BUILDING AN INFORMATION SYSTEMS DEPARTMENT FROM THE BOTTOM UP: THE EVOLUTION OF MICROCOMPUTERS IN TRINIDAD AND TOBAGO'S MINISTRY OF ENERGY

by

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ABSTRACT

Microcomputers have been introduced into developing country governments since the early 1980s. In many instances, no Information Systems (IS) departments were available to help integrate microcomputers into government ministries. This study examines one ministry's experience with managing microcomputers without the help of a formal IS department.

Trinidad and Tobago's Ministry of Energy purchased their first two IBM PCs in 1983. Today, there are fifteen microcomputers in the Ministry. The central government has provided minimal assistance. Development has been fueled by interested staff members who took the initiative and pushed for the acquisition of equipment and other resources. In short, the evolution of microcomputers in the Ministry has been bottom up.

Many cases written up on microcomputer adoption in developing countries indicate that an IS department in not critical when introducing microcomputers into a ministry. This study shows that for use of the microcomputers to go beyond a basic level, a management strategy and policy guidelines are essential.

Models of information technology growth and end user computing studies frame this study and support the key findings. Two findings stand out: first, a management strategy should be created as early in the integration process as possible; second, focal people vested with authority to carry out computer-related decisions must be recognized, and be able to freely communicate with end users and top management.

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CONTENTS

CHAPTER ONE

INTRODUCTION

Microcomputers have been heralded as a tool that can help development progress at an unprecedented pace. A 1985 USAID report stated:

> Microcomputers . . . represent the first significant technological advance which a developing country can assimilate and exploit with a relatively low capital investment and without extensive prior knowledge or involvement in prior technologies. . . . (Westview, 1986:xvi)

In fact, integrating microcomputers into developing country governments has proven to be more difficult than this quote suggests.

For the last ten years, organizations have been grappling with the issue of managing microcomputers. Microcomputers are the latest tool of non-data-processing professionals doing data processing work, termed end user computing (EUC). Microcomputer use has been largely driven by individuals outside of the information systems (IS) departments in organizations. Because the source of growth has been outside of the IS domain, the role of the IS department in managing the exploding use of microcomputers has been unclear.

In some cases, developing country governments face the issue of defining the IS department's role in managing microcomputers. But in other cases, there is no IS department to turn to as a source of expertise or guidance.

This study focuses on the question, how does a government ministry with no computer management experience manage microcomputers? This question is of critical importance in the context of developing countries because microcomputers may be the only computer resource available. When this happens, microcomputers take on the role of larger systems by managing data and applications used throughout the organization. In an environment constrained by a general scarcity of resources, getting the most out of microcomputers takes on great importance.

The USAID quote was accurate in certain respects. The relatively low price of microcomputers has enabled managers to acquire them without going through elaborate purchasing procedures. In many organizations, individuals with great interest in the technology have taught themselves how to use and maintain the machines.

In developing countries, many hope that microcomputers will help professionals become more productive through increasing the efficiency of processing data and providing new tools to assist them in decision making (Westview, 1986). Reports indicate that microcomputer use has produced gains in efficiency and has assisted in decision making, but what has been documented on managing the technology?

Many studies have been done in the West examining the management of information technologies in general, and microcomputers specifically, within organizations. But in

developing countries, studies have concentrated on the initial stages of adoption; the literature has had little to say on the importance of managing microcomputer use once it is accepted into the organization.

Models of IT Growth and End User Computing Studies

Two bodies of literature from the West set the stage for this study. One of them attempts to explain and predict changes in information technology (IT) use over time. Nolan's (1979, and Gibson and Nolan, 1974) stage theory of EDP growth is one of the earliest and most often cited attempts to create a framework for understanding the management of IT. The model breaks the evolution of the EDP department into definable and discrete stages by using the IS budgetary changes as stage indicators. Various aspects of the model have been criticized (Benbasat et al., 1984; King and Kraemer, 1984). Nonetheless, it remains a useful tool to help frame the analysis of the effects of IT on organizations.

Henderson and Treacy's (1984) model of the management of end user computing takes a different approach than the Nolan model. The researchers identify four basic issues in EUC use. Each issue is of primary importance during one of four stages of EUC development. Four management perspectives are suggested as being appropriate for dealing with each of the four basic issues.

King and Kraemer (1986) identify two theoretical

perspectives that commonly account for dynamics in computing use: rapid changes in technology that lead to new and useful capabilities; and changes in organizations that use computing which alter the context within which computing takes place. King and Kraemer combine the two perspectives to create a framework that analyzes the forces affecting the dynamics of computer use. A four cell matrix is used to differentiate between internal and external factors as well as technological versus organizational factors.

Another set of studies conducted through MIT's Center for Information Systems Research (CISR) addresses the management of end user computing. Rockart and Flannery (1983) interviewed 250 people in seven U.S. corporations to gain a better understanding of corporate time-sharing use. Their recommendations, based on the data and personal impressions, are grouped into three major areas: end-user strategy, support of end users by the IS organization, and control of end-user computing.

Quillard et al. (1983) continued the work of Rockart and Flannery with a study of the use of personal computers in ten U.S. corporations. Their study focused on the users of personal computers (PCs) and the IS department's view of the corporate use of PCs. Their recommendations stress the importance of an EUC strategy, and the roles of IS and end user departments in the management and control of end user computing. The researchers note that their recommendations

are essentially in agreement with the earlier time-sharing study.

The Study

This study looks at the experience that the Ministry of Energy in the Republic of Trinidad and Tobago has had with managing microcomputers (micros). The Ministry had no in-house computers before the first two micros were purchased in 1983. At the time, there was no information systems staff in the Ministry.

Today, there are fifteen micros accessible to everyone in the Ministry, and Ministry staff are in the process of setting up a policy document to manage day-to-day operations and formulate a long-term plan for integrating the micros into the Ministry's operations. System analyst positions have been created and filled by staff members with great interest and aptitude in using the microcomputers.

The central government has provided minimal assistance to the Ministry. Development has been fueled by interested staff members who took the initiative and pushed for the acquisition of equipment and other resources. In short, the evolution of microcomputers in the Ministry has been bottom up.

The Ministry of Energy (MOE) plays a special role in the economy of Trinidad and Tobago through regulating the most important sector of the country's economy, the petroleum industry. Because of the technical nature of the oil

industry, over fifty percent of the Ministry's staff has training in engineering or another technical discipline (Mends, 1986).

The degree of technical expertise makes MOE an exception to the stereotypical, bureaucratic public sector organization. There is a high level of professionalism at the Ministry. Many microcomputer-related developments can be explained by the unique profile of MOE.

This unique profile does not mean that lessons drawn from MOE on managing microcomputer use are not applicable in other cases. Organizations go through stages when new technologies are adapted. Raho et al. (1987) state,

> The key to effective technological assimilation is exercising control over its diffusion through the organization. . . . As the IS role has increased in importance, so has the effort to create a suitable framework to identify and manage particular attributes of an IS . . . (pg. 47)

The experience of the Ministry of Energy shows that for microcomputer use to go beyond a basic level, a management strategy must be developed. The Ministry has passed the stage of experimentation with the technology. Many people are using the micros for word processing, spreadsheet, and database applications[1]. But for the most part, these applications

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[1]The word application is used in many ways in the software industry. Sometimes, an application refers to a software package such as Lotus 1-2-3 or dBase III+. In other instances, an application refers to a program that is being developed using a high level language (e.g., BASIC or FORTRAN), or the result of using a software package (e.g., a spreadsheet or database).

(continued...)

replace work previously done manually, and they are not shared among the technical staff. Shortages of hard disk space and machines were widely cited as the major reason for use not progressing further. But many staff members feel that for use of the microcomputers to go beyond the current level, a management strategy is needed to control and guide growth.

Key Findings

Two key points concerning the management of microcomputer use stand out from my analysis of the Ministry's adaptation of microcomputers. First, the stage at which structure is imposed matters; it is important to create a management strategy as early as possible in the integration process. The experience of the Ministry indicates that the initial components of a management structure should include setting standards for software and hardware, setting a procedure for developing applications and setting work priorities, and creating a mechanism to store, catalog, and maintain applications and data.

The case supports a number of reasons for introducing a management framework early on. By addressing selective management issues up front, patterns that inhibit integration and are difficult to change can be avoided. Duplication of

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[1](...continued)
In this study, an application usually refers to the second use just mentioned. The meaning should be clear from the context of the sentence.

effort can be minimized. Proper programming practices can be put in place. Standards can be set early on to insure that the organization can share information and build collectively for the future. A strategy can be developed to integrate the technology in the most sensible way based on the long-term needs of the organization.

The second point that the case supports is the catalytic role of key individuals. Individuals who act as focal points must be in a position to freely communicate with end users and top management. These focal people assist end users in developing applications, manage day-to-day operational issues, and set examples for staff who are interested in getting involved with the microcomputers. The focal people assist top management by keeping them in touch with all aspects of using the system. Rockart and Flannery (1983) found that end users pleaded for a "focal point" person to whom they could turn with all their requests for assistance. To be effective, these focal people must be vested with authority to insure that decisions get implemented in spite of existing power bases that can sabotage implementation efforts.

Organization of the Thesis

This study is organized into four chapters. Chapter Two introduces the case study. First, a two-part framework used to guide the interviews is presented in a section on the study method. Second, the economy and public sector of Trinidad and Tobago are reviewed. Emphasis is placed on factors that effect the management and development of microcomputers in the Ministry of Energy. Next, the functions of MOE are explained followed by a brief history of computing in the Ministry. Factors influencing the pattern of computer use are discussed followed by a section on the Ministry's effort to manage computing. The chapter closes with a summary of computer use in two divisions of MOE that highlight issues related to managing microcomputer use.

Chapter Three presents the major findings of the study. An analysis of the case begins the chapter. Next, the issue of when to introduce a management structure and what are its essential elements is discussed. Models of information technology growth in organizations cited earlier are used to frame the analysis. Third, the importance of personnel functioning as focal points and the authority required to implement computer-related decisions is supported through examples from MOE. The chapter closes by placing my work within the literature on developing countries and microcomputers.

Chapter Four presents a detailed set of recommendations

and strategies for integrating microcomputers into developing country ministries. A brief analysis of the two CISR studies on end user computing in U.S. corporations introduces the chapter. After the recommendations, strategies being tried at MOE are presented as potential models that other ministries or departments can adopt to further their use and management of microcomputers. The chapter closes with suggestions for future research.

CHAPTER TWO

THE CASE: MICROCOMPUTERS AND THE MINISTRY OF ENERGY

This chapter describes the evolution of microcomputer use in the Ministry of Energy. The chapter begins with the method used to study MOE. Next is a description of the organizational factors within and outside of the Ministry that have helped shape the use and management of the micros. A description of the use and management of microcomputers follows. Detailed descriptions of two divisions that highlight important issues end the chapter.

Study Method

The primary data source for the study was a series of open-ended interviews with eighteen Ministry employees. Initial interviews usually lasted about one hour, with a range from one-half hour to one and a half hours. Follow up interviews were conducted with nearly half of the informants and usually lasted about thirty minutes. The majority of the interviews were recorded via note-taking. Usually, the notes were written up in detail the same day. Four interviews were tape recorded to supplement note-taking. This was done with informants who were difficult to reach and were not readily available for follow-up interviews.

The second source of data was documentation produced within the Ministry. Three types of documented data were

examined: departmental reports, internal memos, and transcripts of speeches by Ministry staff. A third source of data was reports from government agencies involved in computerization of the public sector.

The interviews were guided by broad sets of questions. The interviews were characterized by lengthy answers from informants and occasional direction from the interviewer. The follow-up interviews were used to clarify points; unfortunately, there was no time for informants to review draft forms of the manuscript for accuracy. The Ministry will receive a final copy of the study.

Four interviews were with top administrators. This group consisted of the Special Advisor to the Minister, the Chief Technical Officer, and two division heads (see Figure 1). All four were working in some capacity at the Ministry when the microcomputers were introduced in 1983.

Fourteen interviews were with staff involved in the day-to-day use and management of the technology in five of the seven divisions in the Ministry: Energy Planning, Energy-Based Operations, Engineering and Statistics, Geological and Geophysical, and the Library. Job functions of the informants ranged from department heads to clerk-typists.

Four skill levels that roughly correspond to Gotsch's (1987) four levels were used to select the fourteen informants. The lowest skill level, clerical word processing/data entry level, is self explanatory.

Spreadsheet/database users use standard software packages to generate reports, search databases and perform simple calculations. Programmers develop applications and databases using packages or high level languages (e.g., Lotus 1-2-3, FORTRAN). Systems analysts have a deeper understanding of programming and are involved in organization-wide issues related to the information system.

Outside of the Ministry, five interviews were conducted with top administrators and program managers in four government agencies involved in computerizing the public sector. The goal of the interviews was to understand why the central government did not play a greater role in assisting the Ministry in its computerization effort. These interviews were also open-ended and generally lasted close to one hour.

Two perspectives were used to structure the interviews at the Ministry. One referred to the technology and the details of its use. This approach was based on the information processing perspective of an organization (Crowston and Malone, 1987; Galbraith, 1974,1977; Tushman and Nadler, 1978). Researchers have used this perspective to examine the impacts of IT on organizations through examining the kinds of information the organization uses and the ways it processes the information. This approach naturally led into exploring management of the microcomputers through examining problems associated with using the technology. Broad categories of questions based on this approach were: sources of data,

programming tools used, standards, types of analyzes, types of outputs, users of outputs, and sharing of data.

The second perspective focused on internal and external organizational factors that create constraints or opportunities for developing and managing a computer system. This approach drew on King and Kraemer's (1986) model of the dynamics of change in computing. The model differentiated between influences which are internal versus external to the organization, and influences which are technological versus organizational.

A set of variables from the model that address the "organizational context" were used to guide portions of interviews. The external organizational factors identified in the model are: prevailing economic conditions, legal constraints on operations, sectoral trends (e.g., inter-organization relations, reforms), and vision of sectoral organization/purposes. The internal organizational factors identified in the model are: nature of policy leadership, organizational structure, prevailing political coalitions, managerial style(s), attitudes toward technology and change, policies for managing the technology, personal networks/organization behavior, and general knowledge about how to use technology.

The interviews were conducted between March 15th and April 3rd, 1989. Access to the Ministry was obtained through contacting the Chief Technical Officer (CTO). After an

initial phone conversation, a letter was sent outlining the study and the range of people to be interviewed. The letter stated that potential informants would be based on their position in the Ministry and level of interaction with the microcomputers.

Upon arrival at the Ministry, the CTO directed me to the person most closely involved with the microcomputers in the Port of Spain office, the systems analyst, and the Special Advisor to the Minister. A few staff members were pointed out as people who should be interviewed because of their involvement with the micros. To try and minimize bias, staff members who did not use the micros were sought out. Three interviews were conducted with staff not using the microcomputers. Access to all personnel in the Ministry was exceptional; everyone that I approached readily made time for an interview.

Description of the Country and Economy

Trinidad and Tobago is the most southerly of the Caribbean island states. The country made a final break from British colonial rule in 1962 when the Republic of Trinidad and Tobago was formed. The People's National Movement (PNM) was the dominant political party for thirty years through 1986.

The country has the Caribbean's only significant oil and gas reserves. Oil production and refining have dominated the

economy since the early part of the century. The country benefited from the oil shocks created by OPEC between 1972 and 1982. Substantial foreign reserves were accumulated during those years. The country used its windfall revenues to build an iron and steel plant and develop energy-based industries (ammonia, methanol and urea production). The iron and steel plant has not fared well in recent times due to depressed world prices. High prices for methanol has earned the state owned methanol company a good profit in 1988 (Economic Intelligence Unit, 1989).

Since 1985, the country has experienced serious financial problems and a declining GDP. Towards the end of 1988, the government decided to approach the IMF for assistance to meet its balance of payments debt.

Petroleum still dominates the economy, accounting for over eighty percent of foreign exchange. The government is in the process of building up the country's infrastructure to make it a more attractive draw for tourists, a potentially large source of foreign exchange that has been neglected until recently.

State of the Public Sector

The PNM was defeated in the 1986 elections by the National Alliance for Reconstruction (NAR), a coalition of major parties representing the ethnic diversity of the country. The downturn in the economy and corruption in the

PNM were two major factors that helped defeat the PNM after thirty years in power.

Two of the measures taken by the central government to deal with the financial crisis were devaluation of the currency and restrictions on the use of foreign exchange. The Trinidad and Tobago dollar (TT dollar) was devalued by one third at the end of 1985 and by another eighteen percent towards the end of 1988. Shortages of foreign exchange are threatening the operation of private sector companies as well as restraining public sector expenditures.

Turning to the IMF for assistance has prompted severe cutbacks in the public sector to reduce the deficit of the central government. The government announced a plan in September of 1988 to reduce public sector employment by 25,000 via early retirement, rationalization of temporary appointments, and contracting out of essential services. The public outcry against the plan was so great that its implementation was delayed until the end of 1988 (Economic Intelligence Unit, 1988:12). The government implemented an across the board, ten percent pay reduction in the public sector as of April first 1989, to be in effect for two years. Cost of living allowances also have been suspended.

Under these conditions, it has been virtually impossible to fill existing openings in the public sector. Some public sector employees are performing the duties of two or three positions. In the Ministry of Energy, the director of one

division said, "people have been doubling up, doing a lot more than they have been." He went on to say that creating new positions, always difficult because of the amount of red tape involved, is even more remote at this point.

Another result of the government's new fiscal policies is a shortage of basic supplies and restrictions on buying equipment. In the computer area, this is manifested in shortages of floppy disks and printer paper. It is difficult to get approval for new hardware purchases. A planning officer said the Ministry of Energy has been denied funds for purchasing computer equipment since 1987.

Description of the Ministry of Energy

The Ministry of Energy is the result of an evolutionary process begun in the early part of this century when commercial oil production first began in Trinidad. Through the early 1960s, the government monitored and advised the petroleum industry via departments within several ministries with broad portfolios.

The Ministry of Energy gained autonomy in the spring of 1963 as the Ministry of Petroleum and Mines. During the 1970s and 1980s, the Ministry has gone through a series of name changes that reflected new perceptions of the role of the Ministry as well as shifting political winds.

In spite of the changes in scope, MOE has grown from a staff of fifty-three in 1965 to approximately 225, of whom 137

are professional and technical staff (Mends, 1986). Not all of the 225 positions are filled. This is not due to a shortage of trained personnel, but rather to the government's goal, noted already, of cutting back on public service expenditures to meet IMF requirements. The director of one division said:

> It is difficult to fill positions that exist because of the finances as they are. We have a vacancy, people are leaving us, and we can't even get people to fill the posts . . . because government is happy to get people to go.

The main purpose of the Ministry is to oversee all facets of the petroleum and mining companies operating in the country. In a 1986 speech given at a seminar on the petroleum industry in Trinidad, the current Permanent Secretary stated that

> the primary objective of the Ministry . . . is to insure that Trinidad and Tobago's energy (mineral) resources are identified, assessed, "developed, operated and expanded to their maximum potential consistent with their optimal contribution to the Nation."

MOE is organized into seven divisions (see Figure 1). Six of the seven divisions are located in Port of Spain (PoS). Energy-Based Operations is located in the more southerly city of San Fernando (SF) because of its access to the major oil companies' local headquarters.

There are three general categories of personnel at the Ministry: professional, technical assistants, and clerical. Professional staff includes petroleum engineers (PEs), chemical engineers, geologists, and economists. Technical

assistants are classified as petroleum engineering assistants (PEAs) and as various types of inspectors.

Interviews ranged over five of the seven divisions. Two of them are discussed in detail in this chapter: Engineering and Statistics (Engineering), and Energy-Based Operations (Operations). I found the two divisions representative of the types of data processing done throughout the Ministry. Moreover, they provide a contrast in efforts to manage the integration and growth of microcomputers into the functions of each division. Engineering did not have a clear focal point for the computerization effort; a number of people were involved with developing use of the micros since 1983. Conversely, one petroleum engineer in Operations has been the focus of computerization since the microcomputers arrived at the Ministry.

History of Computing Within the Ministry of Energy

The need to computerize was evident in the 1970s. The major oil companies operating in Trinidad and Tobago were making use of the latest information processing technologies. To conduct thorough analyses of the large amounts of data generated by the oil companies, the Ministry needed its own IT capability. In short, the oil companies were a major external factor that acted as a catalyst to bring computers into the Ministry.

An early attempt by the Ministry's to make use

systematically of computers was via a contract with a consulting firm in 1978-79. The consulting firm was to develop a petroleum database for data collection and retrieval on its own mainframe. Part of the contract was the production of monthly reports that were to be sent to the Ministry.

MOE found this arrangement inconvenient and inflexible. It was clear to a group of engineers interested in computing that they needed in-house processing to provide the flexibility, control and timeliness that were lacking with the consulting arrangement. One of the engineers said it was too cumbersome to make a request to the consulting firm for an ad hoc report or data set. He also knew that many of the tasks performed by the engineers were labor intensive and could be done in a fraction of the time with in-house computers. In 1983, the engineers most interested in computing decided to push for microcomputers (micros) on their own.

Why MOE Chose to be Self-Sufficient

Unlike many of the cases written up in the literature on microcomputers in developing countries[1], the initiative to purchase the micros came from within the Ministry, not from an international agency or outside consultant. This was the

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[1]Hecht (1988) points out that most of the documented cases of microcomputer adoption in developing countries are by consultants who worked on international development projects. The microcomputers were usually included as one part of the project, rather than being the focus of it.

first of many unexpected findings I encountered.

The Special Advisor to the Minister, a member of the initial group that pushed for the micros, cited the technical background of the three or four people initially involved as a major factor in their acquisition. Everyone involved was trained either in an engineering or technical discipline where programming on a mainframe computer was a mandatory component of the curriculum. Moreover, this initial group had studied for at least one degree abroad, either in the United States, Canada, or Europe where access to computers was commonplace.

The Chief Technical Officer (CTO), another member of the initial group, cited personal interest as a major factor: "Out of a general personal interest [in electronics] we developed an interest in microcomputers...We were familiar with the technology and the literature."

According to the CTO, microcomputers were chosen for three reasons. First, they were relatively inexpensive. Second, the engineers felt they had the ability to manage them. This meant that no new positions had to be created to manage and operate the system. This avoided a lengthy bureaucratic process of getting approval for new positions:

> The way the government is structured, to get new staff in a ministry, it had to go to several departments to get approval. . . . It can take you two years or so to get a post approved. . . . We said we don't want to go through that particular hassle.

The third reason cited by the CTO was that the central government could not provide any assistance. The central government's computer agency, the National Computer Agency (NCA), was approached to provide a solution. They could not help because of their own resource constraints, workload, and lack of expertise with micros at the time (see Appendix 2).

Initial Uses of the Microcomputer

Within the same year of 1983, two IBM PCs were purchased by the Ministry. At first, the engineers copied programs from petroleum industry journals to do technical analyses. As their expertise grew, they started to modify these programs and then write their own in FORTRAN or BASIC. My impression was that this was primarily an experimental stage that did not yield wide benefits. Individuals developed useful applications for themselves, but the results were not shared within the Ministry.

In the words of one member of the initial group, the most frequent use of the micros in the early days was as a "sophisticated typewriter." Engineers typically produce reports with a lot of numbers; something typists dread because one mistake can mean a lot of messy changes. Engineers began producing their own reports using spreadsheets that made fixing mistakes simple. New reports were not being generated at this stage, but work previously done manually was produced accurately and on time.

Organizational lines were not important when it came to the microcomputers. Anyone with knowledge, including top management, was approached for help. The early stages of micro use were characterized by a loose, unstructured sharing of skill throughout the organization. A petroleum engineering assistant said the early stages were "a learning process for everyone at the Ministry."

Growth of Use Throughout the Ministry

Another unexpected finding was the tremendous initial, and continued, enthusiasm for learning how to use the micros on the part of the staff, who ranged from top management down to the clerical workers. This enthusiasm was all the more surprising when I learned that gaining computer skills did not help further anyone's career path within the public service. The primary yardstick for promotion in the public service is seniority. For example, regardless of the qualifications of two people in competition for a given position, the one with more years in the public service will get the promotion.

If promotion was not the motivation, why the tremendous enthusiasm? Brodman (1987) cited the importance of leadership messages as one key management factor needed for successful integration. But more than one staff member told me they would have pursued learning to use the micros even if top management did not support them. The key to understanding the widespread desire to learn and use the micros lies in two

areas: the profile of the organization and personal rather than institutional incentives.

Profile of the Ministry and Incentives

Four factors were consistently cited as determinants of the open attitude towards the microcomputers: the technical nature of the Ministry, youth of the staff, small size of the Ministry, and high level of education.

I found a fifth factor to be equally important: slack time. One petroleum engineer assistant told me many staff members do not have enough work to keep them occupied eight hours a day. Slack time gave staff the opportunity to experiment and learn without the pressures of getting other assignments done.

I discovered a wide range of personal incentives for learning the technology: ease of completing assignments, resume building, personal interest, acquisition of knowledge to tutor children, and expanding understanding of the world.

Support From Upper Management

Support from upper management has been behind the computerization effort from its inception. The Chief Technical Officer remembered:

> It was relatively easy to convince our PS [Permanent Secretary], who was our administrative head, and the Minister, to do what we wanted to do. . . . They understood we were trying to do it more effectively,

trying to do it more efficiently . . .

Leadership messages were also evident from the start. The Special Advisor to the Minister, a staff position reporting directly to the Minister, was the initiator of in-house courses on computer literacy and applications in the Port of Spain office.

Upper management support was critical in the creation of a systems analyst position in 1986 and in supporting reorganization through unorthodox channels. This has been particularly important because of the central government's preoccupation with reducing the size of public sector employment.

There was no pressure from top management to attend computer courses or integrate the micros into day-to-day work. But anyone who was interested in learning and using the technology was encouraged to do so on their own using the Ministry's computers.

Training

The early users were engineers who built on their mainframe backgrounds to teach themselves how to operate, program and maintain the micros. The lack of assistance from outside organizations was a surprising finding. I did not expect to find the expertise in-house to decide on appropriate purchases, develop applications and to work on the hardware. The CTO recalled,

> In the early days, we did a lot of experimentation. We said that if it [a microcomputer] went bad we think we know what to do; we know how to change chips.

The great demand for computer literacy instruction prompted the Special Advisor to the Minister, a member of the initial group, to develop an Introduction to Computers course as well as an Introduction to PC-DOS in 1986. At first there was some apprehension among clerical staff, primarily due to a fear of not being able to understand the technology. Once they got over that initial fear, they became the heaviest users and most vocal supporters of the technology.

The courses were given during regular office hours at Port of Spain. The introductory courses were one day sessions. As interest grew, courses were developed for specific applications (Lotus 1-2-3, dBase III+, word processing) and programming in BASIC. Applications courses ran for two months, with one or two half-day sessions per week. A separate, but similar set of courses were developed in San Fernando by a petroleum engineer.

Factors Influencing the Pattern of Use

There is wide agreement among department heads interviewed that even today, the bulk of work done on the micros is word processing. Some people were disappointed with this, hoping that spreadsheets, database applications, and development of programs would account for more usage.

Virtually all clerical staff are using the micros at this

point. The mechanism for creating documents is a major factor in the intense use by clerical staff. A document remains in draft form while it is reviewed by a number of technical people. This leads to a large amount of updating, and time on the computer, for each document. The relative ease of learning to use word processing packages is another major reason for its widespread use.

Outside of clerical work, spreadsheets are used extensively by engineers and petroleum engineering assistants (PEAs) to generate reports. One PEA updates six tables on a weekly basis to produce operations reports on oil production, drilling, East coast gas production, refinery throughput, petrochemical production, and natural gas utilization. 1-2-3 is also used by many engineers to generate graphs for reports.

Organization of the Hardware

Currently, the Ministry has fifteen IBM and compatible machines spread across two locations (Port of Spain and San Fernando). The SF office has four machines. One machine is the server for a software network with three dumb terminals attached to it. All but one of the machines in San Fernando is located in a computer room. The other micro is in the office of the petroleum engineer who has assumed systems analyst responsibilities. The six common machines and terminals serve a staff of sixty personnel.

In Port of Spain, eleven micros are distributed among the six divisions: three in Energy Planning, three in Engineering, two in Geological and Geophysical, one in Accounting, one in the library, and one for the Permanent Secretary. One machine in Engineering is dedicated to the systems analyst. Another machine in Engineering is the server for a software network with three dumb terminals attached. The thirteen common machines and terminals serve a staff of 165.

The goal at each location is to use each networked set of terminals exclusively for word processing. The idea is to free up the other machines for applications and database development because of the heavy use of the microcomputers by clerical staff for word processing.

Major Constraints

Among top management, the major constraint mentioned time and time again that is preventing greater use of the microcomputers for other applications is lack of machines and disk space. Financing was universally cited as the root of the problem among the informants. Among lower level staff, there was uncertainty over whether it was exclusively a lack of machines that constrained using the micros for non word processing applications.

One PEA in Engineering who agree with top management said:

> A few people use it constantly. There is no time for people who want to experience it for the first, second or

> third time. . . . Especially in this section [statistics], there is a lot of data on the PCs . . . It is difficult to go and use the spreadsheet or the database program because it ties up the whole word processing area . . . There is only one dedicated PC for our use . . . We do need a lot more machines that people can use actively.

The director of the Geological and Geophysical division cited inadequate processing capability as a constraint:

> I think people have tapered off in the amount of analyses that they do because I think they are seeing out there software to do more . . . and the machines we have can't do it. They get frustrated and they just don't do as much as they want to.

Another PEA in Engineering felt that the problem was not access to a machine, but a lack of access to data. She has been prevented from using the micros because another PEA in the division controls all the data and does not support other people using them. A planning officer in Energy Planning did not feel that access was a problem at all. She felt that if you really wanted to use a micro, you could ask the person on it to get off the machine[2].

There was wide agreement that lack of hard disks has been a major constraint to developing applications. Only five machines have hard disks[3]. Because there is virtually no

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[2]The general policy that has been adopted in Port of Spain is priority work has precedence. But it is up to the potential users to determine which work has a higher priority. Not everyone that I interviewed felt that this was a good way to manage computer time.

[3]It seems that timing worked against the Ministry in the purchasing of hard disks. My speculation is, by the time they realized how essential hard disks are, the central government had cut off all requests for new capital expenditures.

centralized medium for storing databases and applications, technical staff members have tended to develop small databases or applications to fit their immediate needs. The information is stored on floppy disks, and tends not to be documented, shared, or maintained properly.

Another constraint has been a lack of knowledge needed to develop advanced applications. A small number of engineers and PEAs throughout the Ministry have had the enthusiasm and ability to teach themselves programming (e.g. a high level language or dBase III+ language). These have tended to be the personnel that everyone goes to when they have a problem.

For the staff members who have just had the introductory courses, a more structured approach is required to help them integrate the micros as more than word processors. An inspector in San Fernando told me that after the computer literacy course, he did not know enough to make use of the micros. He felt hands-on experience is essential to translate classroom knowledge into working knowledge.

Staggering Use

In Port of Spain, experimental arrangements that allocated computer time between departments were tried, but failed. The systems analyst said the pattern of work was too inconsistent to efficiently allocate time in set blocks. One department would need a few machines for priority work while the department that had access did not really need them.

The current arrangement is first come, first served. If someone has a pressing job, the person asks the current user for the machine. Some staff feel that this contributes to the micros being used primarily as word processors. The priority system has the potential of preventing novice users from gaining hands-on experience in new applications. For example, according to one senior engineer, some engineers who consider using the system see that the terminals are occupied and therefore walk away. They do not ask the people using them, what are you doing? It seems that the engineers assume they have a lower priority than people already on the micros.

Managing Computing

During the initial phase of introducing micros into the Ministry, there was no need for a formal management structure because only four or five people were using the machines. The Chief Technical Officer, a member of the initial group of users, said:

> About two years ago [1986], what we decided to do as we all moved up the system in a sense, we realized that we couldn't really spend as much time in the micros anymore, other people had to do it, and therefore that's when we tried to get a systems analyst, tried to get other people to do some training. Then we decided to do a computer management group which would oversee the development of it.

The Computer Management Committee (CMC) was formed to manage the overall computer needs of the Ministry. The CMC consists of representatives from each department (typically

ones with the most computer experience), the systems analyst and the Special Advisor to the Minister. The committee meets once a quarter. In addition, in May of 1986, "six computer room coordinators" were designated to provide a higher level of service and act as liaisons to the CMC[4].

Committee duties included conducting product evaluations and developing course curricula. As the need became clear, the CMC began to take on operational issues that were not being addressed elsewhere.

An example is standardization of software packages. Standardization became a priority as more people began using the micros and new versions of software came onto the market. It was too inefficient to train people on different packages, plus it was difficult to share work. At one point the Ministry was using word processing packages PFS:Write, WordStar, WordStar 2000 and WordPerfect. The CMC decided on WordPerfect 4.2 as the standard for the Ministry.

Some committee members voiced dissatisfaction with the CMC because it started to take on too much and consequently lost its focus and effectiveness. Operational issues were not being handled well, if at all. To address this issue, the

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[4]A memo circulated to all staff stated the main function of the coordinators was to take care of administrative matters associated with machine availability, software use, and computer supplies (printer paper, diskettes and printer ribbons). In fact, these people took on much more responsibility. Because of their skill levels, they assisted in solving user problems and gave advice on developing applications. Two of the six became the systems analysts in PoS and SF.

Computer Policy Committee (CPC) was formed to create a policy document to manage day-to-day operations as well as create a blueprint for computer development into the next century.

Policy Problems Being Addressed by the Computer Policy Committee

The major issues that the CPC is addressing are a standard for developing software, a mechanism to set development priorities, a system to manage storage of programs and data, mechanisms to enforce policy, and the physical configuration of machines.

The pattern of development until now has reflected the lack of a structured approach. The systems analyst in Port of Spain was particularly frustrated by the pattern of development since she often has to fix the results of poorly thought out applications. She said typically an individual gets an idea to use the micro, then he or she goes off and tries to develop a spreadsheet or database using whatever knowledge they have. She feels that this creates problems: (a)there is a lot of duplication because no one is aware of what has been done; (b)poor choices are made either in selecting a development package or language (e.g. 1-2-3 vs. dBase III+) or in the basic design of the application due to lack of knowledge; and (c)applications are not designed with the organization in mind. An individual might be working on something that, with some modification, could be useful to

others in the Ministry. Yet no mechanisms exist for communicating this opportunity. Work is typically not documented, making it difficult for others to use.

Lines of communication between levels of the organization are not addressing the needs of everyone who wants to use the computers. This has resulted in frustration among some staff members because their ideas are not being heard. In Engineering, one PEA has given up on trying to use the micros because she feels top management does not understand her needs.

A related problem to developing applications is the shifting of staff within and between ministries. A standard policy of the public service is to move personnel around regardless of what they are involved in. A few officers mentioned that this has resulted in development efforts being partially completed, then abandoned. This is another reason why documentation was stressed as being important. If a piece of work is well documented, it will be easier for someone else to pick up the work.

The evolution of computing has also created a problem in managing data. Many people seem to consider their disks personal property. The Chief Technical Officer said:

> I think there is still a bit of resistance . . . whether it is ideal to have a [central] database that people are able to access. . . . Because of the way we have evolved, [people] kind of keep their data to themselves . . . We haven't been able to share data . . .

One planning officer attributes the resistance to the power

inherent in controlling a set of data.

Another restriction against sharing work is the lack of a central database cataloging all computer work. Both systems analysts (Port of Spain and San Fernando offices) cited the lack of a database as contributing to duplication of effort. For example, both offices were working on a production database at the same time.

In PoS, there have been problems in the past with departmental directors not paying attention to procedures set by the CMC or SA because of the lack of an enforcement mechanism. One example cited was a division director "borrowing" a machine while one of his own was broken and the SA was on vacation. It has been extremely difficult getting the machine back from his area.

The lack of hard disks and networking of the dedicated machines are the major hardware problems that the CPC is addressing. It is widely recognized in the Ministry that this is holding back development of the system. As the CTO put it:

> We recognize that we need to have a much larger memory capability; a hard disk that has access to much more information to be able to disperse it throughout the system.

Users do not manage their data and applications efficiently. A few managers said backups are not done properly and many diskettes contain old versions and unused files.

Uses in Specific Divisions

This section gives detailed descriptions of two divisions in terms of their function, staff profile, sources of data, and use of the micros. These profiles stress the issues of management structure and procedures.

Engineering and Statistics

Engineering and Statistics is divided into three sections: reservoir, gas, and records and information. The division is responsible for monitoring production practices, approving programs for secondary and enhanced oil recovery and gas utilization, assessing reserves, evaluating oil properties, and providing production forecasts. The department generates reports on production that are widely distributed throughout government (Central Statistics Office, Central Bank, Ministry of Finance) and to international journals.

The division is made up of three types of personnel: petroleum engineers (PEs), petroleum engineer assistants (PEAs), and clerical staff. Both the PEs and PEAs are subdivided into three grade levels. Because there is no IS group, the systems analyst reports to the senior PE in charge of records and information (see Figure 1).

The primary data source is the oil companies operating in Trinidad and Tobago. The Ministry has a set of standard forms that the oil companies fill out, usually on a monthly basis, covering all activities associated with the industry.

Currently the data transfer is manual. Ministry personnel type in data from the standard forms into the micros. The systems analyst is currently working on transferring production data from the companies to the Ministry on floppy diskettes.

There is a wide range of computer applications in the department. Besides word processing, databases are being developed to track production and drilling information. Spreadsheets are used extensively for engineering calculations, forecasts, and generating graphs and reports. A small number of engineers perform sensitivity analysis to determine the importance of variables in their forecasts. One senior engineer uses a spreadsheet to produce a monthly forecast on gas prices[5].

To overcome the constraint of the hiring freeze, some PEAs' job responsibilities have changed dramatically. In particular, one PEA II has taken on the management of an extensive set of data on production and drilling. This person was pointed out to me by senior people as someone I absolutely would want to talk to. It was clear that this individual was highly thought of by his supervisors.

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[5]This report was produced manually before the micros arrived. The engineer said that, previously, the task was tedious and time consuming. Many applications on the micros were formerly done manually. As people became more adept at using software, new applications followed. For example, in Energy Planning, a model has been developed that enables planners to forecast oil revenues based on projected tax structures and other factors.

This person was not as popular with his peers. Apparently, once this PEA II gets hold of a job, he does not let it go. It has gotten to the point where some staff members have given up on trying to develop their own skills because they cannot get access to data. The PEA II keeps the data disks locked up in his desk and does not accommodate other people's requests.

When I asked one of his peers how this situation developed, the response was, as far as management was concerned, their work was getting done by the PEA II, so there was no need to question what was going on in the department. When management was queried about any communications problems with lower level personnel, the response was there is no problem with communication; the only problem they acknowledged was the lack of access to the machines.

Some technical staff members are trying to develop applications on their own, but it is not considered high priority work. For example, one PEA III has had trouble finding time to develop a project he initiated two years ago. He is developing a fluid injection[6] database using dBase III+. Only one of five modules has been completed. He said, "As soon as I start to pick back up on my programming, something else comes up."

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[6]Fluid injection is a secondary recovery method used in oil production. For example, water and steam injection are two techniques used to force oil out of an area.

Another problem mentioned by a number of people was evident in Engineering. Even though use of the micros was encouraged by top management, there was no pressure to use them or mechanism to make it happen. Personal initiative was expected, but personal initiative was not always sufficient. One PEA III said, "it depends on your immediate supervisor to allocate tasks for you to do on the PC."

If the immediate supervisor of a section was not interested in using the micros, then the entire section did not use them. For example, the PEA III in charge of the statistics section does not use the micros[7]. Consequently, people under her do not use them in their day-to-day work.

The current head of the gas section told me of a spreadsheet he developed to track gas production five years ago. The spreadsheet cut the workload from two man-weeks to two man-days[8]. A subsequent head of the section was not interested in using the micros. The gas production spreadsheet was set aside and the manual system re-adopted.

In spite of the problems just mentioned, there was still a high level of enthusiasm for using the micros among

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[7]This information is from secondary sources; the PEA III was not available for an interview.

[8]What did the section do with the extra time? A broader question is, how did the Ministry make use of the time saved through using the micros? There are two standard answers. For professionals, the time is used to work on other projects. For clerical staff, it means the organization can do the same amount of work with fewer of them. The question is important, but it is not addressed in this study.

engineering staff. One PEA II feels, however, that whatever she learned from the courses has been lost due to lack of hands-on practice. There was a lot of frustration among other staff, but the frustrated are waiting for the policy guidelines to be put in place in the hopes that their needs will be addressed.

Energy-Based Operations

Energy-Based Operations closely monitors the day-to-day activities of the oil companies to insure that the companies are meeting their targets and following appropriate safety practices. The division also helps plan the development of the petroleum industry. Operations is located in the south-eastern city of San Fernando near the oil companies and production sites.

The division is organized into three sections. One petroleum engineer is assigned to each oil company to oversee their activities. PEAs work under the PEs to collect data and summarize data requested by the engineers. In the second section, chemical engineers monitor the petrochemical plants and the one refinery operating in the country. In the third section, mechanical engineers are responsible for safety issues. Petroleum inspectors do the actual field work for the last two sections. The division has sixty staff members. The largest group is the petroleum inspectors (twenty-four) who are subdivided into five groups.

Most of the data used by the division is generated by the oil companies. As in Engineering, standard Ministry forms are filled out by the companies and sent to MOE. There is no electronic transfer of information.

Word processing also dominates the computer time in Operations. But unlike Port of Spain, one petroleum engineer has been the focal point of the microcomputer integration effort from inception. His job has evolved into a systems analyst position. In February of 1989, a memo was circulated in the division that announced the creation of an Information Systems (IS) Unit. The petroleum engineer has been assigned to lead the unit. His title (internally only) has been changed to Petroleum Engineer II/Information Systems (PE/IS).

Through the PE/IS's experiences teaching introductory courses on micros and PC-DOS, he (along with his supervisor) came up with a strategy to introduce the micros into the day-to-day work of the division.

After the introductory courses were given, no one made use of the micros. People could not make the connection between their work and how the microcomputer could help them. The PE/IS designed a series of courses that specifically addressed the different job functions in the division. For the clerical staff, the course was on word processing.

> As a result of those classes, the typists were amazed by what a word processor could do. They immediately came clamoring by my door.

After a few years of experience, the PE decided to

introducing the micros into different groups on an interest basis.

> I computerize by interest. They express an interest and they are enthusiastic. I take them first, this [is my] priority [system] . . . other people get interested afterwards.

Once interest is expressed, a project that will result in a useful piece of Ministry work is used as the teaching mechanism. For example, one group of inspectors is currently working on a project with the PE/IS to create a database of all petroleum storage facilities in the country. The inspectors are doing as much of the development as possible, and are learning how to use the micros at the same time.

Another part of the strategy in Operations is to centralize as many aspects of computing as possible. A memo was recently sent out recalling all diskettes to the newly formed IS unit. All electronic Ministry work will be controlled and maintained by the unit. Individual users will no longer maintain their own copies of data and applications. The PE/IS explained the rationale of the system this way:

> Right now chemical engineers have their diskettes thrown in a draw locked up. I can't access them, nobody can access them sometimes when it is necessary to access them, and that's a big problem. Also they don't have proper backup mechanisms, they don't have proper housekeeping mechanisms. They have their diskettes cluttered with a whole lot of trash . . .

Even though engineers dominate the division, they are at the end of the list for computerization. Off-the-shelf engineering packages have been acquired, but engineers have

not made use of them. The PE/IS has found that

> the programs are too simple and some of them are not geared toward the local environment. . . . Software like log analysis, which is very good for engineers to calculate water saturation is an involved calculation with a lot of interpretation. We have a program called Log Comp. But the parameters that are built into a lot of these programs are not suitable to local parameters because . . . the geology of Trinidad is different, the soils are different, the factors you'd use here are different. Also an engineer is hesitant to use a package plugging in figures and getting out figures and he doesn't know the assumptions that are made. . . . For these reasons the use of these programs by engineers has not really taken off.

For now, the engineers use 1-2-3 for making small computations or creating graphs. They typically type in their data for each application. In the PE/IS's opinion, substantial databases have to be in place before the engineers can do any sophisticated analysis. That is why a major focus is on developing a petroleum database. Once the database is operational, new applications will be built on this foundation.

Access to the machines has not been a problem. The network (same as the one in PoS) is dedicated to word processing. To date, demand for other work has not been high enough to overload the two stand-alone machines located in the computer room.

As in Engineering, jobs have been transformed without any changes in title or salary. The PE/IS is training a PEA II to be his assistant. She is now reporting directly to the PE/IS, bypassing the standard lines of authority. The IS unit is

being built up without going through the normal channels for approving new positions or groups.

The PE/IS and a few others in Operations have used the micros for sophisticated programming and analysis. For example, the PE/IS is developing a financial model that computes the net present value for an oil company's total worth based on ten-year forecasts of revenues and expenses.

Even though the majority of staff is using the micros primarily as word processors or desktop publishing stations, the benefits of using them are substantial and interest still high. The PE/IS feels that the improvements in efficiency and meeting completion dates of assignments has shown staff the benefits of computerization. As mentioned in other divisions, it is recognized that the integration of the micros is an evolutionary process that will take time. This insight reduces frustration as the sections wait their turn in getting detailed instructions from the PE/IS.

CHAPTER THREE

EARLY IMPLEMENTATION OF MANAGEMENT GUIDELINES AND FOCAL POINTS: TWO KEYS TO INTEGRATING MICROCOMPUTERS INTO MINISTRIES

This chapter presents the two central findings of the study. The chapter begins with an analysis of the case. The presentation of the findings follows. The chapter ends by placing my work within the literature on microcomputer adoption in developing countries.

Analysis of Computing in the Ministry

The introduction of microcomputers into the Ministry has been extremely successful. A recent memo that reviewed the development of computerization in the Ministry summed it up this way:

> To date, several manual systems have been replaced by spreadsheets. Additionally, quite a few databases have been spawned and are being used for a variety of applications. There is also, almost total computer literacy in the Ministry. Now, practically all members of staff are at least familiar with computers. This is especially so of the typing staff, who have very quickly come to appreciate the superiority of word processing in doing their jobs.

But the data show that not everyone that could be is using the micros, and that use is mostly at a basic level. Word processing and report generation via Lotus 1-2-3 dominate use. No substantial databases are operational. Only a handful of sophisticated users are developing models to do

intricate engineering, economic, and financial analyses.

A shortage of machines and hard disk space is one reason that was cited for this pattern of use. Another reason was lack of direction at a high level. In the words of one petroleum engineering assistant, there "never really [has] been a set of major programming within the Ministry, except for now." By this he meant, for the most part, people have gone off on their own; there have not been any major projects initiated by a higher authority. Others felt that using the micros for sophisticated purposes has to develop gradually; first, a basic level of computer literacy must be achieved. The memo on computerization stresses the importance of policy guidelines:

> We are now at a stage where, by hindsight, we can understand our mistakes and oversights and are attempting to correct both. . . . One of the worrisome oversights is the non-existence of a policy on computerization for the Ministry. Yet another topic of concern is the re-definition and/or re-emphasis of the Computer Management Committee. . . . It seems that the committee has lost some of its original direction and effectiveness. . . . Other inadequacies and ambiguities exist in the system and these are perhaps direct results of the lack of a structured and co-ordinated approach to the development of computerization in the Ministry.

External Factors

Two major external factors that have influenced the direction of microcomputer development in the Ministry have been the bureaucracy of the public service and the state of the economy. The amount of time and effort required to get approval for new positions or a reorganization of a department

pushed the initial group of engineers to manage computing on their own. The poor state of the economy has resulted in no new funds for capital expenditures from 1987 through 1990 from the Ministry of Finance. The Ministry has not been able to upgrade its equipment, especially in the area of hard disk storage capacity. Purchasing adequate levels of basic supplies has been a problem as well.

It is difficult to say how microcomputer use would have evolved in the Ministry if professional IS help was used initially. Early on, an outside consultant could have been hired to get around the problem of creating new positions. But that was not part of the engineers' plan. One of the members of the initial group characterized the early effort as a "poor boy's operation." Perhaps if an expensive outside consultant had been included in the initial requests for equipment, it would have been denied.

It is safe to say that computing would have evolved differently if a multiple-user, shared-data system had been put in place. But the networking technology was not available for microcomputers when the Ministry was making its major purchases of microcomputers. At this point, the Ministry of Finance is not willing to allocate funds for upgrading the system.

Port of Spain and San Fernando

A sharp contrast between the Port of Spain (PoS) and San Fernando (SF) offices emerged from the interviews. In Port of Spain, there is no strategy to guide computing. One engineer said "pockets of computing" exist throughout the divisions. A lot of people are competing for scarce hardware resources. The allocation of machines in the divisions has resulted in some divisions having a disproportionately high machine/people ratio. Even though people are free to walk into another division to use a micro, it does not happen often. One division director said, "Some people have a problem to leave the department and go outside . . . they may want to be around the office for phone calls or whatever."

The number of machines available to staff in Engineering has significantly restricted use, particularly for experimentation. But another factor in the problems that Engineering has experienced is personalities. One petroleum engineering assistant has created a bottleneck by hoarding data. Lack of interest on the part of some section leaders has prevented their staffs from using the micros.

In San Fernando, one petroleum engineer has taken responsibility for guiding computing. With the support of the division director and his department head, the petroleum engineer/information systems (PE/IS) has mapped out a strategy to create an IS unit and integrate the micros into the daily work of the division. The PE/IS realizes that a major reason

for his power to implement policy is the small size of the division. He said of Port of Spain, "I know they have problems, they deal with a more complex human environment."

Even though a computing strategy exists in San Fernando, they have experienced many of the same problems as Port of Spain in managing data and setting development priorities. The common problems, most forcefully expressed by the systems analyst (SA) in PoS and the petroleum engineer/information systems in SF, support the following findings.

The Importance of Early Implementation of Management Guidelines for Computing

The first central finding of the study is the importance of creating a management strategy as early in the integration process as possible, but not to the extent of creating inflexible control mechanisms. Two questions follow: First, how early? Second, what are the components of the management strategy? Two models of IT growth are helpful in answering these questions.

Models of IT Growth

Models of IT growth suggest the answer to the question of how early depends on the profile of the organization. The data support this point. In addition, the data indicate that constraints matter as well. Two models of IT growth in organizations present a jumping off point to explore this

question.

Gibson and Nolan's (1974) widely cited four-stage model of EDP growth is an early attempt to create a framework for understanding the management of IT. The model uses the EDP budget as an indicator of transition points between stages. Nolan (1979) expanded the model to six stages to account for new developments in hardware and software technologies. The first three stages, which are the focus of this analysis, are essentially unchanged.

The first stage of the model is an initiation period characterized by a lack of management attention and controls. The second stage is characterized by a rapidly expanding EDP budget. Top management is still not concerned with managing use of the technology. It is not until the third stage, formalization, that management recognizes the need for controls and setting priorities in developing applications.

A second model that attempts to identify stages of computer integration is Henderson and Treacy's (1984) model of the management of end user computing. They identify four basic issues in EUC use: support and education, technology infrastructure, data management, and evaluation and justification. They stress that each issue is of primary importance during one of four stages of EUC development. Four basic management perspectives are suggested as appropriate for contending with each of the four main issues.

The first stage is dominated by an implementation

perspective. The focus is on increased usage of the technology and user satisfaction. Control mechanisms are minimal. Centralized help centers and the use of roving consultants provide organizational structure. The second stage is characterized by a marketing perspective in which "market penetration" of end user computing throughout the organization is a primary objective. The organization concentrates on influencing choice and transferring skill. This stage lays the groundwork for the third stage by creating a de facto standard.

In the third stage, operations, integration and managing information technology is the primary objective. The structure implied by this perspective is a centralized planning and policy organization. The central body would also monitor and advise on the operations of major end user projects. The fourth stage is dominated by an economic perspective that strives to maximize the organization's return on investment in information technology.

Even though the emphasis of the two models is different, the first three stages basically follow the same pattern. In the first stage the technology is introduced into the organization. The second stage is characterized by expansion with few management controls. It is not until the third stage, after use has reached a high level of diffusion, that formal controls are called for.

The Timing of Implementing Controls

The experience of the Ministry of Energy with the integration process suggests, in contrast to the two models just discussed, that it is better to introduce controls before microcomputer use has expanded and a significant number of applications have been developed. If the organization waits until expansion has taken place, chances are good that non-standard work has been developed and poor practices have become routine that will be hard to change. Applications might not be developed with the interests of the total organization in mind and duplication can occur. In short, the benefits of using the micros may be restricted if guidelines are set after diffusion has occurred.

Numerous examples from The Ministry illustrate why waiting until use has expanded is not the best time to implement controls. For example, the petroleum engineer guiding development in San Fernando (SF) said:

> [Engineers doing] a 5-year analysis of refinery throughput have the data, but each year is in a different Lotus worksheet. . . . You have formatting, lines, headers and explanations within each sheet. So, you have to join all of them, remove formatting information, then you can probably get a graph. . . . In my estimation this a wrong thing. Lotus in not a good database manager . . . If you had it on dBase you could have exported it to Lotus and done your graphics.

The systems analyst told the story of an engineer in SF who developed a database using R:Base that was to be used in Port of Spain (PoS). No one in PoS knew R:Base, nor wanted to take the time to learn it. The database was redone in dBase

III+, the database package that eventually became the standard in the Ministry.

In another instance, an engineer went off on his own and used 1-2-3 as a development platform for a database application instead of consulting with an experienced user during the design stage. When he ran out of rows and could not add any more data to the database, the engineer went to the systems analyst for help. The systems analyst felt that people are so used to working alone that they are not taking advantage of her expertise.

Conditions and Constraints

An example from the Operations division underscores two important conditions for implementing structure. The PE/IS found that computer literacy courses did not allow staff members to make the connection between the micros and their work. He had to go a step further and give courses oriented toward specific job functions. Once enough people understood how to use the micros on the job and began to use them, standards and guidelines were introduced to manage using the computers.

The example illustrates that the first condition required to implement structure is sufficient understanding and use of the micros in the organization. The Nolan and Henderson-Treacy models underscore this condition. In both models, the first stage is characterized by experimentation and learning-

by-doing. The second condition is designating someone in the organization to take the responsibility to monitor the growth of micro use and know when to introduce structure.

A third condition is the support of top management. In MOE, it has enabled staff to gradually take on the role of systems analyst and work toward building an IS department in the face of externally-imposed constraints.

Constraints also effect the timing of the implementation of management structure. Constraints center around the converse of the three conditions just noted. Without management support, acquiring resources is difficult. Without computer and human resources, diffusing knowledge through the organization is restricted. Even if an innovator existed and pushed for using the micros, he or she would fail because the environment would not support their initiative.

Key Components of an Initial Management Structure

Assuming that the conditions are right for introducing a management structure, what are its key components when it is initially introduced? Gibson and Nolan (1974) caution against imposing a structure that inhibits innovation and may turn people off to using the technology.

A balance can be found between structure that inhibits using the technology creatively and structure that lets users go off in directions that ultimately do not benefit the organization. The Ministry of Energy experience indicates

that the initial components should be setting standards for software and hardware, setting a procedure for developing applications and setting work priorities, and creating a mechanism to store and catalog applications.

The importance of setting standards was illustrated in the R:Base example from the previous section. Because a clear standard was not in place, an application was developed that had to be redone so other people in the Ministry could work with it. Setting standards also makes it easier to share work throughout the organization and transfer data between organizations. The PE/IS in San Fernando said:

> When I set up a [production] database, I want to set it up in such a fashion that I have a seamless transition when we go to download the information electronically from the oil companies, which is the next stage. . . . The technology is here . . . this is what I envision for the future. All the data in the Ministry should be heading for that kind of environment.

Another important area for setting standards is in the storage of data and programs. In MOE, many users do not have a procedure for managing their own files. Floppy disks are full of old, useless versions of files that take up valuable space. The director of one division said:

> People get data on diskettes and they never erase as time goes on . . . so you have a lot of disk space that is wasted. . . . That is a problem of archiving material and updating your files . . . That is a big problem, you have too much garbage.

In other instances, files are named so poorly that they cannot be located easily when needed. The need for these kind of standards hit home among the clerical staff earlier this

year (1989). The minister needed a file for a speech. The clerk-typist who worked on the file was out that day. Other staff members went through a large number of floppy disks looking for the missing file. Soon after, naming conventions and a log book were being used to manage all word processing files.

Setting procedures for developing applications saves time in the short- and long-run. Time savings in the short-run is illustrated by the example of using 1-2-3 for a database application. A procedure that provides design guidance for the end user before he or she starts development could have avoided the inappropriate use of 1-2-3.

In the long-run, setting standards for documentation and programming practice frees the organization from depending on the initial developer. Many engineers in MOE stated that lack of documentation is a major constraint to making better use of the micros. It is difficult to use someone else's work when documentation is not available. One engineer told me it takes him a significant amount of time to relearn how to use his own applications. A well-documented application enables a new user to quickly learn the application without depending on other staff.

Setting work priorities enables applications to be built in a way that maximizes the efforts of end users. For example, the PE/IS in San Fernando told me that he is holding off on training engineers in his division until a petroleum

database is in place. He has found that engineers need a production database as a foundation to do significant analyses. Without a central database, the engineers are forced to enter small data sets by hand each time they want to do an analysis. This practice is inefficient and limits the scope of their analyses.

A mechanism to catalog computerized work cuts down on duplication and enables work to be shared throughout the organization. For example, the Ministry has been developing a petroleum database that will be the foundation for a large number of analyses and reports. But two parallel efforts were underway. A PEA in PoS was developing one at the same time as the PE/IS San Fernando. Once this was discovered, the effort in PoS was scrapped.

The SA in Port of Spain and the PE/IS in San Fernando felt another way that a database of computer work cuts down on duplication is through enabling an end user to check for all work related to his or her current project before the project begins. An application or database might be available that ties into the project, thus creating savings through avoiding a new development cycle.

In short, the management initiatives that I am proposing are ones that do not inhibit creative uses of the micros. The guidelines do not prevent staff from proposing ideas and experimentation. The goal of the controls is to try to make any end user computing effort as productive as possible for

the organization in the short- and long-run.

The Importance of Key Personnel Strategically Placed Within a Division

The second major finding of the study centers on the role of key personnel who act as focal points in the integration process. In MOE, top management has supported the development of the micros from the beginning. But these people have other responsibilities that prevent them from devoting a lot of time to the micros. Lower level individuals devoted to the growth of microcomputer use in their sections are critical in keeping development moving forward.

I found that individuals, if they are to play a key role, must be in a position to freely communicate with end users and top management. In addition, these focal people should not be centrally located. This observation backs up Rockart and Flannery's (1983) recommendation of the importance of a "distributed" organizational structure for end-user support.

In the two divisions cited in the previous chapter, key people (the SA in PoS and the PE/IS SF) took on the role of systems analyst and acted as change agents to keep the development of the system moving forward. Both people are at a level in the organizational hierarchy where they have easy access to top management. Staff at all levels feel free to come to them for help or advice on computing matters.

Their roles have been, and are, continuing to evolve. At

this point, some of their main functions are developing Ministry-wide applications and assisting end users in problem solving and applications development.

In addition, the systems analyst has been a catalyst promoting the setting of operational standards and a methodology for developing applications in Port of Spain. In San Fernando, the PE/IS has set standards and developed a strategy to create projects that fuel interest in the micros. A Ministry-wide goal that both of them are pursuing is to have each section use the micros in their day-to-day work.

In MOE, these two focal people were self-selected. The SA in PoS told me she pursued an interest in computers based on her experience in another ministry. She was sent by MOE to the University of the West Indies program in computer science. The PE/IS in San Fernando got intrigued by the potential benefits of using the micros in his work and spent all his spare time teaching himself how to use them. His engineering work was gradually assigned to other people. Now he is devoting all his time to computerization of the Ministry.

Self-selection of staff interested in computers is not unusual[1], but it is not a guarantee that a person will become a focal point. For example, in the Engineering and Statistics division, a PEA II has taken on a lot of responsibility for

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[1]In a study of the implementation of computers in planning agencies, Innes et al. (1988) found that there seems to be at least one key person who takes the lead in initiating and attempting to see projects through.

maintaining databases. The person is knowledgeable and enthusiastic towards using the micros. Many people come to him because of his control over data. But he has no authority to create or implement policy guidelines to manage any aspect of using the microcomputers.

It is difficult to characterize a typical self-starter from one case study[2]. But from my experience in the software industry, people who are attracted to writing programs and are good at it seem to have the following characteristics: they think in a logical and structured way, thrive on detailed work, are organized, and enjoy the challenge of making something work (in this case a computer program).

In the Ministry, the focal people are an important communications link between top management and end users. They are in touch with all operational issues affecting use of the system. The focal people can relay information to top management that can help them set priorities. The focal people can also correct wrong perceptions of top management in terms of who is using the micros and what they are doing with them.

For the end users, these key computer personnel are resources to help guide development of applications and solve problems. They are in a position to understand the needs of the general end user population through day-to-day contact.

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[2]Turkle (1984) attempts to characterize people who are interested intensely in computers and programming.

The Need for Clear Lines of Authority

Many staff members felt that for the focal people to be effective, clear lines of authority and mechanisms to enforce committee decisions must be in place. The PE/IS in San Fernando said one of his goals is:

> to get them [the Computer Policy Committee] to define how this committee [Computer Management Committee] is to be constituted such that it will work properly recognizing the problems we have had in the past. The chairman must be given specific powers . . . also the committee must be given specific powers. It must be written down. . . . Right now it is an ad hoc committee. . . . No one can quote some authority saying the computer committee is responsible for decisions of this kind and no department head, bar none, can go against it.

In Port of Spain, decisions made by the Computer Management Committee (CMC) have not been implemented because there is no clear authority to implement them. Division or section heads with established power bases tend to ignore CMC directives. One example previously cited was a division director "borrowing" a machine while one of his was broken and the systems analyst was on vacation.

In other instances, projects that require Ministry-wide input have not progressed because there is no one in charge to keep the effort moving forward. In 1988, a committee was formed to advise the Ministry on computerizing data. Data requirements were to be collected from every department as input for a Ministry-wide database. One of the committee members went on vacation. The project was put on hold and never resumed.

The authority of the PE/IS in San Fernando illustrates the importance of having power to enforce decisions. The division is making an effort to centralize all aspects of computing. Part of the centralization strategy is to locate the micros in a central computer room. There has been pressure from staff members to distribute the machines among the sections. The PE/IS has the backing of the division director and therefore has been able to maintain the central facility in spite of the pressure for change.

Past Experiences in Managing Micros in Developing Countries

The literature on developing countries and the adoption of microcomputers has had little to say on the importance of managing microcomputer use in the IS sense just described. The area that is covered extremely well is how to initially introduce microcomputers into a government organization. Hecht (1988) found the recommendations on adoption strikingly similar throughout the literature.

I feel the omission is primarily due to microcomputers being introduced for a specific project, rather than being viewed as a platform for meeting the data processing needs of an entire organization. The immediate goal was to get the system up and to train staff in using it.

Another reason for this lack of emphasis on management is the background of many of the people writing the analyses. In most cases, the analysts were not trained as organizational

specialists, or their interests did not lie in studying the organizational impacts of managing the technology. In general, their focus was on getting a project operational, rather than on creating mechanisms to smooth long-term integration of the technology.

One of the few analysts that have mentioned the IS function is Wescott (1987). He gives a detailed account of using micros to produce Kenya's 1985/86 budget. A MIS section was set up to insure optimal use of the computers. Wescott recounts some of the management tasks that had to be performed, but he did not include setting up a MIS section as one of his recommendations for introducing microcomputers.

Other analysts mention institutionalization as an important factor. Gotsch (1987) states that a number of substantive and administrative changes will need to be made within the organization to insure growth and develop of the system. Beyond that broad statement, he focuses on the need to assign someone to maintain the machines and their functions and the development of career paths for personnel who take on IS responsibilities.

Pinckney, Cohen, and Leonard (1987) also focused on institutionalization. They served as advisors on a project to improve the financial management of Kenya's Ministry of Agriculture. In their view, institutionalization was complete when the Kenyans performed all operations, did all programming, and included maintenance and supplies as part of

the budget. There is no mention of setting up an institutional structure to manage the tasks on their list.

Brodman (1987) recognized the importance of management systems and structures as critical issues when introducing microcomputers in developing country governments. Four management factors are cited that impact decision making: leadership messages, requisite training, the incentive system, and the power structure.

I found all of these factors to be important in the adoption of the micros in the Ministry of Energy. Leadership messages have been consistently strong in support of the micros. After training in computer literacy, the Ministry moved on to a more detailed level of training. In chapter two, the importance of incentives was discussed. The power structure of MOE has supported the evolution of IS staff and departments in the face of resource constraints from the central government.

But these factors do not address how the system is to be managed once it has been accepted in the organization. This chapter has presented two key findings from the study that stress the importance of creating a management strategy early in the integration process. The following chapter presents recommendations based on this study to help manage the computer system, and strategies to speedup the diffusion of the technology throughout an organization.

CHAPTER FOUR

RECOMMENDATIONS FOR MANAGING MICROCOMPUTER USE

This chapter is devoted to spelling out the lessons learned from the Ministry's experience with microcomputers. They are supported by examples from MOE and the literature. Some of the recommendations were mentioned in the chapter presenting my main findings. They are recounted here in more detail for the sake of emphasis.

Along with recommendations for managing the evolution of the micros, techniques for introducing them into day-to-day use are presented as suggestions to guide others faced with similar situations.

The Findings and End User Computing Studies

Some of the recommendations presented in this chapter agree with the recommendations made by Rockart and Flannery (1983) in their study of end user computing in U.S. corporations, and Quillard et al.'s (1983) work on the use of personal computers in ten major U.S. corporations.

The major difference between the two EUC studies and my work is the presence of an IS department in each of the corporations surveyed and the lack of a formal IS department in the Ministry. Because there is virtually no differentiation between IS personnel and end users in MOE, the issue of IS staff not understanding the needs of the end user

departments becomes less relevant. For example, Quillard et al. call for cooperation between IS personnel and end user departments in managing use, a non issue in the Ministry of Energy.

Another difference is that, in MOE, the micros are being used as the basis for all computing in the organization. In the end-user studies, sharing databases between mainframes and the end users was a major issue.

Because this study is oriented towards government ministries that do not have the resources to acquire IS expertise through external means, some of the following recommendations are at a more basic level than the ones presented in the two end-user studies. These recommendations address general data processing issues that are applicable to all classifications of computers.

Recommendations

Create a computer management committee as a forum for expressing concerns and setting policy.

Once the micros begin to filter through an organization conflicts arise that can stifle growth and use. A computer management committee that is representative of the entire organization is a mechanism for addressing issues that cannot be handled at a lower level. It also provides a central forum that can set policy based on input from all sections of the

organization.

But setting up a committee is not enough. In the Ministry of Energy, a computer management committee was created to plan and control the development of computerization within the Ministry. The committee consisted of managers from each division, the two systems analysts, and the Special Advisor to the Minister. The committee has attempted to deal with conflict and set guidelines, but it has not been successful in meeting all its goals (see chapter two, Managing Computing, and chapter three, Analysis of Computing in the Ministry).

One reason cited for the failure of the committee was the absence of a clear mandate and a mechanism to enforce its decisions. The Ministry is attempting to learn from its experience; a computer policy committee is in the process of creating a policy document that clearly defines the role and powers of the computer management committee.

Gibson and Nolan (1974) recommend a high-level steering committee as a mechanism for communication between top management and departments. They state that such a committee provides a means for setting priorities and provides a vehicle for confronting and resolving the political problems that inevitably arise with the computer's impact on manager's roles, organizational structure, and resource allocation. No mention is made of how to enforce decisions made by the steering committee.

Quillard et al. (1983) advocate a committee composed of IS

management and user management as a mechanism for making strategy and policy decisions. They cite an example of one corporation where such a committee was doing an especially effective job of managing EUC.

Create short-, medium-, and long-term plans and let everyone in the organization know what they are.

Formulating plans serves two main purposes. First, every step in the evolution of the technology will be toward minimizing mistakes, wasted effort, and the benefit of the organization as whole. Secondly, support among staff will be maintained if everyone understands why certain steps have been taken that might not be in the best interests of a particular section, but ultimately will make the organization function better.

Examples were cited in the last two chapters of the lack of direction resulting in duplicated and wasted efforts in MOE. Other people in the Ministry feel that the lack of planning has resulting in decisions being made without the entire organization in mind. For example, one member of the Computer Policy Committee said:

> We have department heads who go out and they are negotiating computers to come into the Ministry on their own . . . I have no problem with computers coming in, but maybe if it was discussed at the level of the Computer Management Committee we could have advised them better into getting a machine that would be not used just for [their own purposes], but when a computer comes in it can be used for other things as well. . . . By just altering the configuration of the machine slightly we . . . can take care of needs wider than a sectional interest.

Rockart and Flannery recommend setting an end-user strategy. Moreover, they recommend that the strategy should be promulgated throughout the organization. Their data revealed that end users are confused about the actions being taken by IS departments with respect to EUC. Letting end users know the IS department's plans enables the end users to make informed decisions based on the computing alternatives available to them.

I realize that planning does not always lead to positive results. If plans are adhered to rigidly, unexpected opportunities can be lost. In the computer field, technology is changing so rapidly that it may be difficult to do planning for longer time horizons. Given the reality of rapidly changing technology, choices still can be made that enables an organization to build on its technological base. For example, one reason that DEC has been so successful with its minicomputer line is that software written for any one machine can be used on any other. An organization that chose a DEC computer was not locked into using that particular machine.

Chapter Three outlined a set of guidelines and procedures that can give staff a firm sense of the priorities of the organization and a structure to help them reach the organization's goals. The Ministry of Energy is in the process of implementing many of these guidelines. The main purpose of the guidelines is to make all computing efforts help the organization as a whole. They do not preclude new

ideas from being incorporated into the planning process.

In short, no planning leaves people without a sense of where the organization is heading. Even if plans change, by keeping people informed apprehension and confusion can be diffused.

Set standards early on to avoid incompatibility of software and hardware and to manage data efficiently.

As early on as possible, standards should be set for both software and hardware. Setting standards insures compatibility and lets work be shared throughout the organization. People can move easily from department to department and not have to spend time learning a new system. For the operations people, it is easier to maintain a standard set of software and hardware.

For example, in MOE, standards were set by the CMC for word processing once it became clear that using four or five word processors was inefficient. A period of experimentation was necessary to sort out which package best met the needs of the Ministry. Standards soon followed for spreadsheet and database packages.

Rockart and Flannery point out the importance of providing end users with a wide spectrum of products. They note that one software package cannot effectively perform all tasks for end users. They recommend providing end users with at least half a dozen types of different software, but they do not

specify whether they mean one package for each area of specialization or not[1].

Create a mechanism that enables everyone in the organization to know what work has already been automated.

Duplication of effort can be minimized if a database is available that can quickly let staff know what work has been done in their area. As noted in the last two chapters, duplication was a problem between the Port of Spain and San Fernando as well as within the divisions in PoS. As the PE/IS in San Fernando put it:

> Nobody knows what EPD [Energy Planning Division] has done, what South [San Fernando] has done, who has what on Lotus, who has which data where. Nobody knows anything about what is in electronic media.

A database is being created for the Ministry that will contain references to every piece of work that has been automated.

Set priorities in developing databases and applications.

The order of developing applications and databases is important because some work requires another piece to be in place. Setting priorities helps the organization focus on

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[1]Even though the trend in the industry is toward machines and software being able to 'talk to' each other, there are still advantages to setting standards. One, with standards, less money is spent on buying different variations of software that essentially do the same thing. Two, maintaining the computer system is easier. On the software side, there are fewer programs to install and update. On the hardware side, special equipment is not necessary for communication between machines that are based on different technologies.

developing the critical pieces that form the foundation of future applications development.

Another advantage to priorities is in promoting designs that are flexible and allow for growth. If a path for building applications is laid out, developers can take the future into account in their initial design. Poor design of a database or application that is the foundation of a larger system can make later modifications at best a very unpleasant experience, and at worst a waste of time.

The importance of setting priorities is illustrated in MOE through the widely recognized the need for a central, production database. In Energy Planning, a 386-based machine was recently acquired to be used as a platform to develop an energy balance[2]. In order to use the energy balance program, a production database must be in place. In the meantime, the structure of the database has been defined so development can proceed.

Rockart and Flannery call for the flagging of "critical" applications. These are applications whose failure to run would significantly impair the ability of the organization to run efficiently on a daily basis. In most cases, the

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[2]The machine is part of a grant from the European Economic Community (EEC) development section. Two consultants from the EEC were in Trinidad working on the energy balance program. An energy balance tracks the transformation of a primary energy source (e.g., crude oil, natural gas) to its final use (e.g., sale, consumption, storage). It is used to analyze supply and demand for energy in the economy.

researchers found the necessary documentation and/or controls for these critical systems lacking in the end-user developed systems. The production database being developed in the Ministry of Energy is a "critical" application. It will be used as a foundation for a large number of new applications; without the production database, the new applications cannot be used.

Create a standard for developing computer-based work.

Since the nature of end user computing is for non-professional personnel to develop applications, it is important to set up development guidelines and a mechanism to manage development.

Without guidance, poor choices for a development environment, or poor design, can set the user up for an insurmountable impasse down the road. Help from a trained staff member can often insure that proper choices are made. Suggestions to expand the project to tie into other work can be made that enhance the usefulness of the project to the organization.

Part of the Computer Policy Committee report will be a mechanism to include the systems analyst in all phases of application development (see Appendix 1). Many examples were cited in the previous two chapters on the importance of setting development guidelines in the Ministry.

Quillard et al. recommend that one key aspect of

supporting end users is providing consultation as to what is the best solution for a given application problem. Rockart and Flannery stress the importance of including an IS expert in deciding how an application is to be developed and maintained.

Document!

The call for documentation has been heard in programming shops for as long as there have been computers. Documentation serves several purposes. One, work that is put aside can be returned to and understood in a fraction of the time it takes to go through the code to jog one's memory about the subtleties of the design. Two, well documented work means that it is easily understood and useable by other people in the organization. Three, if the original developer leaves the organization, the details of the design are not lost. Four, it is a lot easier for a new person to maintain and enhance the software.

Examples from many people were given in previous chapters stressing the importance of documentation in the Ministry. The Chief Technical Officer summed it up by saying, "We recognize documentation is essential if we are to share the data and share the programs."

Strategy for Developing an IS Function From the Bottom Up

Be creative in acquiring human and physical resources.

Constraints from outside the organization might inhibit development of an IS department. MOE provides a good example of developing an IS group within the constraints set by an external agent, in this case the central government.

The difficulty in creating new positions, reorganizing departments, and hiring new people was handled by pushing for development from within the Ministry. Existing positions were gradually transformed to IS-type positions without going through standard channels. A core set of personnel have been used to create virtual IS departments within both Port of Spain and San Fernando. Examples of job transformations are given in the section on Uses in Specific Departments in Chapter Two. Having these working departments in place will make it easier for the Ministry to formalize them at the appropriate time.

In addition to staffing constraints, MOE has had trouble in acquiring equipment. The central government has refused new hardware purchases since 1987. Funds are so scarce that the simplest supplies, such as stationary and paper, are in short supply.

The Ministry is taking advantage of its relationship with the oil companies to acquire additional equipment. Their strategy is to suggest to the companies that it is worth their

while to donate equipment to the Ministry as part of a bid for work.

An example of this strategy is the method used to acquire a geological workstation. A technical equipment bonus was attached to recent bids for gaining exploration rights. The company that won the bid provided the Ministry with a sophisticated workstation.

It was emphasized that the technical equipment bonus was not the most important factor in deciding which company won the bid. The idea is not to bribe a company but to provide an extra incentive that could make a difference at the margin.

Strategy for Expanding Training

Prepare selected staff to be trainers and local resource personnel.

In MOE, people who were unusually enthusiastic or knowledgeable about computers were singled out early on and given extra responsibilities. In most cases, they evolved naturally into resource personnel. In other cases, the Computer Management Committee targeted personnel as good candidates to take over training in computer literacy and applications courses.

Besides acting as resource people to answer questions and help with problems, the early users got other staff members interested in using the microcomputers. The example of the

petroleum storage database being developed by a group of inspectors illustrates the point; another group of inspectors has started their own project based on seeing the potential benefits of using the micros in the other inspection section.

Strategy for Developing User Skills

Develop user skills through project-oriented training.

A major constraint to building skill throughout an organization is the amount of available personnel that can do the job. In MOE, the San Fernando office came up with a strategy that gets around this problem.

The engineer acting as a systems analyst in the Operations division trains groups in each section based on a project that will be used by the section. He has the group members do as much of the development as possible, providing them with valuable hands-on experience.

One group member is designated as the "scribe." This frees others from taking notes and allows them to try to concentrate on understanding the concepts being explained. The scribe writes up the notes and has a typist put them on the micros. This forms the basis of a design document that tracks every phase of the project's development.

This strategy has created a lot of interest in sections that were not using the micros. Part of it was curiosity at seeing fellow employees working on something new. But the

major benefit was in seeing the micros applied to real work. This enabled personnel to make the connection between the micros and work in their sections. Training in computer literacy was not enough to make the benefits of the microcomputers clear to many staff.

An additional benefit of this approach is that the final product of the training is a useful piece of work for the section. The final product becomes a working model that can be used as a guide for future applications in the section.

Future Research

I was fortunate to visit the Ministry of Energy at a point in the evolution of their microcomputer use where management issues were the focus of many people's attention. The Ministry had gone through enough experiences to make clear some of the hazards and suggest ways for others embarking on the same journey to avoid them.

It has been pointed out that generalizations extrapolated from a single case study are often of questionable validity. The recommendations of the last two chapters are strongly supported from the literature. In addition, my seven-year experience in the software industry as a developer and manager support the findings and recommendations. In spite of this support, I agree that a single case study is not a sufficient data base. There are a few questions that can be incorporated into future research that will help enrich the data from this

case.

First, has the profile of the Ministry, especially the technical backgrounds of the Ministry personnel, given them a unique opportunity to integrate microcomputers on their own? There are many stories of organizations with no computer experience teaching themselves how to use micros. But many of these cases are using microcomputers for single applications such as accounting or inventory tracking. Unlike these cases, the Ministry is trying to use the microcomputers as the central computing platform for the entire organization.

Second, if the experience of MOE is not unique, have other ministries experienced a similar pattern of development? Have they been able to anticipate some of the problems encountered at MOE? If so, how did they anticipate them?

Third, has technology improved (and costs come down) to such a level that many of the problems at MOE are moot? Hard disk drives are standard on many microcomputers sold today. Local area network technology is improving and coming down in price.

A Closing Note

A constant adjective that was used to describe the process of integrating microcomputers into the Ministry was evolutionary. The findings of this study should be taken in the same spirit; they are offered as a guide that can help others begin the evolutionary process of integrating

microcomputers into their organizations in a way that builds progressively for the future.

APPENDIX 1. COMPUTER POLICY COMMITTEE RECOMMENDATIONS

The Computer Policy Committee (CPC) policy recommendations are in the process of being finalized. The members of the committee are a subset of the Computer Management Committee (see Chapter Two, Managing Computing). One goal of the CPC is to have some of its recommendations operational by the end of June 1989. A draft copy was not available.

The major problems that the CPC policy document will address are a standard for developing software, a system to manage storage of programs and data, the role of the Computer Management Committee (CMC), and the physical configuration of machines.

The systems analyst (SA) will be the core of a computer services group in Port of Spain. The group would be responsible for purchasing, maintenance, programming and internal consulting. Staff would be built out of existing personnel who show an interest in computing.

A key component of the new development guidelines is the involvement of the SA from the initial idea stage through completion of a project. Proposals for developing new applications will be presented to the Computer Management Committee (CMC) through a section representative. The CMC will decide on which proposals are accepted. This is a mechanism to cut down on duplicate efforts and to determine if

the proposal has Ministry-wide use, or can be modified to serve a larger group of people.

Once a proposal has been approved, the SA will manage the development effort. The SA will help choose the appropriate software and give guidance in the initial design. The idea is for the staff member to do the actual development work. The SA will act as an enforcement mechanism to insure that the application meets Ministry guidelines.

The computer services group will be vested with authority to manage computer resources[1]. There have been problems in the past with departmental directors not paying attention to procedures set by the CMC or the SA.

The problem of addressing the needs of everyone in the organization will be handled through a representative to the CMC that will present proposals from his or her section.

Lack of documentation was cited by many people as a constraint preventing sharing of data and applications. The policy document stipulates that documentation is a mandatory part of development. Two enforcement mechanisms will be created: first, by tracking development efforts, the SA will make sure documentation is complete, and second, if any of the guidelines are not adhered to, future support will not be available from the computer support group.

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[1]It was not clear where this authority would come from, i.e., from the Minister, the Computer Management Committee, or another source.

Another component of the policy guidelines is the creation of a central repository of all computer work. The Ministry library has been designated as the location for computer-generated work. All computer work will also be catalogued in a library database package developed by UNESCO called CDS/ISIS. CDS/ISIS will be used as another mechanism to cut down on duplicate work by making all electronically generated Ministry work easily accessible.

Lack of hard disk space has made managing data more difficult. To address this problem, the CPC is proposing to develop a local area network (LAN) for the non-word processing machines. A central area would be designated for the network server that would house storage devices and printers. This setup allows for centralized control and distributed access concurrently.

The problem of managing data on floppy disks will be minimized when the LAN and central storage are in place. People will still be free to develop their own work in any way they desire. The goal is to standardize and manage all Ministry work and eliminate the pockets of computing that have developed in the absence of a computer management policy.

The computer resource group will oversee new equipment purchases to insure compatibility with existing hardware. Currently, division heads go outside of the ministry to acquire hardware without input from the CMC. By going through the committee, every new acquisition can be worked into the

long-term computing strategy of the Ministry.

APPENDIX 2. THE NATIONAL EFFORT TO COMPUTERIZE THE PUBLIC SECTOR

The Chief Technical Officer strongly felt that the central government could not help the Ministry with its integration effort:

> The National Computer Agency . . . did not have micros. We had micros before them. Therefore, how could we really ask them for advice? I don't want to sound vain about it, but I don't think we could have got advice from them because they were not into micros.

Why couldn't the National Computer Agency (NCA), a government agency created in 1973 to manage the computerization of the public service, help the Ministry of Energy? The assistant director of the NCA provided an answer to this question.

The NCA's original mandate was included in a 1987 NCA report:

> [The NCA's responsibilities are] reviewing and approving all electronic data processing proposals from Ministries, Departments, and Statutory Boards; and preparation of government's over-all policy with respect to the use of electronic data processing techniques in the public sector.

According to the assistant director, the second effort, that is creating government-wide policy guidelines, never got off the ground. The immediate data processing workload took up most of the NCA's time[1]. Because of this heavy workload,

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[1]Most of the applications were batch transaction processing jobs done on an IBM mainframe. By 1983, when the Ministry of Energy began using micros, the NCA had not developed extensive experience with the decision support applications that the Ministry was interested in.

the full plan for assessing the public service needs was never implemented.

Today, the data processing needs of the public service are so great that the assistant director believes the NCA cannot do the job alone. Other government agencies have gotten involved with the national effort to computerize. But the assistant director feels that the government is not serious about computing. Publicly, leaders call for the need to computerize, but when it comes to providing resources or direction, they do not follow up.

The assistant director cited lack of consistent leadership from the top as one problem. People who are interested in computerization get shifted out of their job and momentum is lost. The NCA itself has been shifted between ministries[2]. The shifts have been costly in terms of getting funding approval from a new administration at each move.

The NCA has been hurt by the current economic contraction. When people leave the agency, they are not replaced. A recent report on information technology in the public sector put the number of positions filled in the NCA as thirty-five out of forty-six. The budget for basic supplies has been cut. The NCA is advising ministries to do as much as they can on their own.

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[2]The NCA has been moved from the Office of the Prime Minister to the Ministry of Finance to the Ministry of Industry and Enterprise and back to the Office of the Prime Minister.

Organization and Management Division

The Organization and Management Division (O & M), which is under the Office of the Prime Minister, has gradually gotten involved in the effort to computerize the public service. The O & M is responsible for advising and developing systems and procedures for the government service[3]. A few years ago, requests gradually came in asking for assistance with computer systems. After a few successful systems were developed, more requests followed.

The O & M only has two full-time positions in the MIS area. One of the positions is currently vacant. The remaining officer said at the request of the head of the public service:

> we did a paper on an integrated approach to computerizing the public service. Because we feel strongly that there is a need . . . to put in place certain guidelines, to identify a body that would coordinate the whole computerization effort of the government. There has not been a discussion on how this is to be implemented or if it is feasible at all.

The MIS officer felt that the roles of the NCA and the O & M were not clearly defined. But he also felt that the new government thought the computerization effort might move faster if the O & M were involved.

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[3]Their MIS officer cited a wide range of activities: financial, organizational structure, staffing, filing, and registration.

Education and Training

A large number of public agencies are involved in training the public service and the general public in computer literacy and computer science. For example, both the NCA and the O & M run training courses similar to the ones in the Ministry of Energy (Introduction to Computers, Introduction to DOS, etc.). The National Institute for Higher Education (Research, Science and Technology) (NIHERST) runs advanced courses in Techniques of Systems Analysis and Information Engineering.

Officials at the NCA and NIHERST said both agencies had tried to run special courses for high level public officials. The goal of the courses was to increase top level officials' awareness of what information technology could do for the public service. The courses have been ineffective. Either the response was poor, or officials sent their technical personnel who already knew about the capabilities of IT.

National Strategy

The informants in these national agencies plainly stated that there is no national strategy for computerizing the public service. A seven-year national development plan drafted by the Ministry of Planning and Mobilization (Ministry, 1988) does not mention computerization of the public service anywhere in the plan. The absence of a computerization strategy is due to a number of factors, but a

lack of ideas for implementing a national strategy is not part of the problem. The recommendations of the O & M study were essentially the same as a strategy proposed by a report done in the 1960s by an external advisor. The NCA produced a similar set of recommendations in 1987. NIHERST has put out a series of papers calling for a national strategy.

The problem seems to be one of attitude rather than information. The assistant director of the NCA feels there is a mentality at the top against anything new. He tied this into the seniority system for promotions that was cited earlier in Chapter Two; since performance does not count for promotions, there is little incentive to learn something new, particularly for people from a generation that did not grow up with computers.

The microelectronics specialist at NIHERST feels the political will does not exist to push IT in the public service. One factor cited was that top level officials do not understand the value of IT. Since they do not understand the value, they ignore it.

The head of the IS group at NIHERST feels that computerization is probably not a priority because of other pressing problems. He feels that the need is recognized, but high capital costs makes it prohibitive. The microelectronics specialist does not agree with this view. He said even during the boom times coordination was a low priority item on the agenda. But both NIHERST staff members agreed that the

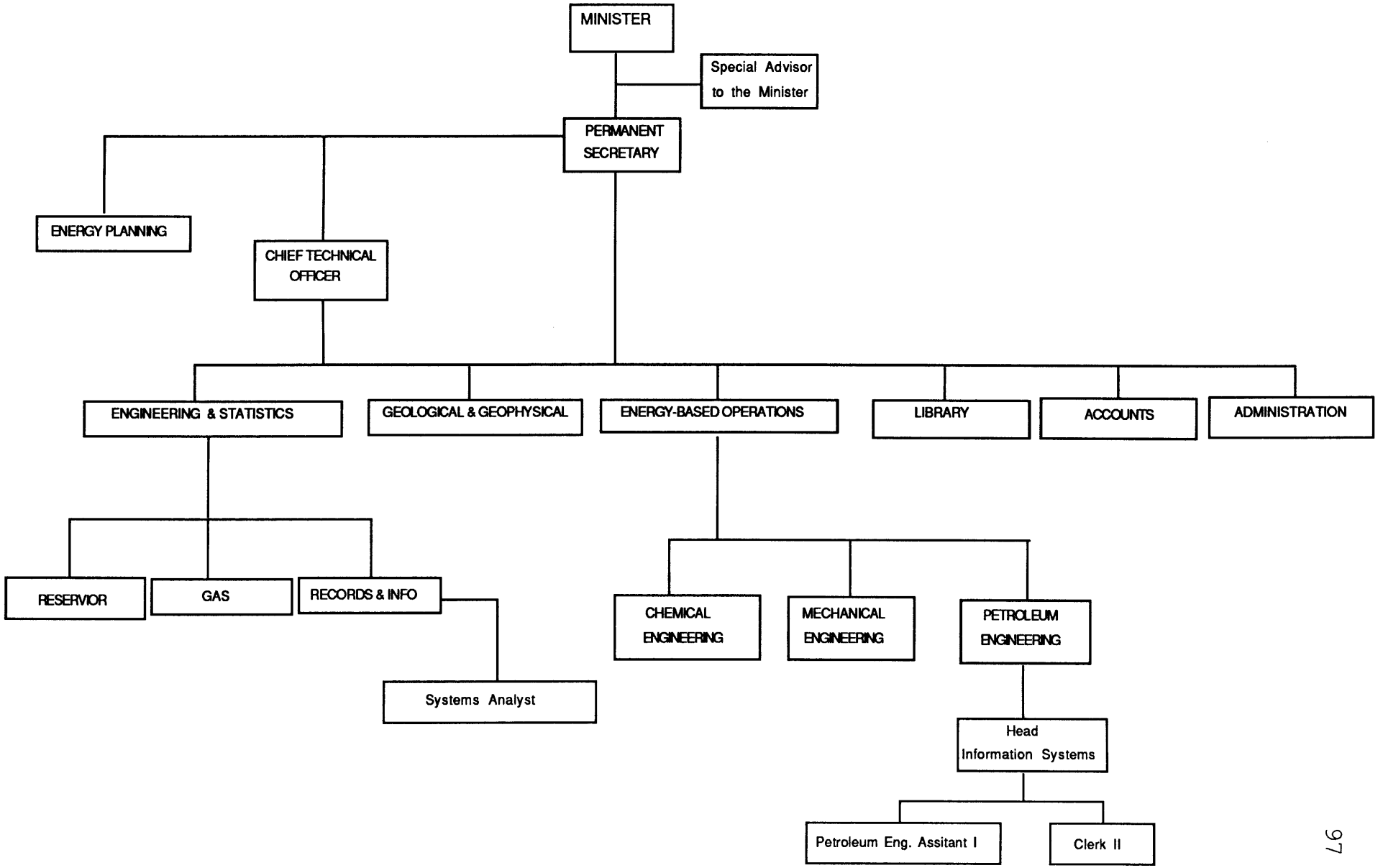
expertise does not exist in the NCA or the O & M to understand and coordinate a national computerization effort.

The desire of officials in ministries to hold onto power was cited by a few informants as another constraint to implementing a national strategy. Controlling computer resources and information is one way to hold onto and expand bureaucratic power.

Based on this information, it is not surprising that the Ministry of Energy has gone it alone. I was told that many other ministries have taken the same course out of frustration in waiting for the NCA to provide guidance and services. The microelectronics specialist summed up the current situation: there is not much you can do if the top people do not understand the benefits or are unwilling to learn.

In the meantime, reports will be generated and committees will be formed. Hopefully when the window of opportunity opens to implement a national strategy, the pieces will not be too disjointed to prevent it from happening.

FIGURE 1. PARTIAL ORGANIZATION CHART - 1989
MINSTRY OF ENERGY



Source: Ministry of Energy, Trinidad and Tobago

TABLE 1 HARDWARE PURCHASED BY THE MINISTRY OF ENERGY
Note: the table includes only major purchase

Year of Purchase	Description	Quantity
1983	IBM 5150 microcomputer and related hardware	2
1984	IBM PC with double density disk drive	2
	NEC Spinwriter 3550 printer	1
	Epson FX-80 printer	2
	Epson FX-100 printer	2
	HP Graphics Plotter 747A	1
	Tallgrass 20 MB hard disk	2
1985	IBM PC-AT with 1.2 MB disk drive	3
	HP LaserJet	1
1986	AT&T 6300 microcomputer with two double density disk drives	7
	PC Shadow Terminal	7
	Microscience 20 MB internal hard drive	1
	Iomega 20 MB Bernoulli Box	2
1987	Excalibur PC with one double density disk drive	1
	Epson FX-286 printer	3
	Maynard 20 MB internal hard drive	1
1988	HP Rugged Writer printer	1
	3 1/2" Double Density disk drive	2
1989	5 1/4" disk drive	2
	Seagate 80 MB internal hard drive	1

Source: Ministry of Energy, Trinidad and Tobago

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