situation, patients often found lying still difficult. The population of patients having head scans was even more prone to movement. To rule out structural etiologies, head scans were
often performed on patients who exhibited abnormal behavior patterns. These individuals frequently had difficulty controlling themselves in familiar environments; the task became even more difficult when their head was submerged inside the gantry. Consequently the greater the number of head scans performed the more chronic a problem motion artifacts became.¹¹

Given that motion was a problem, whenever patients began to move repeatedly CT techs had to stop the scanner, enter the gantry room, and attempt to convince the patient that it was important that they remain still. In many cases, one visit to the patient resolved the problem for the remainder of the scan. However, other patients continued to move despite the tech's intervention thereby necessitating a second and perhaps a third or forth trip to the gantry. From the CT tech's point of view, having to repeatedly caution a patient against moving meant delaying the scan and ultimately creating a backlog. Although techs did not mind attending to patients obviously in distress (eg. people who were nauseous, nervous but apologetic, etc), they came to resent patients who moved ceaselessly without an obvious motive and over whom they had no control.

Under most circumstances, even chronic "movers" were handled sympathetically to their face, regardless of the tech's actual feelings which were usually reserved for the privacy of the control room. However, under the correct set of circumstances the distance between the patient and the CT tech took its toll. If technical problems repeatedly developed at the same time an "uncooperative" patient was being scanned, a self-amplifying spiral could develop to crush the pretense of concern. The spiral might develop in the following way. Initially the scanner
would appear to be working, but the patient would move, so the tech would have to stop the scanner to speak with the patient. When scanning resumed, the computer would crash. Since the techs could not scan while the machine was down, the scanner drew the tech's attention while the patient lay on the table becoming even more restless. By the time the scanner was on-line, the patient was now more prone to move, necessitating another trip to the gantry. If the scanner failed a second time, the loop would repeat itself.

The longer the scanner remained inoperable the more likely the patient was to complain as well as simply move. In such cases, it might eventually become necessary for the techs to cease working with the machine to cool the patient out. If the situation continued, the technologists might become so stressed by the dual demands that they would act impatiently with the patient. No other technology created the possibility of such an interaction between patient and technologist, because no other technology created an environment that separated patient work from technical work.

Radiologists' Relations with Patients

Like most social worlds, the medical world contains its stereotypes. For example, in their more caustic moments, physicians may claim that radiologists are doctors who discovered in medical school that they didn't like working with people and therefore sought a speciality that involved no patient contact. Although I eye skeptically the aspersion thereby cast upon the personal traits of radiologists, in both hospitals the organization of radiologist's work was such that the
stereotype could be readily maintained. If the technologist's opportunity to interact with a patient was brief, the radiologist's contact was even briefer.

Compare the average percentage of an examination's duration that radiologists were with patients (Table 7A) to the corresponding percentage for technologists (Table 6A). In every case, at both hospitals, radiologists spent far less of each procedure with the patient than did the techs. The minimum difference occurred in Suburban's CT scanner where technologists spent twenty-two percent more of a scan in the patient's company than did the radiologists (26% from Table 6 less 4% from Table 7). Routine x-rays spawned the greatest discrepancy: at both sites the technologist was constantly with the patient who was never seen by a radiologist. But, the actual constraints on interaction between radiologists and patients become even clearer when one considers the mean number of minutes that radiologists and patients were together over each type of procedure (Table 8). With the important exception of special procedures, on average, contact between patients and radiologists lasted less than six minutes.\textsuperscript{12}

As the data on both average time and average percentage of duration suggest, if one ignores special procedures, the radiologist's contact with patients was unaffected by whether or not the patient's study was performed by a new or traditional technology. The conclusion is born out by the analyses of variance in Table 7B. When one considers data from all six procedures listed in Table 7A, both the department ($F=16.5$, $p<.01$) and whether a new technology was used ($F=24.96$, $p<.01$) account for differences in the radiologists' contact with patients. However, when one deletes the data on special procedures and repeats the
Table 7
A: Average Percentage of Various Procedures’ Duration that Radiologists Were with Patients

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Suburban</th>
<th>Urban</th>
<th>Total</th>
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<tr>
<td></td>
<td>N</td>
<td>Mean %</td>
<td>N</td>
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<tr>
<td>Routines</td>
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<td>0%</td>
<td>6</td>
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<td>I.V.P.'s</td>
<td>22</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Barium Enemas</td>
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<td>15</td>
<td>24</td>
</tr>
<tr>
<td>Specials</td>
<td>44</td>
<td>64</td>
<td>8</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>27</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td>CT Scans</td>
<td>42</td>
<td>4</td>
<td>45</td>
</tr>
</tbody>
</table>

B: Analyses of Variance

I. Special Procedures Included:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>1</td>
<td>1.03</td>
<td>1.03</td>
<td>16.5**</td>
</tr>
<tr>
<td>New vs. Traditional</td>
<td>1</td>
<td>1.56</td>
<td>1.56</td>
<td>24.96**</td>
</tr>
<tr>
<td>Residual</td>
<td>266</td>
<td>19.25</td>
<td>.06</td>
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II. Special Procedures Excluded:

<table>
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<tr>
<th>Source</th>
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<th>Sums of Squares</th>
<th>Mean Square</th>
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<td>Department</td>
<td>1</td>
<td>.067</td>
<td>.067</td>
<td>2.55</td>
</tr>
<tr>
<td>New vs. Traditional</td>
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<td>.019</td>
<td>.019</td>
<td>.73</td>
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<td>Residual</td>
<td>214</td>
<td>5.56</td>
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** ≤ .01
Table 8

Mean Minutes of Contact Between Patients and Radiologists +

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Suburban</th>
<th>Urban</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
<td>N  Mean</td>
<td>N  Mean</td>
<td>N  Mean</td>
</tr>
<tr>
<td>Routines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5   0 (0.0)</td>
<td>6   0 (0.0)</td>
<td>11   0 (0.0)</td>
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<tr>
<td>I.V.P.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22  4 (3.4)</td>
<td>6   3 (2.0)</td>
<td>28   4 (3.1)</td>
</tr>
<tr>
<td>Barium Enema</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22  6 (5.7)</td>
<td>24  6 (5.6)</td>
<td>26   6 (4.9)</td>
</tr>
<tr>
<td>Specials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>45  54 (27.5)</td>
<td>8  100 (48.1)</td>
<td>53  61 (35.0)</td>
</tr>
<tr>
<td>Ultrasound</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27  4 (2.9)</td>
<td>18  1 (3.3)</td>
<td>45   3 (3.4)</td>
</tr>
<tr>
<td>CT Scans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>42  2 (4.5)</td>
<td>45  8 (8.2)</td>
<td>87   4 (6.8)</td>
</tr>
</tbody>
</table>

+ numbers in parentheses are standard deviations of the mean
analysis, neither distinction carries any explanatory power. Consequently, it would appear that as a group the new technologies did little to enhance the radiologists' opportunities to interact with patients. The only technology to significantly alter the pattern of minimal interaction between radiologist and patient was the special procedure.

As in the case of the technologists, average time and average percentage of an exam's duration, are only parameters, constraints that condition interaction between radiologists and patients. They tell nothing about the nature of the interaction. Conceivably equally brief relationships could be dramatically different. On the other hand, with the exception of ultrasound, radiologists and patients were brought together only for the duration of an injection, ingestion, or infusion. From this perspective, regardless of time spent together, relationships in special procedures and IVP's could be quite similar. To settle the issue, let us consider briefly interactions between patients and radiologists across types of procedures and technologies.

**IVP's:** For radiologists, IVP's were "in and out" encounters. The radiologist was with the patient only long enough to administer an injection of iodine dye. Since the syringes were already filled by the technologist, the radiologist merely needed to "make the stick" and inject two or three syringes of contrast as rapidly as possible. Upon entering the examination room radiologists introduced themselves and immediately began to locate a vein in the patient's arm. If the radiologist forgot to tell the patient his name, the technologist rectified the oversight immediately by making the introduction herself. Invariably, while injecting an IVP the radiologist would first ask the
patient about the symptoms that he or she was experiencing, explain the possible side effects of the dye, and follow the explanation by a statement designed to "normalize" the patient's perception of the sensations. Note that in most cases the technologist had already broached both topics with the patient, and in fact, had relayed information on symptoms to the radiologist when she brought him the scouts. Radiologists rarely learned anything new from repeating the question. Rather the question allowed the radiologist to preoccupy the patient in a doctorly fashion. By the time the radiologist had covered symptoms and side effects, the injection was complete and the radiologist left the room. Only if the patient was verbose would interactions cover more topics than these two.

A sense for the quality of interaction between radiologists and patients during an IVP can be gleaned from the following two transcripts that record IVP injections. Both transcripts are complete. The first is selected because it is typical in its length. The second represents an abnormally lengthy dialog between patient and radiologist. The first injection lasted 2 minutes, the second 6 minutes:

T: (to patient) Mrs. Y____, this is Dr. X____.
R: (Taking patient's arm in hand) We're gonna find a vein here and inject some fluid. Gettin' ready to do an x-ray test on your kidneys. Will you tell me who your doctor is and what complaint....
P: Dr. G____. Well, I pulled a muscle. I got this very sharp pain in my chest and a pain in my, in my back.
R: Umhum....
P: The pain was pretty intense.
R: Did he do a urinalysis on you?
P: No.
R: Make a fist..........(inserts needle)........Now release it will you dear..........(attaches syringe and begins to inject).................You'll get a sensation
of warmth..........(attaches and injects second syringe).......... Feel warmth?
P: Yeah
R: (detaching syringe from needle) I'm going to leave the needle in for a few minutes. So don't touch your elbow.

T: (to patient) Mr. Z_____, this is doctor Q_____.
R: (to patient) Good morning. How you doing?
P: (to Rad.) As long as you don't stab me too hard, you're fine.
R: (to patient) Oh,..Ha,ha. (Ttaking patient's arm in hand) Have you had a....Have you had a IVP? Before?...(patient shakes head no)...OK. Never. Do you have any allergies to any medicine?
P: (to Rad) No.
R: (to patient) Make a fist and squeeze tight. You have a choice. (Referring to which arm to inject into.)
P: (To Rad) Huh?
R: (to Patient) We have a choice.
P: (to Rad) We have a choice. Ha! You don't have any choice in that arm. They didn't make any veins.
T: (to Patient) What does the blood pass through in? Rubber hoses?
R: (to patient) Ok, you're gonna feel a pinch. I'll tell you when. Right now. (makes the stick).
T: (to patient) Try to relax.
R: (to patient) Now keep your...you can relax your fist and keep your arm still.
P: (To Rad as he detaches first syringe) That's all I'm gonna get?
R: (to patient) Wait a minute, we're not through yet.
P: (to Rad) Alright. Gonna get another one, huh?
R: (to patient) Alright, Now, you might feel this going in. Sometimes it feels cold. Alright?
P: (to Rad) Yeah.
R: (to patient) It should not sting or burn. OK?
P: (to rad) Sometimes it feels hot.
R: (to patient) Well once it gets in and starts circulating through your body its gonna make your body feel hot. OK? That hot feeling will last about three or four minutes. You may also taste a fishy or metallic taste in your mouth. And you may feel slightly nauseous. These are all side effects of the medication. They are quite normal. It is not a reaction. They're are temporary. I don't want you to get scared. Take some slow deep breaths. How you doin?
P: (to Rad) Alright.
R: (to tech) What centimeters did I say?
T: (to Rad) Eight and ten.
(to patient) How you feelin'?

P: (to tech) Alright.

T: (to pat) Cold? OK, that's gonna pass in a few minutes....You want a towel for your head? Or, are you ok?

R: (to patient) Slow deep breaths. It'll go away in about another half a minute. OK. Slow deep breaths. (Radiologist now leaves the room).

As radiologists administered the injections, they employed many of the same strategies that technologists used to manage encounters with patients. For example, in the two passages above both radiologists spoke euphemistically: the first called the iodine dye, "fluid," while the second referred to the needle's stick as a "pinch". In both cases the terminology was chosen to mollify the patient's perception of events. The first radiologist addressed the patient using a term of endearment, "dear," while the second goes to great lengths near the end of the encounter to diminish the severity and duration of the side effects. In fact, the second radiologist's whole speech regarding side effects may be seen as a lengthy prior counter made quite explicit, "I don't want you to get scared". Thus, aside from actually injecting the dye, the radiologist's interaction with an IVP patient was in many ways a compact version of the technologist's, albeit a review performance delivered with the professional and therefore generally more staid bearing of a physician.

**Barium Enema:** Like the technologist's, the radiologist's interaction with a patient during a barium enema was conditioned by the type of fluoroscopic equipment used. However, the radiologist's role varied with the technology in a pattern the mirror image of the technologist's. Whereas the technologist was in the background during a tables side procedure and in the foreground when a remote control booth
was used, the radiologist's relative salience to the patient was precisely the reverse. When standing beside the examination table moving an intensifier above the patient's body, the radiologist assumed primary responsibility for the managing the patient. If a radiologist intended a tablesde exam, he almost always went directly to the table on entering the room and introduced himself to the patient. Following the introduction, the radiologist generally inquired after the patient's health and ended the inquiry with a brief mention of what was to be done. Given that the radiologist was a doctor, patients were usually more willing to discuss their problem than they had been with the technologist. As the enema actually started, the the nature of the radiologist's interaction with the patient became bimodal: his communication was directed either to telling the patient how to move or to managing the patient's discomfort. The two modes of interaction were intimately interwoven as the following transcript from a tablesde barium enema makes clear:

(The tape begins after the radiologist has introduced himself and asked about the patient's problems. The patient is in the process of recounting a surgical history)

P: (to Rad) I had a gall bladder.
R: (to patient) Uhhuh.
P: And part of my liver.
R: Part of your liver?
P: Uhhuh.
R: What, what, why was that done?
P: There was cysts on my liver, I was told.
R: I see, ok. How long ago was that?
P: Nineteen Seventy-Nine. I had a breast removed in August.
R: Uhhuh. How you been since then? You been ok?
P: As far a I know.
R: Why are we doing this test now?
P: Cause I had trouble with my bowels.
R: What kind of trouble?
P: Well I'm constipated and I get a mucous....
R: Oh yeah! How long has all of that been going on?
P: Oh, I always had diverticulitis.
R: Oh, Ok. Lets have a look here. And I think you know that we're gonna give you an enema. Right?
P: Yep.
R: Now if you have any trouble holding it....
P: I hate these.
R: I know you do. Everybody loves the enema. If you have any trouble holding it you let me know. Bend this knee here up in the air a little bit please. And turn this way a little for me...A little more please.....That's fine.
(to tech) Start..............................You can stop now (takes a spot film).
(to patient)Lie on your back please.......(gives hand signal to tech to start barium)......How you doin'? Alright?
P: (to Rad) Alright.
R: (to Patient) Good. Turn towards me now....A little bit more towards me. That's a girl.
(to tech) Stop it X____.
(to patient) That ok? We're stopping here for now. Just hold your breath please. Don't breathe. (Takes a film) Now, breathe. Were almost done.
(to tech) Get the film.
P: (to rad) I'm having trouble.
R: (to patient) Are you now? Ok, we're gonna put just a little more in. Almost through.
(to tech) OK. (tech opens clamp)
(to patient) Turn a little bit. Bend a little bit. You're doing a good job.
(to tech) Off. (tech closes clamp)
(to patient) OK, hold your breath now. Don't breathe. (Takes a film.) Good. Now breathe. Lie on your back again....Slide this way. There you go, that's what I like...(gives tech hand signal to turn barium on)
P: (to rad) I think I....
R: (to Patient) You're alright. You're doin' fine.....(hand signal to tech to turn barium off)......I know it's getting a little uncomfortable.
P: Yeah, I wanted to tell you that I had two polyps removed.
R: (to patient) Oh, you did. How long ago was that?
P: (to Rad) The last one about two years ago.
R: (to patient) Just hold your breath now please. Don't breathe. (Takes film.) Now breathe. Lie flat on you back. It's all over now. We're just gonna take some pictures of you now, OK?
Over the course of the procedure, the radiologist grants the validity of the patient's complaints ("I know you do," "I know you're getting a little uncomfortable) and provided encouragement (eg. "You're doing a good job"). He also negates complaints ("You're alright) and diminishes both the exam's duration and the quantity of barium to be used, ("OK, we're gonna put just a little bit more in. Almost through"). The phrase, "That's a girl," combines a diminuitive form of address with an encouragement. Thus in the barium enema, radiologists manage patients much like a technologist would in their stead.

The interaction of the radiologist in the tableside examination can be contrasted with the behavior of the radiologist conducting an examination from a remote control booth portrayed in the previous section on the technologist's interactions with patients. There we saw that the radiologist performed no patient management tasks and that on only one occasion did he speak directly to the patient. If the radiologist were to use the microphone, the interaction would have appeared as a hybrid of the two transcripts with the radiologist talking more directly to the patient but relying on the technologist whenever an actual tableside intervention was needed. With remote control booths, radiologists were less likely to introduce themselves and less likely to inquire about the patient's symptoms. It would seem then that to inquire after a patient's health served two purposes: aside from the obvious information that might be gleaned, the inquiry was also useful to radiologists as a tactic for defining oneself as a doctor with a right to conduct a barium enema. That radiologists tended to omit the question when using a remote control booth suggests that the inquiry's
relevance for defining the situation as a doctor-patient encounter was primary.

**Ultrasound:** Except when they trained new sonographers or conducted a second exam in hope of clarifying ambiguous data, Urban's radiologists rarely visited the ultrasound department and therefore interacted with very few ultrasound patients. Only at Suburban did opportunities for interaction between radiologists and patients occur regularly in ultrasound. Yet, when compared to the social context of an ultrasound, relations between radiologists and patients during the IVP and barium enema appeared rich and multifaceted. Although radiologists introduced themselves to patients as they entered the room, unless they used the transducer themselves, radiologists were unlikely to talk to the patient. Instead, Suburban's radiologists usually stood in front of the monitor beside the sonographer who in turn stood beside the patient. As the real-time review progressed, the radiologist spoke mostly in whispers to the sonographer and addressed questions to the patient only when a specific piece of information seemed pertinent for understanding the images. In fact, some radiologists, on occasion, asked the sonographer to "ask the patient" or to "have the patient" rather than address the patient themselves. The following transcript represents a rather typical series of interactions during the review of real time ultrasound images. Note that the radiologist only addresses the patient twice.

R: (to patient) Hello, I'm Doctor T______. How are you?  
P: (To Rad) Fine.  
S: (To Rad) Doctor T______, this woman is suspected of having a cystic ovary.  
R: (To Sono) Yeah.
S: (To Rad) The uterus measured two and a half. This is the left ovary and this is the right over....
R: (To Sono) That's the left ovary there, or...
S: (To Rad) Yes, that the left ovary.
R: (To Sono) Ok, now let me see the uterus.
S: (To Rad) There's the uterus right there.
R: (To Sono) Ok, where's the right ovary.
S: (To Rad) Right there.
R: (to Patient) How old are you?
P: (to Rad) Thirty-five.
R: (to Sono) Very good.
S: (to Rad) Thank you very much.

The typical structure of interactions during an ultrasound underscored the fact that the richness of relations between patient and radiologist was linked directly to the latter's need to manage the patient. Since the ultrasound was a benign procedure and since the sonographer literally stood between the radiologist and the patient, the radiologist had little need to control the patient. In fact, since the sonographer had usually obtained and synthesized a relatively detailed account of the patient's trouble, the sonographer was better positioned than the patient to provide relevant medical information since the sonographer could separate the important from the unimportant. Consequently, a radiologist's interactions with an ultrasound patient only became more extensive when he himself had to manage the transducer or deliver bad news as when a miscarriage or dead fetus were discovered. The relative differences parallel the differential interaction contexts created by tabletop and remote fluoroscopy.

CT Scanning: As in the IVP, the radiologists' interaction with most CT patients occurred around the injection of iodine dye or sedatives. At both sites however, the radiologists' took steps to unburden themselves of the duty. At Suburban, technologists began to inject patients after the fourth week of the scanner's operation. The
alternative was adopted because the two experienced techs had performed all injections at their previous place of employment. They, in turn, taught the inexperienced techs to inject. After Urban hired a second nurse for the radiology department, CT injections were to become the nurse's responsibility. However, since the nurses also assisted in special procedures and began to inject IVP's, Urban's radiologists administered contrast more frequently than Suburban's radiologists because the nurses were more likely than a CT tech to be preoccupied elsewhere in the department. At both sites, radiologists usually performed "bolus injections" in later phases of a scan.

The structure of interaction between radiologist and patient surrounding an injection in CT differed very little from what took place in an IVP. The radiologist's conversations centered on the patient's health and symptoms and the side effects of the dye. During the injection the radiologist might also impress on patients how important it was that they lay still and regulate their breathing according to the lights on the inside of the gantry. As in an IVP, by the time these topics were exhausted the injection had usually ended and the patient was ready to be positioned -- a task for the technologist.

While the scanner did not create new interaction structures for patients and radiologists, the decoupling of technical and interpersonal work that characterized the CT tech's relations with patients also affected radiologists. Because managing the patient was no longer interwoven with the technical work, it became relatively easy for radiologists to become absorbed in the technical side. To the degree that this happened, the patient's behavior could be perceived by a radiologist as a nuisance and as the major obstacle to an adequate
diagnosis. The more the radiologists sought technical perfection in the images, the less they were able to empathize with the patients' experience of the exam. By breathing at the wrong moment, by moving about on the table, by developing itches or the need to go to the bathroom, or by refusing contrast injections patients could mitigate the possibility of obtaining the best possible series of images. In fact, when the scanner was working correctly and when the technologist had positioned the patient properly, only the patient's behavior could mar the quality of a scan.

This perception of a patient's behavior as a technical nuisance occasionally shaded the radiologists decisions and actions. For example, on several occasions, I observed radiologists tell technologists not to inform patients that a technical problem had occurred since "for all he knows things are going as they should". The radiologist feared that if the patient believed the scan was being prolonged, he might become restless and later disrupt the scan once the scanner was back on line. Without the distance between patient and control room, such a ploy would have been impossible. Impatience with patients also grew out of a radiologist's desire for technical perfection. Radiologists on occasion became disgruntled because a patient needed a urinal or bedpan during a scan. In the act of using either, patients were likely to reposition themselves on the table and thereby invalidate reference points that allowed the radiologist to estimate distance. Consequently, when possible, patients were kept from relieving themselves unless it appeared that they would do so regardless or that they would become so restless that they would mar the study anyway. In the latter cases, a radiologist might see the choice as one
between the lesser of two technical evils. Patients who refused contrast because of fear were perceived by some radiologists with great disdain. In refusing the patient precluded any opportunity for the radiologist to definitively distinguish between small vascular and pathological structures. From the radiologist's point of view, when patients refused contrast the scan became useless and the patient merely began to take up time and space that could more effectively be allocated to another individual. Given that technical involvement was more likely when radiologists became absorbed in the day to day aspects of scanning, these attitudes were more prevalent at Urban than at Suburban.

**Special Procedures:** Radiologists at both hospitals eagerly pointed out that special procedures had brought radiologists more patient contact, a point well documented by the data presented at the beginning of this section. However, contact does not in and of itself mean that the nature of the radiologist's relations with patients changed. More contact could mean simply longer interactions, more of the same. In fact, when one considers the actual interactions that occurred between patients and radiologists during special procedures, it would seem that specials changed the nature of radiologist-patient relationships less than radiologists believed.

If the radiologist's relationship with a specials patient was distinctive, the differences all tended to occur prior to the time the catheter was actually placed. Unlike other examinations, specials required the radiologist to explain the procedure and have the patient sign a consent form absolving him and the department from liability. In a regular angiogram the duty brought the radiologist to the patient's room, an interaction setting uncommon for radiologists. However, since
digitals were performed on an outpatients, the radiologist's explanation of the risks took place in the examination room as would occur with any other procedure. When explaining a special procedure, the radiologist sought to minimize the importance of the risks and to abbreviate the explanation so that he would not increase the patient's anxiety. Consequently when explaining a special procedure, the radiologist's interactional tactics differed little from those used in an IVP:

R: (to patient) Mary, the examination that we're going to be doing this afternoon is called digital angiography. What that entails -- means going into your arm or maybe your groin--I like to preferrably go into the arm. (Radiologist begins to place a tourniquet on the patient's arm) Then we're gonna pass a small tube up into the large vein by way of the small vein in your arm. (He points to the carotid.) Then we'll make an injection of a material that we can see on the x-rays.

P: (to Rad) They told me that.

R: (to Pat) When we're making the injection you will feel a hot flash. After that, we want you to lay perfectly still for a few minutes. The feeling won't last very long. Do you have any allergies?

P: (to Rad) No.

R: (to Pat) The only possible problem is you might have an allergy to the material. It is really rare, but it is a possibility.

P: (to Rad) Everybody's got allergies today with the air the way it is.

R: (to Pat) I just need for you to sign this consent form. It just says that I've explained the examination to you.

As in other examinations, the radiologist employs euphemisms ("material" "big vein") and indexical references (points to carotid) to present potentially disturbing information. He diminishes the effects of the contrast as well was the likelihood of a reaction. The consent form is presented in an off hand manner and its importance is minimized ("just
says). Thus even though the special procedure involved more risks than an IVP, it was presented to the patient in much the same manner.

At the beginning of each special procedure, the radiologist would stop by the table before suiting up to greet the patient. During these periods the radiologist would not only explain the exam if he had not already done so, but he might, like the technologists, attempt to humor the patient. Similarly, radiologists might joke with willing patients up until the time the catheter was actually placed. The greater likelihood that radiologists would spend several minutes in light conversation with the patient was rather unique to the special procedure. However, the form of interaction did not last long. In most procedures, the interpersonal atmosphere shifted as soon as the procedure actually started. From the time the radiologist injected novocaine until the time he removed the catheter the radiologist's interaction with the patient was minimal and strictly task oriented.

During most of the procedure the radiologist spoke to the patient only to warn him when he would feel certain sensations ("a little pressure now") or to ask that the patient turn a part of his body this way or that. Unless the patient actually grabbed for the catheter, most patient management tasks were the responsibility of the nurse or the technologist who monitored the patient's state and provided encouragement while the radiologist worked. During the catheter's placement, the interactional context was so arranged that the radiologist would not be distracted from his work by the need to relate to the patient. During the runs, radiologists also rarely spoke with patients except to tell them to hold their breath or to ask them if the hot feeling had subsided after the injection.
When the procedure itself was over, the radiologist might converse with the patient if he decided to hold the incision until it clotted and if the patient was not still heavily sedated from injections of Valium. It was at this time that the radiologist was most likely to talk to patients about themselves and to find out about the patient's personal identity. Moreover, since the danger of the procedure had passed most patients expressed gratitude to the radiologist at this time. Such conversations were more frequent at Suburban where radiologists applied pressure to the incision rather than use a compression clamp to accomplish the same purpose. At Urban, compression clamps were routinely used so that the radiologist did not have to remain tableside when the procedure was over.

Suburban's digital equipment led to atypical interactions between radiologists and patients. Because of Suburban's physical layout, the patient had to be brought through the control room to change clothes in the bathroom. In passing through the control room, the patient could not help but see the computer console and its monitors. If the radiologist remained in the area to review the images, as radiologists often did, the patient might ask the radiologist about the images on the screen and whether he had found any indications of disease. Depending upon the identity of the patient and the radiologist, such inquiries could lead to the radiologist's showing the patient the images and telling the patient what he saw in them. Under most other circumstances radiologists would not reveal diagnostic information. Had the layout of the rooms been different at Suburban, Suburban's radiologists would also have been less likely to do so.
In sum, it would appear that the new imaging technologies did very little to alter either the duration or the nature of the radiologist's relationships with patients. Even special procedures which brought radiologists into contact with patients for longer periods of time changed the nature of the radiologist's interactions with the patient less than the radiologists might believe. While the technologies altered the radiologist's work, that work did not usually involve relating to the patient. Consequently, relations with patients continued to be shaped primarily by the exigencies of infusions, injections and ingestions rather than the variety of the technologies used. Only in fluoroscopy and CT scanning were slight modifications of the radiologist-patient role relationship technologically induced.

Technologists' and Radiologists' Relations with Each Other

There are good reasons to believe that radiological technologies were among the most important situational forces (if not the primary force) that shaped relations between technologists and radiologists. The social ecologies and cultures of the two radiology departments were such that techs and radiologists, by and large, only interacted around examinations and the use of a machine. The spaces in which radiologists and technologists otherwise spent their time were well segregated. The radiologist's offices and reading rooms were removed from the film library and main darkroom at Suburban and from Urban's alcove and lunch room (See Figures 5 and 6 for precise locations). The separation was most complete at Urban where radiologists did not even need to pass through the tech's turf in order to reach their offices.
At Suburban, radiologists often came into the main darkroom to get a cup of coffee or to view films hanging on the light boxes mounted on the darkroom's walls. On these occasions, radiologists and technologists were likely to chat briefly about incidentals such as TV shows and local events, as well as departmental business. However, aside from the examination, no other space regularly brought members of the two groups together. Interaction was even more severely curtailed at Urban where norms existed against radiologists frequenting the lunch room. Though the lunch room contained the department's coffee pot, radiologists rarely sought their coffee there. Instead, they sent secretaries to the cafeteria for coffee. On those occasions when a radiologist dared to visit the lunch room, his presence immediately changed the room's atmosphere. As the radiologist entered, most conversation in the room ceased. The techs or secretaries who were in the room at the time often spoke to the radiologist only if he first spoke to them. Given the interpersonal chill, few radiologists lingered in Urban's lunch room longer than was necessary to draw their coffee.

Lunch time also provided few opportunities for interaction between techs and radiologists. At both hospitals, radiologists and technologists traditionally sat at different tables in the cafeteria. At Urban, the segregation was formally institutionalized by reserved tables clearly labeled: "Physicians". At Suburban, seating was open and segregation informal. Nevertheless, on only one occasion did I ever observe one of Suburban's radiologists sit with the x-ray techs at lunch. The radiologist was a substitute filling in while several regular radiologists were on vacation. The techs accepted his presence gracefully after several minutes of bewilderment. Since Suburban's CT
techs ate at odd hours, a radiologist occasionally joined them at a table when no other radiologists were in the cafeteria at the time. If interactions between technologists and radiologists revolved around the conduct of procedures, then as with the other two role relations already discussed, the amount of contact during an exam should set broad constraints on the nature of the relationships that could develop. Table 9A displays the average percentage of a procedure's duration that technologists and radiologists were in face to face contact. The means suggest that radiologists and technologists spent consistently less time in each other's company when traditional technologies were used. In both hospitals, the smallest average duration for the newer technologies is greater than or equal to the largest average duration observed in the main department. The analysis of variance in Table 9B verifies that the distinction between a new and a traditional technology was extremely significant for determining the amount of contact between techs and radiologists ($F=68.32$, $df=(1,252)$, $p<.01$). Equally important is the evidence that the distinction was consistent across research sites: knowing the department accounted for almost no variation in duration of contact ($F=1.73$, $df=(1,252)$, $p=n.s.$). Therefore, it would seem that by creating more opportunities for interaction than existed in the main departments, the newer technologies set the stage for radiologists and technologists to develop different types of relationships. How these relationships differed from their counterparts in the main department and the reasons for those differences consumes the remainder of this chapter.
Table 9

A: Average Percentage of Various Procedures' Duration that Radiologists Were with Technologists

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Suburban N</th>
<th>Suburban Mean %</th>
<th>Urban N</th>
<th>Urban Mean %</th>
<th>Total N</th>
<th>Total Mean %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routines</td>
<td>5</td>
<td>0%</td>
<td>6</td>
<td>0%</td>
<td>11</td>
<td>0%</td>
</tr>
<tr>
<td>I.V.P.'s</td>
<td>19</td>
<td>17</td>
<td>6</td>
<td>14</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>Barium Enema</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>8</td>
<td>39</td>
<td>14</td>
</tr>
<tr>
<td>Specials</td>
<td>44</td>
<td>66</td>
<td>8</td>
<td>73</td>
<td>52</td>
<td>67</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>27</td>
<td>41</td>
<td>17</td>
<td>14</td>
<td>44</td>
<td>31</td>
</tr>
<tr>
<td>CT Scans</td>
<td>42</td>
<td>20</td>
<td>40</td>
<td>48</td>
<td>82</td>
<td>34</td>
</tr>
</tbody>
</table>

B: Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>1</td>
<td>.119</td>
<td>.119</td>
<td>1.73</td>
</tr>
<tr>
<td>New vs. Traditional</td>
<td>1</td>
<td>4.698</td>
<td>4.698</td>
<td>68.32**</td>
</tr>
<tr>
<td>Residual</td>
<td>252</td>
<td>17.192</td>
<td>.069</td>
<td></td>
</tr>
</tbody>
</table>

**p ≤ .01
Temporal Structuring of Interaction

Except for when they were assigned to routine radiography, at some point during every study x-ray techs needed to seek out a radiologist to read films, inject a patient, or perform fluoroscopy. Until a radiologist was found and his attention was engaged, the study could proceed no further. To locate a radiologist, the technologist often had to search several offices and ask other technologists about the radiologist's last known whereabouts. Even after the tech found a radiologist, there was no guarantee that he would be immediately available. At the time of the tech's arrival, the radiologist could be talking on the telephone, discussing a film with a physician, consulting a colleague, or about to go off to perform another examination. In each instance the tech would have to wait. If the technologist engaged the radiologist's attention and made her needs known, she still had no firm claim on the radiologist. The radiologist could always be diverted by any number of events including a telephone call, a consultation, or even another tech requiring assistance. On a number of occasions, I witnessed techs summon radiologists to an IVP or fluoroscopic exam only to discover, several minutes later, that the radiologist had "forgotten" to follow the tech to the patient. In such instances the tech delivered grudgingly a second summons after granting the radiologist a period of grace to show up on his own.

For these reasons, x-ray techs consistently complained that the most irritating aspect of their work was that "you can never find a radiologist when you want one." The techs interpreted the difficulty in a number of ways. At Suburban, techs used the situation to justify their claim that the department needed to hire an additional
radiologist. More importantly, at both sites, techs maintained that the difficulty of securing a radiologist attested to the radiologist's callousness, "They think nothing of keeping a patient waiting twenty minutes." Even in Urban's fluoro area, where radiologists remained near the rooms for most of the morning, techs became irate whenever the radiologist left the area for one reason or another. In contrast, complaints about not being able to find a radiologist were less prevalent among specials techs, CT techs, and sonographers, even though they too had to summon radiologists at certain points over the course of a study. To understand why the attitudes differed, one must understand how the temporal organization of technologist's and radiologist's work differed and how the technologies influenced the way the two meshed.

Figure 11 documents the events of a 5 hour period in the work day of a radiologist at Suburban. Except when he was conducting an angiogram (9:43 AM - 11:04 AM) and eating lunch (12:31 PM - 1:37 PM), the radiologist spent the entire time in the main department. Discounting the angiogram and lunch, the radiologist engaged in 51 separate tasks or encounters with a mean and median duration of 3 minutes and 2 minutes respectively. He was interrupted twelve times by technologists and clerks, four times by his colleagues and four times by a referring physician for an average of approximately eight interruptions an hour. This flow of events and their timing typified the structure of radiologists' work in both main departments.

As the example makes obvious, the average work day of a radiologist in a main department was composed of a large number of discrete events all of relatively short duration. At any moment, the radiologist could be drawn for a brief span of time into the work world of any of a number
Figure 11

The Course of a Typical Day of a Radiologist Assigned to a Main Department

(Suburban Hospital)

<table>
<thead>
<tr>
<th>Beginning</th>
<th>Duration</th>
<th>Event/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:35 Am</td>
<td>4 min.</td>
<td>Reads and dictates study in office.</td>
</tr>
<tr>
<td>9:39</td>
<td>1</td>
<td>Clerk enters and removes studies previously read. Informs radiologist that requested study has been mounted on microfilm machine.</td>
</tr>
<tr>
<td>9:40</td>
<td>2</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>9:42</td>
<td>0.2</td>
<td>Specials tech summons radiologist to angio suite by telephone call.</td>
</tr>
<tr>
<td>9:42</td>
<td>0.8</td>
<td>Finishes dictating study.</td>
</tr>
<tr>
<td>9:43</td>
<td>81</td>
<td>Performs carotid ANGIOGRAM in angio suite.</td>
</tr>
<tr>
<td>11:04</td>
<td>3</td>
<td>Speaks with family of patient who had angiogram</td>
</tr>
<tr>
<td>11:07</td>
<td>2</td>
<td>Returns to office. Reads another study.</td>
</tr>
<tr>
<td>11:09</td>
<td>.5</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>11:10</td>
<td>2</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>11:10</td>
<td>2</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>11:12</td>
<td>2</td>
<td>Technologist enters with scouts from IVP. and summons radiologist to the injection.</td>
</tr>
<tr>
<td>11:14</td>
<td>1</td>
<td>Technologist leaves. Radiologist finishes dictating study.</td>
</tr>
<tr>
<td>11:15</td>
<td>7</td>
<td>Injects IVP patient.</td>
</tr>
<tr>
<td>11:22</td>
<td>2</td>
<td>Begins to wash hands after IVP, but returns to exam room when patient begins to make odd noises.</td>
</tr>
<tr>
<td>11:24</td>
<td>2</td>
<td>Consult with colleague on ultrasound study.</td>
</tr>
<tr>
<td>11:26</td>
<td>2</td>
<td>Reviews old study mounted on microfilm reader.</td>
</tr>
<tr>
<td>11:28</td>
<td>2</td>
<td>Returns to own office. Consults with urologist who is waiting there with films.</td>
</tr>
<tr>
<td>11:30</td>
<td>1</td>
<td>Urologist leaves. Technologist arrives with IVP films.</td>
</tr>
</tbody>
</table>
Figure 11 continued:

<table>
<thead>
<tr>
<th>Beginning</th>
<th>Duration</th>
<th>Event/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:31</td>
<td>1</td>
<td>Technologist arrives to summon radiologist to a BARIUM ENEMA.</td>
</tr>
<tr>
<td>11:32</td>
<td>2</td>
<td>Conducts BARIUM ENEMA.</td>
</tr>
<tr>
<td>11:34</td>
<td>1</td>
<td>Consulted by colleague about knee film.</td>
</tr>
<tr>
<td>11:35</td>
<td>2</td>
<td>Returns to office. Finds urologist there. Reads films urologist has hung on boxes.</td>
</tr>
<tr>
<td>11:37</td>
<td>3</td>
<td>Reviews second study for urologist.</td>
</tr>
<tr>
<td>11:41</td>
<td>1</td>
<td>Urologist leaves. Read next study.</td>
</tr>
<tr>
<td>11:42</td>
<td>1</td>
<td>Read next study.</td>
</tr>
<tr>
<td>11:43</td>
<td>3</td>
<td>Notices mistake on earlier reading. Reads study second time and re-dictates.</td>
</tr>
<tr>
<td>11:46</td>
<td>2</td>
<td>Consulted by physician.</td>
</tr>
<tr>
<td>11:49</td>
<td>1</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>11:50</td>
<td>2</td>
<td>Tech enters with follow-up IVP films.</td>
</tr>
<tr>
<td>11:52</td>
<td>6</td>
<td>Tech leaves. Resume reading study begun at 11:49.</td>
</tr>
<tr>
<td>12:01</td>
<td>1</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>12:02</td>
<td>3</td>
<td>Two techs enter simultaneously. One with post-void of IVP. One with question about problematic mammogram.</td>
</tr>
<tr>
<td>12:05</td>
<td>2</td>
<td>Resume reading study began at 12:01</td>
</tr>
<tr>
<td>12:07</td>
<td>1</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>12:08</td>
<td>6</td>
<td>Converses with colleague on telephone.</td>
</tr>
<tr>
<td>12:14</td>
<td>17</td>
<td>Reads &quot;whole body&quot; series.</td>
</tr>
<tr>
<td>12:31</td>
<td>66</td>
<td>LUNCH</td>
</tr>
<tr>
<td>1:37</td>
<td>7</td>
<td>Conducts CARDIAC ULTRASOUND.</td>
</tr>
<tr>
<td>1:44</td>
<td>15</td>
<td>Injects IVP on young child.</td>
</tr>
<tr>
<td>1:59</td>
<td>7</td>
<td>Provides wet readings for 4 technologists who have queued up during IVP.</td>
</tr>
<tr>
<td>2:08</td>
<td>3</td>
<td>Consulted by colleague on ultrasound study.</td>
</tr>
</tbody>
</table>
Figure 11 continued:

<table>
<thead>
<tr>
<th>Beginning</th>
<th>Duration</th>
<th>Event/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:11</td>
<td>3</td>
<td>Technologist summons radiologist to MAMMOGRAM.</td>
</tr>
<tr>
<td>2:13</td>
<td>5</td>
<td>Performs CARDIAC ULTRASOUND</td>
</tr>
<tr>
<td>2:18</td>
<td>1</td>
<td>Returns to office. Technologist enters with films from child's IVP.</td>
</tr>
<tr>
<td>2:19</td>
<td>2</td>
<td>Speaks with child's mother who has requested information.</td>
</tr>
<tr>
<td>2:21</td>
<td>10</td>
<td>Consulted by physician.</td>
</tr>
<tr>
<td>2:31</td>
<td>3</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>2:33</td>
<td>4</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>2:38</td>
<td>1</td>
<td>Reads next study.</td>
</tr>
<tr>
<td>2:39</td>
<td>1</td>
<td>Techs enters with films from mammogram.</td>
</tr>
<tr>
<td>2:40</td>
<td>2</td>
<td>Take tape of dictations to secretaries.</td>
</tr>
<tr>
<td>2:42</td>
<td>2</td>
<td>Attends MAMMOGRAM</td>
</tr>
</tbody>
</table>
of individuals. It was as if the radiologist existed at the nexus of a number of trains of action that ran on unpredictable schedules and made unanticipated stops. Thus the temporal boundaries of the radiologist's work were extremely fluid and the punctuation of his day into segments was largely out of his control. The radiologist accommodated to such a world by treating time and events flexibly, for the nature of the work did not allow the radiologist to deal with one thing at a time. In between interruptions and summons, the radiologist attempted to work his way through the ever present pile of unread films that represented his formally allotted task.

In comparison to the disorderly and unpredictable world of the radiologist, the work of the technologist was rigidly structured and well behaved. The technologist's day was chunked into much larger segments defined by the duration of an exam. In between the exam's beginning and end flowed a series of well rehearsed activities that unfolded in a linear, one after the other fashion. If the technologist was not working the outpatient area, even the sequence, if not the precise timing, of exams could known ahead of time. In fact the only sure uncertainty that plagued the temporal order of work was the need to engage the radiologist.

The difference between the temporal ordering of the radiologist's and the tech's worlds parallels Edward Hall's (1959) distinction between polychronic and monochronic cultures. According to Hall, in a polychronic culture, individuals place less value on temporal order, tend to accept events as they arise, and engage in multiple activities simultaneously. In contrast, people from monochronic cultures seek to structure activities and plan for events by allocating specific slots of
time to each event's occurrence. Hall suggests that when individuals from polychronic and monochronic cultures are forced to interact, conflict and tension arise:

I have described two ways of handling time, monochronic and polychronic. Monochronic is characteristic of...peoples who compartmentalize time; they schedule one thing at a time and become disoriented if they have to deal with too many things at once. Polychronic people...tend to keep several operations going at once, like jugglers. Therefore, the monochronic person often finds it easier to function if he can separate activities in space, whereas the polychronic person tends to collect activities....Monochronic northern Europeans find the constant interruptions of polychronic southern Europeans almost unbearable because it seems that nothing ever gets done. Since order is not important to the southern Europeans, the customer with the most "push" gets served first even though he may have been the last to enter (Hall, 1969:173).

The tension experienced by the Northern European in southern Europe is precisely analogous to that felt by an x-ray tech forced to operate on radiologist's time. The inability to immediately locate a radiologist violated the technologist's sense of order, a sense made more acute by the rather accurate perception that the patient also operated in a monochronic world. Much of the hostility that x-ray techs felt towards radiologists resulted from the need to link their own monochronic work world to the polychronic world of the radiologist long enough to get the radiologist to perform some act so that the linear flow of the exam could continue. Like attempting to engage a high speed flywheel with a low speed clutch, the tech's attempt to engage a radiologist often resulted in the social equivalent of a grinding noise.
The situation was different in the newer technologies where the temporal structures of technologists' and radiologists' work were not as disparate. While the worlds of the specials tech, the CT tech, and the sonographer were as linear and as monochronically ordered as the world the x-ray tech, the newer technologies altered the temporal structure of the radiologist's world. In particular the CT scanner and special procedures slowed the radiologist's world so that it was easier for technologists to mesh the flow of their own work with the radiologist's. When assigned to the CT scanner, radiologists at both hospitals had fewer duties to perform. At Urban, CT duty meant that the radiologist attended only to the day's work in the head and body scanners and consulted only with physicians interested in reviewing or ordering scans. Although Suburban's radiologists linked CT duty to ultrasound duty, together the two technologies still produced fewer studies than the main department as a whole. Moreover, like Urban's radiologists, when on CT duty a radiologist at Suburban consulted primarily with physicians who had ordered scans or ultrasounds. Finally, when assigned to CT duty, radiologists spent most of their day in the CT area itself so that it was less difficult for a technologist to find them when they were needed. Thus by reducing the variety and the number of activities that the radiologists needed to perform and by segregating the radiologist from the remainder of the department, CT duty mollified precisely those structural aspects of the radiologist's work that contributed to a polychronic work culture. Linking with the technologist's world in a more "timely" fashion became a less chronic point of contention.
The length of a special procedure forced the radiologists to share the same temporal order that defined the special tech's work, at least for the duration of the procedure. However, even the initial summoning of the radiologist was not as difficult for the specials techs since they could estimate when they would need the radiologist and summon him by phone several minutes before they were actually ready for him. In contrast, x-ray techs only sought radiologists at the point they needed assistance and always did so in person. Moreover, radiologists knew ahead of time when a specials was scheduled and could therefore anticipate their involvement. When assigned to specials work, few other activities took precedence. In line with the temporal constraints of a special procedure, radiologists adopted a more monochronic perspective. If several specials were booked back to back, the temporal structure of the radiologist's day began to run parallel to that of the specials tech.

Although sonographers needed to summon radiologists to real time reviews at Suburban and to take films to radiologists at Urban, their frustration with the radiologists' polychronicity was less severe than the x-ray techs'. The difference occurred for several reasons. First, radiologists were more willing to respond to a sonographer's summons since real time reviews were generally seen by radiologists as more interesting than IVP injections. Second, since Suburban's radiologists were responsible only for the CT scanner in addition to ultrasound, they were not as likely to be pulled in as many directions as radiologists in the main department. Finally, if necessary sonographers could decouple from the radiologist's polychronicity. At both sites sonographers could record real time images on video tape for later review if radiologists
always easier to sustain when the former's expertise subsumes (or is thought to subsume) the skill and knowledge of the latter. Without such a distinction, rights to occupational privilege and authority rest more exclusively on appeals to tradition, a foundation that becomes shaky without the mortar of expertise. As I mentioned in Chapter 5, new imaging technologies may, at least initially, loosen traditional definitions of who knows what, and thereby diminish the knowledge gap that separates radiologists from technologists in the new technological settings. At this point, I wish to consider more closely the potential equalization of expertise that the new radiological technologies sired and trace the implications of that equalization for relationships between radiologists and technologists. To do so, two loci of expertise must be considered, knowledge of the technology itself, and knowledge of the images that the technology produced.

Radiographic and fluoroscopic technologies, the traditional machines of radiology, have not changed radically since the early 1900's. While incremental innovations have gradually made modern devices more sophisticated, complex, and automatic, their general principles have remained constant. Moreover, while the quality and readability of radiographic and fluoroscopic images have been greatly improved, the language, or system of signs, that the images represent to the radiologist has only been slowly refined. Because both technical innovation and diagnostic discovery have been incremental, neither techs nor radiologists have had difficulty assimilating changes.

In medical school, all radiologists learned not only to interpret radiographic and fluoroscopic films, but also the principles by which traditional technologies operate. Radiologists in both departments knew
how the various parameters of an x-ray machine (eg, KV's, MA's, 
collomation, etc) affected the quality of films, and most could, if 
necessary, take their own films. To be sure, some radiologists would 
appear to fumble beside a well practiced technologist, but regardless of 
the figure they cut at the controls they could still produce x-rays. 
The distance between the radiologist's and the x-ray tech's knowledge of 
the technology was also reduced by typical career structures. 
Radiologists remained radiologists throughout most of their working 
life. As a group, however, x-ray techs tended to have brief careers. 
Most of the x-ray techs at both departments were younger than 
twenty-five, and had less than five years experience in the field. 
Consequently, it was likely that experienced radiologists might actually 
know as much about the traditional technologies as many of the 
technologists they employed.

The pattern of incremental technological change, differences in 
training, and alternate career paths combined to create a situation 
where radiologists in the main department knew (or had reasonable 
grounds for claiming that they knew) what the x-ray techs knew. But, 
the technologists could not claim, in return, to have the radiologist's 
knowledge. Thus, the radiologist's expertise subsumed the 
technologist's. The nested structure of expertise revealed itself 
whenever technologists showed radiologists films. As I pointed out in 
the last chapter, after glancing at the films that technologists had 
taken, radiologists frequently told techs to alter specific aspects of 
their technique, to recenter, or to reposition the patient. Direct, or 
at least more physical, evidence for the structure of knowledge was 
evident in fluoroscopy. Not only did radiologists guide the
intensifier, shoot films, and at times, set techniques, but when using a "remote" room Urban's radiologists would occasionally go so far as to take overheads at the end of an exam. This hierarchically nested distribution of technical and interpretive expertise was often dramatically altered by the newer technologies.

When a new technology like ultrasound or a CT scanner first arrives in a radiology department, it brings with it a radically new language of images, a completely different system of signs that must be mastered before radiologists can use the images to diagnose disease. Although other individuals in other places may have used the technology before and may have mastered its system of signs, most of the radiologists at the new site will not know how to read the images because they have never needed to do so. At both hospitals all but one or two radiologists knew little about body scans, and in previous years a similar situation had occurred with ultrasound and special procedures. Two of Suburban's older radiologists were still learning ultrasound at the time the study took place. Moreover, the same two radiologists did not perform or interpret special procedures. At Urban, one radiologist had no part in special procedures and remained fairly detached from the new CT scanner. Although all of Urban's radiologists read ultrasounds, five years earlier such had not been the case.

At the same time that a new modality brings a new diagnostic language, it also confronts members of a department with a technology quite unlike any they have previously used. The CT scanner, ultrasound, and digital subtraction were far more complex and mysterious than the mechanical x-ray machines. Even at Urban where a head scanner had operated for six years, the radiologists and technologists found an
interactive computer more difficult to master than they had initially thought probable. The opaque semantics of computer languages and the rigid rules of syntax were foreign in a world that revolved around mechanics rather than electronics, a world mastered by acts not symbols.

Given that the new machines brought a new diagnostic language and a technology foreign to the everyday experience of most radiologists and technologists, three alternate distributions of knowledge became possible depending upon who was hired and who happened to interact with whom. The pattern common in the main department was duplicated when experienced radiologists worked with inexperienced technologists: the radiologist knew more than the tech about both the technology and the language of images. If experienced technologists were hired or if inexperienced radiologists did not begin to work with the technology until after technologists gained experience, then situations could arise in which a technologist would know more than the radiologist about the technical and even the diagnostic aspects of the technology. Finally, when the experience of the technologist or the radiologist were matched, rough equivalence of understanding would define a situation of parity. That alternate distributions of knowledge were possible when technologists and radiologists interacted around the use of a new technology meant that the relations between the two were likely to vary from those found in the main department even though the same radiologists were involved in both contexts.

Technical Relations: In theory, x-ray technologists were the masters of their machines, and in fact, at both sites radiologists generally left the running of the technology to the technologist. Techs claimed not only that radiologists did not understand the machines but
that if allowed to intervene, they would surely "screw up" the films. However, despite the technologists' beliefs about who knew what about the machines, when radiologists and technologists did interact over technical matters, the encounter took one form: the radiologist told the technologist what to do. Moreover, when impatient, radiologists were not above taking technical matters into their own hands. At times, a radiologist's action or suggestion caught the technologists by surprise and they would comment later that they did not realize that the radiologist knew so much about what they did. More frequently, however, the technologists reacted indignantly, especially if the radiologist was shown to be wrong. Techs strongly believed that radiologists should stick to reading films and leave the taking of films alone. However, technologists never openly challenged the radiologists right to direct their technical maneuvers. Rather they did as they were told, or they did what they thought best and led the radiologist to believe that they had followed orders. A sense for the x-ray tech's attitude and the typical relations sired by a radiologist's technical directives can be gleaned from the following angry comment:

Smith said 120 KV for Rheno, but it's really 75. If you did an IVP at 120, you'd never see the contrast. But you don't tell a radiologist anything. If they say 200, you set 75. When they see the film they'll say to you, 'see didn't it turn out good.' When Dr. Jones first got here, he'd change your techniques. He'd just walk up and push the buttons. We had to slap his hands to get him to stop.

As the comment suggests, even if the radiologist understood the technology (Techs thought Jones did) it was inappropriate, from the
technologists' point of view, for him to intervene in their work. Intervention threatened to expose the techs' knowledge as non-exclusive and therefore as less valuable than they had been socialized to believe. Since the wider norm of the main department was to accept a radiologist's order without dispute, to be told how to run a machine symbolized subservience in precisely that domain where the technologist was presumed professional.

In the newer modalities, interactions between technologists and radiologists were likely to bolster rather than deplete the technologist's sense of technical expertise. Because most radiologists never formally trained on the technologies and because few worked closely with the machines on a day-to-day basis, most respected and even deferred to the technologist's opinions on technical matters. Even experienced radiologists consulted with technologists when the latter had prior experience or had demonstrated, over time, proficiency with the machine. As interpersonal encounters, these interactions were structured differently than their analogues in the main department. Whereas radiologists most frequently told x-ray techs how to adjust machines, radiologists often asked technologists in the newer technologies for an opinion or else discussed the matter on more or less equal footing. In return, CT techs, specials techs, and sonographers were more likely to tell the radiologist when they perceived a technical course of action to be ill-advised and would even take time to teach radiologists what they knew. As a CT tech at Urban said to me one day after a radiologist asked her about a software routine, "It's pretty strange to be asked your opinion. I think I like it."
The form of interaction between radiologist and technologist was not the only way that radiologists communicated respect for the technologist's technical expertise. On a number of occasions Urban's radiologists brought physicians into the CT control room to show them the technology. In the course of explaining the machine, the radiologists emphasized how difficult it was to learn to operate the scanner. Suburban's radiologist's took great pride in pointing out that the scanner's manufacturer had asked Suburban to serve as a demonstration site for prospective customers interested in the scanner and the digital subtraction equipment. The company was said to have chosen Suburban because it thought the operations were extremely well-run. The radiologists credited the efficiency to the CT techs and the specials techs. At both hospitals, the radiologists openly admitted that ultrasound would fall apart if it were not for the competence of the sonographers. Thus it would appear that the newer technologies reinvested technologists with reputations for technical expertise, a reputation somewhat tarnished in the main departments.

**Interpretive Relations:** The previous chapter's section on the technologists' interpretive abilities documented the fact that techs and radiologists in the newer technological settings were more likely to discuss films and images. There I noted several distinguishing characteristics that encouraged such interaction: the novelty of the new diagnostic systems, the need for radiologists to survey films during the studies, and the new technologies' cybernetic requirements. Interpretive discussions were not only less common in the main department, they were less variable. Whereas interpretive interactions in the new technological subcultures were structured in one of four
ways, most analogous encounters in the main department had only one structure.

In the first and most prevalent structure, the radiologist told the technologist something about the anatomical or pathological information he extracted from the images. The flow of information was from the radiologist to the technologist, a pattern predicated on the fact that the radiologist knew more than the technologist to whom he was speaking. If questions were raised, the technologist posed them; if opinions were offered, the radiologist stated them. By and large, this was the only format by which radiologist's passed interpretive knowledge to the technologists in the main department. Although the pattern was also common in the new technologies, the tenor of the transactions was often critically different (a difference nicely captured by the two excerpts on page __ in Chapter 5).

When radiologists mentioned interpretations in the main department they usually did so in an off-hand manner, they simply noted something that stood out in a cursory overview of the film. In "telling" the technologists what they saw, radiologists made no special attempt to engage the tech's attention or to ensure that the technologist retained the information. Although radiologists casually noted findings for CT techs, specials techs and sonographers, they also actively strove to "teach" the techs to recognize anatomy and pathology. When teaching, as opposed to telling, radiologists went beyond simply naming and noting to explain signs and their implications. Moreover, radiologists made explicit their intention that the tech learn. During the first several weeks of Urban's body scanner operation, the CT experienced radiologists repeatedly told the new CT techs that they would have to learn to
recognize anatomy and pathology in CT scans. At Suburban, I observed, on several occasions, the experienced radiologist draw anatomical diagrams to teach inexperienced techs to recognize landmarks of cross-sectional anatomy. Teaching was also common in specials and ultrasound. By way of example, consider the following transcript of a radiologist at Suburban teaching a new sonographer to perform a gall bladder study. The radiologist's talk tacks back and forth between how to move the transducer and the images on the video monitor. At the very end he speaks specifically of signs and how to discriminate real pathology (lesions) from artifacts (fallout). Interactions like this were unthinkable in the main department where it was not important that techs understood what they saw:

(The sonographer stands next to the patient holding the transducer to the patient's abdomen. The radiologist stands beside the sonographer and speaks of images on the screen.)

R: (pointing to the monitor) Ok, that's just fluid. Have to go transverse to get the long axis...It isn't very well centered...She's still holding it (eg. the patient is still holding her breath).
T: (to patient) Breathe.
R: (to patient as sonographer moves transducer) Still holding it? Let it out. Now take another deep breath in. And hold it....Alright, breathe.... OK....Push your stomach out. Stomach out. That's it. Let it out....And breathe....OK, take another deep breath in and hold it in. Hold it right there. (to sono) Ok, that's bladder. Now we come down to....
(to patient) OK, breathe normally....OK, once again, take in a deep breath. Hold it in....Breathe....Deep breath in.
(to sono) Look at this portal vessel.....and transverse this...

(Radiologist now takes transducer himself)
R: (to sono) Try to get to the long axis here. (points) What we like to do on the gall bladder....you have to come all the way through and make sure that you get back to where you've done (eg. you rotate the probe). (to pat) OK, breathe...OK, deep breath in again. Hold it. (to sono) Now you have to do the liver. Plus the kidney. Ok, you want to make sure that this area here is the same....Run straight over and view a stretch of diaphram and then you walk around the surface going the other way. Then you start getting your duct down here again..You're just sliding over towards the midline. (to patient) Ok, breathe when you have to. (to sono) Your liver texture. Make sure that you go over it. This is a tricky area. This is a big fooler. You get this fallout down here. OK, you've got to be very careful that you're dealing with just fallout, and not a lesion. But you can practice. Whenever you see it make sure, when you get that fallout, that it is fallout...Make sure that you can see the echoes are there.

Once a technologist in a new technology became familiar with the language of images produced by the technology, a second form of interaction could occur between radiologists and technologists, a "mutual discussion" of the films. Mutual discussions were more or less spontaneous, unselfconscious acts that occurred either when the technologist showed the images to the radiologist or when both watched images appear for the first time on a video monitor. In a mutual discussion both radiologist and technologist were equally likely to ask questions and offer opinions. Thus, the form of the mutual discussion was similar to discussions that might occur between two radiologists. The tacit presumption of such an interchange was rough situational parity, a presumption which never guided interchanges between techs and radiologists in the main department.

The following two excerpts from transcripts demonstrate mutual interpretive discussions between technologists and radiologists. The first occurs in Suburban's angio suite as a radiologist and two specials
techs review runs from a carotid digital subtraction on a video monitor. The techs and the radiologist question whether a vertibral artery is occluded and look for evidence of the artery's existence which they cannot find. Hence, they conclude that the vertibral is completely blocked. The second excerpt documents an occasion of Urban's sonographer presenting an abdominal ultrasound to a radiologist for review. Note that second transcript lacks the enhanced spontaneity that was more typical of such exchanges when the films were viewed on a video monitor.

(Digital Subtraction at Suburban)

R: Fred, can you run one of those to see if there's any vertibral arteries. Ah, I thought she did have vertibral arteries....
T1: Yeah, she had the left. It overlaps the...ahh...
R: The left. And how about the right? I see the left.
T1: The right, I didn't see. Let me see if I can see it on this first run. (He now has the computer bring films from the first run to the monitor)
R: Right vertibral. (Run begins to appear.) Shit, I don't believe it. She has all kinds of problems.
T1: She had periferal disease too.
R: That's the first run?
T1: Yeah.
R: See, your first run came out right. I think the rest of it had to do with the machine (eg. why we had a problem). See how beautiful this is?
T1: Yeah. I don't think she has a vertibral on that side, does she?
R: No.
T1: What's this?
R: No, that's a...I'd say a pocket. Keep going there.
T2: (coming to the monitor) Where's the vertibral?
T1: I don't think she has a right.
T2: No!

(Sonographer enters radiologist's office)

R: Hi, what you got, Diane?
S: Ah...
R: (reading from requisition) 73 years old.
S: Gall bladder-pancreas echo. She's had her gall bladder out.

(radiologist hangs films on lightbox)

R: OK, so the patient has something. "Pain, question pancreatitis. Right sided pain." (reads from requisition) Is that what it says? It says, "Patient with something pain." Back pain maybe. Question pancreatitis. Who can read it? (eg. a doctor's handwriting on the requisition) Why bother to write it, it you can't read it....OK, gall bladder-pancreas. Gall bladder out ......Is this all one cyst here?
S: There's two.
R: There's two?
S: (pointing to films) There's one right there before...there's one (film) you can see both of them together.
S: I got another view.
R: So you think this one is located anteriorly and that one sort of posteriorly? That's anterior and that's posterior.
S: Umhummm.
R: OK, and -- pancreas looks alright....The intrahepatic biliary tube is dialated so...what's a matter blah blah...I don't understand it....(reads chart)....lymphocytopenia. Urinary tract infection. Lymphocytopenia? Bleeding? OK, thank you Diane.

Regardless of whether interpretive interactions between radiologists and technologists occurred as instances of telling, teaching, or mutual discussions, the structure of the relationship was always skewed towards the radiologist having the more substantial understanding of the films. Even in the mutual discussion, it was always clear who was formally the expert. For example, in both excerpts above the radiologist led the interchange and showed himself to have no real lack of understanding. In no way then, did the interactions really challenge the radiologist's superior interpretive expertise. Rather, they merely marked the disruption of the norm of not granting techs interpretive skill. Yet, in some situations, actual role inversions occurred during interpretive
interactions between techs and radiologists in the new modalities. In these cases, the radiologist showed himself to have less understanding of the images than the technologist. Questions came from the radiologist and opinions or statements from the technologist. These interactions formed what might be called occasions of "reverse teaching". Never, under any circumstances imaginable would such an interchange occur between a radiologist and an x-ray tech.

The following three excerpts illustrate instances of "reverse teaching". The first two occurred in Suburban's CT scanner and took place between two different CT inexperienced radiologists and an experienced technologist. The third, arose in Suburban's ultrasound department. As I mentioned earlier, at the time of the study, two of Suburban's radiologists were in the process of attempting to learn ultrasound.

(CT, Suburban)

R: You just photographing them?
T: Yes, I'm rematrixing
R: Is that a fracture?
T: No that's probably a foramen?
R: Did you see a disk there?
T: I just saw a little bit. It's so small you can't see it.

(CT, Suburban)

R: Now that is the posterior fossa. (pointing to screen) It's too noisy isn't it?
T: A little.
R: This was a bleed without trauma wasn't it? This was a ruptured aneurism?
T: Yes.
R: How old?
T: Twenty four hours. (points) That's the same level, we repeated it.
R: Now is that blood in the temporal lobe?
T: Yes I think so. (Tech measures the density of the area)
R: Fresh blood is about what?
T: About 35-40 (Hounsfield numbers).
R: There's the cordoid plexus here. (points) Either that's on the inside of the ventricle or the fissure. This is the pituitary?
T: Yes.

(Ultrasound, Suburban)

S: (referring to uterus on screen) It's 4 cm in the longitudinal and 3 in transverse.
R: This is transverse, where you've got her?
S: Yes sir.
R: I don't see any ovaries, do you?
S: I don't either.
R: The ovaries probably atrophied.
S: Probably, I haven't seen anything.
R: Uterus is normal size isn't it.
S: Yes, for her age. There's the uterus there. Now, moving to the right
R: So, nothing to explain the assymetry.
S: Right.
R: Ok.

Interactions such as these could only occur when the radiologist thought the tech knew as much, or more than he. Because they were blatant contradictions of the accepted order, such situations were delicate matters to be handled with aplomb. Both radiologists and technologists became a bit anxious when they perceived themselves in situations of "reversed teaching". CT techs at Suburban claimed that they felt uncomfortable "doing the radiologist's job," that they were not trained to give diagnostic information and that they ought not be put in such a position. Before coming to Suburban, the experienced CT techs had never been positioned to know more than a radiologist who was not a medical student. Sonographers had more experience with the phenomenon and had developed a philosophy as well as tactics for handling the touchiness of
reverse teaching. Largely, the interpersonal situation was managed by the sonographer's assuming a deferential and humble manner ("Yes, sir") guided by the credo, "We recognize pathology, we don't diagnose it".

Some radiologists were also apparently unnerved by interactions structured as reversed teaching, although they never admitted their discomfort openly. To have done so would have been to admit that the status system was, at least for the moment, reversed. Rather one had to read the radiologists' discomfort from their actions. For example, when placed in such situations, some radiologists covered themselves by nervously joking about the fact they had asked an interpretive question:

(CT Scan, Suburban)

R: Boy, that's a nice view of the pituitary fossa and the sella. I don't see any pathology. Find me some.
T: If you don't find anything, you say it's normal.
R: You've got to understand that these people are paying big dollars for these scans. They want pathology.

In part, to avoid precisely such situations the inexperienced radiologists at Suburban began after the fourth week of the scanner's operation to withdraw from the day to day operation of the machine. Instead, they spent most of their CT assignments in the radiologist's office, reviewed images at the monitor in relative silence, and waited for hard copies of the films so that they could consult with the CT experienced radiologist (See Barley, (1983a) for a detailed discussion of how the situational compromise evolved). At Urban, radiologists avoided any semblance of the situation by allowing the CT experienced radiologists to dominate the scanner during the first six months of the scanner's operation. Moreover, since Urban's CT techs had no prior
experience with body scanning, under no circumstances could they have, at least initially, engaged in reversed teaching. Since the sonographers' reputations for interpretive skill and situational finesse were well established and since they were seen as trusted professionals, radiologists were less likely to be pricked by the interpersonal edges of ultrasound.

Opportunities to See Mistakes

Given the brevity of their encounters with radiologists, the routine nature of the technology in the main department, and the nested distribution of expertise, technologists in the main department had few opportunities to observe radiologists make mistakes. To be sure, techs could fault a radiologist on moral grounds for refusing to cancel a barium enema on a senile patient or for failing to introduce himself at the start of an exam. But, to catch a radiologist in a technical or interpretive blunder was rare. Since radiologists understood the technology sufficiently well and since their role in the procedure was limited, the radiologist's technical errors were more or less confined to fumbling with a machine's controls (hardly damaging since radiologists weren't thought to understand machines anyway) or failing to locate a patient's vein on the first stick. Interpretive errors were even more difficult for x-ray techs to detect. Not only did radiologists and technologists rarely discuss films, but techs were rarely present during consultations. Moreover the traditional distribution of expertise mitigated against the x-ray tech detecting a misinterpretation should they happen to observe a consultation.
In contrast, CT techs, specials techs, and sonographers were much better positioned to observe a radiologist's failings, particularly when they had a grasp of the technology and were more familiar with the diagnostic implications of the technology's images. For example during the first several months of scanner operations at Suburban, CT inexperienced radiologists occasionally ordered contrast injections for patients whose suspected malady, if it existed, would have been obscured by the iodine. In these instances, the technologists had to explain why the course of action would be ill-advised and suggest an alternate protocol. Suburban's radiologists also frequently and proudly led physicians into the control room to display the scanner's technological wonders. If a scan was on the video monitor at the time (and one usually was) the physician inevitably asked the radiologist what he saw in the film. Since to do otherwise would be to undermine the physician's confidence in the radiologist's expertise, at minimum the inexperienced radiologist had to point assuredly to anatomical structures and express marvel at their clarity. During such show and tell sessions, the radiologists occasionally named an anatomical or pathological structure wrongly. Recognizing that the radiologist needed to save face, the technologists always waited until the doctors had departed before noting among themselves that the radiologist had been mistaken. Nor did they later call the radiologist's attention to his error.

Even Urban's inexperienced CT techs were better situated than their counterparts in the main department to observe radiologists make technical and diagnostic errors. As the CT inexperienced radiologists began to work the body scanner, they were frequently accompanied by one
of their two more experienced colleagues. While standing behind the technologists at the console, the radiologists openly debated the anatomical and pathological implications of the images on the monitor. During these conversations, the inexperienced radiologists often named structures and maladies with great excitement only to be contradicted by their colleague. A novice's orders to a technologist about how to proceed with a scan were similarly open to review and countermand by more experienced radiologists. These technical errors regarding technique, scanning distance, and so forth were more obvious to the techs than the radiologist's diagnostic mistakes because technical miscalculations required the techs to alter their own work in mid-course. Thus, despite their relative inexperience, within a few months time Urban's CT techs articulated well formed notions about the identities of those radiologists who did and did not "know what they were doing".

But of all the technologists in a radiology department, it was the specials techs who were privy to the radiologists' most serious blunders. While CT techs and sonographers could observe radiologists miscalculate the technology or misinterpret films, only specials technologists regularly observed mishaps that endangered patients. If a radiologist suffered a lapse of skill while inserting a needle or placing a catheter, he could not only cause the patient pain, but in freak instances, trigger a stroke, a pneumothorax, or even the patient's death. It would be naive to expect that any physician or surgeon could treat patients without making a number of mistakes over time. The radiologists at Urban and Suburban were no different. For example, while watching special procedures, I observed radiologists
transfix a patient's stomach mistakenly identified as a kidney, reinsert biopsy needles up to twenty five times without tapping the abcess, and call off angiograms after the catheter triggered minor heart attacks.

Opportunities to observe radiologists in trouble shaped relationships between radiologists, CT techs, sonographers, and specials techs. The technologist's support was necessary if the radiologist was to define mishaps not as reflections on his skill, but as events that could happen to anyone. It was therefore important that radiologists and technologists alike sustain the plausibility of accounts that lodged responsibility for a mishap in externals such as the unforseen characteristics of the patient's anatomy or an inopportune technical malfunction. If techs were to offer other accounts they could seriously damage the radiologist's reputation. So adept were the techs at their obligation that they were often the first to suggest a cause for a mistake: "Well it's pretty easy to confuse the two since they look so much alike". Moreover, if a radiologist began to blame himself for a mishap, technologists would try their best to stop the radiologist from personalizing the situation. After an unsuccessful special procedure observed in the course of the study, a radiologist immediately became depressed and claimed several times that he had no excuse for making the mistake that was apparently made. Within the space of five minutes the technologist had discovered four distinct rationales for why "it could have happened to anyone else" and that therefore, "there was nothing you could do about it". Under the circumstances it became easier for radiologists to discount the technologist's mistakes.
General Tenor of Relations

Given the contrasting temporal structures, the alternate distributions of expertise, and the different opportunities to observe radiologists' mistakes, it should come as no surprise that the general tenor of relations between radiologists and technologists in the main department differed from those found in the newer technological settings. In the course of a typical day, an x-ray technologist only had occasion to interact with a radiologist when his assistance was needed to complete an exam. However, since the worlds of the radiologist and the x-ray tech were temporally as well as spatially segregated, the technologist was always placed in the position of having to seek and potentially wait for the radiologist. Since the distribution of technical and interpretive knowledge was well nested, the radiologist could at least presume that he had a competent grasp on the the parameters of the techs' work. The presumption combined with the brief, task specific nature of the radiologist's role in the various procedures to foster encounters in which the radiologist issued orders and offered critiques, but rarely sought opinions. Since the x-ray techs had never been formally or informally trained to read films and since they had few opportunities to even observe the radiologists make technical and interpretive mistakes, the techs had no recognized basis for challenging the radiologist. Thus, the traditional technologies supported an interaction order that instantiated a well defined status hierarchy. At the same time, the interaction order spawned a matching technological subculture among the technologists that added affective tone to the structural flesh.
While most technologists were willing to admit that the radiologist's were knowledgable individuals, they also claimed that radiologists "thought they were God." Technologists held that it was useless to try to "tell a radiologist anything" or for technologists to make decisions on their own. If one made a decision you would "be yelled at," and if you made a suggestion the radiologist would ask "who are you?" Consequently, the technologists argued that they had little choice but to do what the radiologist said and refrain from giving the radiologist advice, regardless of whether they were certain the radiologist was wrong. These sentiments of subordination, powerlessness, and passivity at times seemed to reach absurd proportions, particularly at Urban where x-ray techs submitted to radiologists far more readily than at Suburban. By way of example, during one morning's fluoroscopy at Urban, a radiologist had difficulty deciphering the following handwritten comment on a patient's requisition, "No B.M. in 20 days". After noting that he couldn't make sense of the sentence he went to his office to call the referring physician for a translation. In the radiologist's absence I asked the tech if she didn't think that the requisition meant the patient hadn't had a "bowel movement" in three weeks. The tech replied, "Of course that's what it says, but who am I to say?"

As the incident makes clear, the technologists' tendency to subordinate themselves and to accept passively the radiologist's orders was tinged by more than a little hostility. In fact, their passivity and failure to make suggestions or provide information veiled aggression. It was the technologists version of working to rule. Moreover, the technologist's tendency, as one tech actually put it, to
"take the lower role", created a self amplifying loop. By not speaking their mind and by carrying out the radiologists dictates regardless of whether they thought him wrong, they enhanced their own felt lack of importance. If later events seemed to vindicate the technologists' initial opinion, they took the incident as further proof that "you couldn't tell radiologists anything" and, at least for the moment, the hostility perpetuated itself. At the same time, by not taking action until told to do so and by not intervening when they thought intervention necessary, the techs created the impression among radiologists that as a group the techs were less skilled and responsible than they should be. The perception reinforced the radiologist's willingness to issue orders and an obliviousness to the technologist's opinions and perceptions. Thus the cycle expanded.

The tenor of relations in the newer technologies was quite different. While hostility and anger towards the radiologists did arise among the technologists, the interaction order was not structured so as to perpetuate hostility. Since the spatial and temporal worlds of the radiologists and technologist overlapped more extensively, summoning a radiologist was less burdensome and did not carry the connotations of supplication prevalent in the main department. The novelty and excitement that surrounded the new technology when it first arrived, the alternate distributions of technological and interpretive expertise, and the potential for technologists to observe radiologists make mistakes worked to reduce traditional status distinctions. Not only would radiologists ask technologists for opinions and include the techs in technical and interpretive discussions, but CT techs, specials techs,
and sonographers actually felt that they could offer suggestions when they felt the situation warranted their opinion.

At both hospitals technologists sensed the difference. CT techs, specials techs, and sonographers at Urban all contrasted their relations with radiologists to analogous relations they had experienced in the main department in terms of "teams" versus "employees": "It's more like being the member of a team. In x-ray you're like an employee". Suburban's CT techs claimed that the difference was that radiologists "treated you with more respect than they do over in the main department". Even the radiologist's were aware of the different interpersonal atmospheres. On the way to lunch one day, two of Urban's radiologists were speaking of the difference between the techs in the main department and the techs in CT. One radiologist said to the other, "I see what you mean by the joys of industrial peace". The radiologists went on to say that they did not feel nearly as embattled when they worked with CT techs, specials techs, and sonographers. It would appear then that by creating structural conditions that decreased status segregation between radiologists and technologist and by forcing cooperation between members of the two occupations, new imaging technologies led to potentially more satisfying work relationships for both technologists and radiologists.

Summary

Over the course of this chapter I have examined relationships between technologists and patients, between patients and radiologists, and between radiologists and technologists themselves to discover if their contours were influenced by the technologies around which all
radiological encounters center. Of particular interest has been the question of whether the new technologies shaped role relations in particular directions.

We may dispose of role relations between patients and radiologists in short order. By and large, interactions between radiologists and patients appeared unaltered by any technology except special procedures. Outside of special procedures, the radiologist's contact with patients was always brief, lasting on average no more than six minutes. Moreover, the interactions themselves were predicted on injections, ingestions, or infusions of contrast mediums (either iodine or barium). Hence, the contours of the radiologist's role relationship with a patient were structured by the peculiarities of managing an invasion of the patient's body and not by exiguousness specific to particular radiological technologies.

The special case of a special procedure is perhaps not as special as it first appears. Although the special procedure clearly alters the radiologist's work, and brings radiologists into contact with patients for longer periods of time, the analysis suggests that the technology does not dramatically restructure the nature of the radiologist's relationship with the patient. Rather in the special procedure, the radiologist was most likely to enact the same role as he would in an IVP except for a longer period of time. If there were any differences, these were found in the slightly greater likelihood that the radiologist would learn something about the patient's personal circumstances.

Like the radiologist's, a technologist's relationship with a patient was influenced by the need to manage potentially painful, objectionable, and sometimes untoward encounters. But the technologists
interaction with a patient was also strongly shaped the technology used even though no distinctions marked the newer technological settings consistently from the old. Rather, each technology had its own idiosyncratic effects. In the outpatient areas, electronically and mechanically sophisticated x-ray equipment eased the technologist’s task of manipulating equipment, relieved the tech of having to leave the patient alone, and was therefore more conducive to pleasant encounters. The presence or absence of a remote control booth determined whether the technologist would interact with the patient during fluoroscopy and also shaped the tech’s role vis a vis the radiologist. The risk involved in specials technology generated more personal relations between technologists and patients. Moreover, the tenor of the interactions between patients and technologists followed a distinct series of phases keyed to the technical progression of the work. Ultrasound largely eliminated the need for sonographers to manage risk, pain, or potential humiliation, but in its stead, posed the sonographer with a problem faced by no other technologist: how to manage a context in which information was more open and in which the technologist could be seen to possess "guilty knowledge". Finally, whereas specials and ultrasound led to more personal encounters with the patient, the CT scanner distanced the technologist from the patient. Unlike other technologies, the scanner separated the task of managing the patient from the technical aspects of the exam. The spatial and temporal segregation of the two primary duties of technologist's work led to social and psychological separation between patient and technologist.

Relations between technologists and radiologists were also strongly shaped by the technologies that drew them together. But unlike the
technologists' interactions with patients, the nature of relationships between radiologists and technologists were less dependent on the idiosyncracies of the particular machines. Rather the structure and tenor of the interactions reflected a clear schism between the interaction order of the main department and that characteristic of the newer technologies. While the use of technologies in the main department sustained a rigid, interoccupational status hierarchy, the newer technologies relaxed status differences and thereby led to more open interaction contexts marked by mutual sharing of information and knowledge. In particular, the newer technologies mollified the temporal incongruities between the work worlds of technologists and radiologists, gave technologists an opportunity to observe radiologists make mistakes, and perhaps most importantly, made less prominent the hierarchically nested distribution of knowledge that characterized the main department.

It would seem then, that radiological technologies rather strongly shaped role relations in radiology departments, but in two radically different ways. As tangible entities, as a machine or a set of stylized actions, the technologies had their greatest impact at those points where the technology met the human being. The humans at the interface were most likely to be the patient and the technologist. In the classic sense of man-machine relations, the technology's technical constraints shaped the contours of interactions between those most proximal to the technology itself, again, the patient and the technologist. That the technologies did not similarly influence the radiologist's relations with patients follows from radiology's division of labor. It was the tech, not the radiologist who usually managed the patient in the service of technical and diagnostic aims. Thus, technological variations in
patient-technologist interactions are linked to the attributes of the entity or the action. Since each technology differed in respect to its tangible qualities, their ramifications are unsurprisingly idiosyncratic.

The technologies' power to structure interactions between radiologists and technologists derived from a different source. Most important in this interactional realm was the issue of knowledge and its distribution, essentially a social rather than a technical phenomenon. The critical factor that distinguished all radiological technologies was that they produced information. Moreover, the ability to understand the information translated into power within the technologological and occupational world of radiology. When the technologies and their images were well understood and when the technology required no cybernetic connection between the image and its production, then the technology could support an occupational status system predicated on the segregation of execution and conception. However, when technologies required the operator to understand the images in order to use the technology and when knowledge of the technology and its images was a relatively rare commodity, the traditional status system no longer could operate so rigidly. By investing the technologist with scarce knowledge of the machine and by creating conditions in which the technologists needed to understand what they saw, CT and ultrasound, mitigated against the recreation of radiology's traditional social structure. To these forces were added the fact that in the new technological setting, most radiologists were inexperienced with the images. As a result, even though radiologists still had the right and the training to utilize diagnostic information more fully, the information became more of a
common good as the technologists and the radiologists cooperated to comprehend and make use of the technology and its information. In sum, the new radiological technologies altered certain role relations because they were different types of machines, they altered others because they created new forms of knowledge whose effective use was somewhat incompatible with the former social order.

FOOTNOTES

1. The data represent the proportion of a procedure's duration that the technologist and the patient were in the same room together. Triggering a film or a run was not counted as a separation of patient and technologist.

2. The departmental differences between the duration of contact between technologists and radiologists occur at two points, as can be seen from examining the percentages for each department in Table 6. Fluoro techs at Urban consistently had less contact with patients than their counterparts at Suburban because the fluoro aide performed so many of the more objectionable aspects of fluoroscopy at Urban. Sonographers at Urban had to leave the patient to show films to the radiologists while Suburban's radiologists came to the ultrasound department. Consequently the sonographers at Suburban did not need to leave the patient alone as often.

3. I too found myself using the technologist's vocabulary instinctively. If fact, I did not realize that had adopted the practice until one day I said, "Oh I think I'll watch, I've never seen a 'toe' before." I was overheard by an older technologist who pointed out what I had said and who suggested that I had become as 'bad' as the technologists themselves. While it may be easy for an outsider to criticize the linguistic practice, or any of the other practices that I speak of in the text, I would caution that righteous and moral indignation does understanding little good. If patients did not become "toes" or "heads" and if techs became absorbed in the patients' problems and individuality like much medical work, some radiological exams would become harder, if not impossible, to accomplish. I saw extremely competent technologists slip up and become bewildered when they allowed themselves to identify with the patient. My own preference, as a patient, would be to be treated competently as a piece of meat rather than incompetently as a human being. My sense is that I would be better off in the long run.
4. Several explanations for these misconceptions are viable. First, patients could easily hear barium but not enema and mistake the enema for the swallow. Second, many patients who had upper GI's also had "lower" GI's. These patients could get the two mixed up when they came to the department. As the examples in the text suggest, patients confuse the two barium exams frequently. These explanations do not preclude the more likely one that physicians aren't explicit and that patients don't understand the language in which the exams are explained.

5. There was possibly another less obvious reason for not informing patients about the possible symptoms of an allergic reaction to iodine dye: to keep patients from claiming to have had such reactions in the past. On several occasions patients were shown to lie about having contracted hives from previous injections in order to get out of an IVP or a CT scan. The information was known to be false because these patient's doctors had phoned the radiologists to say that the patient was nervous about the exam because a relative had had a reaction but that they themselves had not.

6. A kidney's not "draining to well" could indicate a number of problems. A stone could be lodged in a ureter. A tumor could be pinching the ureter off. Or, the kidney could have ceased to function altogether, in which case no dye would enter the ureter leading from that kidney to the bladder.

7. The reader should compare this excerpt with the one which appears on page of Chapter 4. The two transcripts depict different technologists and radiologists at work. The striking similarity between the two transcripts provides a sense for how regularly radiological encounters were patterned.

8. It is interesting to note that technologists presented the problem as the patient's and not their own. When blankly asked if they were conscious of and needed to think about the patient's sexuality when doing BE's female techs would even deny that an issue existed. That the stance was false was dramatically demonstrated one morning at Suburban where one morning I asked a new technologist about her tactics for managing sexuality in barium enemas. The tech assured me that the sex of the patient was no problem. A half an hour later the technologist was asked to perform a BE on a 18 year old male. As I was about to accompany the technologist to the room the tech turned to me as said, "I don't think you should come with me, he might be embarrassed." The technologist then approached a male technologist and asked him if he would insert the tip for her. Similarly sexuality was clearly the reason why male techs did not perform BE's at Suburban. When asked why the male techs did not do BE's I was told by several techs that once a male tech had mistakenly placed a tip in a patient's vagina. After that, all males were barred from performing the exam. Similarly, techs were conscious of my
sex also. The only time I was regularly barred from an enema room was when the patient was female and appeared to be in her teens or early twenties -- the age of bracket of most technologists.

9. In the following discussion I shall speak mostly of technologists and patients. The points are equally relevant for Urban's nurses.

10. The different modes of address that sonographers used to speak with patients were made clear to me by a natural "breach" in the normative context of ultrasound. Between the departure of Urban's first sonographer and the arrival of his replacement, an x-ray tech who was being trained in the technology conducted the department's ultrasounds. This technologist tended to relate to patients using interactional ploys common in the main department. When I first heard her call a patient "hon", my reaction was shock. The term appeared so blatantly "out of context," with my then implicit understanding of sonographers work. To check the validity of my discovery, I began to pay explicit attention to how the female sonographers at Suburban addressed patients when doing ultrasound and when performing procedures in the main department. The hypothesis was supported. The women used terms of endearment profusely when doing radiographic work, but dropped them when the transducer was in their hand.

11. In Urban's head scanner the problem of chronic motion was reduced by administering valium to patients who became frightened or moved incessantly when placed inside the gantry.

12. Subspecial procedures did tend to bring radiologists and patients into contact for longer periods of time since their structure was a cross between fluoroscopy and the special procedure. However, in relation to all the other examinations performed in a main department, patients having subspecials made up a very small proportion of the caseload. I have no time data on subspecials with which to provide accurate estimates of duration of contact.

13. Because I had spent three months observing CT scanners at a medical center before the scanners came to Urban and Suburban I was at times able to recognize simple anatomical mistakes myself (for example, confusing a solus muscle for a kidney. Both are round objects that appear in the same quadrants of abdominal scan taken at different levels). Other mistakes were noted by technologists. In either case, I attempted to verify that a mistake had been made. Some mistakes were verified by later showing the image to an experienced radiologist and asking him to name the structure in question. Other mistakes were verified by the later course of the scan itself, as when vessels mistakenly called metastases were shown by contrast injection to be blood filled.
CHAPTER 7
WHITHER THE MACHINES MAY TAKE THEM

At the end of the third chapter, after piecing together a springboard called the "reverberation framework," we plunged headlong off the precipice of theory and speculation into the murky waters of daily life in two radiology departments. For some three hundred odd pages we swam back and forth amid the scenes, actors, and technologies that inhabit those waters gathering together, with what one hopes was a sharp sociological eye, observations on the social patterns of actors and technologies that populated those scenes. Occasionally, we surfaced long enough to deposit buckets of observations and to suggest how they should be sorted before plunging once again to the depths. The time has come to crawl up on shore and pick through our findings to see if the swim was profitable. As we dry off, it may be reassuring to recall why we went diving in the first place.

Long ago, in the first chapter, I suggested that by advances in microelectronics we have slipped into an era of social transformaton somewhat reminiscent of the early industrial revolution: new technologies again promise to alter our world by shaping the places where we work and the types of work that we do. To be sure, I can claim no originality on this score, but I did intend to strike a somewhat different chord by noting that amid the plethora of new technologies stand a handful of machines quite unlike those that have come before. These technologies, which I called "knowledge processors" (a term coined
by a computer scientist named Terry Winograd), do more than manipulate and synthesize previously available information, some actually create radically new forms of information and support new intellectual and pragmatic endeavors. In sharp contrast to most technologies known to alter work worlds, knowledge processors tend to be used by professionals and semi-professionals in settings rarely associated with processes like "automation" and "mechanization". Given their recency, it is not surprising that there has been no research on how knowledge processors might shape the social worlds of the people who use them.

It was to shine some small light into this void that we were drawn to radiology departments where, over the past decade and a half, computer-driven imaging technologies have proliferated at what can only be a geometrical rate. Each of these technologies have allowed the medical community in general, and radiologists in particular, to peer inside the human body in ways long imagined, but never practical. This ability has, quite literally, revolutionized the diagnosis of disease by pictorial images. Moreover, the technologies have led radiology departments rather enthusiastically from a world of predominately mechanical equipment into realms of esoteric electronics replete with the full mysticism and wonder that often attends such machines. Given the rapidity of radiology's transformation, the implications of multiple new semiotic systems for the work of radiologists, and the sudden technological metamorphosis of the radiological technologist's work, radiology departments propitiously offered a unique opportunity for an initial investigation of how knowledge processing technologies shape the social organization of the work worlds they enter.
After reviewing bodies of previous research on how technologies alter workplaces, all evidence pointed to a dictum for profitably formulating any sociological study of how new technologies change the social organization of work, namely: a technology is likely to most strongly and consistently affect the social organization of work at the level of its most proximal users. From this dictum, I argued that larger social changes triggered by a technology must ultimately be traced to the social order surrounding the technology's immediate use. Consequently, to understand what new imaging technologies imply for the social organization of radiology departments and the occupational orders of radiology and radiological technology, one should start by examining the actual tasks that technologists and radiologists perform, and the relationships that arise between radiologists, technologists, and patients as they enact the medical event known as a radiological "examination" or "procedure".

Guided by this conception, I then posed the question the research was to answer: "Are the new radiological modalities embedded in social contexts that are similar to one another and at the same time different from the social milieu surrounding more traditional technologies?"

Unless the question could be answered affirmatively, there would be no grounds for claiming that the new machines have altered the work worlds of radiologists and technologists and hence, by ramification, the social organization of radiology departments and their adjunt occupations. To answer the question, a synchronic comparative stance was assumed. Each technology needed to be compared and contrasted with every other technology to discover if the new technologies grouped together along dimensions of social use that separated them from the traditional
technologies of the main department. It was at this point that we plunged into the social worlds of radiology at Suburban and Urban hospitals in search of information about the tasks and work roles of radiological technologists (since it is they who were closest to the machines) and about the role relations that occurred between radiologists, technologists, and patients. With this said, we may now review what we found in order to draw some tentative conclusions about technologically driven social change in radiology and about the social implications of knowledge processing in general.

What Was Found?

Chapter 5's excursion took us to the radiology departments in search of comparative data on the work worlds and roles of CT techs, specials techs, sonographers, and x-ray techs in the main department. Over the course of the journey, a pattern of results emerged to suggest that the new technologies had created work settings and work roles quite unlike those x-ray techs experienced. Moreover, the differences that appeared when the new technologies were cast against the old became less distinct when the new technological milieus were held side by side. Thus, we were led to conclude that the new technologies changed the work of technologists in a number consistent ways.

One the whole, CT techs, specials techs, and sonographers were more likely than x-ray techs to enjoy a measure of variety in their work. Taking variety to mean the probability that the next exam would be like the last, only when performing routine x-rays could techs in the main department find diversity in their work. Other duty stations were so organized that for significant portions of the day, x-ray work became,
in the techs's own words, "factory-like" in its monotony. Most of the
time, CT techs were probably not much better off. However, when
compared to IVP, mammogram, or fluoroscopy duty, the scanners did offer
a somewhat larger assortment of procedures to fill the tech's day. More
important, though, for the CT tech's sense of diversity was the
likelihood that the day's routine could be shattered at any moment by an
emergency scan or an unpredictable technical malfunction.

It was danger, rather than technological caprice, that spiced the
work of specials techs. The nature of special procedures was such that
any exam was at least liable to minor gliches, and an appreciable number
of procedures became genuine medical emergencies. Thus the course of a
special procedure was never predictable. The sonographer's diversity
was more subtle. In ultrasound every study became unique, for unlike
other technologies, the sonographer needed to locate the anatomical
structure or pathological entity before it could be filmed. Since every
patient's anatomy was somewhat different and since similar symptoms
could accompany different problems, no two ultrasounds could be alike
except in the most global sense that they might share the same name and
send the sonographer looking for the same organs. Thus, not only was
the x-ray tech's work subject to less variety, but when that variety did
occur it was contingent on factors external to the work itself, for
example, the random arrival of patients. In contrast, despite the
idiosyncratic sources of diversity that characterized each of the newer
technological worlds, in each case the variation was more securely tied
to the nature of the work and the technology itself.

The new technologies also freed technologists from the watchful eye
of the department's administrators. While the daily work of the x-ray
tech was subject at any moment to intervention from the Chief or Assistant Chief Technologist, by and large, administrators did not frequent ultrasound, the angio suite, or the CT department. Instead, if anyone supervised sonographers, specials techs, and CT techs, it was the radiologist. However, in most cases, the lack of close supervision even on the part of the radiologists contrasted strongly with the radiologists' willingness to direct and critique the x-ray tech's work. Except for the specials techs and the CT techs at Urban who were rather closely supervised, techs who operated new technologies had considerable leeway to exercise discretion in their daily work. Thus, although the trend was not universally observed across both departments, most technologists in the new modalities worked with far more self-direction than did their counterparts in the main department.

The work worlds of the x-ray tech and the technologist in a newer technology were also distinguished by certain, rather fundamental structural attributes. First, the actual location of the areas were physically distant from one another. Clear sectors of space allocated to the radiology department were set aside for the CT scanner, the angio suite, and ultrasound. While these areas might be near one another, they were separated from the main department by rooms, doors, and corridors that militated against constant interaction between groups of technologists. Second, x-ray work tended to be an individualistic enterprise in which technologists conducted exams by themselves. In contrast, the newer technologies tended to be staffed by teams of technologists who worked in pairs or even triads. Finally, even the temporal parameters of work differed from those of the main department. X-rays techs worked an eight-hour day and a fixed shift work week.
While CT techs, specials techs, and sonographers also worked eight hour shifts that were usually fixed, at least one technologist from each area was "on call" whenever the area was officially closed. Since the newer technologies, especially the CT scanner and special procedures, were important in emergency medical diagnosis, techs "on-call" were often summoned back to hospital after they left. Thus while x-ray techs knew the work day was over the minute they left the department, when wearing a pager work could, at any time, invade the private lives of technologists who operated new technologies.

But perhaps more important than all other distinctions was the fact that CT techs, specials techs and sonographers played work roles far broader in scope than the role of the x-ray tech in the main department. All three groups possessed skills and assumed responsibilities that violated traditional divisions of labor. In the main department administrators were responsible for managing the department's boundaries with the world outside radiology. They maintained and replenished inventories of supplies, transacted business with vendors, and ensured the repair of broken equipment. X-ray tech were minimally involved in the pathways by which supplies entered the department, never transacted business with vendors, and took little interest in mechanical breakdowns after reporting a malfunction's exisstance to the Chief or Assistant Chief Tech.

By comparison, CT techs, specials techs, and sonographers were active participants in the maintenance of their work world. At minimum, these technologists assumed responsibility for monitoring their own use of supplies, keep inventories, and submitted requisitions to administrators when supplies needed to be replenished. In some cases,
however, the techs placed orders directly with suppliers, voiced their opinions on the purchase of new items, and occasionally negotiated directly with vendors' representatives.

The new technologists were even more involved in maintaining their machines. At both hospitals, sonographers, CT techs, and specials techs took primary responsibility for summoning engineers whenever their equipment malfunctioned. Often, the techs made an assessment of the problem and passed the assessment on to a service representative before they bothered to inform either a radiologist or an administrator that a problem existed. Most indicative, however, was the fact that specials techs, sonographers, and CT techs sought to learn the workings of the technology they operated and used this knowledge to diagnose and perhaps even eliminate technical malfunctions. Thus did it appear that the newer technologist's work role assumed elements of the administrator's traditional work.

More distinctive was a loosening of the dichotomy of skill that separated technologists from radiologists in the traditional radiography. If there was one critical move that gained radiology its professional monopoly over the interpretation of medical images, it was the profession's success at barring technologists from knowledge of diagnostic signs. Radiology's traditional division of labor has been predicated on the successful segregation of production and interpretation. The well trained, or at least the well-behaved, technologist created images, but did not deign to read them and certainly did not presume to speak to physicians about the content of a study. As we saw in Chapter 5, the historical separation still ruled the main departments where x-ray techs knew comparatively little about
the images they produced and inhabited a world world that rarely intersected with the world of the referring physician.

On these two scores, the CT tech's, the specials tech's, and especially the sonographer's deviance was extreme. When compared to their counterparts in the main departments, almost to a person, technologists who ran newer technologies knew far more about images than any technologist who worked exclusively with radiography and fluoroscopy. The only exceptions were the inexperienced CT techs who had not yet had time to gain the breadth of interpretive knowledge that a seasoned x-ray tech might have gleaned over the years. The fact that technologists who ran new technologies knew something about anatomical and pathological signs was no secret, especially in the case of the sonographer. In part, because the techs were seen as the second best alternative to speaking with a radiologist and, in part, because the they were more likely to keep their own records and to schedule exams, physicians more frequently sought information from sonographers, CT techs, and specials techs than they did from technologists in the main department. Thus not only were techs in the newer technologies more likely to have forms of knowledge traditionally in the radiologist's exclusive province, but at times they found themselves interacting with physicians in a manner historically forbidden.

As we discovered more fully in Chapter 6, the interpretive skills of the sonographer, the CT tech, and the specials tech both determined and were determined by their unique relationships with radiologists. In the main department, x-ray techs had relatively few opportunities to interact with radiologists outside the brief context of certain procedures. Only when a procedure required a technologist to present a
radiologist with films for charting the future course of an exam was the tech likely to learn much about interpretation. On these occasions, a radiologist might nonchalantly mention an obvious malady while cursorily glancing at the films. Otherwise, radiologists did not attempt to familiarize x-ray techs with information contained in the films.

Far different was the situation in ultrasound, CT, and special procedures where radiologists regularly informed technologists about the pathologies they observed. Whereas the diagnostic education of an x-ray tech took place during unmeditated encounters with radiologists structured as incidents "noting," or "telling," radiologists "taught" the new technologists how to read. The critical difference was that in the first case the radiologist made no overt attempt to engage the technologists' attention and to ensure that they retained the information. However, when speaking to sonographers, CT techs, or specials techs about the meaning of a film, radiologists were often quite explicit about their intention that the technologist learn.

Differences in the nature of interpretive interactions between radiologists and technologists in the various areas could become even more extreme once the technologist had some familiarity with the images. When CT techs, specials techs, or sonographers knew enough about anatomical and pathological signs, it was possible for the tech and the radiologist to carry on spontaneous discussions of images at points in time when images appeared on a video monitor or when techs brought radiologists films. Unlike incidents of telling and teaching in which information flowed in one direction, from the radiologist to the tech, these interactions involved a two-way exchange of opinion. Similar encounters were almost non-existent in the main department.
Finally, because the technologies were recent, it was possible that particular techs might have more experience with the technology and its images than specific radiologists. The situation came about in one of two ways. Either the department hired experienced technologists from the outside at the time the technology was adopted or, radiologists not formally trained in the technology waited for a period of time before learning the modality. In the latter case, even originally inexperienced techs had time to learn so that, at least initially, their familiarity with the diagnostic language might be greater. Given such a distribution of knowledge, it was possible that techs could actually find themselves teaching a radiologist to interpret, a situation unthinkable in the main department.

While interactions between radiologists and technologists around the interpretation of films were far more open in the newer technologies, sharing of diagnostic information was not the only characteristic that set these relationships apart from relations between technologists and radiologists in the main department. In Chapter 6, I argued that when assigned to a new technology the temporal structure of radiologist's work shifted from a polychronic flow to a more monochronic or linear orientation. Since all technologists worked in a monochronically structured world, the temporal order of the radiologist's and the technologist's day were at odds in the main department, but more nearly matched in the newer technologies. The difference meant that it was more difficult for x-ray techs to mesh their world with the world of the radiologist even when such links were crucial for completing studies expeditiously. Consequently, x-ray techs were more likely than techs in the newer settings to find their work stalled by the need to wait for a
radiologist. The temporal discrepancy created situations conducive to misunderstanding, anger, and hostility between radiologists and technologists, since the techs were also pressured by the need to manage a patient who, like the technologist, presumed a monochronic world.

Finally, relations between technologists and radiologists differed by the degree to which the radiologists were willing and able to tell technologists how to operate their machines. Although x-ray techs thought that radiologists were less competent with the technology than they and that therefore, radiologists should remain aloof from the technology's actual operation, the radiologists knew enough to believe that they could provide technologists with technical pointers and, on occasion, even intervene directly in technical matters. Whether or not the radiologists were correct in their assumption (and at times it appeared that they were), technologists never challenged the radiologist's directives regarding a technical issue. Instead, they either did or pretended to do as they were told. A radiologist's direct technical intertervention, by either word or deed, was usually less frequent in ultrasound, CT scanning, and special procedures. Either because the radiologists did not actually understand the technology or because they considered the techs to be experts, they were more willing to grant the technologist dominion over the technology's operation. Moreover, the techs themselves were more willing to offer suggestions and even take issue with the radiologist if the situation warranted. If fact, when technical matters arose, radiologists were likely to consult sonographers, CT techs, and specials techs whereas, in the main department, similar consultations were more often aimed at an
administrator or occasionally an older tech recognized as an individual with technical panache.

Together, the greater openness about interpretations, the more congruent temporal orientations, and the willingness of the radiologists to grant technical expertise joined forces with a trend toward longer interactions to lend a different tenor to relations between radiologists and technologists in the newer technological settings. In the main department, encounters between radiologists and techs were typically brief and characterized by the radiologist's giving the technologist orders. In ultrasound, CT, and special procedures analogous encounters were more frequently longer and marked by sharing of information. Since the interaction context of the main department reinforced hierarchical, superior-subordinate relationship, x-ray techs were more likely to harbor animosity toward the radiologists. In contrast, the interactional context of the newer technologies was characterized by a somewhat greater sense of equanimity between techs and radiologists. Consequently, even though the status system remained intact, the interaction order was less likely to self-amplify temporary animosity into a perpetual phenomenon.

Our review of the findings we dredged from the two radiology departments is now almost complete. To what has been said needs to be added only those observations made in Chapter 6 regarding the radiologist's and the technologist's relationships with patients. By and large, it appeared that radiologists' encounters with patient's were largely unaffected by the technologies. Only when performing special procedures was a radiologist's interaction with a patient appreciably longer or of a different caliber than that found anywhere else in the
department. By contrast, the nature of the technology dramatically influenced the technologist's relationships with patients. However, no clear distinctions could be drawn between patterns seen in the main department and patterns associated with ultrasound, CT scanning, or special procedures. Instead, each technology idiosyncratically shaped the contours of a technologist's encounter with a patient. While special procedures and ultrasound led to more personalized encounters (but for very different reasons), the CT scanner distanced technologists from patients. A similar degree of variation was observed in the main department where relations were less controlling and more congenial during procedures that required no invasion of the patient's body and where the technology eased both the technologist's and the patient's work.

Given the pattern of results it seems reasonable to conclude that the new imaging technologies have indeed altered the work roles and role relationships of technologists and radiologists. Moreover, the differences that distinguish the social organization of ultrasound, CT scanning or special procedures from the world of traditional radiology are similar even though they vary in strength depending on which new technology one happens to observe. The question then, is why did the social orders surrounding the new technologies diverge from the social order enveloping the older technologies? The question's answer requires that attention be paid to an interpenetration of the technologies' technical and social attributes.
Why Did it Occur?

When they first arrive on the scene, new radiological technologies bring to a radiology department two significant novelties. First, is the tangible and physical technology itself. Ultrasound, CT scanners, and digital subtraction equipment introduced radiology to the computer. Whereas earlier technologies were mechanical devices controlled by manual action, computers epitomize the electronic gizmo ruled by symbols. While radiologists and technologists may be technical masters capable of long dissertations on the principles of operating an x-ray machine or fluoroscope, few individuals in a radiology department currently understand computer technology with equal acuity. In fact, most have never touched a computer in their lives. Hence a new modality is at first likely to be a technical mystery.

To the foreign nature of the technology may be added technical complexity. In computerized systems complexity arises from the multiple, tightly coupled subsystems that comprise the machines. In regular angiography complexity arises from the unknowns associated with entering a patient's body and the dangers attending such an act. As complexity and tight coupling increase, technical problems not only become more frequent, but when they arise they are likely to paralyze operations. Since the new technologies are bought singularly, without the redundancy of duplication, technical breakdowns imply the cessation of work until problems are corrected. The cessation of an imaging operation implies backlogs of work, inconvenience for patients, and lost revenues, all of which are unlikely in the main department where redundancy and looser coupling are the rule.
Finally, to be used effectively, the newer imaging technologies require cybernetic links with the images they create. To create a superb radiograph with an x-ray machine, one need not, and in fact, can not rely on films for guidance. The technology is such that the films are seen long after the act of procuring them is over. If the films are marred the whole process must be repeated. In contrast, to operate a CT scanner, to plan the next run in an angiogram, or to conduct an ultrasound exam, one must use prior images to guide the collection of later images. In the newer technologies, successive films are not discrete or independent entitites as they are in radiography. The cybernetic requirements of the newer technologies reaches its peak in ultrasound where the the sonographer's perception of the image and her movement of the transducer are almost simultaneous.

The technical novelty of the technology itself is married to semiotic novelty. New modalities imply a distinctively different system of signs whose meanings must be discovered and learned before competent diagnoses can be rendered. Like most other professionals, radiologists do not learn bodies of literature until they have need to. Therefore, even if an imaging technology has been used long enough to generate a literature, most radiologists will not begin to familiarize themselves with the body of knowledge until the machines arrive and they are in a position to use them. In fact, since the variations of diagnostic signs are mutiple it would seem that learning by doing (or in this case "learning by reading") is the only reasonable approach to mastering the semitotic system. Thus when a new modality arrives in a radiology department, at best, only one or two radiologists, usually newly hired, will have used the technology before.
Together, technical and semiotic novelty combine to reduce most members of the department to the status of novices. At the beginning then the new technology creates a social lacunae within the department were status differences predicated on a division of knowledge are muted. By leveling distinctions based on expertise, the technologies block simple transfer of the traditional social system into the new technological setting and clear social space so that a new social order reflecting alternate technical and social conditions can arise around the technology's use. At this point, two additional social factors join the technical to shape the social order that develops: enthusiasm and the distribution of experience with the particular technology.

The new technology's arrival is surrounded by a level of enthusiasm and excitement. Not only do radiologists and technologists associated with the technology have an opportunity to learn something new and challenging, but the technology itself symbolizes the department's arrival at the current cutting edge of radiological practice. The enthusiasm links with the more level distribution of expertise to create a climate of joint venture: in learning to master the new technological world radiologists and technologists need each other. Consequently, radiologists are likely not only to spend more time with the technology and the technologists, but as fellow learners they likely to talk to technologists as they grapple with the images and their meaning. In turn, technologists are, for similar reasons, willing to share with radiologists what they extract from their experience with the machine. The social press that leads radiologists to teach technologists about the images, is enhanced and reinforced to the degree that knowledge of the images is necessary for operating the technology effectively.
If it should occur that experienced technologists have been hired, radiologists may see them as additional sources of interpretive knowledge and on occasion ask questions accordingly. Even though the situation may be uncomfortable for radiologists and technologists alike and both may therefore seek to avoid interactions that symbolize a reversed status order (See Barley, 1983), the situation is nevertheless still structured to reinforce the technologists' autonomy, discretion, and the perception of their own expertise. If all technologists are inexperienced and if only experienced radiologists operate the scanner, at least for an initial period, the radiologists are still likely to teach the technologists at the same time that they avoid situations of reversed expertise. Hence, while the distribution of expertise may vary the exact form that interpretive interactions will take, they still remain more open than is characteristic of the main department.

As time passes, the technologists associated with the machine become more experienced with the technology's operation and its idiosyncratic requirements. Since no other individuals in the remainder of the department except the radiologists who work with the technology are in a position to understand its workings or explain its failures, the technologists gradually become local experts. Even though their understanding may not always be accurate or extensive, within the department their expertise is rather exclusive. As local experts on the technology the techs are not only consulted on technical matters but are best positioned to expedite the work of engineers who repair the technology. Technical attributes of complexity and tight coupling enhance the critical importance of speedy repair when the technology has no backups. As a result, the technical aspects of the technology may
amplify the importance of the technologist's socially exclusive knowledge of the machine to make their technical acumen even more valuable. By this process technologists in the newer technologies not only become recognized technical experts, but they assume duties which administrators can no longer effectively perform because they do not have a day to day working knowledge of the technology.

Thus the social and technical attributes of the technology interpenetrate to engender a social context characterized by the technologist's enhanced autonomy and importance and by more cooperative and open relationships with radiologists. At the same time, the technology's more idiosyncratic and more purely technical aspects shape the technologist's relationships with patients. Technical factors gain assendancy in this realm for unlike the radiologist, both technologists and patients experience the man-machine interface in a literal sense. Only they are in direct contact with the physical attributes of the technology for the full course of a radiological encounter and must therefore accommodate to the technology's tangible constraints. Since the tangible or physical aspects of technologies are usually unique, the new modalities have shaped relations between patients and technologists in idiosyncratic directions. Hence, it is unproductive to attempt to argue that new medical technologies, in general, either personalize or depersonalize medicine. Rather each technology's affect on relations with patients must be considered independently.
How Inevitable?

In Chapter 3 I noted that the study of any technology's implications for the social organization of a workplace should involve a parallel comparison of two or more organizations so as to enable an assessment of the plausibility of the findings. To this end, the research intinerary was a shuttle back and forth between Urban and Suburban hospitals. Throughout this monograph, when comparing Urban and Suburban, I have noted that the patterns of social change were stronger at Suburban than at Urban, at least in regard to the CT scanners and special procedures. Ultrasound operations at the two sites were nearly alike with two exception: Suburban's radiologists reviewed real time studies and Urban employed fewer sonographers since they performed fewer ultrasound exams.

The differences were most obvious in the degree of autonomy that CT techs and specials techs experienced. Radiologists at Urban were far more likely than their counterparts at Suburban to intervene in the day to day routines of these two groups of technologists. In part, the situation was predicated on three site specific adaptations: (1) the larger role of the nurses in special procedures whose relationships with the radiologists at Urban resembled the relations between specials techs and radiologists at Suburban (2) the fact that Urban hired no new CT techs experienced in body scanning, and (3) the more or less exclusive association of the experienced radiologists with Urban's scanner for the first three month's of its operation. In the the case of special procedures the nurses tended to edge the technologists to the sidelines while in the CT scanner, the distribution of knowledge was such that the
status system of the new department could be more easily duplicated than at Suburban where experienced technologists were employed.

While these site specific adaptations explain why Urban and Suburban were structured differently, they do not in and of themselves explain why Urban's radiologists were more controlling. Even with such structural constraints it is convievable that Urban's CT and specials techs could have been less closely supervised than they were. The situation at Urban can only be fully comprehended when one examines Urban and Suburban as total departments. When compared to Suburban, the level of autonomy for all technologists except sonographers was far less at Urban. For example, when performing fluoroscopy Suburban's techs were subject to the coordinating hand of the person on films and potential critique from radiologists, but they were not under constant scrutiny. Rather, for most of a fluoroscopic procedure Suburban's techs worked independently. In contrast, fluoroscopy at Urban was so organized that throughout the morning technologists were in the constant presence of a radiologist who could at any moment take issue with their work or apply pressure for more efficient performance. Hence, there was evidence that tighter control structures and closer supervision characterized Urban's main department as well.

In part, because of the tighter control structures and, in part, because Urban had a history of labor strife the atmosphere of the two radiology departments also differed. Although tensions existed between radiologists and technologists in the main department at Suburban, for the reasons discussed in Chapter 6, the level of hostility and anger among technologists toward radiologists was far greater at Urban. This tension was maintained by a more complete social segregation of
technologists and radiologists as well as by a self-amplifying loop in which techs responded to control by passively, but aggressively, working to rule. Working to rule, in turn, triggered even stronger attempts to control on the part of the radiologists. Thus a work culture arose in which technologists believed they were thought incompetent and irresponsible. In retaliation, they acted in ways radiologists took to be signs of incompetence and irresponsibility. The radiologists were then more likely to intervene because they thought they saw incompetence and irresponsibility thereby perpetuating the techs belief that they were thought incompetent and irresponsible. Since techs at Suburban, were less likely to act out retaliation, they were on the whole considered to be quite competent.

Thus the cultures of the larger departments infused the new technological settings. At Urban, the specials techs and several of the CT techs had previously been members of the x-ray department. Both they and the radiologists, who also worked the main department, brought to the new settings a perceptual set about the nature of relations between radiologists and technologists. The techs expected radiologists to be controlling while the radiologists thought they had to control. At Suburban, where a larger culture of autonomy existed, the hiring of experienced technologists from the outside solidified and perhaps even amplified the tendency towards autonomous work roles.

The importance the larger radiology department's culture for the development of new technological subcultures is nicely documented by events in Urban's ultrasound department. As I mentioned earlier, after Christmas Urban's original sonographer left the department to assume other employment. Without doubt, this sonographer had enjoyed far more
autonomy than the sonographers at Suburban. Not only did the radiologists not insist upon reviewing his real time work, but he was allowed to write his opinions in the margins of requisitions and to dismiss patients when a radiologist was not immediately available to scrutinize films. In the interim between the first sonographer's departure and the eventual hiring of a second experienced sonographer, the radiologists began to train in ultrasound an x-ray technologist whom they considered exceptionally competent.

As one might expect, given the tech's inexperience with ultrasound, the radiologists began to review her real time studies before allowing her to dismiss the patient. To have done otherwise, to have granted the novice the freedom of an expert, would have been negligence that would have endangered the patients. What was not expected was the sonographer's reaction to the radiologists' attempts to teach her to read ultrasound images and her discovery that the language of ultrasound ambiguous. Perhaps the best example of the technologist's attitude occurred after a radiologists had reviewed a real time study. The radiologist had gone to some length to explain signs on the video monitor. After the radiologist left the room the technologist comments: "Smith will come in here and say what's what. I said, 'How do I know? If you don't know, you expect me to tell you?' Half the time they won't know either, so what's the use?" The comment, which reflected attitudes about radiologists prevalent in the main department, contrasted starkly with the culture of ultrasound at Suburban as well as with the stance of Urban's former sonographer. The x-ray tech who was used to antagonistic relations with radiologists framed the radiologist's attempts to teach as attempts to assert authority, an authority that appeared illegitimate
in light of the radiologist's willingness to admit ultrasound's ambiguity. Relations between the sonographer and the radiologists deteriorated as the radiologists began to question the tech's competence and willingness to accept responsibility. When the new sonographer was hired, the x-ray tech was eased out of ultrasound and relations between the new sonographer and radiologist reverted to an earlier peace. Telling is the fact that the newly hired sonographer, like the original sonographer, had never worked in the main department.

The larger culture of a radiology department may, then, dampen or enhance the dynamics created by the introduction of a new imaging technology. At Urban the patterns of perception and behavior that characterized the larger culture mollified aspects of the social order that the technologies might have otherwise more fully nourished. Nevertheless, as I have attempted to document throughout the monograph the seeds of that order accompanied the technologies even to Urban. We have seen for example that Urban's CT techs and specials techs were more adept than x-ray techs at reading films, that Urban's radiologist's attempted to teach CT techs to read scans, and that techs in all three new technical subcultures had more frequent interactions with physicians. Thus, although existing social orders (which I have called "cultures") may modify the social ramifications of the new technologies, the technologies continue to press away from the traditional forms of organization that characterize radiological work in a main department. Nothing less than an interaction between technical and social forces can be expected when technologies are understood to be social rather than purely physical entities.
Occupational or Organizational Implications

The advent of new imaging technologies and the forms of social organization they inspire hold significant implications for the occupation of radiological technology and even for the medical specialty of radiology itself. As was discussed at the end of Chapter 5, the attributes that characterize the social contexts surrounding the new technologies fertilize incipient occupational identities. CT techs, sonographers, and specials techs are well positioned to recognize that they and their immediate colleagues share a work world unlike that of the main department. The simultaneous perception of social similarities and differences may lead technologists in each of the newer modalities to differentiate themselves from other groups of technologists and to devise an occupational identity by making figural the unique aspects of their technical knowledge and skill. The tendency towards differentiating a work based identity is enhanced by spatial separation from the main department and by temporal demands that allow work to invade private time so that the worlds of work and leisure are no longer clearly separable. If an incipient occupational identity forms, technologists associated with a particular technology may forge a set of beliefs, perceptions and behaviors both related and unrelated to the work itself that are known only to members of the group and that set members even further apart from other technologists. Thus with time distinct technologically driven subcultures may form within the radiology department.

The rise of occupational identities and subcultures around new technologies may lead groups of techs doing similar work at different
hospitals to an awareness of each other. The process will be enhanced to the degree that the skills required to run the technology are rare, not easily learned, and in demand, for in such a situation the technologists gain power in the labor market surrounding the technology. As members of various site specific technical subcultures move from job to job, a network of acquaintances develops, practices diffuse from site to site, and specific operations begin to develop reputations. By such a process can the technology eventually lead to the differentiation of a new semi-profession as has occurred with ultrasound.

The social orders that arise around the new technologies challenge traditional divisions of radiological labor based on the separation of production and interpretation. Since the occupational control system of a radiology department has traditionally been built on a rigid dichotomy, the breakdown of the radiologist's exclusive claim to interpretive understanding and the enhanced importance of the technologist's knowledge of the machine alters the structure of interoccupational relations. Whereas the prior system supported the radiologist's domination of the technologist, the technologically induced reallocation of expertise militates against extreme subservience and moves work relations from the sphere of the "employee-employer" towards the sphere of "a team of professionals". While the radiologist retains a position of higher status and greater expertise, the technologist is empowered so that the status difference is not as great as before. Members of each occupation recognize the others expertise.

The status equalization is initially predicated on two forces: the novice role assumed by both technologists and radiologists in the face
of a new technology and the cybernetic requirements of the technology's operation. To the degree that the initial equalization is predicated on the first the social order is likely to be temporary. As medical schools train more radiologists in the technology, as the diagnostic language becomes refined, and as the initial generation of technologists is replaced by succeeding generations, conditions supporting the alternate social order may disappear and the older order may return. However, the more the boundaries of expertise are made permeable by the cybernetic requirements of the technology, the more likely is the shift in social order to be permanent. In such situations, return to the former order in untenable unless radiologists decide to eliminate the technologists and operate the technologies themselves. Of all the new technologies, ultrasound was found to best exemplify the distinctions between new and old technological orders precisely because the cybernetic requirements of the technology are so extensive that the technology's operation becomes a craft.

The genesis of semi-autonomous, technological orders within the radiology department holds organizational as well as occupations implications. By reducing the technologists' interactions with administrators while enhancing their ties to radiologists, the new technologies engender two worlds of radiology. The first composed of the main department tends towards a mechanistic social structure, while the second, composed of the new technologies, tends towards an organic social structure. Said differently, the main department remains essentially bureaucratic while the newer technologies generate a professional form of organization. The radiologists are the main actors who link the two work realms, but as we have seen, their relations with
x-ray techs are limited. Consequently, from an organizational perspective, it is possible to view the historical accretion of newer imaging technologies as a schismatic process. As it adopts new technologies a radiology department may actually become two departments: one nominally controlled by radiologists and actually controlled by administrators, and a second in which nominal and actual control are reversed.

To the degree that such a schism occurs, it is likely that conflict arise within the department. Technologists working in the main department may look to technologists in the newer technologies and see inequities. Viewing themselves in a have not position, the x-ray techs may even become militant. Such a situation had begun to occur at Suburban just as the study ended. At the time, the x-ray techs had mounted a campaign designed to limit the autonomy and separatism of CT techs who were seen as sharing none of the burdens of the main department's work. Since sonographers and specials techs worked the main department when their areas were not busy and since the CT techs did not, the x-ray techs found allies in the sonographers and specials techs. To solve the problem, Suburban's administrators granted the validity of the inequity and begun to require the CT techs to work in the main department whenever the scanner was undergoing preventative maintenance. As one might expect, the change lead to dissatisfaction among the CT techs who, up to that point in time, had been relatively happy with the state of affairs.
Social Ramifications of Knowledge Processing

It would seem rather premature to draw general conclusions about the implications of knowledge processing technologies for the social organization of work from one study which has concentrated on medical imaging technologies in two hospitals. Like other computer technologies, knowledge processors are a diverse lot. For example, an expert program providing medical diagnoses is fundamentally a different type of machine and likely to be a different type of social object than is a CT scanner. At least on the surface the first would appear to encode existing expertise while the latter, as we have seen, expands expertise. Hence, rather than say what knowledge processors will do, I will conclude by pointing out what they need not necessarily do.

When reviewing previous work on technologically driven occupational change I noted that several authors have speculated that computer based technologies will "deprofessionalize" professional occupations. The deprofessionalization argument is a variant of the deskilling argument which holds that new technologies cheapen the skills of an occupation and therefore lessen the occupation's power. This does not seem to have been the case in the radiology departments. Instead the new technologies created something of a win-win situation for both technologists and radiologists. The individual technologists who operated the new technologies found themselves in an enhanced position of importance with situationally valued knowledge. If anything then, the technologists were empowered relative to their previous status as x-ray techs. At the same time that radiologists may have given up an element of control over the technologists and may have suffered an
assault on the steadfastness of their interpretive monopoly, they gained
by having new diagnostic tools at their disposal. Each technology
brought under the radiologist's professional control a new diagnostic
language and the ability to assess a wider range of disease processes.
As gatekeepers of knowledge produced by the technology, the radiologists
thus became more central to the process of medical diagnosis. The
discrepancy between these results and current sociological thought on
the implications of advanced technologies for the social organization of
work only underscores a point made long ago: no productive theory of the
computer's implications for the worlds of work will be viable until we
have at least first constructed a reasonably sound empirical typology of
the computer's various social uses. Towards that end I offer this study
as one small chip in the larger machine.


University of Illinois at Urbana-Champaign. Oct. 16, 1980.


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