DESIGN FOR THE WORKPLACE: A NEW FACTORY

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The people I love best
jump into work head first
without dallying in the shallows
and swim off with sure strokes almost out of sight.
They seem to become natives of that element
the black sleek heads of seals
bouncing like half submerged balls.
I love people who harness themselves, an ox to a heavy cart
who pull like water buffalo, with massive patience
who strain in the mud and muck to move things forward
who do what has to be done, again and again.
I want to be with people who submerge
in the task, who go into the fields to harvest
and work in a row and pass the bags along,
who stand in the line and haul in their places,
who are not parlor generals and field deserters
but move in a common rhythm
when the food must come in or the fire be put out
The work of the world is common as mud.
Botched, it smears the hands, crumbles to dust.
But the thing worth doing well done
has a shape that satisfies, clean and evident.
Greek amphoras for wine or oil
Hopi vases that held corn, are put in museums
but you know they were made to be used.
The pitcher cries for water to carry
and a person for work that is real.

Marge Piercy
"To Be of Use"

ABSTRACT

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The production capacities of industry have enlarged greatly in this century. While this has meant a wider spread of material goods, this growth has occurred at the expense of those who have carried out this production. Worker control and participation in the shaping of the product and of the work environment has diminished.

The design of industrial buildings has not commonly been the domain of architects. Industrial forms have largely been determined by characteristics of the production process, often at the expense of those who work in those processes.

The issues of the workplace are varied and extremely complex. They are political and social before they are physical. But there are ways in which physical organization and built conditions can have an impact on the quality of the work experience.

Worker dissatisfaction has in some cases forced changes in the organization and from of the work environment. Some architects have recently been involved in the design of forms to accommodate these changes. There has been some influence by designers in the changing of the organization itself.

In this thesis I will argue that architects must be increasingly involved in designs for industry, and gain an understanding of the factors which influence industrial physical form. I have worked to apply these factors to a design for a specific site and industrial program. My intent was to gain a broad understanding of the issues and evaluate my search.

Thesis Supervisor: Chester L. Sprague
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INTRODUCTION

There are many factors which influence the physical form and organization of an industrial building. Among these are: the process and product, the needs of those who work there, the organizational philosophies, the existing local context, site microclimate, and cost. The ranking of their importance has varied over time and according to specific projects.

While they are all interconnected, the planning and design of any industrial building requires careful attention to each of these factors. With such a focus will come some awareness of that which is of constant and underlying importance beyond issues specific to certain industries.

In our times, cost, process and product, and organizational philosophies have generally been the primary determinants of physical form. Their importance is based upon the assumption that the goal of industry is the increase of productivity which leads to profit.

Philosophies of management and organization form the basis for all the factors which influence physical form. Some have led to a stronger focus on the process of production in its most rational extreme. Others begin to recognize the needs of the people who are part of the process. Each extreme has impacted the physical form.

The kink in my back is gone. Yesterday's work did it.

Eric Hoffer

There is a production game that is played between workers and their supervisor. The supervisor or foreman almost always wants the people he is responsible for to produce more. Most workers seem to know instinctively that 'more production' either leads to the challenging game of 'you want more but I don't want to work harder' or to a bottomless pit. The challenge of the game can be the most interesting part of the job.

Robert Schrank

Early Factories and Management Theories

The first factories were narrow and long in plan to allow the natural light to illuminate the work space, as there was no electricity. These buildings were designed by architects with the express intent that the classical facade have an institutional, almost church-like quality. There was less thought given to the inside space.

Already by the 1840s came steam power, a technological innovation which changed the location of these factories. As coal could now be used to power factories and railroads, it was no longer necessary that they be located at the sources of water power. More factories were built near population and trade centers, and rather than building the company housing around the factory, the housing of the workers was left to the towns and the private sector.

With the changed source of power also came changes in the machinery, and it was increasingly heavier. The famous Pemberton Mill, with its prize classical exterior collapsed under the weight of the new machinery. This catastrophe had ominous implications for the architects of the period. The insurance companies who covered these factories began to demand some involvement in the design of the factories. The insurance companies turned to engineers, not architects, for assistance in design.

Previously most engineers had been civil engineers, involved in such public sector projects as bridges and dams. The design of factory buildings was the first incidence of engineers in the private sector. Their involvement minimized the physical appearance of the factory. These physical changes were supported by the factory owners who became increasingly interested in fast-built, cheap and functional structures. By the 1850 standard factory designs were published in books.

The earlier concern for beauty in the exterior was lost, and the notion that the interior be functional becomes increasingly important. The buildings become proportionally lower and wider. The structural members which support the roof are many, and the debris collects around them making the attic space an incredible fire-trap. As with many things, it was not until after several disastrous factory fires had occurred that innovations were developed to change the attic space and roof. In the 1860s a slow burning roof of heavier timbers was designed to make the attic more open, preventing the collection of flammable debris. The slope of the roof was less steep and the roof itself was lighter, which allowed the exterior bearing walls to be lighter, and large windows were possible.

Increasing attention was paid to the functional aspects of the interior, and as the machines became increasingly complex, attention was paid to the functioning of the "machine-like" work force as well. Engineers had more impact upon the work processes. With the importance of the smooth flow of production, the factory itself becomes like a machine and increasingly distant from earliest attempts to link the factory in a symbolic formal sense to non-industrial (church) institutions.

Much of this increasingly rational approach came from the work of Frederick Winslow Taylor and his "Theories of Scientific Management" which were proposed in the 1870's. His ideas had an enormous impact on the production process.[1]

Until that time factory production was determined by the skill of the individual craftspersons on the job. Knowledge of the skill was important and was handed down from generation to generation on the job.

According to historian David Montgomery, there was a strong moral code amongst these workers. The code emphasized collective support and mutual assistance on the job. The rate of production was also determined in the factory. A worker who produced at a faster pace was considered to be dishonorable, one who undermined the jobs of

others. Beyond this tacit moral code the collective group set work rules. For example, a group of window glass blowers rules included: No working from June 15 to September 15 (i.e., no working near hot furnaces during the summer heat); a standard size, based on the size that a person could blow, was set; similarly, there was a limit to the number blown each hour; quality work was expected and workers were fined for the mistakes they made.

There existed a sense of dignity and pride in the work done to such high standards. And there was a collective direction which rejected both directives from management as well as individualistic behavior.[2]

From his observations and research, Frederick Winslow Taylor concluded that most factories were very inefficient. He devised four "steps to scientific management" which struck blows at the traditional order.

First, each task should be developed as scientifically as possible to replace the methods handed down in the traditional ways. Second, train individual workers for specific tasks. Previously workers were placed at jobs of their own choosing or randomly, and learned the tasks on the job. Third, do everything to make performance of each task as efficient as possible. Fourth, management should

take over all work for which they were more capable, dividing work and responsibility equally between managers and workers. Previously workers had done most of the work and collectively held much of the responsibility.

Taylor felt that increased efficiency meant potential benefits to both the management and the work force. Taylor advocated the notion of the new "functional foreman," who achieved the position be being one who knew more than the others about a certain task or operation. Rather than rise in the factory hierarchy or represent some moral code, the "functional foremen" could be trained for their role. Foreman positions were established for each task, thereby increasing specialization and establishing more positions between managers and workers.

Workers were separated from their individual methods of doing their task and from their individual tools. Previously the workers had owned and maintained their own tools. With Taylor began the practice of having standardized tools provided by the factory in an attempt to minimize product discrepancies which had resulted when workers used their own.

Taylor believed unabashedly in the notion of human perfectibility and upward mobility. He believed that the

rational perfection in work was possible when all the necessary assistance was provided. He established the idea of an incentive system in which workers were rewarded for performance excellence. Each worker's potential for upward mobility rested upon one's ability to perform better than those around one.[3]

One key word which describes the intent and influence of Taylor's ideas is flow. There was much interest in constructively channelling the energies of the worker. To this end Frank and Lillian Gilbreth (of "Cheaper by the Dozen" fame) developed their concept of time and motion studies. The Gilbreths initially studied bricklayers at work analyzing the physical motions of each task. They isolated eighteen separate motions and after further study suggested a new method which involved only two motions. When trained in the "new" method, the average bricklayer could lay 350 bricks per hour--an almost threefold increase from the rate of work at the old "traditional" method. New, lighter tools were invented to make the work easier and more efficient. The Gilbreths developed flow charts, merit rating systems and other ways of analyzing efficiency of workers. They felt that communication between all parts of the factory was important,

especially between workers and mangement and advocated the use of simple but specific written instructions.

Clearly, the increased efficiency led to an increase of production. Taylor encouraged management to learn about factory processes and, in the way of the Gilbreths, consider changes which will increase the efficiency.

While he encouraged communication between managers and workers (through the foremen) he proposed that management move to a corner of the factory. In later times this separation of planning from production was carried further as management moved away from the factory to an office "downtown."[4]

The moral code which had (collectively) set standards and limits to work was seen as laziness by Taylor who did not believe that those doing physical work had much capacity for understanding. The notion that work is not creation but is production makes the process more important than the product. The power to make decisions about how the work is to be done is removed from those who do the work. The what? why? and how? of production are questions no longer decided by the workers. Management is to set standards and judge merit. The number of managers increased.

Montgomery describes an early Ford assembly plant as a "perfect situation for scientific management." The company slogan for hiring was "No experience is preferred," and there were 14,000 unskilled assembly line workers to 200 highly skilled workers in machine tool production and repairs. There were as well many managers and supervisors. (A further example to illustrate the trend toward an increase in white-collar staff--In the 1890 coal mines there was one foreman for 100 miners. In 1970 coal mines there is one supervisor for every eight miners.)[5]

While there have been occasional "Algeresque" tales of "rags to riches" mobility, it is clear that the transformation of industry toward a national science did much to increase the workers' dependency upon industry, narrowing rather than broadening their skills.

The flaw of Taylor's theories was its disregard for humanity. (A protégé of Taylor's, Karl Barth, spoke of a day "when all the world would run to a single metronome.")[6]

The ideas of Taylor were acclaimed by many around the world (including Lenin in Russia). His theories brought major change to industry everywhere but there was resistance from the start.

The Gilbreths did studies on the impact of fatigue to health and productivity. Others later urged management to be sensitive to the human nature of the worker by stressing the need for simple encouragement beyond pay incentives. Another engineer, James Hartness, wrote a book in 1921 which he called The Human Factor in Works Management. In this book he encouraged those who designed machines to gain a more intimate knowledge of those workers who would be using those machines. He believed that repetitious work freed the workers' minds to consider other ideas. (Perhaps an interest that human minds be efficient at all points too.)[7]

While these concerns represent some of the first involvement of psychological and social sciences in the workplace issues, these reforms were still directed toward the goal of increased productivity. The strongest resistance came from the workers themselves.

The period of 1910 to 1930 was a time of worker struggle. There was widespread resistance to the incentive system's hourly rate plus a premium for extra work for it broke down the moral code and collective tradition. Time clocks and time and motion studies were also resisted. With the strikes of 1917-18 came the

abolition of these studies and in time the 8-hour day was set. Later depressions and periods of unemployment overwhelmed some resistance though organized union strength grew in time.[8]

In his book America by Design Science, Technology and the Rise of Corporate Capitalism, David Noble points out that it is unclear how such resistance shaped industrial process. "The engineering and management of production rarely if ever involved simply the transfer of designs from drawing board to shop floor. New approaches were introduced and abandoned, or endlessly revised to better adapt them to the work situation, a context in which people with conflicting interests, rather than mere considerations of elegance or efficiency, determined the final outcome. Without a precise description of how this has happened, the history of technology must remain a one-sided and hence distorted account."[9]

In his book Designing for Industry, Grant Hildebrand speaks of the early 20th century and the growing awareness of the industrial landscape. The awareness manifested itself in two ways: first as a symbol for designers, and second as an "operational" and "economic" challenge. Both ways were aware of management needs but not the needs

of the entire workplace community. The factory image and the efficiency of the production process were key determinants of form.

In the first way, the importance of the factory image spread beyond the industrial landscape. Ralph Bennett has described the superficiality of the Modern Movement's concerns for the industrial aesthetic in the following way: "I believe that the mechanistic enthusiasms of the modern movement, while enabling a clarified understanding of many architectural situations, prevented any constructive reformation of the workplace, especially the industrial workplace. It was precisely the confidence placed in industrialization as providing a better life to the users of its product which prevented any investigation of the actual working situation within the greatly admired factories. The factories themselves were important icons for their mechanistic and therefore truthful form, but not for the quality of environment provided for their occupants."[10]

Hildebrand points out that the Modern Movement's awareness of the industrial landscape involved few changes to the traditional design approach. "This view presumed the architect to be acting in his traditional artistic

guise as the conscious interpreter of the spirit of an age, and this was the way taken most notably by Peter Behrens and Walter Gropius. There was another way as well, however, that involved changing one's view of the architect's role, setting aside his traditional aesthetic concerns in order to concentrate almost exclusively on a more complete fulfillment of this building type's practical operational and economic needs. This was an at least equally fertile approach in that it held great promise for real operational solutions, from which new formal patterns could be generated--patterns that had not been part of the original, conscious intent of the designer."[11]

Of these two approaches, the latter was that of the famous designer of industrial buildings, Albert Kahn (1869-1942). Practicing in Detroit, Kahn designed over two thousand factories in his career as well as many non-industrial structures. Albert Kahn was a very different architect from those who glorified the industrial aesthetic. "His practice was not to be of the usual sort, and for his particular future he began with an ideally open neutral attitude extraordinarily uncommitted to an expressive formal or compositional position. His

approach from the beginning was pragmatic and it continued to be so throughout his career."[12]

The clients for whom Kahn did the most work were the automobile industries. He designed huge complexes for Ford, Chrysler, Chevrolet, Fisher, De Soto and General Motors. Kahn's office saw its task as putting an efficient economical enclosure around an industrial process. They left the process organization to the industry who in their view was more capable in that area. The office was enormously successful, designing a huge volume of industrial work and numerous non-industrial projects which came through contacts with top industry executives.

Hildebrand reveals a personal trait which may prove important to an understanding of the new role of architect as typified by Albert Kahn:

"All the evidence indicates that he had the prized quality of being a good listener. Men of humble beginnings often retain from early life a feeling that the other fellow may know a great deal, that the rest of the world may harbor an unsuspected wealth of knowledge. In some men this feeling is disguised by bluster and a false front; in others it fosters the ability to really listen to what the other fellow has to say not just out of courtesy

but from a belief that his knowledge may be of great value. Whether this is the way it happened with Kahn or not, no one can say, but by all accounts he had this quality to a remarkable degree. It lay behind two of his most important future assets--his ability to form and lead a genuine team and his ability to respond sensitively to his clients' needs. In fact this ability to listen coupled with a mental attitude free of preconceptions may have been the cornerstone of his unique career."[13]

Albert Kahn's designs for the many enormous industrial projects express a remarkable concern for process efficiency. The planning of these buildings was done by management and not by those involved in the production process.

The extreme rationalism of Taylor and the tendency to separate planning from production is a keen political issue. At its core is the assumed democratic capitalistic intent increasing efficiency and productivity for profit. Any marked change in this basic goal would involve some fundamental systemic changes. Most attempts to reorganize the workplace have been based upon the goal of increased productivity. All reforms have been based upon this intent. And newer theories of management have been

developed to this end. While these theories are based upon the goal of increased productivity, this has not meant that all advocate increasing the skills and power of managers at the expense of the workers. The emphasis remains, as it does in our society, upon the individual rather than the collective experience.

I once told an audience of school children that the world would never change if they did not contradict their elders. I was chagrined to find next morning that this axiom outraged their parents. Yet it is the basis for the scientific method. A man must see, do and think things for himself, in the face of those who are sure that they have already been over that ground . . . Independence, originality and therefore dissent: these words show the progress, they stamp the character of our civilization . . . dissent is also native in any society which is still growing. Has there ever been a society which has died of dissent? Several have died of conformity in our lifetime.

J. Bronowski

Workplace Reforms and Organizational Changes

While legislation advocating workplace improvements for safety and health standards (OSHA codes) has been enacted, other workplace changes have come through the union and collective bargaining. Understandably, the issues of comfort in the workplace are generally not viewed in physical architectural terms. Comfort and control are initially discussed in terms of hours worked, rate of work, amount of overtime and health/safety issues. "When the younger workers in some General Motors plants began to talk about humanizing the assembly lines, the greatest resistance did not come from GM management. It came from the United Auto Workers leadership, which insisted on talking about money, pensions, hours off, coffee breaks--and so on."[14]

In his wonderful book about working life, Ten Thousand Working Days, Robert Schrank has discussed this hesitation on the part of unions and workers to consider more major changes to the workplace setting. He describes a gathering of "seasoned automobile workers" of whom he asks the question: "If you had the option of running your plant in some way other than what is now being done, or in any way you thought would be better for the people working there, how would you do it?"[15]

Initially those who responded to this question proposed minor changes in the existing setup. "Clean the place up," "reduce noise levels," "improve the ventilation," and "get rid of all the foremen, or at least some of them."[16]

Schrank recounts his initial dismay when they "only came up with more collective bargaining demands."[17] He then proceeds to toss out strategies of team work instead of an assembly line and the group's general response was "The company knows more about this than we do and if this was a good way of doing things wouldn't they do it this way?" "This company is in business to make money not to run Mickey Mouse programs."[18]

Schrank realizes how difficult it is for us all to grasp concepts of participation and collective work when so much of our experience (and motivation) has been directed by individual achievement. Going beyond the limits of one's experience and traditions can be difficult.

After some discussion the group "agreed that there were alternative ways to run a plant but that there would have to be a major learning of new, more cooperative attitudes in order to really achieve a more human workplace."[19] The "lack of knowledge is based on a lack of

experience with anything that is not hierarchical by organization," and Schrank suggests that managers, behavioral scientists, owners and workers all know very little" and "suffer from a collective ignorance when it comes to this form of social action."[20]

While this remains the case, there has been an increasingly prevalent movement away from the Tayloristic views of management. In 1960 while at the MIT Sloan School, Douglas MacGregor analyzed managements' attitudes toward the workplace, and the subsequent approaches, which he called THEORY X and THEORY Y.

The Theory X attitude assumes that people are unmotivated and lazy, performing only in reaction to orders or rules imposed from above. Theory X assumes that people do not want an understanding of their work nor do they seek responsibility for the work. This theory reflects basic Tayloristic notions of general low hierarchy worker attitudes.[21]

The Theory Y attitude on the other hand assumes that people are motivated, seek outlets for creative expression and take responsibility for their own work.

MacGregor's work in this area initiated a period of interest in the workplace by behavioral science. Most

behaviorists interested in workplace reforms have emphasized the Theory approach and have sought for ways to encourage satisfaction among workers. According to MacGregor, "Management has, due to codes, provided for the physiological and safety needs. Unless there are opportunities at work to satisfy (these) higher level needs, people will be deprived and their behavior will reflect this deprivation."[22]

Worker dissatisfaction had, in some large industries, led to periods of lower productivity, so management was also interested in exploring changes which might impact worker satisfaction, thereby increasing productivity. Many described many conditions necessary to a satisfying working environment.

A behaviorist, Abraham Maslow, proposed that there is a hierarchy of needs and these influence behavior. He ranked them as follows:

1. Physiological (food/shelter) needs
2. Safety needs
3. Social needs
4. Ego needs
5. Self-fulfillment needs

According to Maslow satiation of one level of need will cause behavior to be determined by the next higher level of needs.[23]

Allen Pincus has described four "Dimensions of the Institutional Environment" which form a good basis for analyzing an existing environment for designing for a new one. His work was done in institutions for the elderly, but the concepts may be applicable to an industrial setting.

First, there is a distinction between "public" and "private." He discusses the importance of a place which individuals can use which is not open to public view or use. Second, there is the issue of a "structured" or an "unstructured" environment. Are there strict rules to which individuals may adjust or is there room for choice and personal initiative.? Third, the environment may be "resource sparse" or "resource rich." It is important to consider the extent to which there exists a range of opportunities and activities. And also the importance of allowing for social interaction in various work and recreational settings. Fourth, there is the important consideration of the extent to which the institution is "isolated" from or "integrated" with the community in

which it is located. To be integrated with a larger community there must be opportunities for interaction with a range of people and in a range of settings.[24]

It is true that those who work in factories are different from those in old age institutions in that they are only in the job setting for part of each day. It is true that many find satisfaction, privacy, an unstructured and resource rich environment integrated with family and friends within their own homes and outside activities. These people have seen home as an escape from work.

However it is also true that there are some persons who may view work as a place to escape from an unsatisfying home life. When so much time is spent on the job it should never be assumed that satisfaction not present at work will be found elsewhere. It is, of course, desirable for satisfaction to spread to all facets of a person's life.

In an impressive article on industrial space, Gustave Fischer and Abraham Moles have characterized such space as being of a higher intensity than other types of use spaces. "In general as industrial density increases, the ancillaries (canals, railroads, highways, power lines)

increase in density, changing the pattern of the landscape, replacing it with a total industrial scene. This scene can be said to predominate once 30% of the space is actually occupied by industrial facilities."[25]

Fisher and Moles argue that the sense of industry intensity tends to be overwhelming. "Because industry imposes a temporal and spatial constraint on its employees, people feel that there is antagonism between the factory itself and industrial space on the one hand and 'human spaces' on the other."[26]

Of course, there is the issue of scale of operation. E. F. Schumacher discusses the fact that in a very strictly organized, hierarchical company of a small size there may be a sense of belonging which belies the strict hierarchy.[27] This gives us a clue that the physical environment does have a role to play in workplace comfort.

But it is essential to remember that an industrial setting may seem to many to be more overwhelming than any other setting of comparable size. This is not an argument in favor of making industrial spaces less industrial as if to make them more "human." This does argue for the existence of human scale forms and human intervention and participation within the rich and

sometimes overwhelming industrial setting. It is very important to remember that what seems overwhelming to some, is not always overwhelming to those who are familiar with it, who use it, and who may have built it.

The ability to have privacy within a public setting is based upon an ability to make choices. "The degree to which the individual can lay claim to and secure an area or an object, he (she) maximizes his (her) freedom of choice to perform any behavior."[28] This ability to claim space or an object, according to Michael Brill, is socially (not physically) determined. Two things which contributed to a social setting conducive to claiming space are, the length of time in the space, and second, whether individuality is recognized and encouraged.[29]

While it may be true that the social setting must allow for this, there are obvious physical clues as to whether or not it is possible and encouraged.

In an old mill or workshop there is often an accumulation of additions to the physical setting which have occurred over time. Some of the life of such places has been described by John and Mart Myer who wrote of the qualities in such a workplace. It is "a built environment which has been generated incrementally and periodically, as needed,

through deploying the locally made piece of dimension lumber, gives one the understanding of how it got generated and even the sense of being able to have generated it oneself or with a small group of others. This mill which has been incrementally achieved, has no fixed limit in its growth. Not only can one sense how it was built but also that he (she) or others could readily extend it, a quality most of our modern plants lack. Like the form itself, which has no association to completeness but rather to incremental initiative, one is not blocked in physical built form. Rather the mill is open to such initiative and even suggestive of it."[30]

As Michael Brill and the Myers have suggested, part of the important ability to affect one's environment comes from personal confidence, sense of mastery of skills, and a sense of being part of an ongoing potential for changes.

Pyschologists like Abraham Maslow and Frederick Herzberg speak of the need for jobs to allow individual autonomy and creativity and make a job challenging. To Herzberg this does not mean asking an employee to do more of the same or rotate doing similar jobs, but means an increase in responsibility and a chance to grow.

Herzberg cites six principal ways to job enrichment and the potential results from their implementation. 1) Remove some controls (responsibility and personal achievement), 2) Increasing the accountability of individuals for their own work (responsibility and recognition), 3) Giving a person a complete unit of work, rather than piecework (responsibility, achievement, recognition), 4) Grant additional authority to plan job/time (responsibility, and recognition), 5) Introduce new and more difficult tasks (growth and learning), 6) Assigning specialized tasks which allow them to become experts (responsibility, growth, advancement).[31]

This need for individual autonomy or creativity should not exist at the expense of the small working groups. Participation must occur at the group level to avoid the competition when workers are forced by incentives to be better than others often at the expense of others. Schrank discusses the importance of maintaining the community spirit in participation, and suggests that some industries are more conducive to participation and job enrichment than others. "At the point of production, decision making is at its lowest level since all design and manufacturing issues are settled long before they

reach that stage. To participate in decisions that affect the organization beyond the point of production requires a broad knowledge of the organization that most people have no access to. . . . Most manufacturing plants do not lend themselves to the democratic model of worker participation in decision making, particularly if the finished product has a large number of parts or sub-assemblies (like the automobile) that require considerable overall planning. Participation is much more feasible in continuous-process operations . . . which can be highly automated, where the major work task is equipment adjustment and maintenance for product control. While the area of decision making here too is limited, there is a much greater potential for decentralizing control than in unit manufacture."[32]

Participation in decisions of organization or production harks back to the pre-Taylor periods when such decisions (made collectively) were common. To be successful there must be a real sense of community and solidarity. This enhances an important sense of security important to the early stages of experimentation with this "new" participation.

(Of course participation when carried out to its furthest end begins to mean a sharing of responsibility

and even ownership amongst workers and managers. It would be naïve to think that at such a level of participation there would be no risk, or that no security (ownership) could ever be assumed.)

But such conditions in large-scale American industry are not imminent. There have been many experiments with increasing paritcipation in the workplace. The initial experiments took place in Europe and in time some of the concepts have spread to American industry. In Europe labor has been more involved in changing the organization. In the U.S., the changes toward increasing participation have been generated and supported by management who have viewed improvements in work environment as a means toward increasing productivity.

In some cases, changes have meant rearranging the work schedule. In the mid-1960s European companies began instituting programs of "Gleitzeit" or "gliding time." In the early seventies the idea began to have an impact in the U.S. where it was known as "flexi-time." Basically it allows employees to have some control over the scheduling of their work hours, giving flexibility to people who want to avoid rush hours, be at home when their children return home from school, etc. The response to this innovation has been tremendously positive, offering social benefit

to the workers and economic benefits to the company. "Some managements reported up to a 12 percent increase in productivity, overtime, and short-term absenteeism dropped by nearly one-half. . . . Most people happily trade stolen hours for the freedom to set their own hours. The ubiquitous appeal of this tradeoff may have to do with intangibles like human dignity."[33]

Beyond the changes of schedules (flexitime) there have been larger changes in the industrial process itself which have affected the physical form of the factories. Generally innovations in workplace organization have occurred within the largest industries. First, because it is the largest industries where the effects of the dissatisfaction (which leads to absenteeism, sabotage and lower productivity) are on such a scale as to really be felt. Second, any organizational changes involve some risk and outlay of capital for an uncertain return. This becomes a cash problem for smaller industries, who indicate they cannot afford the time lost in reorganization. This is less often the case with larger industries.

The cost issues are a prominent feature at all levels of workplace design. The cost of new facilities when calculated over time (the life of the building) is minimal, relative to the other costs of materials and salaries.

(One figure I heard somewhere was in the order of merely 2%-5%.) Changing facilities, process or organization may mean some cash problems but the long run benefits may far outweigh the temporary inconveniences and costs. In the largest companies temporary losses may be absorbed elsewhere. In the smallest companies there may well be an intimacy of scale and existing participation based on the clear understanding of each individual's capabilities.

The move toward Theory Y attitudes in organizations has been called "Industrial Democracy" by some. Its basic premises are that workers can take over increasing responsibility for their work with fewer orders from above. "Management decides on production goals and the workers decide how to accomplish the work as a group. Incentive is no longer based on piecework, but on the number of operations a worker can perform and the quantity and quality of the group effort. The system is based upon the workers' control of themselves as a group."[34]

The experiments in industrial democracy were initiated in Norway and Sweden. Tardiness, absenteeism, turnover, sabotage, theft, deliberate waste and other disruptions impacted productivity enough so that Volvo and Saab and other companies reevaluated their assembly line operations and turned increasingly toward teamwork organization.

(Richard E. Walton suggested in an article in the Harvard Business Review that "violence against persons and property in industry occurs more often than we would think," but that the "private sector tends to keep it quiet.")[35]

The new teamwork reflects a "desire for more equality which tends to enhance cohesiveness," and in varying degrees it leans away from "differential rewards for individual merit, which may be more equitable, but can be divisive."[36] Though there are many differences between Scandinavian society and labor and American systems, worker dissatisfaction is common to both societies. Similar experiments in "industrial democracy" have been initiated by management for some American industries.

One example is the Volvo U.S. car manufacturing plant in Norfolk, Virginia. The new plant was designed by Mitchell/Giurgola Architects. Romaldo Giurgola described the design process as a uniquely collaborative effort among process engineers, management and the architects. While the management was responsible for the changes in the basic process, Giurgola felt that there was room for substantial input from the architect who worked more as an advocate for those who worked there. Giurgola's concerns were that production efficiency be accommodated, but not at the expense of the workers.[37]

The innovations at Volvo involved setting up worker teams to assemble a single car. Within each team there will be job rotation so that each person had an opportunity to work on all phases of the car assembly and not simply repeat a single task. One "innovative technique"[38] was a trolley-like vehicle which will guide automobiles through the assembly process without the restrictions of the traditional assembly line. "This trolley or carrier can pivot the car on its side to allow a worker easy access to the underbody."[39]

The size of production teams apparently determined the size of each "shop." Giurgola described that his experience with other institutions had led him to feel that 100 to 150 persons was the maximum group size beyond which easy communication was not possible. He felt that his experience was considered in the establishment of a group size of 130 workers per shop.[40]

Each team has their own production shop, lounge, locker rooms, courtyard and entrance. There were assumptions made that had implications for the form and materials building: 1. That the entire assembly process be "visible to team members affording them a comprehensive understanding of their role in the completion of the car."

2. That locker and lounger areas be convenient to work areas yet separate and "identifiable" having a domestic scale "to act as a transitional link between the home and work environments." 3. That there be "awareness of nature and presence of natural light "to enhance the quality of the space" and provide relief from the intensity of the work experience."[41]

The building seems to articulate these intentions in its visible, human scale entrances and lounges, its natural light, outdoor and indoor views. Though the architecture successfully respects and enhances the new process, there may be problems with the process in the face of which the architecture may be irrelevant.

One ironic problem is that the workers for whom these changes were made had little or no input into them. "Though the workers at the Volvo truck plant thought team assembly was OK, they did not feel it was theirs, they did not own it. The Saab team assemblers said this is OK, it's a job, the company set it up this way so we will do it."[32]

There is a story of an American automobile worker's comments on the "innovative technique" at Volvo (by which the chassis is rotated for working on the underbody, which was aimed at replacing the pit situation common

to the assembly line, where the worker works under the car from the pit.)

The American worker spoke of preferring the pit to the new system, saying: "When I'm in the pit I have a certain amount of control and privacy. Management says it will take me 50 seconds to complete my task. But actually it takes me twenty seconds and then I have thirty seconds to rest. No one sees me resting because I'm in the pit. If I was up on the ground working on the tilted chassis they would make me work faster."[43]

Richard Walton analzyed a new food processing plant and arrived at some other problems with the industrial democracy system as well as some benefits.

Major problems lie with lower level supervisors and managers who feel their authority is stripped away as more control is allowed the workers, or that the changes "implies they have been doing their jobs poorly."[44] Some workers resist the increased responsibility or are uncomfortable with the participation and group decisions. And interestingly enough, "outsiders" (salesmen, etc.) are uncomfortable dealing with workers as the company's representatives."[45]

There have been many benefits reported in terms of increased satisfaction and a sense of involvement and

cooperation. "People will help you; even the operations manager will pitch in to help you clean up a mess--he doesn't act like he is better than youare."[46]

There are indications that productivity rises enormously as the new system begins to run smoothly. Not only is productivity an important management goal (which may have initiated the changes initially), but it is easy to measure over time. Richard Walton correctly points out that "we do not have equally effective means for assessing the quality of work life or measuring the associated psychological costs and gains for workers."[47]

It is clear that in order for changes to work there must be a real commitment to the changes in organization by all members of the workplace community including workers and management. Commitment to the openness and flexibility needed for job enrichment can be enhanced by physical changes. But all the physical changes will have no impact unless the attitudes behind them are supportive of the change. As we have discussed earlier, people can put up with some unpleasant working conditions if there is a strong sense of community. And conversely, the cleanest, most beautiful elegant setting matters only as an image if there are rigid (Theory X) attitudes present.

Men feel lonely when they do not do the one thing they ought to do. It is only when we fully exercise our capacities--when we grow--that we have roots in the world and feel at home in it.

Eric Hoffer

Qualities Important to a Good Workplace

If we assume that strong Theory Y attitudes exist in an industrial setting what physical (built) things can be done to support (or at least not to detract) from these attitudes. To get at this we must define that which is part of a positive workplace. At the most general level we are concerned with allowing for flexibility, an understanding of the whole integrated community (rather than promoting a hierarchy), providing for physical safety, creating a range of environmental conditions and allowing for the personalization of space.

Schrank has a lot to say about the sense of community so important to every workplace. He says "it is hard for me to recall a workplace where older men were not protected by the younger. This is one of those unwritten concerns of men and women for their fellows that tends to grow in work communities and can make tough workplaces like coal mines, foundries and steel mills far more human than they might appear to the casual observer. This is one reason why behavioral science studies of workplaces tend to be tales of horror. When people who work there read the studies, they might respond with "Oh hell, it ain't that bad."[48]

Schrank speaks of some of the jobs he had where the organization did not allow for the sense of belonging to a community to happen easily. He speaks of being forced to be more creative in his work so that he could work more efficiently so that he would have time for "schmoozing" --"time to wander around the plant, visit and talk with people in other departments and not be stuck in one spot doing the same thing."[49]

It is the daily contact and "rituals" beyond the work which nurtures a community feeling in a workplace. According to Schrank these "rituals" include: greetings on arrival, coffee breaks, lunch, smoke breaks, teasing, in-jokes, endless talk about almost everything."[50] Community feeling is also promoted by union activities where working places are organized.

There are many things which contribute to an integrated community and a sense of the workings of the whole organization. Sharing of facilities by managers and workers is important. There should be no separate entrances or "preferred" parking and other facilities for management. Lockers, cafeterias, bathrooms, meeting rooms can be used by the entire community. It is often the case in a factory setting that some offices may need

to be physically separated so that noise and grime of the plant are not permitted to enter. But this separation does not mean that there cannot be windows and doors which make access between office and plant easier. (There may be a few cases when fire codes will make such difficult.) Those in the office need to be able to connect with the plant and vice versa. The offices need not be all above the plant looking down in a symbolic "guarding" way. Those in the plant should be able to look into the office and see the workings. And finally there should be some means of looking out over the whole operation, a high point perhaps from which to view production.

Understanding the workings of the whole may also be articulated in the building massing. It can be clear from the outside where production occurs, where there are large, important, and relatively unchanging equipment, views of production, where there are entrances, places to relax and where there are offices.

Beyond promoting ritual contact within the workplace community, contact with the outside is also important. One important suggestion Schrank makes is that there be easy access to phones in a factory. Like a view from a high place, a phone call would be another (aural) "view"

of the outside, an important contact which may ease the strains of a working day. This is not to advocate endless phone conversations but the ability to make the contacts with other facets of one's life and community outside that helps nurture those ties. This seems especially important in our times when men and women leave their families to work.

There should be an important physical connection with the surrounding community. Beyond the articulation which gives one some indication of what goes on inside, the building mass should reflect the scale of its surroundings as much as possible. Impact of the whole industrial process must be considered early on when a site is being chosen. Disruptive activities must be minimized (i.e., transport of materials) or if they will have too great a negative impact, a new site must be found.

While there must be an attempt to reflect the scale of the existing context, it may well be true that an industrial building may contain huge spaces for the process which are very different from most spaces in buildings of the private sector. Their great scale (high ceilings, long walls) have a more "public building" character, and their different scale adds variety to the surrounding smaller scale.

This brings up the question of sharing some facilities with the surrounding community, and with the workers and their families. Could industry provide facilities for recreation and childcare for collective use and share existing community facilities? There could be tradeoffs. For example, could an industry provide childcare facilities to its workers and to the area and in return have use of the local recreation facilities? "In 1974 a law was passed in Sweden whereby all firms making over $22,000 in profits were to place 20% of those profits in tax-free building funds. These funds were administered by joint management-labor committees for any improvements desired--swimming pools, sauna baths, furniture, sound insulation, etc."[51]

Fischer and Moles decribe and categorize types of interior industrial space: working places, raw materials storage, finished product storage, "buffer" spaces for semi-finished items, space for trash, circulation spaces, administrative spaces and interstitial spaces.

The first seven are fairly straightforward use spaces and the proportions and amounts of each space will vary according to the product and process of each specific industry.

The "interstitial space" category covers all uses that do not fit into the other use space categories. "For the architect these may be wasted spaces, for the president, forgotten spaces, and for the worker, breathing spaces."[52] These are the least understood spaces in the industrial environment and their existence runs counter to the very rationalist approach to factory planning where economics and process efficiency rule. However a study by Proshansky has shown that these are precisely the spaces used by people who work in the factory and that planned spaces are used less at breaks, etc.[53]

Schrank discusses the importance of the bathrooms for social interaction in many industrial settings. They are often the private place to which one can be away from rules (and the eyes) of foremen, places to "schmooze" (Schrank's word for the talking and socializing in the workpalce whether it is sanctioned or not).

"It can be said that depending on their position in the hierarchy, human beings resist to their utmost the rationalism that is forced on them by the factory. They invent their own freedom out of the workplace depending on how much time and space they may have access to and depending on who far they can move without special

justifications."[54] This is not to say that all workers are unhappy. As Fischer and Moles correctly state, "many people <u>are</u> loyal to and have a genuine interest in the company's success."[55] The ability to claim territory enhances these feelings.

There should be a range of spaces which offer some refuge from the pace of the factory. There should be spaces where individuals can claim space on a relatively permanent basis. On the other hand there might be some places which can be used on a temporary basis by a person or persons to rest or share an intimate conversation. What are some important physical qualities of such spaces?

Julie Moir has defined "four archetypal contemplative spaces" where one can have some control, yet distance from a fast pace environment:

The first is a "water place." Water in all forms, a still pool, a bubbling fountain, a view of ocean waves or the expanse of sea is very soothing. Moving water is especially calming.

The second is an "open place," a place one can look over preferably from a position where one has one's back to a wall. One has a sense of intimacy and security against the wall with an expansive looking out feeling from the openness ahead.

The third is an "enclosed place," which is not necessarily dark or light but has a variety of sun and shade. A sense of inhabiting a place and individual control can exist if there is a place where there is some ability to shut a door, or control an entrance in some way.

The fourth archetype is a "high space." There is the importance of a new view of the world and a detachment from the activity of the ground.

In these contemplative spaces individual use is possible. It should not be so remote from others so as to feel unsafe, and there is the possibility that it can also be used collectively. Though publicly owned and maintained, they are places where individuals can go to rest and be renewed.[56]

Other places should be able to be made personal in a more permanent way. Though it does not mean that there should be fixed and solid walls, "a place is created to the extent that it is surrounded by surfaces."[57] Partitions of wood and soft materials which can be added to or to which personal things can be attached. "Installation of personal objects, having a personal semantic significance, allows private meanings to be imposed on the workplace (or the refuge place)--within the rational space

of work . . . the very fact of filling space with objects which are seen to be useful only by the occupant of the space is one of the main elements of 'nest-building,' of creating a 'place' out of a location."[58]

In the factories I have visited there has not been much evidence of individual place making--which may not mean that it does not occur but only fails to be obvious to an outsider. But in some of the older factories where there was wood framing or detailing, there was evidence that photographs and personal items were attached. In the newer factories the wider spans make the distance to the edge greater and the harder (more durable, cheaper) "modern" materials (concrete, steel, plastic) make attaching things more difficult. Some low temporary partitions in some areas have helped. (Steel frames to which material or homosote, etc., can be attached.) Bring an "edge" closer to each worker when it is possible.

It is not just having personal-like objects in a factory setting. Things that are soft or in any way different from the working spaces are important as a contrast. Similarly any changes in light, noise levels, temperature or scale which vary from the working spaces are important. But control over them is as important as their presence.

Personaliztion of working space is more possible when there are some individual controls of ventilation, noise, light and all other environmental factors. There should be light sources at each work area. These are more effective than an overall overhead system though some overhead systems will be needed to supplement the natural lighting, and the "local" lighting.

Where there are concrete floors there should be movable wooden pallets which can be moved to any work area where long hours of standing would be uncomfortable on the hard concrete. End grain (wood) floors may be considered, though they are not much softer than concrete. Low partitions can be used to provide some display surfaces and/or privacies.

The issue of flexibility is one of the most important issues of the workplace environment. While it cannot be ascertained that growth will occur, it is a fundamental goal of industry. While growth of the whole may not occur, changes within the industry certainly will. Market pressures may cause an industry to shift its focus away from production, toward assembly of parts that can be produced more cheaply somewhere else. This will mean certain sections of the company will grow while others may shrink, or remain the same.

Issues of flexibility may impact the choice of site from the beginning. Any given site may realistically accommodate needs for space in the present but have little room for future expansion at the ground level.

It is common to think of industrial buildings as single-story structures with 12 to 18 foot clearances and a minimum of structural columns. Expansion might occur on other levels over time although early structural decisions must be made to make it possible. Although most industries have evolved toward a single-story facility, there may be tradeoffs which make a multi-story facility very desirable and possible for many industries: Site constraints in an urban setting, gravity feed processes, and narrower, higher buildings to allow for natural lighting.

The large single-story widespan building has also evolved from increasingly sophisticated mechanical systems. Carried to its ultimate expression we have windowless industrial buildings, very popular in some circles because they are easy to maintain and there are fewer things to "distract" the work force. In our time of energy shortages these environmental controls are increasingly costly and this has forced rethinking.

While it is hard or impossible to predict what kinds of changes may occur over time, it may be possible to isolate activities in the factory which are least likely to change. These may be areas which require heavier construction to support very heavy loads. Or there may be areas where plumbing will be fixed or very large special machines such as cranes, storage tanks, furnaces, etc., will make future change difficult in those areas.

It is important to have a general conception of where and how things can expand. Examine several options, analyzing the tradeoffs of each. It is not necessarily true that walls or smaller enclosures preclude future change. First, I have heard many stories of companies changing--putting down and taking up partition walls with relative ease. And second, if flexibility becomes all important there may be a real loss of the ability to claim personal space, greatly affecting the morale.

Providing for the health and safety of the work force has been a primary determinant in reforms from early industrial periods. This factor has led to the development of building codes and the Occupational Safety and Health Administration (OSHA) standards.[59] Much of the regulation is purely common sense. Rather than get

into the specific codes regulations I would simply say that it is crucial to have a clear understanding of each industry and where specific safety concerns might lie within this industry.

The codes may not determine every facet of a building. For example some highly flammable processes must be constructed of certain high fire rating materials. But it may be possible to isolate the most flammable components, clad them in the most fireproofing and use "lighter" materials in other less flammable parts. These decisions must be clear early on, having an impact on the general organization of the building.

It is clear that there must be a certain quality of air in an industrial building. Employee exposure to hazardous fumes, mists, and dust must be minimized and carefully vented so as to protect the safety of workers and the surrounding community. Respiratory equipment should be worn under extreme and/or prolonged conditions.

First aid services must be available to all employees and access to doctors, ambulances, medical supplies, etc., should be clear to all who work there, and centrally located if possible.

Drinking water must be provided and water for industrial purposes (which is not fit for human consumption) must be clearly identified.

Toilets must also be provided and according to the codes, at a ratio of two toilets (or 1 toilet and 1 urinal) to 40 workers. The issue of accessibility may mean more facilities are desirable. If the industry is multi-story it may be reasonable to have toilets on each floor. (In our experience here at MIT we have discussed that 100-150 feet seems a reasonable maximum distance to travel to the bathroom (and phones). Beyond that it becomes quite inconvenient.) It will be up to the decision of the work force if separate facilities for men and women are desirable at all points.

Similarly industries which are involved with application of contaminants will be required to provide washing areas for easy removal of such substances.

And finally, two very important factors in industrial settings are levels of light and noise. Each are regulated by standard tables which outline allowable levels of decibels (noise) and footcandles (light).

The OSHA codes indicate that noises above 90 decibels will harm hearing when one is exposed to them daily for

8-hour periods. Bob Newman, acoustics specialist, suggests that 85 decibels may be a better maximum limit, but he suggests a better "rule of thumb": "Speech interference" is a good way to rate noise (and quiet) levels. When it is too noisy, communication on the phone becomes impossible. Conversely, in a too quiet environment private conversations are difficult.[60]

In the industrial setting there are often high noise levels, depending on the nature of the industry and the machines. While most do not expect the noise levels to be as quiet as home, extreme noise levels can create stresses and make the kinds of communications which contribute to a community feeling impossible. There have been some researchers who have shown that people are able to cope while in situations but that they became less able to cope with things after being under such stress all day. It is therefore important to consider the whole picture of health, not simply health and safety on the job.

Other research has shown that people are able to cope with extreme situations if they know that they have some control by being able to leave or shut the noise-creating machines down, when they want to.[61]

The only real way to isolate noise is to put up solid barriers. Low partitions can have some impact but sounds can be reflected from hard surfaces above. In many (including office) settings, application of absorbent materials ("fuzz") such as carpet and some acoustic tiles may minimize reflection of noise.

Application of "fuzz" may be possible in some industrial settings; however, it is more than likely that it will not. Harder surfaces are generally easier to clean in work spaces where there is oil in the air, etc. In a factory it may be possible to isolate behind walls those areas of extreme noise and make earphones available to employees. Similarly, care should be taken to isolate those areas which need to be quieter than the factory.

It should not be a goal to make things as quiet as possible, Some of the noises of industry reinforce the awareness of what goes on there. But there should always be places which are easily accessible to which persons can escape the noise.

Noises of our industry may have a large and unfavorable impact on the surrounding community. The noises from trucks and increased traffice, generators and other equipment must be taken into account. Perhaps these noises

are infrequent, and can be scheduled for times when they will least bother the community. If the impact will be too great, the decision to choose another site will be the only fair way to approach such a problem.

Energy shortages have caused many to reconsider using natural light rather than relying on artificial lighting systems. Total reliance on natural light is not sensible in an industrial setting where safety or seeing levels of detail require constant and direct illumination. A combination of natural and artificial light can both minimize energy costs and create more variety in the working spaces.

The importance of natural light is, at its basic level, the notion of connection to the natural forces. Architect Louis Kahn explained this as "knowing that there is life outside the room."[62] Studies have shown that while we are unable to discern the levels of natural illmination vs. artificial illumination, the presence of natural light is important. In one such study "the authors . . . have made the assumption that . . . daylighting should be the dominant source of lighting of a room in phsycial terms. However the present experiment showed that people's estimates of the level of daylight illumination were far from accurate, and that they still

felt that they had a considerable proportion even when there was scarcely any."[63] They went on to say that "the experiment showed how the estimate of the level of daylighting was related to the apparent brightness of the window. If the view of the window was obscured by partitioning . . . people would feel deprived of natural lighting and a view from the building."[64]

Views are an important element of the working place, and studies have shown that a majority of workers feel that it is important to have poor views rather than no view at all. K. W. Nichols in an article entitled "Urban Office Buildings: View Variables" cites several reasons for having views out of the building: it affords daylight, minimizes the sense of enclosure, creates "cheerful more relaxing" conditions, shows what's happening outside, and gives eye muscle relief. Nichols goes on to say that "skylights do not minimize the sense of enclosure" but that "eye level windows do." In the studies it was determined that people who worked in areas without windows often "journeyed" to window areas and that "not all the trips were job related."[65]

Views of within reinforce a sense of the whole, and views to the outside can be a connection to the

surrounding community. Reciprocally, community views into the workplace might increase an awareness of what goes on inside.

The placement of windows and skylights is as important to adequate lighting as it is to affording views within and views without. Windows ideally should be located as high as possible on a wall. This allows more reflection from the ground outside to the ceiling inside and enables light to get deeper into a room. According to Roger N. Goldstein in this thesis on "Natural Light in Design" (MIT, 1976), the effective natural light (unilateral) will not be felt when the room is deeper than "2 to 2-1/2 times the height from floor to window head."[66] The ceiling and opposite wall from the window should be light colored to best reflect the incoming light around the room. Although windows should extend as high as possible in a wall, it is also important that there be some windows at eye level. It is important to be able to open windows in order to obtain some natural ventilation as well.

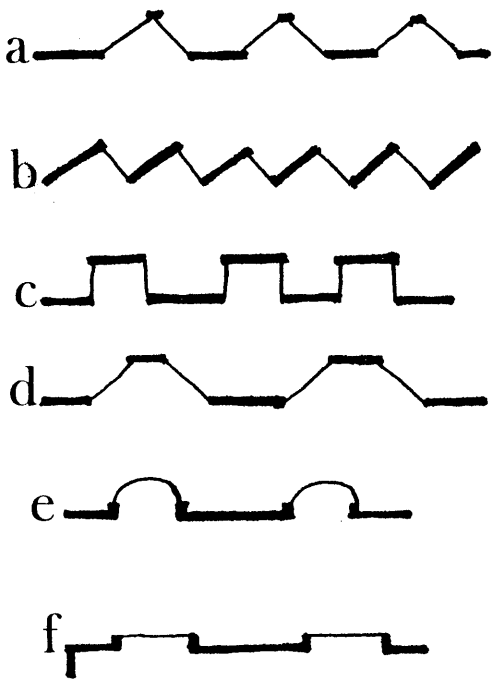
Glare can occur when there is excessive contrast between the light from window openings and the window wall. For exmaple, there is more "glare from a large

window on a dull day (when interior light levels are lower in proportion to the sky brightness) than on a bright day."[67] The impact of glare can be minimized by changing a person's position with respect to a window, but as Goldstein points out, this can be difficult in many work situations where tasks are fixed with respect to windows. In such a case, it is best to fix working areas parallel to windows rather than facing them.

Light colors in the window wall, window frames, and the mullions themselves will lessen the contrast and therefore lessen the glare.

Windows on the northern exposures where there may be heat loss in the colder months should be kept to a minimum. However, well-insulated clerestories and skylights facing north provide a consistent (and never direct) daylight. Lighting from two or more sides minimizes glare problems. In New England the east, west, and southern exposures will receive the most direct sunlight at various times of the years and shading devices should be considered.

Roof lighting makes illumination of interior areas (far from the edges) possible, especially when partitions or equipment block the light coming in from the windows.



Roof lighting can be provided in serveral ways. Goldstein outlines six possibilities: "Type a gives uniform sky illumination but the sunlight can be troublesome; type b has less uniform light but the sloping glass increases the amount of daylight reaching the working plane; types c and d provide good uniform light; with types e and f maintenance of the horizontal glass (as well as sloping glass) may cause problems and the distance between adjacent areas of glazing should not exceed 2 times the height of the roof light above the working plane. And finally the ceiling should be light colored in order to maximize the interreflections of light that enter the room."[68]

Enormous insights can be gained from visiting industrial operations. When approaching a design for a specific industry it can be helpful to visit several similar operations (if such is possible), and thereby see a variety of approaches to similar problems. Understanding the production process and the needs of all those who are involved in that process is an enormous task and may take many visits and many more careful questions. Having a clear picture of the relationships of different stages of production and their present/ future space needs is essential. (While this may be

overwhelming initially good information and common sense will be invaluable.)

Listening and asking important questions is as crucial as relying on the comments and experiences of others. Robert Schrank illustrates this in an anecdote in Ten Thousand Working Days. He describes a visit to a European Saab factory with a group of American industrial specialists. One of the members of the visiting team commented that the noise levels were high. Schrank replies that the noise does not seem particularly troublesome to him and asks the other person if they had ever been in a metal-stamping plant, where there is "incessant pounding." Schrank makes his point that individual responses are conditioned by the individual's experience. To the one person the Saab plant was extremely noisy compared to their familiar office setting. To Schrank the noise seemed reasonable compared to many of the industrial enviornments he knew. The importance of asking "compared to what?" should not be overlooked.[69]

The designer must recognize that the management (who usually has hired her/him) will not want any superfluous spaces which will lead to extra cost or inefficiencies. Yet if these are the spaces which help to humanize the workplace they must be included.

Our surrounds become more than associative form, they become the arena for our doing, making, a context which we can find to be better or worse, even reinforcing our intentions or obstructing them. It is important to contrast this to a compliant relationship to the external world in which 'the external world and its details . . . are recognized only as something to be fitted in with or demanding adoption.' Here one's own intentions become subordinated to the intentions and creativity of others. There is a sense of uselessness, . . . 'of futility that nothing matters and life is not worth living.' What is essential to this position is the ability to take initiative, to eventually gain mastery . . . one can be comparatively small, but master something great and in such mastery experience self-esteem.

John and Mart Myer

DESIGN OF A NEW FACTORY:

Site, Program, and Premises

SITE

In order to explore workplace issues in a more specific manner I have worked on the design of a small factory for an urban site.

The site is a vacant piece of land in North Cambridge. Its eastern border is a dead-end residential street, Cogswell Avenue. To the north lies Pemberton Street and a large expanse of playgrounds and playing fields. To the west there are four tennis courts. The southern edge is the Boston & Maine railroad line.

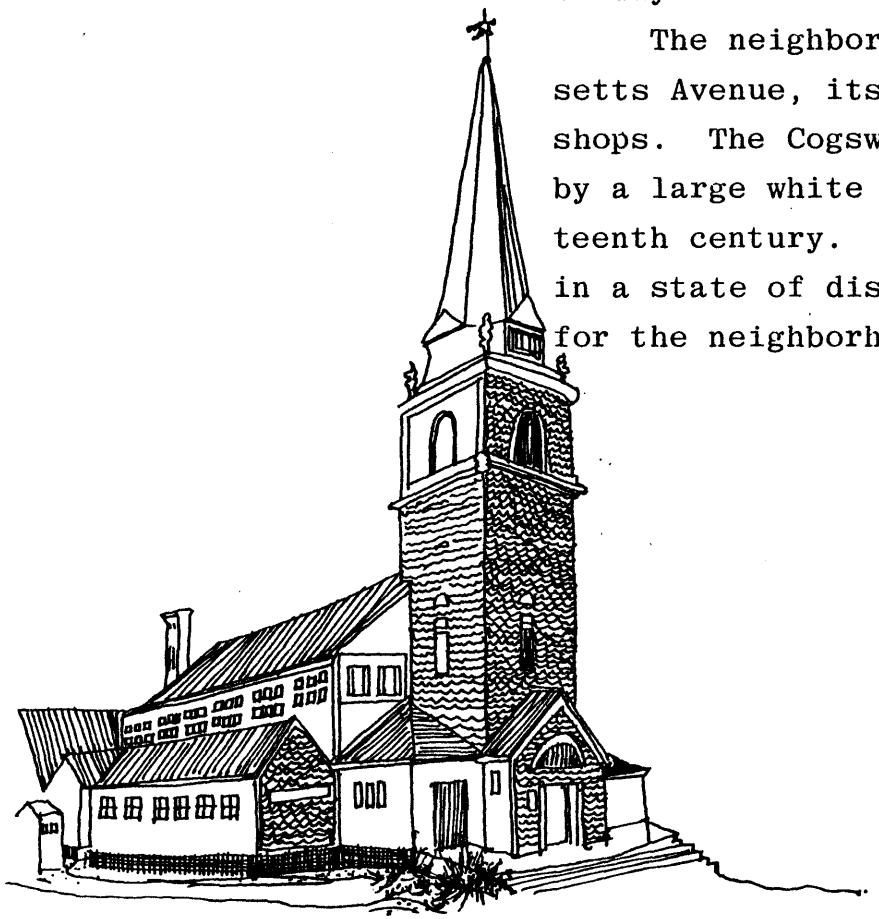
My principal interest in the site lay with the opportunity it offered to design an industrial building in a predominantly residential neighborhood. There are some other industrial buildings (and a fine crane) across the tracks.

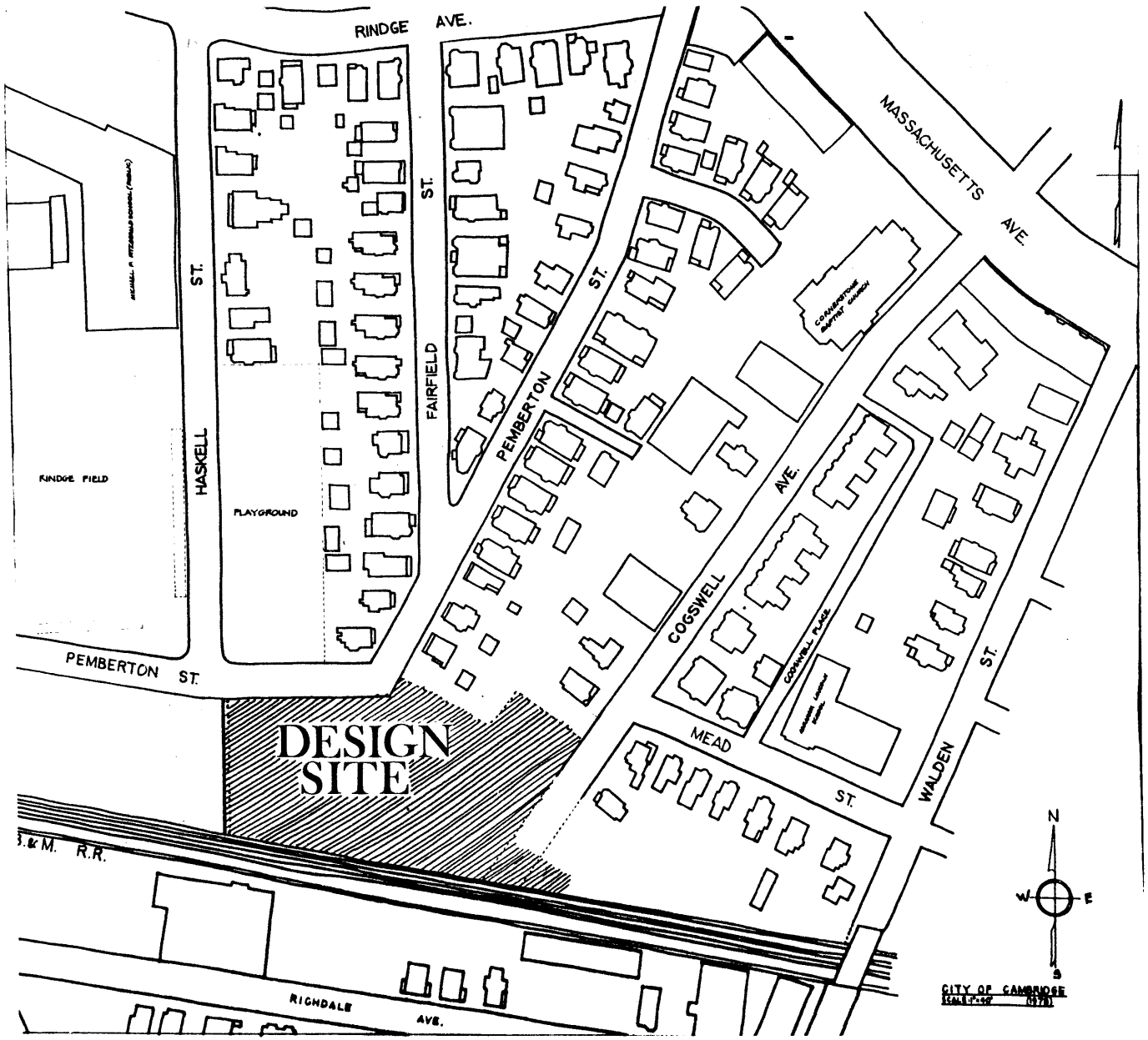
I think that certain light industries can coexist with residential uses. Such a mix of uses provides an important variety of buildings (in scale and often materials), and offers the potential for sharing certain facilities.

Finally, the presence of an industry offers an opportunity to view how things are made. (I grew up in suburban areas where residential, commercial and industrial uses are quite stratified. I have always felt

that certain understandings of how things worked or how things are made were overlooked when there was no day to day contact with non-residential activities.)

The neighborhood is close to the bustle of Massachusetts Avenue, its traffic and assorted food and specialty shops. The Cogswell Avenue corner at Mass. Ave. is marked by a large white wooden Baptist church built in the nineteenth century. Though the church is for sale, and is in a state of disrepair, it remains a strong landmark for the neighborhood.




RINDGE AVE.
MASSACHUSETTS AVE.
HASKELL ST.
FAIRFIELD ST.
PEMBERTON ST.
COGSWELL AVE.
WALDEN ST.
MEAD ST.
RINDGE FIELD
PLAYGROUND
PEMBERTON ST.
DESIGN SITE
B. & M. R.R.
RICHDALE AVE.
CONGREGATIONAL BAPTIST CHURCH
CITY OF CAMBRIDGE
N
W
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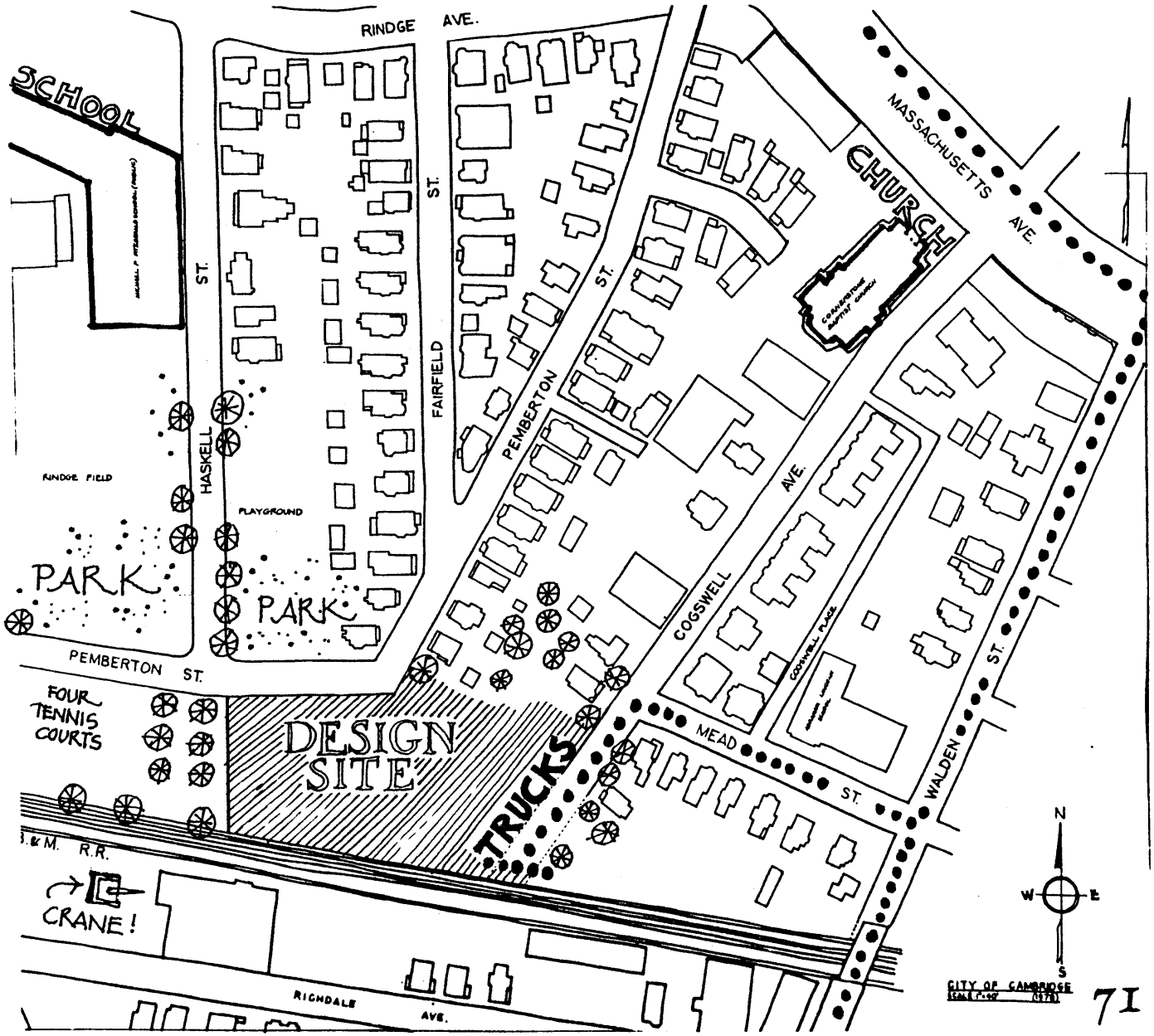
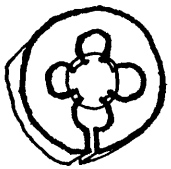
S

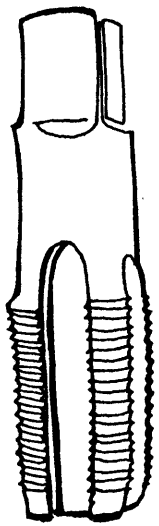

RINDGE AVE.
SCHOOL
ST.
FAIRFIELD
PEMBERTON ST.
CHURCH
MASSACHUSETTS AVE.
RINDGE FIELD
HASKELL
PLAYGROUND
PARK
PARK
PEMBERTON ST.
COGSWELL AVE.
COGSWELL PLACE
FOUR TENNIS COURTS
DESIGN SITE
TRUCKS
MEAD ST.
WALDEN ST.
N
W
E
S
CRANE!
RICHDALE AVE.
CITY OF CAMBRIDGE

PROGRAM

die



tap



The program is based on a large existing industry which produces taps, dies, and other small tools. I have taken the existing program (for which a single building was recently built) and pared it down to a size which seemed reasonable for the site and the scope of this thesis. (This is roughly one half of the actual program.) The process is one which takes raw steel, cuts it, and machines it into small tools. These are then packaged, and shipped. At the present time, storage and packaging areas require the most space. There are also offices which coordinate plant activities and provide services which necessarily accompany the production and sale of tools.

The industrial process involved was completely foreign to me at the outset of this project. I have read about the process and visited several similar industries in an attempt to understand it. I will try to clarify the role each department of the industry has in the production of tools. My understanding may be "full of holes," but such that it is, it has formed the basis for design decisions.

DESIGN PROGRAM

Use	Square Footage	No. Persons
GROUND LEVEL		
Receiving	800	2
Shipping Room	100	1
Compressor Room	120	-
Electric Room	120	-
Barrel Room	250	-
Plant Supervisor	150	1
Boiler Room	100	-
Bathrooms (2)	160	-
Steel Storage	1200	2
Loading Dock/Storage	2500	1
Forming	3600	6
Forming Office	100	1
Rustproof	200	1
Men's Locker Room	1500	-
First Aid	400	1
Reception	450	1
Secretaries	300	3
General Office	400	3
Mail/Work Room	200	-

Use	Square Footage	No. Persons
GROUND LEVEL (cont.)		
Bathrooms (2)	120	-
Janitor	100	1
Die Office	100	1
Tap Office	100	1
Dies	2500	5
Taps	4000	8
Tap Finishing	2000	4
Oil Filtration	1200	2
Metal Lab/Q.C.	600	2
Bathrooms (2)	120	-
Heat Treat	600	1
Sandblast	500	1
Cafeteria	1500	-
Kitchen	400	-
Daycare	900	2
Bathroom (1)	80	-
Tools	800	2
Phones (3)	100	-

Use	Square Footage	No. Persons
+10' LEVEL		
Women's Locker Room	1500	-
Lounge	300	-
Bathroom	50	-
Phones (3)	100	-
Conference	250	-
Vice President	200	1
President	200	1
Chairman	300	1
General Office	500	4
Purchasing	200	1
Storage	400	-
Bridge	1000	-
+18' LEVEL		
Foreman Office	200	1
Packaging	2500	8
Storage/Order Picking	10400	12
Bathrooms (2)	120	-
Janitor	60	-
Shipping	2500	4
Bathroom	60	-

Use	Square Footage	No. Persons
+18' LEVEL (cont.)		
Conference	300	-
Bathrooms (2)	160	-
Lounge	150	-
Phones (3)	100	-
Printing	300	1
+20' LEVEL		
Computer	400	1
Union Office	200	1
Storage	200	-
Bathrooms (2)	120	-
Lounge	400	-
Industrial Engineer	200	1

DESIGN PROGRAM
TOTALS

Square Footage	51,740	sq. ft.
No. Persons Employed	90	persons
Parking for 56 Cars on the Site . . .	22,400	sq. ft.
Existing Site	86,900	sq. ft.

LOADING DOCK. A recessed area is needed for the large flatbed truck which will deliver raw steel once per week. Two loading docks will be needed for a steady stream of goods received and shipped.

STEEL STORAGE. The twelve-foot bars of raw steel are delivered on a flatbed truck once per week. The crane is used to take the steel off the truck and transfer it to a side loading forklift. The side loader moves it to the storage racks which sit upon a concrete pad designed for an extra heavy load.

FORMING. In this department the 12-foot steel is cut down to 3" to 12" lengths suitable for machining. Most of the machines require oil for cooling. The oil is cleaned in a filtering tank for reuse and is recirculated to each machine. There is a gas-fired wash tank to remove the oil from the cut steel which needs direct exhaust. There are two water-cooled compressors.

DIES. In this department the dies are machined from the raw steel. All grinding machines and two gas-fired wash tanks need direct exhaust. Compressed air and a service sink are required.

TAPS. The taps are machined from the raw steel in this department. Oil is recirculated in each machine and

thrown away when each machine is cleaned. Compressed air is needed for operation of the air vises, for a marking machine, for cleaning and for the sandblast area. The gas-fired washing tank needs a direct exhaust.

TAP FINISHING. This area contains Hertlein grinder machines which use copious amounts of oil to lubricate and cool during the grinding process. Each machine has protective plexiglas panels to minimize oil splashing, and there is a lot of oil mist in the area. The oil is recirculated in each machine and is reused after going through a filtration process. All the grinders and the gas-fired wash tank require direct exhaust. A window fan is needed for further ventilation. Compressed air is needed for cleaning.

HEAT TREAT. The finished taps are heat treated to strengthen them. They are placed in furnaces and quenched in tanks of oil or caustic. They are then sandblasted to remove the discoloration and residue caused by the heating and cooling process.

TOOL ROOM. This is the area where a variety of hand tools are kept and where repair is done on machines and machine parts which break down. Direct exhaust and compressed air is needed. Some storage areas must be able to be locked.

PACKING. The finished taps and dies are packaged for sale in this department. Some parts of an item may be shipped from elsewhere and the complete item will be assembled here. Compressed air is needed for cleaning and some packaging machines. There should be a service sink.

STORAGE. The packaged tools are gathered and stored in piles on wooden pallets. These are moved by forklifts (which require 6'-0" aisles). The pallets are organized in racks 4' x 4' x 4' which extend to 16 feet in height. Some smaller items are stored in bins 3' x 3' x 2'. (These storage areas are very heavy and floors should be constructed accordingly.)

ORDER PICKING. Each order is filled from the storage racks. Forklifts or mezzanines allow upper rack levels to be reached. Ordered tools will be placed in small boxes for shipment. These boxes may be moved on smaller cars.

SHIPPING. Here the boxes are prepared for shipping. Compressed air and a service sink are needed. There is an office for the coordinating of the shipping.

PRINTING ROOM. Packaging materials and other data are printed in this small area.

PLANT OFFICES FOR:

Industrial Engineer

Union Representative

Forming Coordinator

Tap Coordinator

Die Coordinator

Tap Finishing Coordinator

Heat Treat Coordinator

Packaging/Order Picking/Storage Coordinator

Receiving/Shipping Coordinator

QC ("QUALITY CONTROL") AND METAL LAB. This is a small area for testing finished products and analyzing problems with materials.

FIRST AID. A small area consisting of a toilet, sink, bed and desk. It should be quiet with easy ambulance access. It should be centrally located between plant and offices.

OIL TANK AND FILTRATION PIT. There are two tanks (requiring 18 clearance) for storage of oil used in the machines. The oil is returned to the filtration system in the pit near the tanks by a gravity flow and is recycled to the machines after filtration. Location near Hertleins is good. While the Hertleins used the most

oil the oil can be piped to other areas of the plant.

BARREL ROOM. Certain oils and fluids used in smaller quantities are stored in drums set on high racks.

COMPRESSOR ROOM. This room houses the central compressors. The compressed air is used in many departments in the plant.

ELECTRIC ROOM. The transformer and other gear to power the plant are located here.

RUSTPROOFING. This is a laquer coating process to protect the tools. Compressed air is needed for cleaning.

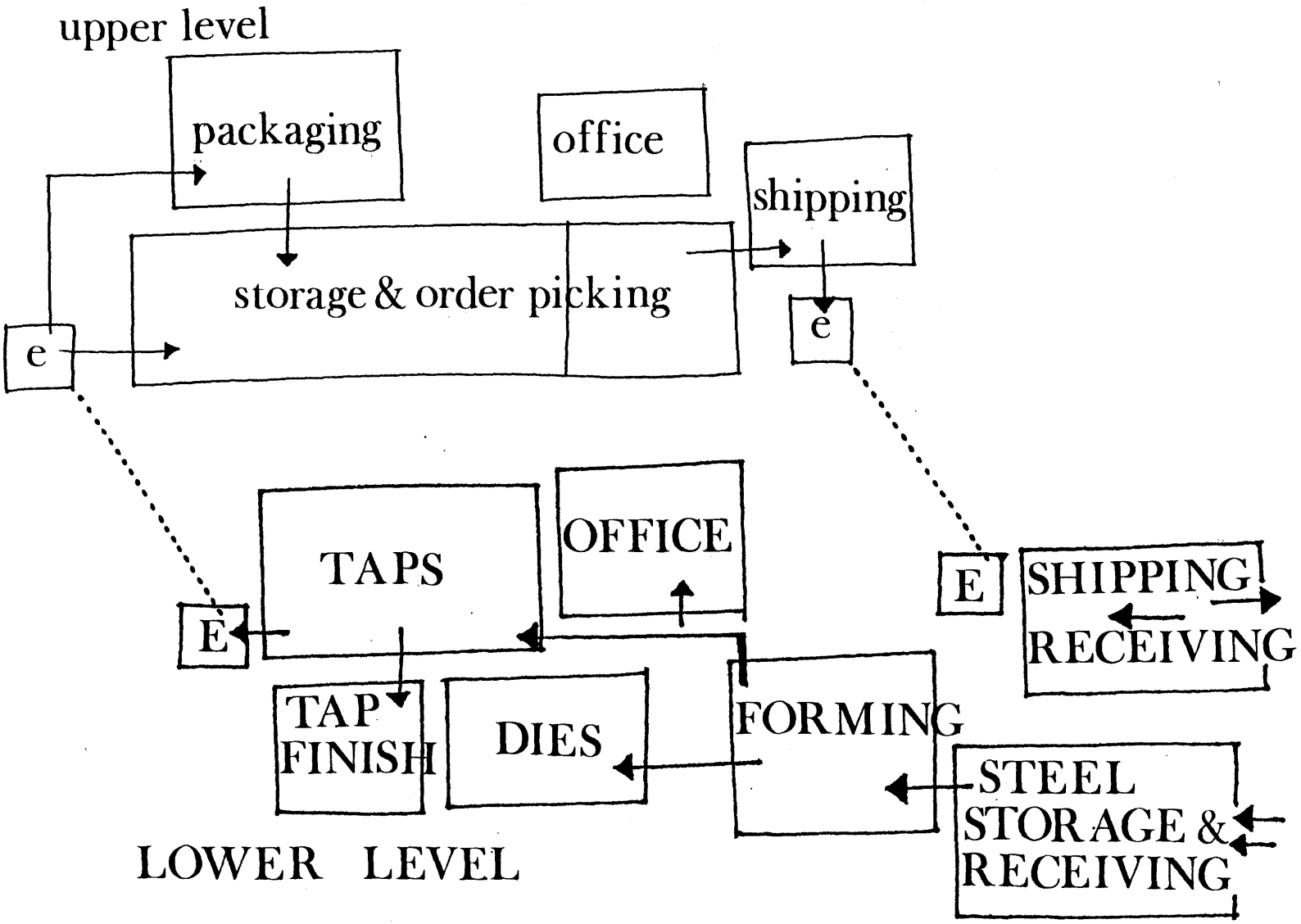
BOILER ROOM. The central control for the HVAC system is located in the Boiler Room.

LOCKER ROOMS. These locker rooms are for men and women office and plant workers. Each contains two showers, sinks, toilets/urinals and a locker for each worker.

JANITOR. Small storage closets for cleaning tools and materials should be located in the plant and offices.

RECEPTION. An area for product display graphics, desk for receptionist, phones, and waiting area. There should be easy access to toilet/sink.

CAFETERIA. A room with seating for office/plant workers. There should be easy access to a kitchen.


upper level
packaging
office
shipping
storage & order picking
e
e
TAPS
OFFICE
E
SHIPPING
RECEIVING
E
TAP
FINISH
DIES
FORMING
STEEL
STORAGE &
RECEIVING
LOWER LEVEL

PREMISES

The seven basic pre mises for the design of this small factory were as follows:

First, I felt that a small tool manufacturing operation could easily coexist with the surrounding residential, and nearby commercial uses. It would offer jobs, provide and share neighborhood facilities, and offer a view of how tools are made.

Second, by virtue of its larger scale, the factory could become an important landmark for the surrounding community.

Third, I assumed that the operation would be in a multi-story building due to the constraints of the site, and also to my own sense that the quality of the physical working environment would be enhanced by having a variety of vertical dimensions.

Fourth, the location of the nearby Fitzgerald School (at Rindge and Haskell) made it important to consider other access routes for the transport of raw material and the shipment of finished goods. Rather than increase truck traffic near the school, a connection to the busier Walden Avenue (to the east) seemed best. The truck traffic would be routed from Walnut Avenue, onto Mead Street, to Cogswell Avenue. Though Cogswell Avenue is

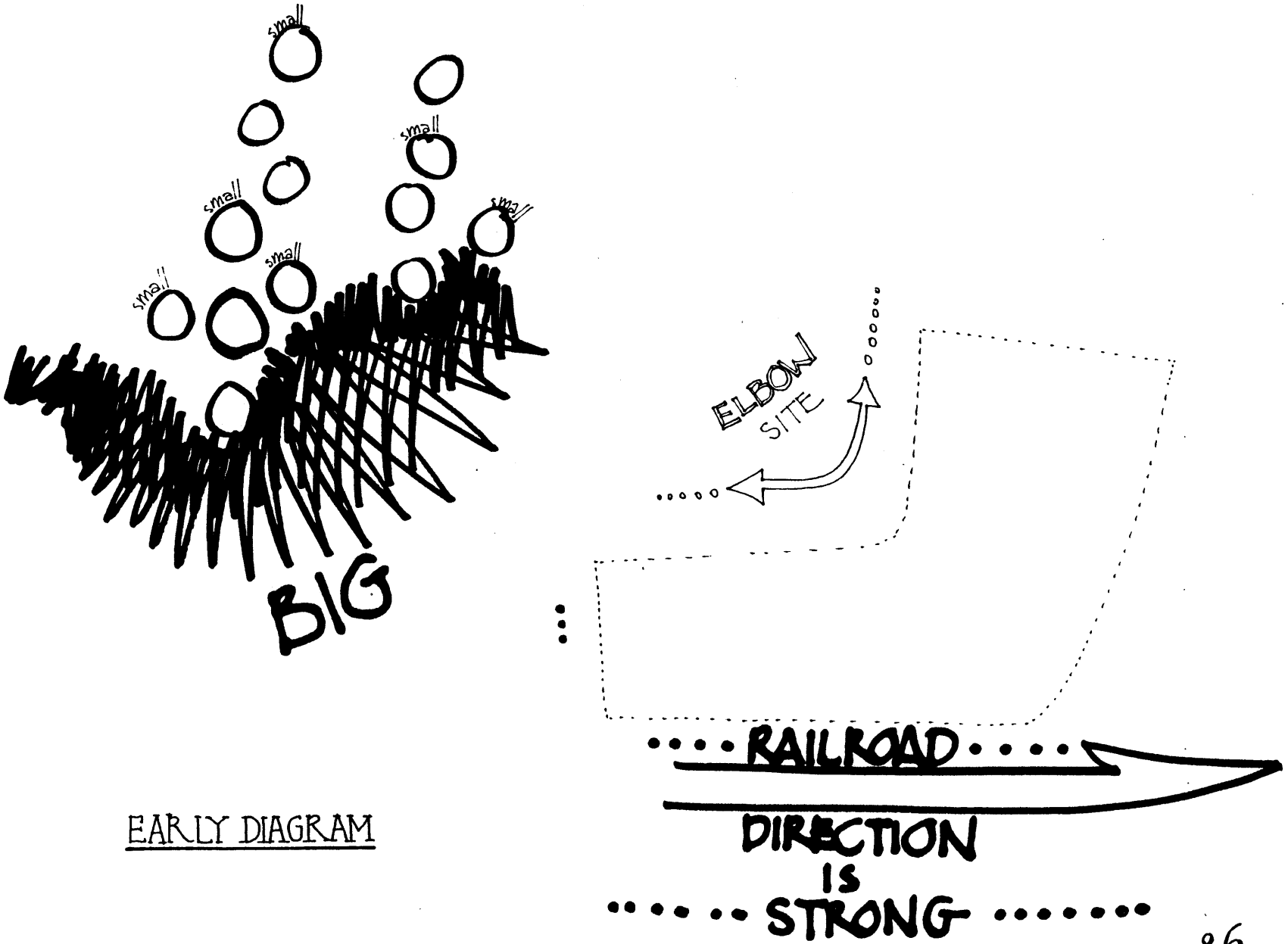
not a through street there was enough room for trucks to turn around. (There will be one load per week of raw steel (i.e., one large truck unloaded by the crane) and daily traffic from smaller trucks, delivering and receiving smaller packages.)

Fifth, in the spirit of "Theory Y" I decided that there would be no hierarchical distinction between facilities for management staff and production staff. There was to be a common parking lot, entrance, lockers, bathrooms, kitchen, cafeteria and lounges. For acoustical and sanitary reasons there would generally be walls between the offices and the plant. These walls would have windows and there would be a feeling that those in the plant can see into the offices (and vice versa) for a better overview of the entire operation.

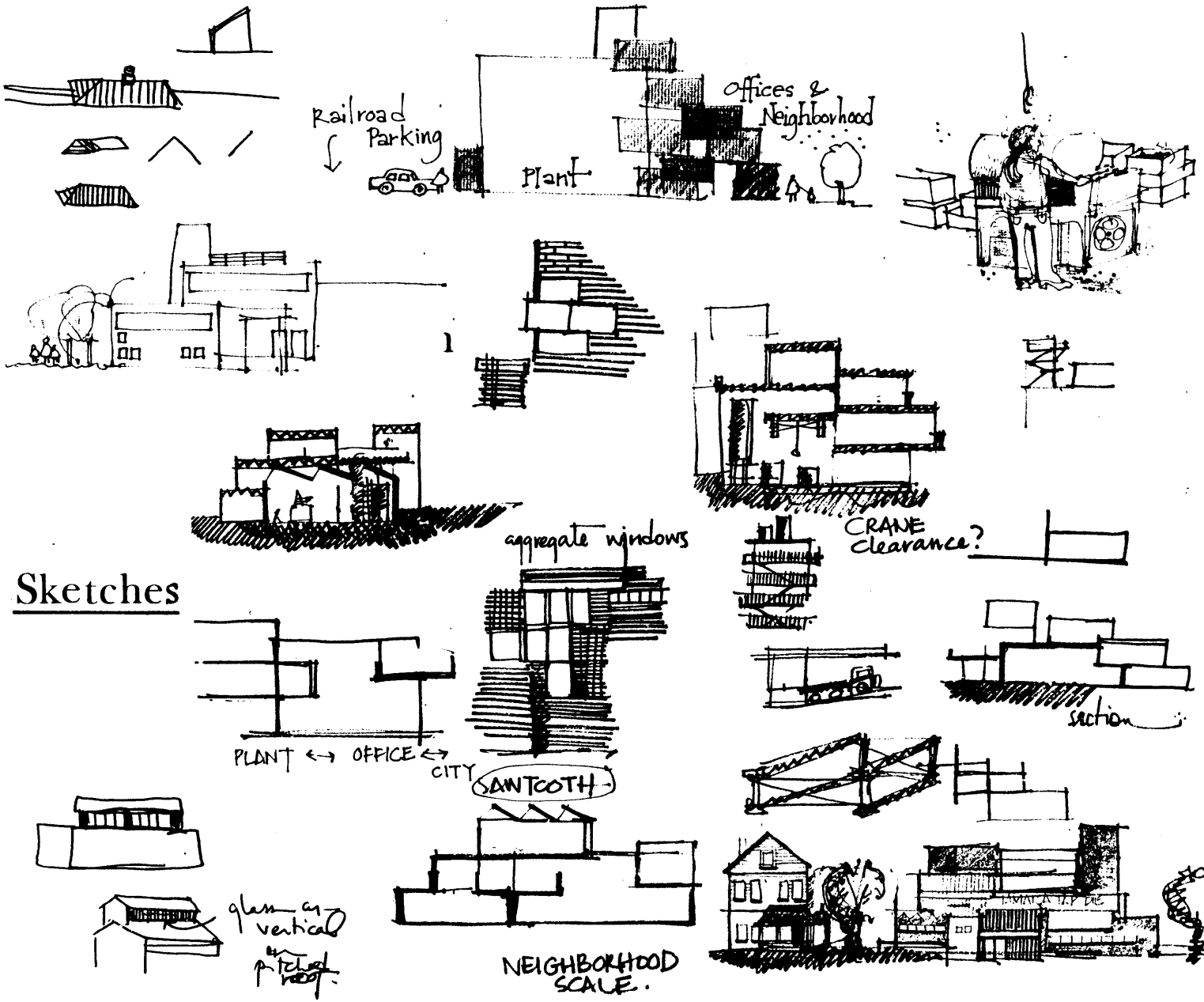
Sixth, I assumed that the building would take into account all of the physical elements which would support a "Theory Y" organization (as discussed on pages 44 - 66,) including: flexibility, integrated uses, natural light and ventilation, sound, safety, easy maintenance and individual or collective personalization of the space. (Of these I do not feel that time has allowed more than a cursory attention to the issues of safety and maintenance

in my design.) I have tried to focus on the design of a building and not interior design issues. Bright paint and soft materials play a role in the industrial setting, and are often the kinds of minimal changes that are implemented to improve existing facilities. But I have attempted to deal with more fundamental organizational and physical decisions about scale, flexibility, integrated use which will help to make interior design possible in a personal or collective way.

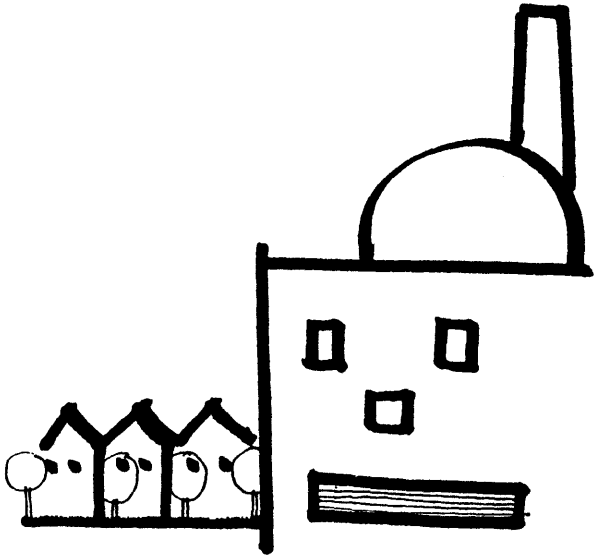
The seventh premise is that the building should respond to the local microclimate conditions and be sensitive to the local context. In this case it means careful attention to the surrounding residential and recreation areas and maximizing the benefits of the north-south orientation.



EARLY DIAGRAM

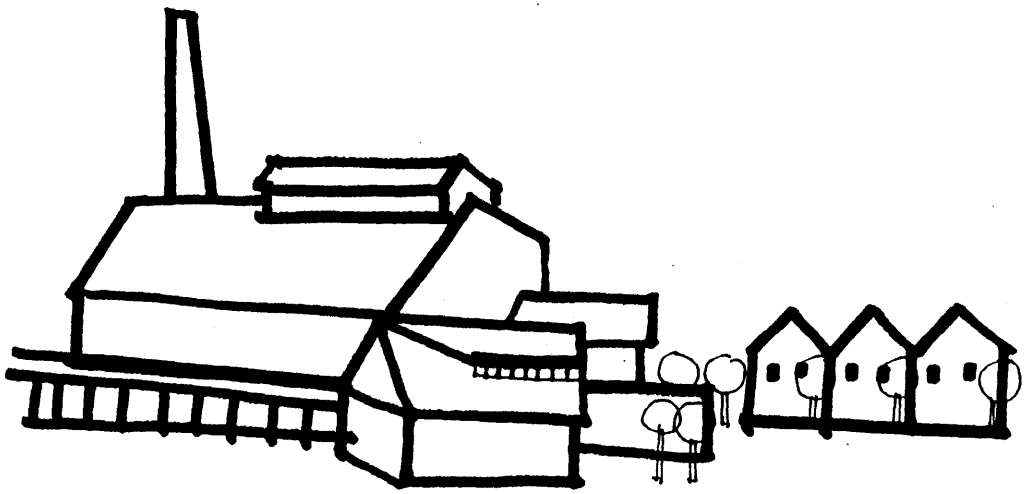

Railroad
Parking
Plant
offices &
Neighborhood
aggregate windows
CRANE
clearance?
section
PLANT ↔ OFFICE ↔ CITY
SAWTOOTH
glass on
vertical
pitched roof
NEIGHBORHOOD
SCALE.

Sketches



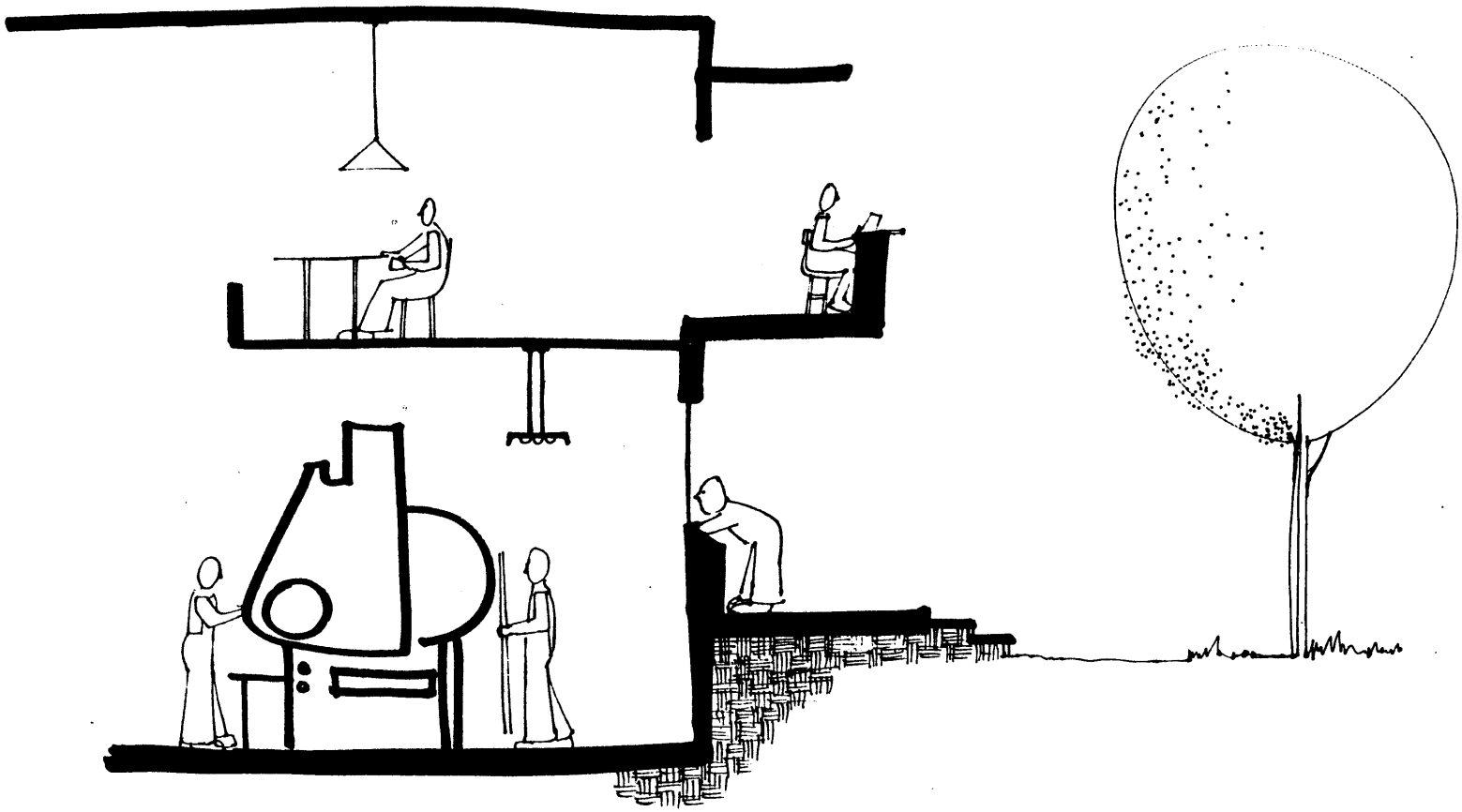
MENACING!

HOSTILE
HUGE
HORRENDOUS

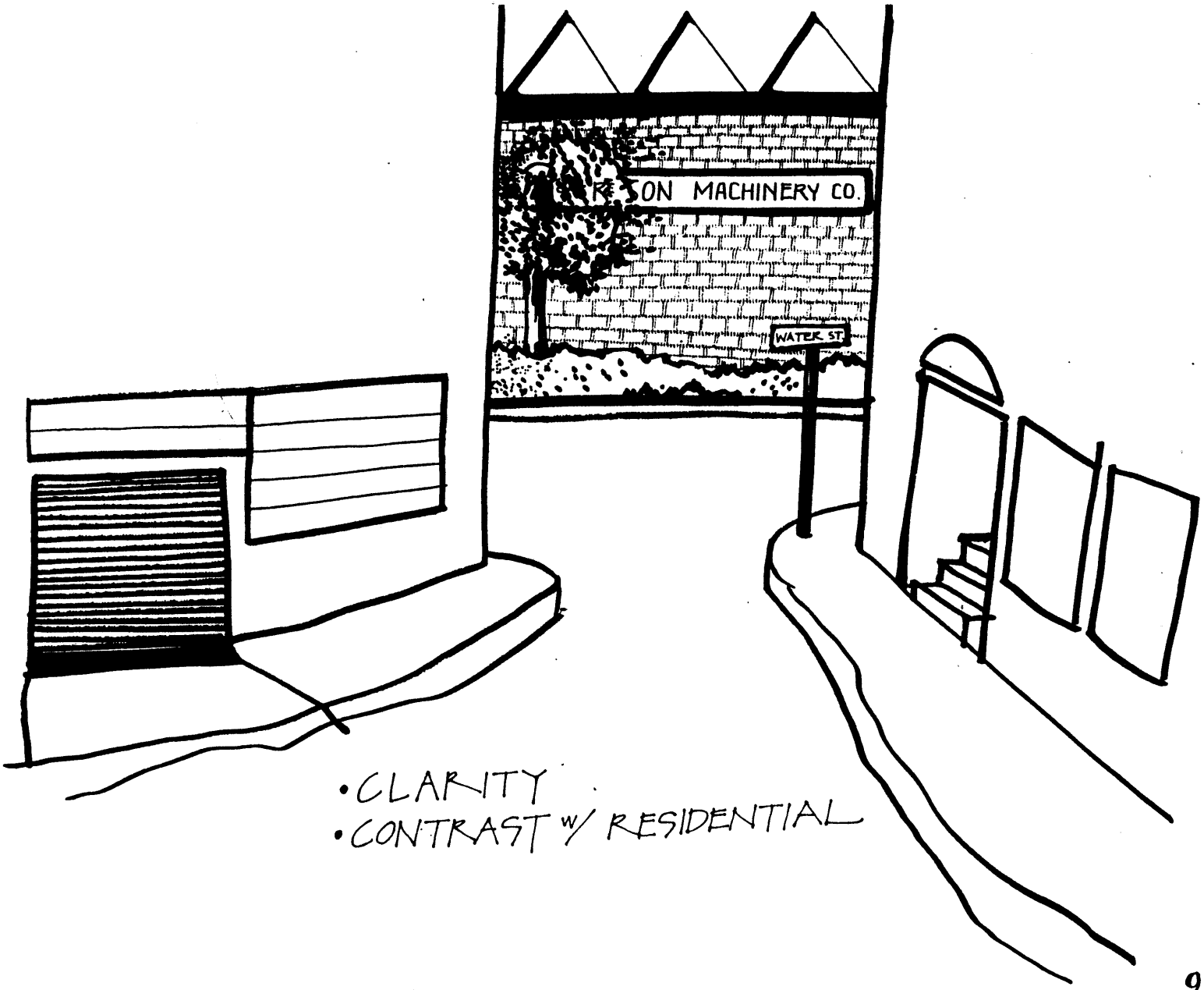


APPROACHING

BENEVOLENT



... ← VIEW IN and VIEW OUT → ...



- CLARITY
- CONTRAST w/ RESIDENTIAL

In the morning before turning to work I happened to think of the outcry of the intellectuals when the bay bridges were being built during the depression. The intellectual sees man's handiwork as a defacement. His glorification of nature stems partly from his deprecation of practical achievements. He does not object to monuments, statues and non-utilitarian structures. The fact that bridges and freeways are utilitarian prompts him to see them as a defilement. With common people it is the other way around. They see man's work as an enhancement of nature. On the whole common people have a better opinion of mankind than do the educated. If it is true, as Bergson says, that 'the human nature from which we turn away is the human nature we discover in the depths of our being' then the intellectual is in a hell of a fix. There is no getting away from it: education does not educate and gentle the heart.

Eric Hoffer

DESIGN OF A NEW FACTORY:

Images and References

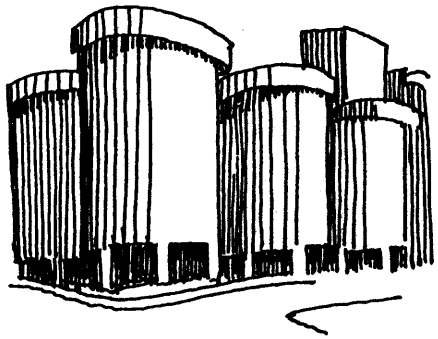
Il Duomo

I began by collecting images focusing on that which I considered positive about working spaces, and industrial forms.

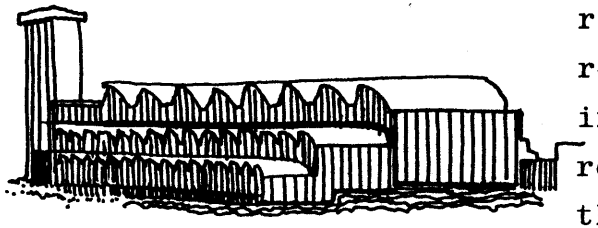
First there is the image of a big form surrounded by smaller forms. This is the "cathedral in the town" image. My favorite example is Il Duomo in Florence.

There is real discontinuity evident and a break from the surrounding residential fabric. The scale of the huge dome and the materials are very different from the surrounds. The building becomes a wonderful landmark and the discontinuity is not overwhelming. The power of the institution is apparent, but there is a benevolence in the authority. In the case of Il Duomo, the variety of materials and scale, and the views we have of the church as one approaches it seem to draw on toward it.

The large scale of industrial and other institutional buildings allows us to experience many views--views up to the building, views down from the building, views looking out over the surrounding community and views within the building itself. Grain elevators, lighthouses and other towers allow us to perch above the world. And they become landmarks for us as we approach them from afar.



In the intense industrial landscape such as a refinery, there is a network of strong horizontal and vertical forms, and there are the molded, plastic forms of tanks and tubing which are exposed to view. John and Mart Myer suggest that these are forms we like to see as they remind us of bodily parts--tendons, arteries, and organs--and we can associate with them. These parts are often hidden from view in offices and residences. The industrial landscape offers a wonderful view of these normally hidden "guts."



When we view the modern industrial landscape we are impressed by the horizontality of the forms, and the repetition of simple forms. A good example of such repetition are the sawtooth roofs which are seen in industry. Beyond the good qualities of light which such roofs afford, there is a wonderful rhythm established by the repetition of a simple form. (It is important to note that too much repetition emphasizes an unending lack of concern for "local" qualities and local changes.)

In the industrial landscape we are aware of the variety of materials which compose the landscape. We delight in the variety of colors and light/dark qualities. An example of such variety is an unenclosed steel stair

against a masonry wall. Such lighter, framework elements help to give us an idea of the scale of a wall or building by being a recognizable part and one which we can change over time.

A special part of the industrial landscape are signs. They can be huge towering signs or tiny signs incorporated into the details of the building itself.

If the signs do not alert us to what goes on in an industrial building (or even if they do), many of the workings may be unenclosed and in the public view. The fascination with mechanical, kinetic objects (like drawbridges) is unending. One must consider that there may be situations where operations should not be exposed, either because the outside world interferes with the workings within or vice versa.

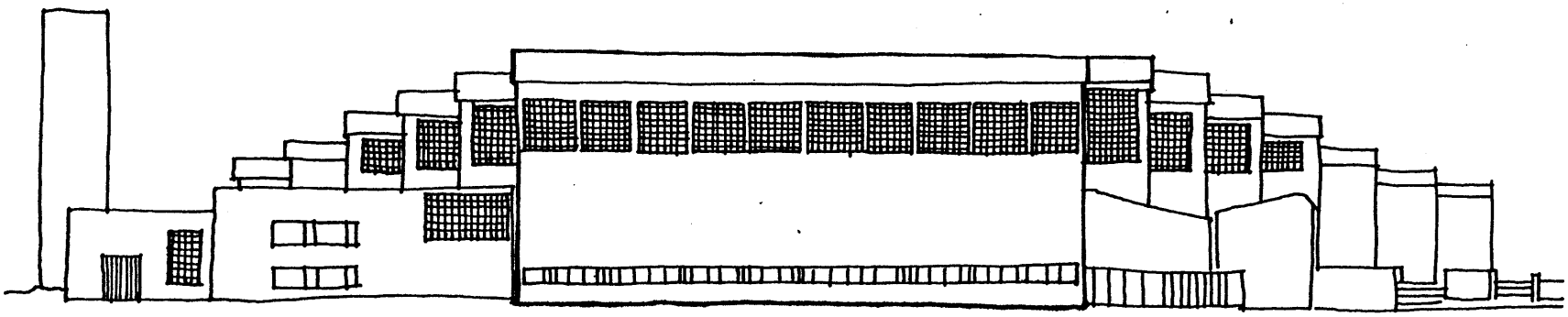
As discussed earlier the design of industrial buildings has increasingly become a task for engineers. Concern for efficient process and cost have been the major form determinants. Ralph Bennett points out that "architects are usually not involved; where involved they are invited to style a wrapping for the process, a wrapping which is at best a distant relationship to the issues of the individual workplace. . . . in a most extreme example of the architects' services to the

client, as distinguished from the user, the architects' efforts are often lavished on the executive pavillion, while the workplace receives little if any attention. While the insufficiency of such environments is clear to even a casual visitor, it has long been accepted as norm by worker and architect alike."[70]

The commissions for design of these "executive pavillions" have resulted in some spectacular monuments and have granted large industries the distinction and prestige of being enlightened patrons of the arts. These designs are well published, and an excellent comprehensive catalogue of many (and other less famous) industrial buildings has been compiled by Walter Henn in the two volumes, Buildings for Industry.

In the course of this project I have been inspired by the work of R. M. Schindler, Alvar Aalto, Carlo Scarpa, and Atelier 5. Scarpa and the architects of Atelier 5 have designed all projects with an elegance and unusually fine awareness of materials. Their works are jewels but one has little sense that there is any predominating concern for human comfort. In Schindler's work there is also an awareness of materials, and a special concern for economy and efficiency.

Of all the "star" architects, Alvar Aalto seems to come closest to connecting an architectonic delight in form making and use of materials, with a concern for important issues of human comfort and siting. The sensitivity of the siting (making possible an awareness of nature), the understanding of process in the building mass, the enjoyment of repetitive form, all indicate to me that Aalto is unusually concerned with providing a wide range of experiences in his buildings.



AALTO: Sports Pavillion at Otaniemi 1952

I do not think that truth becomes more primitive if we pursue it to simpler facts. For no one fact in the world is instant, infinitesimal and ultimate, a single mark. . . . In the language of science, every fact is a field--a crisscross of implications, those that lead to it and those that lead from it.

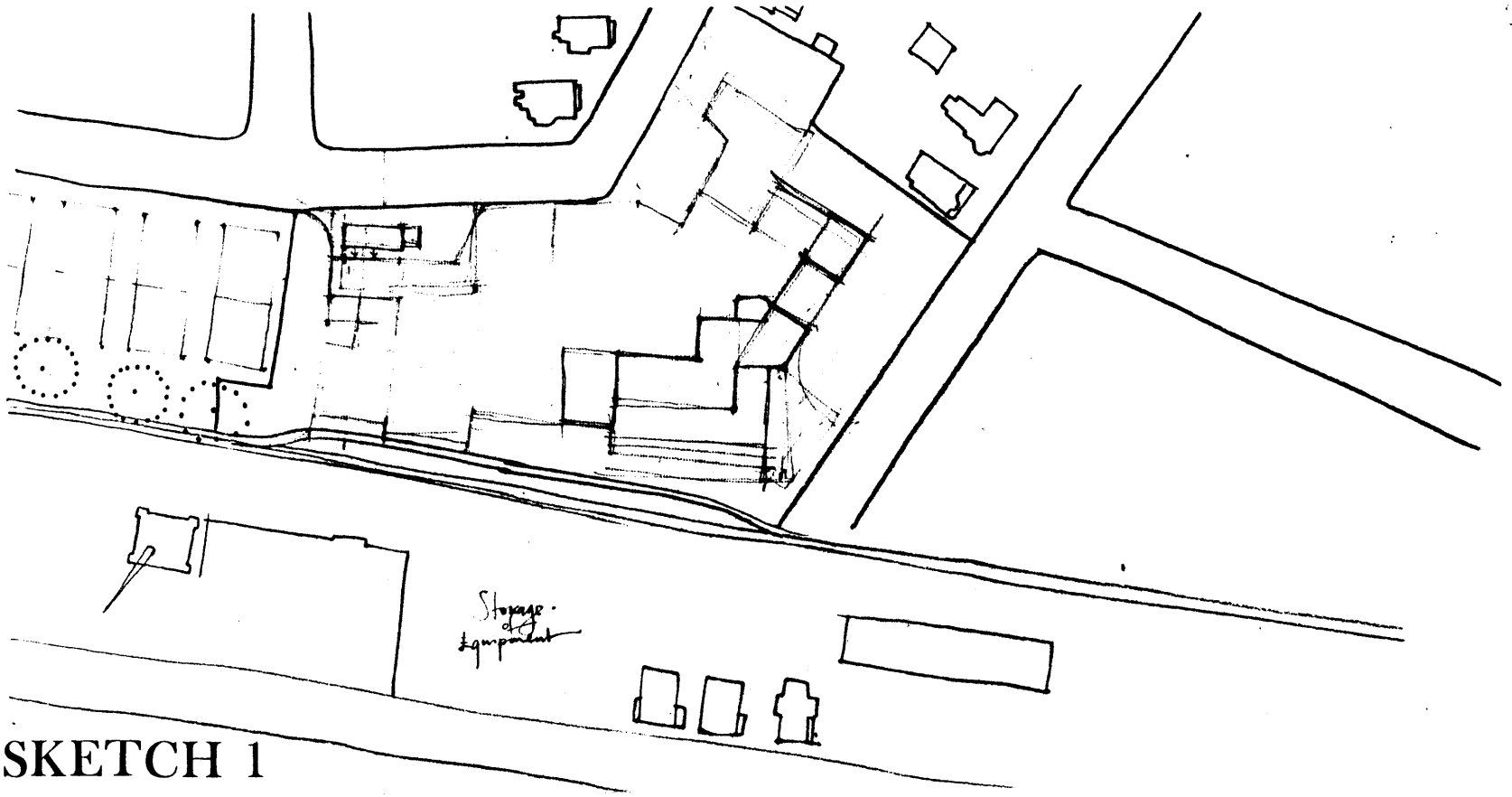
J. Bronowski

DESIGN PROCESS:
Twenty Sketches and Final Drawings

In the early stages of the project I organized the programmatic and site material I had gathered in an attempt to understand the workings of the factory process and the limits of the site.

The industry from which I got much of the program information is now located in a new single-story building. They had been previously located in a five-story building and welcomed the change. From my research I concluded that the production and machining processes could be on one floor, and the packaging, storage, and shipping facilities could be on another. The plant operation was organized for two levels. Similarly the organization of the offices was changed to a multi-level space. This was due, in large part, to the desire that interaction be possible between the various operational parts, including interaction between office and plant.

I have included twenty sketches which illustrate the process from the earlier stages of design. My comments about each sketch are based in large part upon journal notes kept throughout the duration of this project.

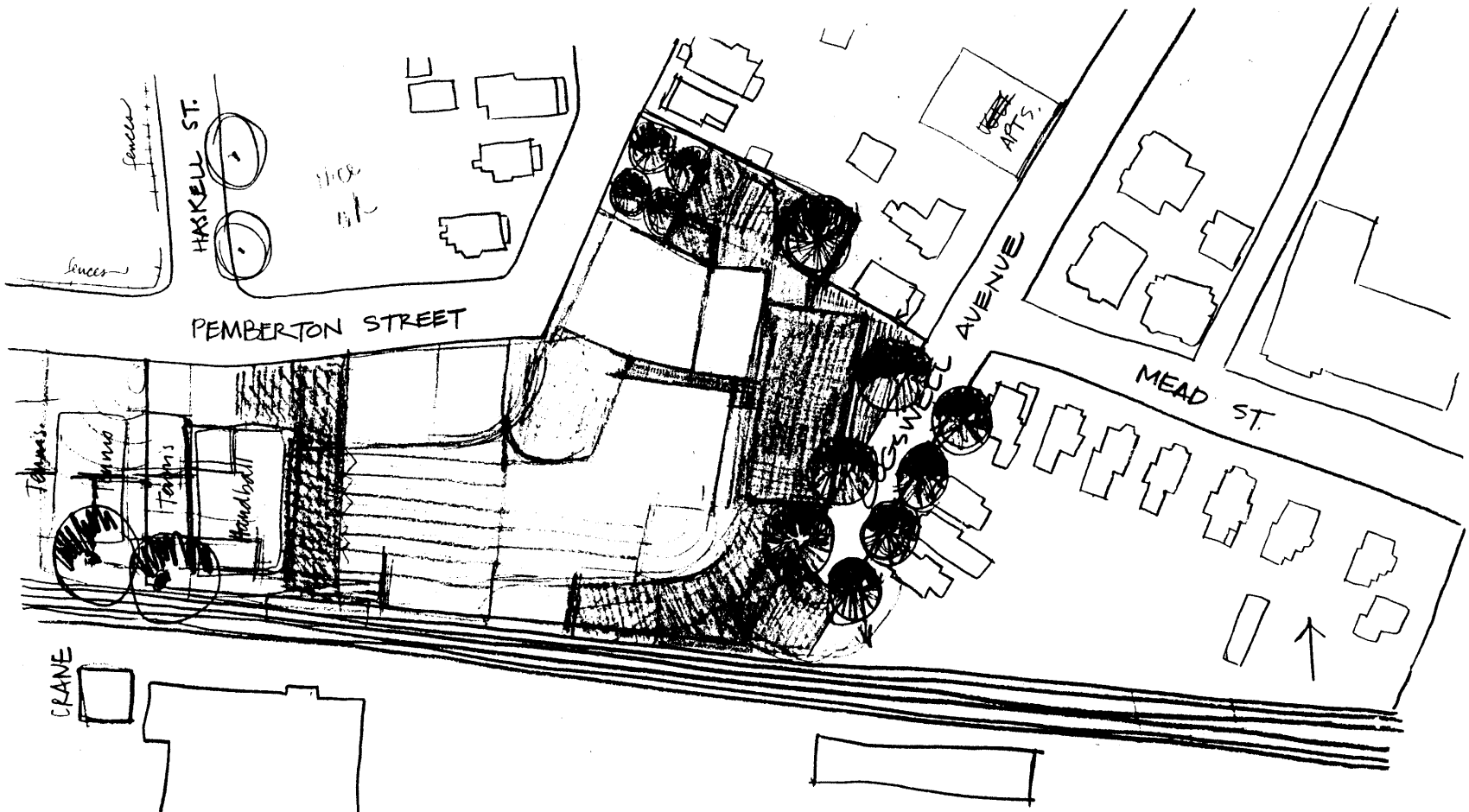


SKETCH 1

SKETCH 1

In the earliest stages I considered general site conditions--the southern exposure, the strong direction of the railroad tracks and the multi-directional site. Because Cogswell Avenue is a dead-end street I considered Pemberton Street for transport of goods and supplies and decided that entry of trucks on Pemberton Street for exit onto Cogswell Avenue broke down the site too much. In a site visited I noted the small bit of residential use across the tracks seemed overwhelmed by the industrial buildings nearby. The crane there is great, though, as are the large willows along the tracks. I considered use of the railroad tracks for delivery of raw steel but the operation is relatively small and would use only one boxcar per month.

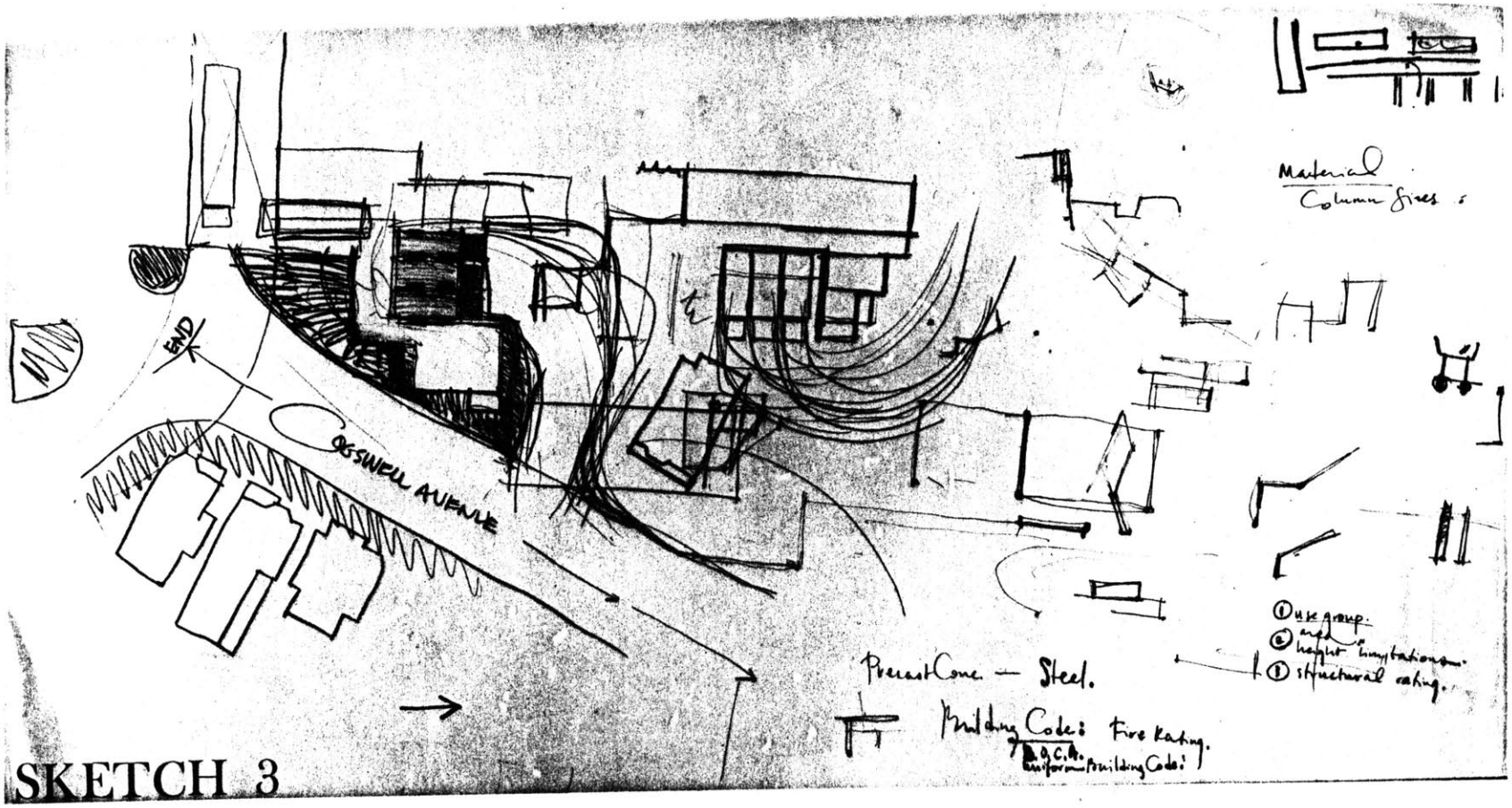
On a visit to an exhibit of old mill photographs I enjoyed one where all six hundred employees assembled before the camera. I noted that it should be important to consider designing a space where everyone can assemble at once.



OUT. 18 - **SKETCH 2**

SKETCH 2

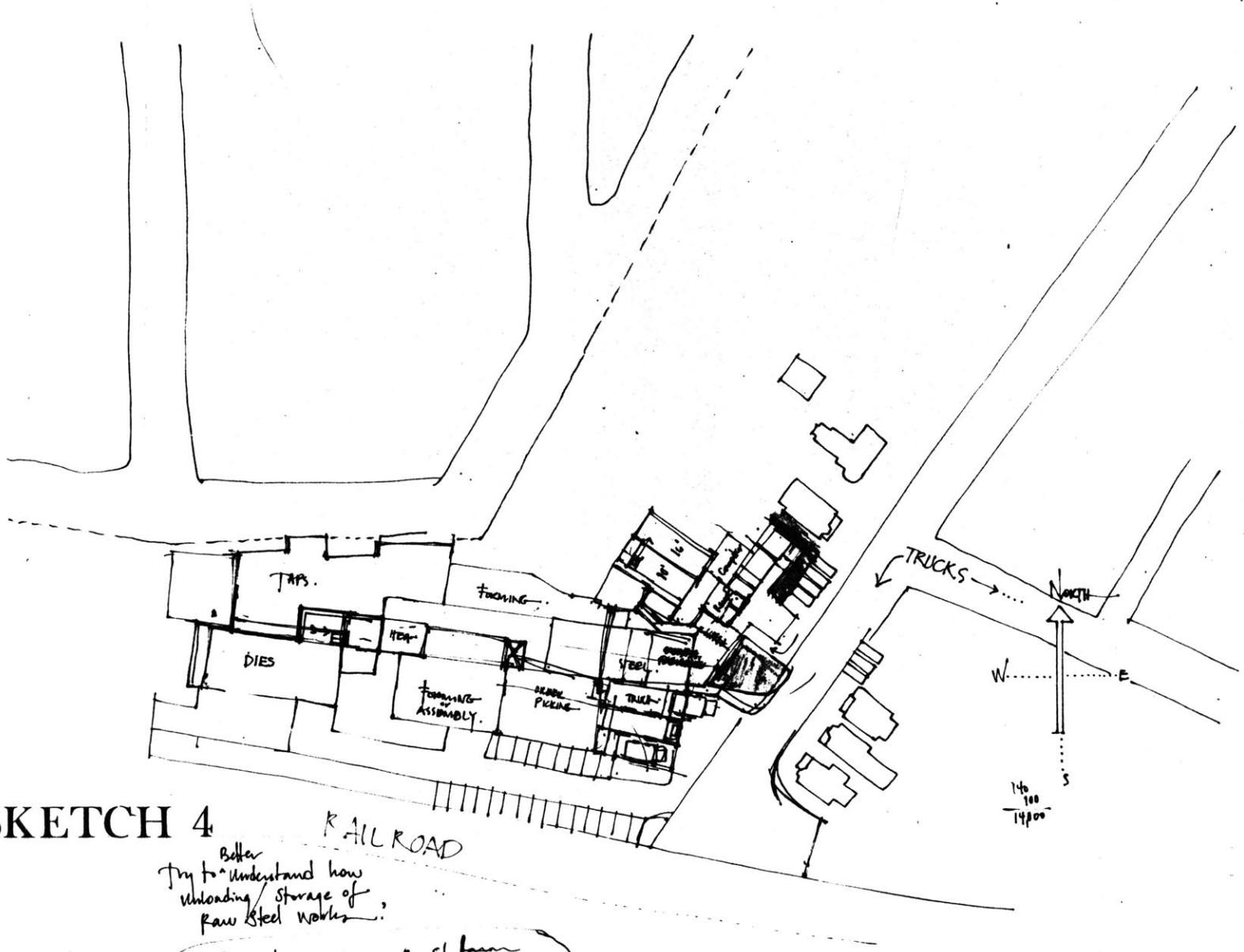
Here I still considered Pemberton Street and Haskell Street good routes for transport. In this massing sketch the building was pushed against the railroad tracks with a long dimension parallel to the tracks to take advantage of the north-south orientation. More park could be made at the end of dead-end Cogswell Avenue and the building would be divided in two, broken by a path to the Pemberton Street park, across the site. I began to realize that the parking requirements would take up a lot of the site.


END
OSSINGTON AVENUE
Material
Column sizes
Precast Conc. — Steel.
Building Code: Fire Rating.
N.B.C. Uniform Building Code:
① use group.
② and height limitations.
③ structural rating.

SKETCH 3

SKETCH 3

After much discussion with critics on the transport route I agreed that although Haskell and Pemberton are the least residential streets, the presence of the school (and children walking to and from the school) was a good reason to avoid such a route. The alternative was to connect to busy Walden Street via Cogswell Avenue and Mead Street. This would mean trucks would have to turn around at the end of Cogswell Avenue. (Again the relatively small volume of transport would probably not justify building a railroad crossing at the end of Cogswell Avenue.) Initial discussions about materials --steel or concrete? Concrete is more fireproof, steel with fireproofing sprayd on is less pleasing aesthetically.



SKETCH 4

Try to Better understand how unloading/storage of raw steel works.

How to Avoid Bottleneck ← Receiving Raw Steel
→ SHIPPING TOOLS.

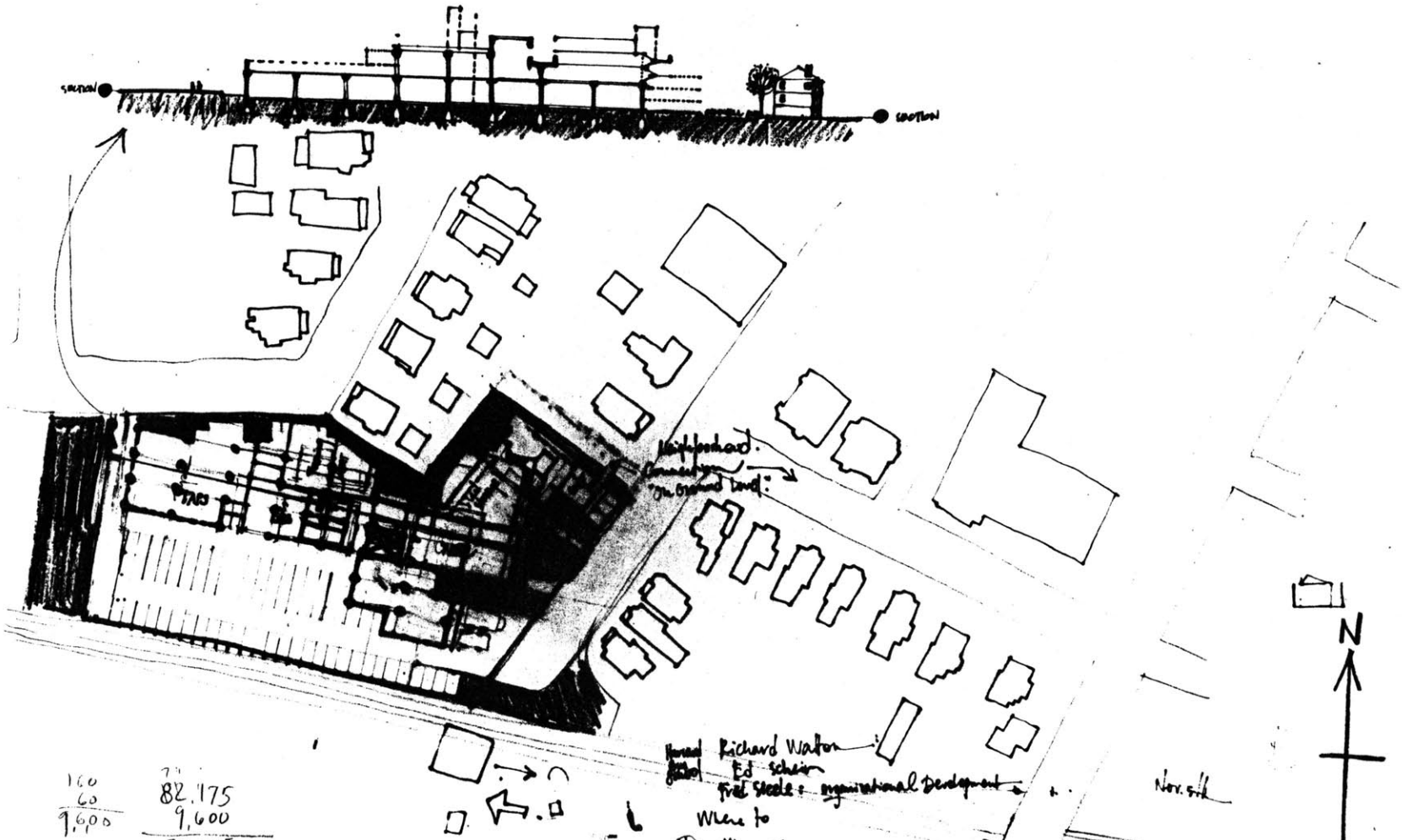
SKETCH 4

This was the first attempt to order the production process on this site. The offices and transport are all located on the Cogswell Avenue edge. This was also the first parking scheme (sixty cars). I wondered if lining them up along the entire length of the site made the southern edge of the site too strong. Two truck loading areas are needed, one to have a crane for unloading raw steel which arrives once a week. The other is for more frequent daily traffic--shipping and receiving --of a smaller size. In this early diagram I placed the "Heat Treat" process in the center of the building, wondering if the furnaces could add something to the heating of the building itself. I wanted activities/work which involve the most people to be at the edges, closer to the natural light.

SKETCH 5

SKETCH 5

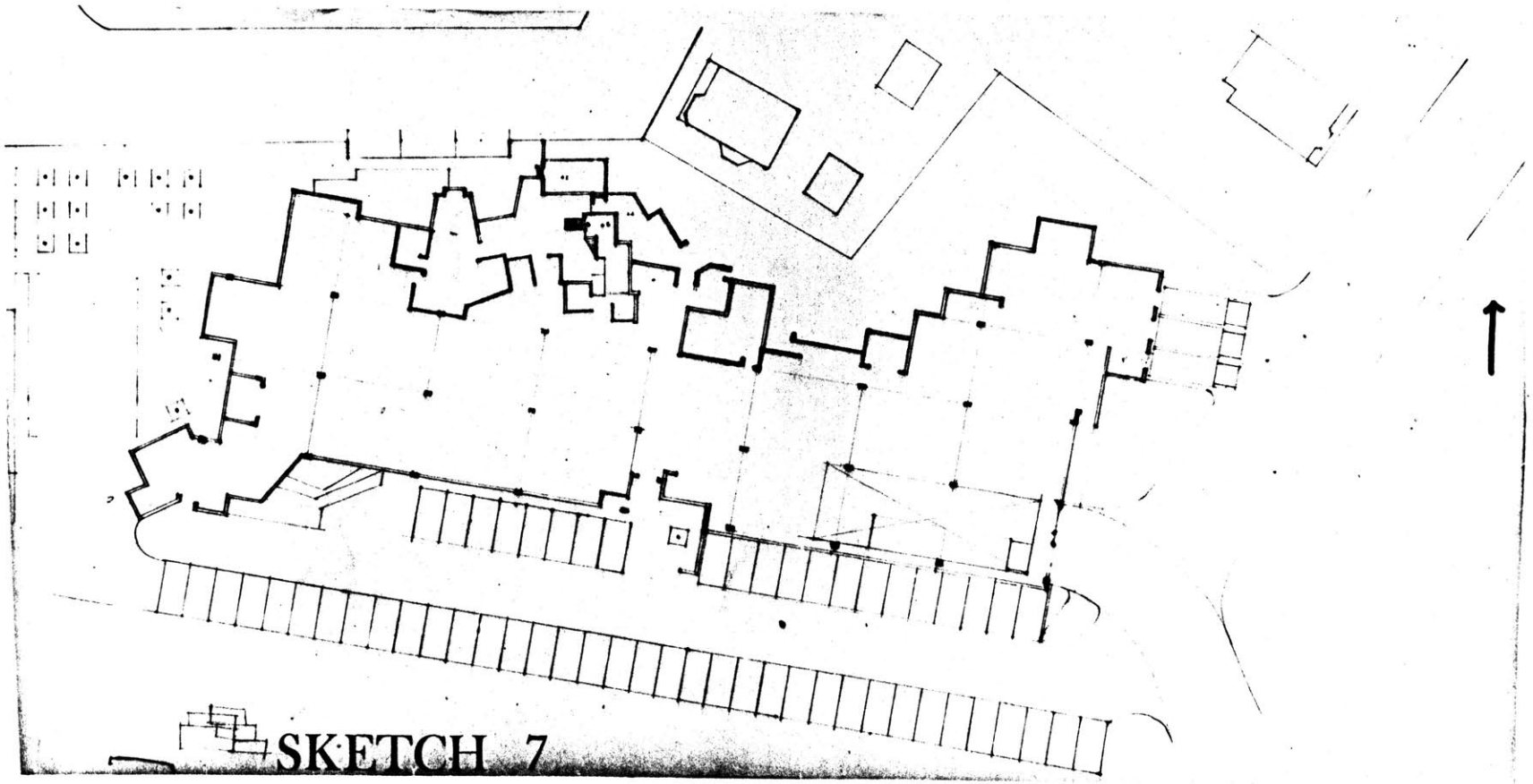
In talking with a critic we discussed that I had been too focused on "efficient flow" of the production process, and that a simple ordering of spaces was lacking. My design was aware of the myriad influences and directions of the site rather than a consideration of what ordering decisions I could make which would simplify this myriad of influences. The organization of structure was especially problematic, especially with the converging of two directions of grid. This occurred at the elbow of the site, exactly where it could least afford any confusion. We discussed the simplifaction of structure in the machine areas especially--not column free but open for potential flexibility and expansion. The offices and cafeteria, etc., can be smaller spans. The image of the large plant surrounded by smaller forms was discussed and visualized as a "cliff with barnacles growing on and up it."


N
Richard Walton
Ed Schein
Fred Steele - organizational Development
Where to
Tom Allen
82.175
9,600
72,575

SKETCH 6

SKETCH 6

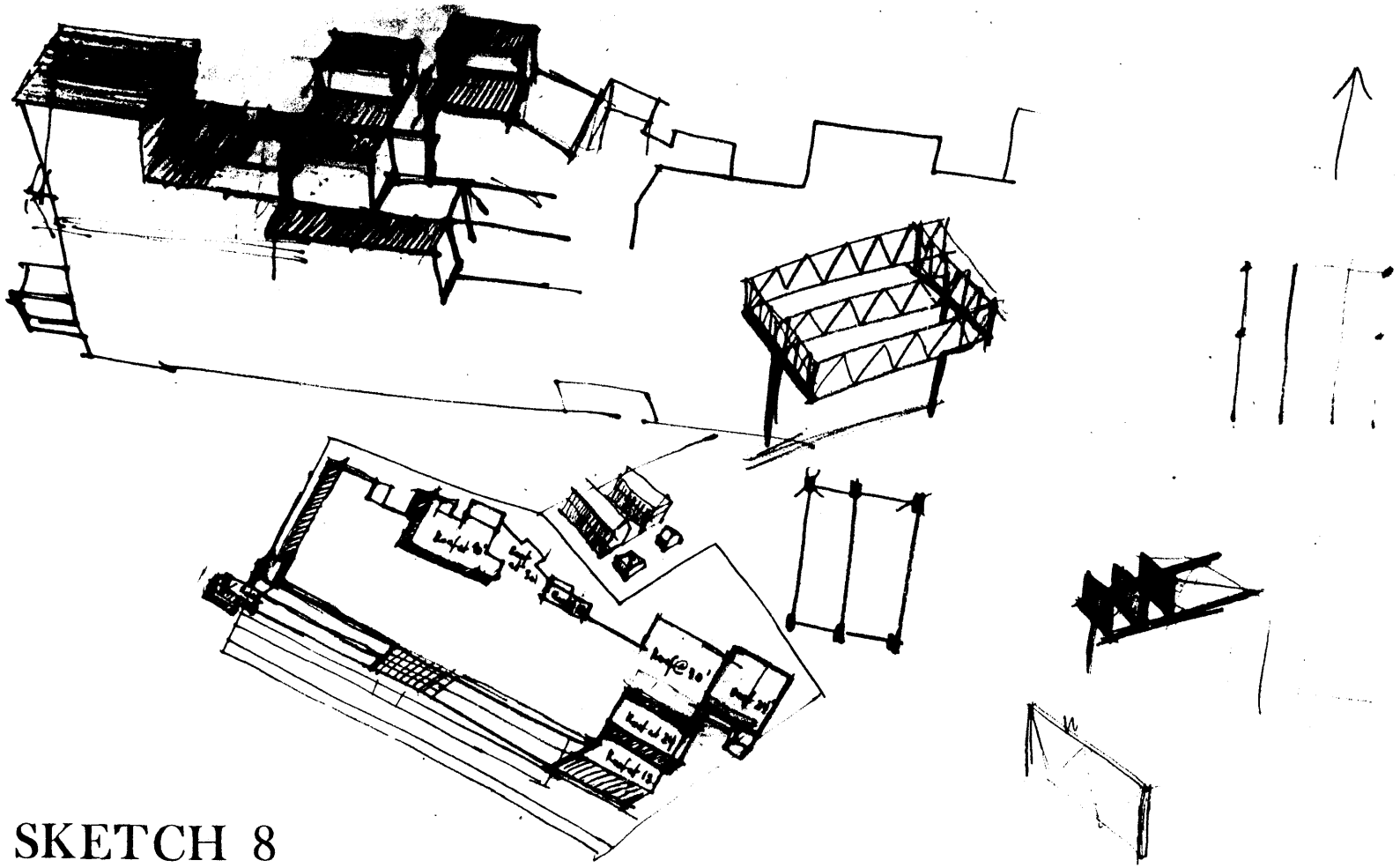
This sketch includes a second proposal for parking which takes up almost half the site, with entrances and exits at both Pemberton Street and Cogswell Avenue. The plant form pushes against Pemberton Street and the parks and all the activity seems directed to Cogswell Avenue. An early section showed a concern for the interaction between large-scale industrial use and smaller scale office uses. Also it indicates an urge to go up high, to be a landmark in the same way the large church at the corner of Massachusetts Avenue is a landmark.



SKETCH 7

SKETCH 7

Rather than locate the offices near Cogswell Avenue they were moved to the Pemberton Street edge. This was an attempt to reflect the surrounding residential context by putting the smaller scale office uses nearby. Having the truck loading areas and the offices on Cogswell Avenue was too intense. The main structural grid runs in one long direction (along the tracks and parking) along the southern edge. The main employee entrance will be from the parking on the south side. Expansion of the facilities (and the grid) can occur to the south. The more permanent and smaller span places--visitor entrance, offices, conference rooms, plumbing, Heat Treat, elevators, etc., were organized along the north edge, at the residential interface. The smaller span construction tries to reflect the many directions of the site along the northern side, and have a different character than the plant. At the southwest corner a change of direction attempts to make a formal ending to the building and provide a smaller scale edge facing the park.

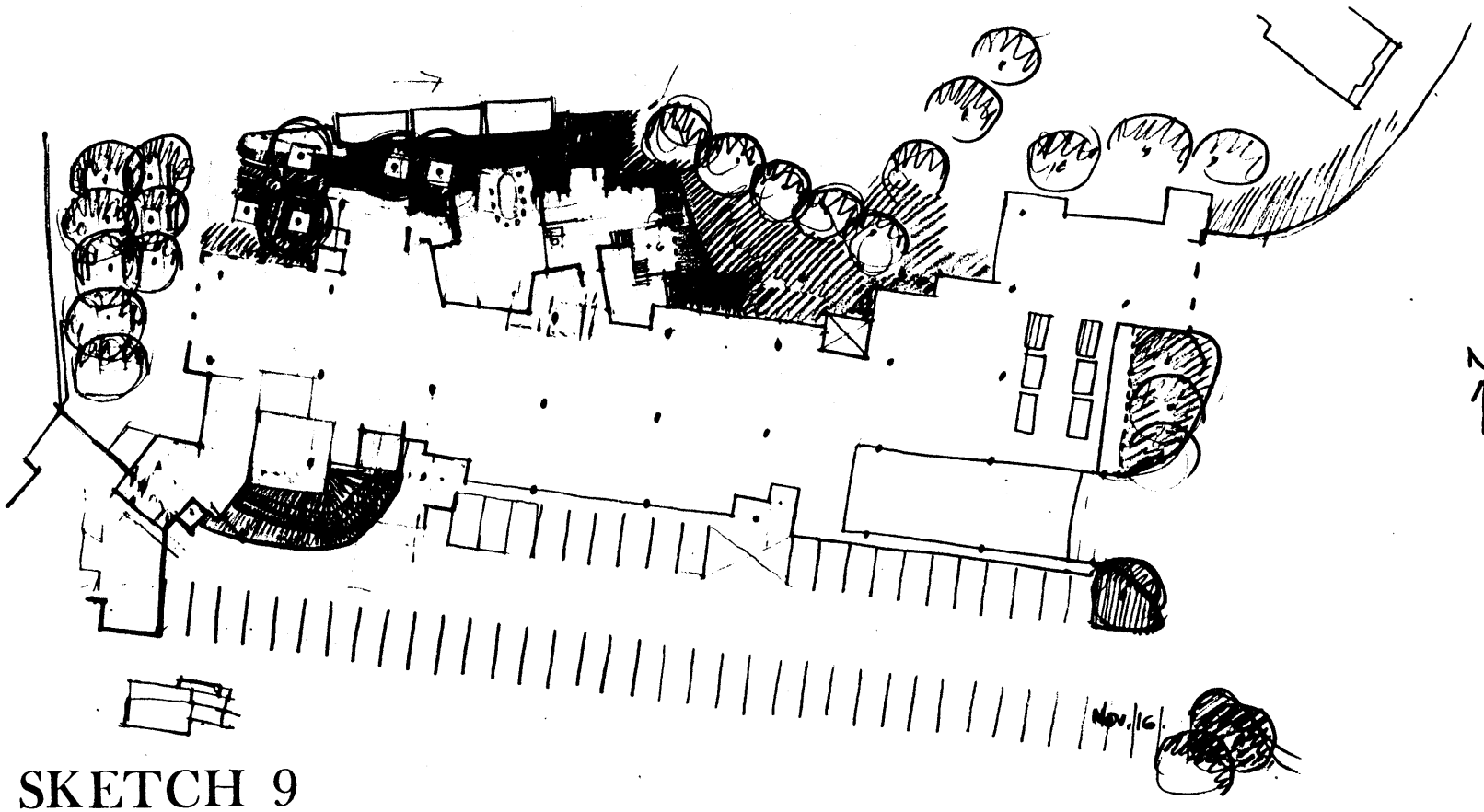


SKETCH 8

SKETCH 8

The first discussion of structure led to a decision to try using a column and truss system. A critic felt that this building was too small to use poured-in-place concrete efficiently, and that precast panels did not allow for enough variety. The steel system could be fireproofed and/or sprinkled if necessary. I reordered the process (from the original program) so that machining occurs at the ground level and storage, packaging and order picking occur on the upper level. The bulk storage of these small tools is very heavy. To support such a load the trusses on a 12-foot by 36-foot grid will be three feet deep to support the upper level of the plant and two feet deep to support the roof. The crane at the southeast corner of the building will need its own supports. A critic suggested that I continue the same structural grid throughout the building and make directional changes in the exterior walls. I felt the offices and other shared facilities on the northern edge should have a different character and that this should be reflected in the structural system as well . . . These early massing sketches indicate a desire to break the large plant volume down at the residential edge, the

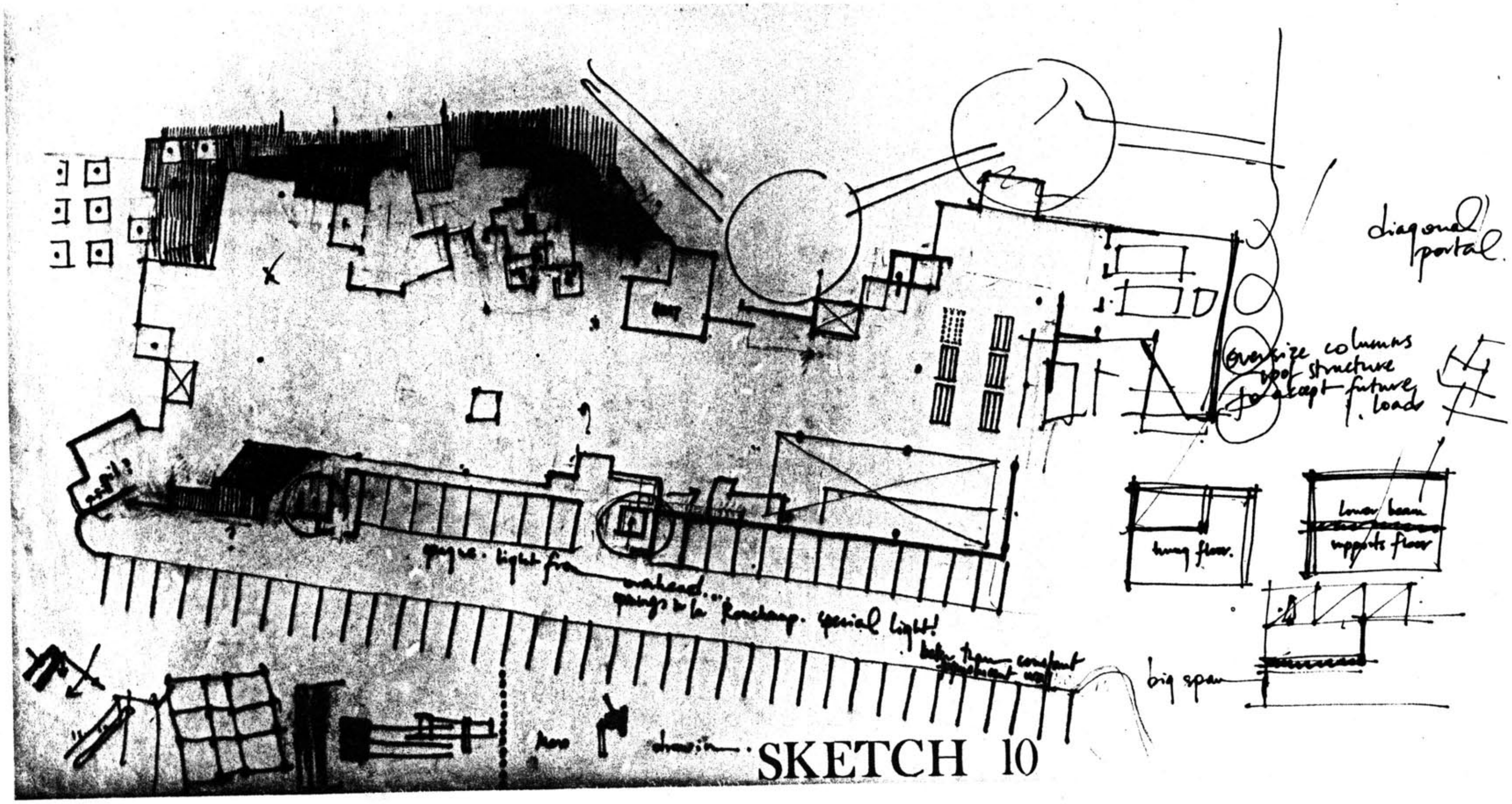
park edge and also at the crane (in order to emphasize this special use in the massing).



SKETCH 9

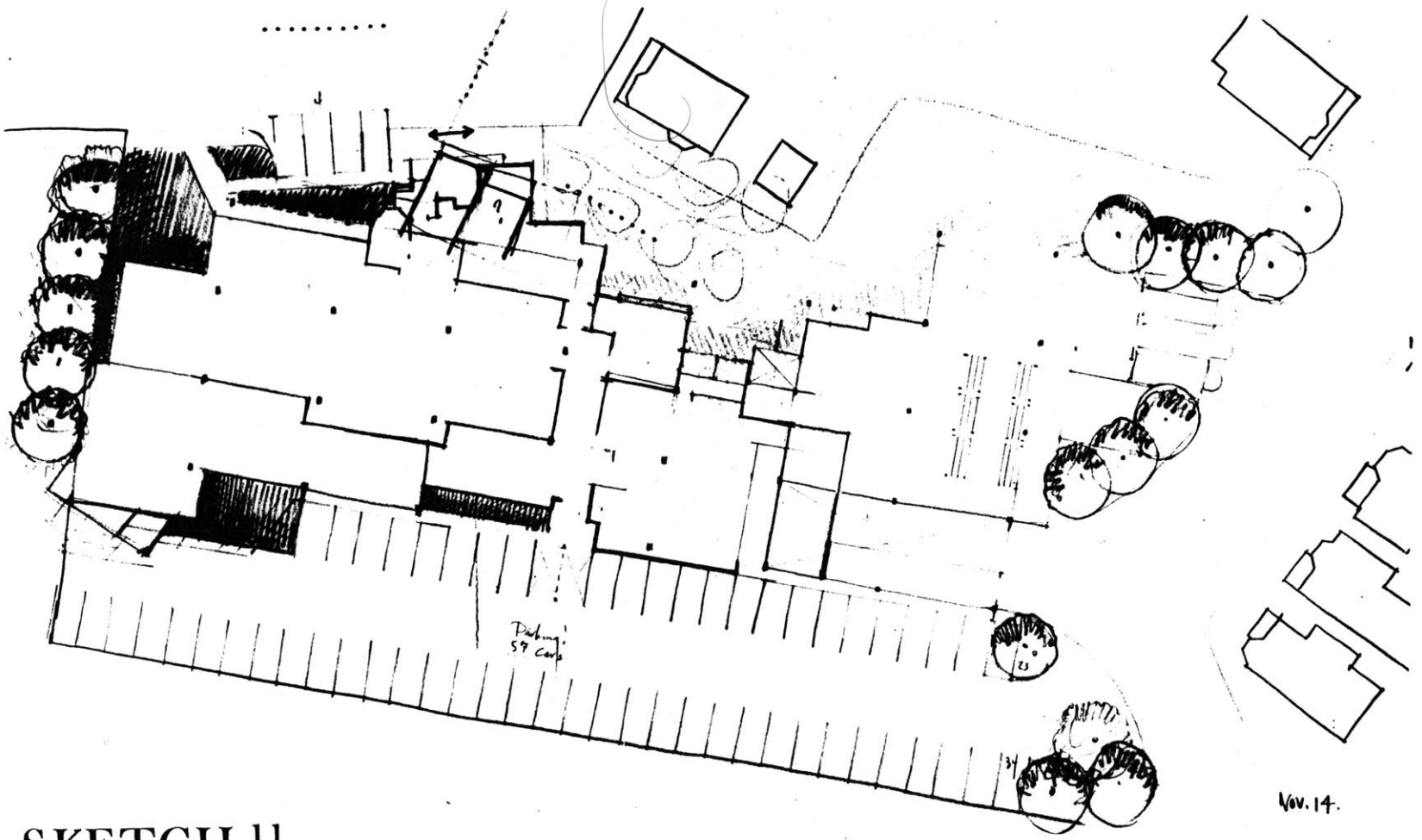
SKETCH 9

I was concerned here with the community edges at the northeast side. At ground level facilities which can be used by the community should be located conveniently to public access from Pemberton Street. Less public office uses can be placed in upper levels. I tried to define the outdoor spaces adjacent to the park. The northwest corner was, I felt, a good location for an outsider's view into the industrial building, as well as an outdoor gathering place where one could watch tennis games or the workings of industry and where workers could go during breaks. At this point I also tried to simplify the northern edge of the building and not make quite so many irrational jogs in the wall. The jogs were present in an attempt to reflect neighborhood scale. This breaking down of the large form could occur in a simpler (and cheaper) way in the elevation or in use of smaller secondary construction pieces. "Breaking down the wall" could occur at special places but not just randomly.


diagonal portal
oversize columns
roof structure
to accept future
loads
hung floor.
lower beam supports floor
big span
SKETCH 10

SKETCH 10

In this sketch I began to consider the negative impact of the trucks on Cogswell Avenue: the noise of standing trucks unloading with motors running, the unsightly view of the loading docks. The large steel delivery occurs only once per week but the daily traffic of smaller trucks can perhaps be tucked away off the street for some visual and acoustical separation. The importance of pedestrian travel across the north edge of the site was discussed. Can there be views ahead to tell someone who is walking through what lies ahead. There should be some access to this outdoor area from the plant. I was considering the southwest corner of the building as a location for oil storage tanks and filtration system. Oil could be delivered here (access from the parking lot). An elevator at the western edge will carry finished machined parts up to the upper level for packaging and storage. The orders will be picked up and sent down the elevator at the eastern edge (near the trucks) to be shipped.



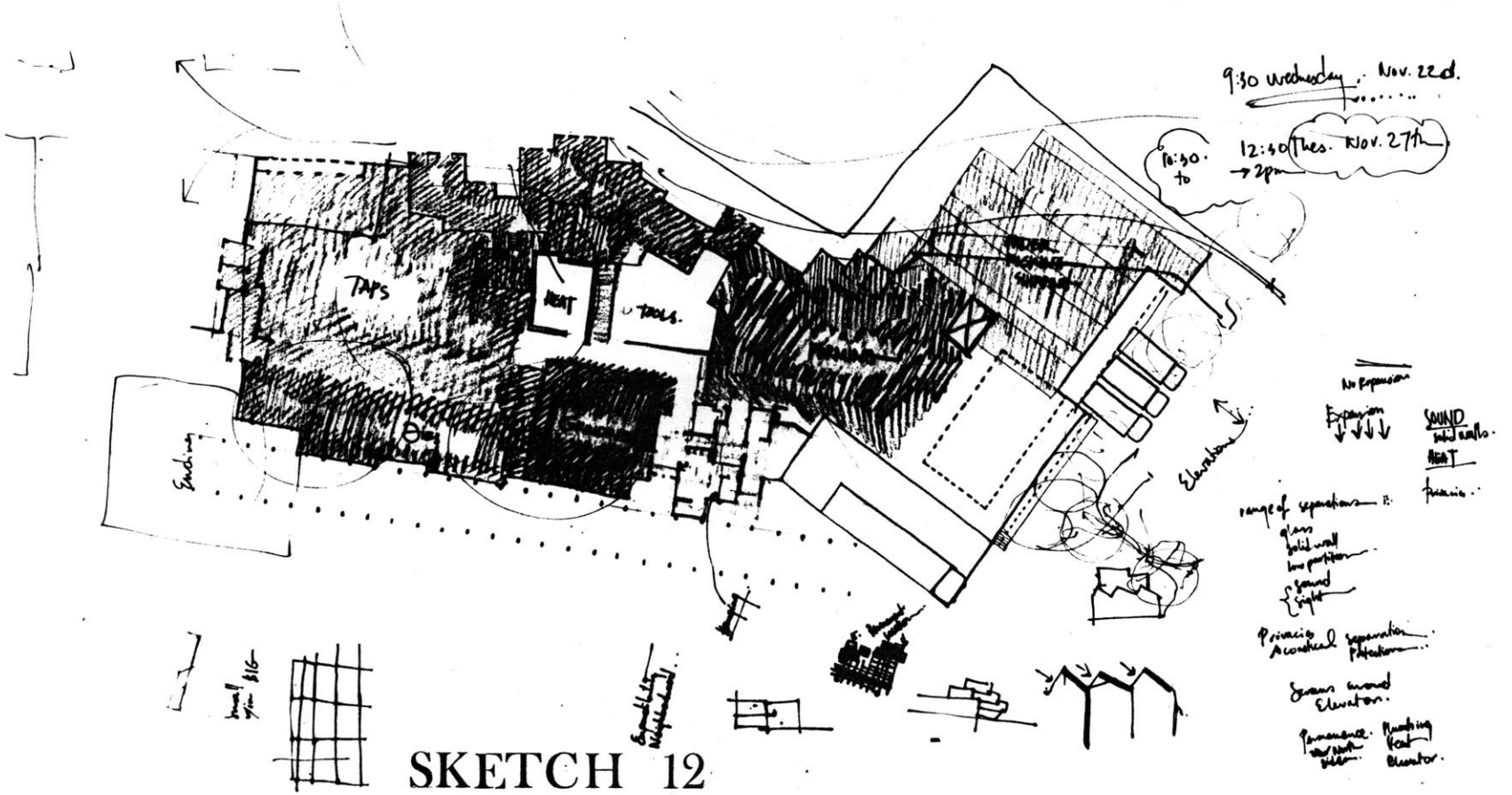
SKETCH 11

SKETCH 11

In this sketch I was trying to simplify the ordering of the building. I followed an earlier suggestion that I maintain the same structural grid throughout the entire building (offices and plant), with non-load-bearing exterior walls which in some cases would reflect the various directions of the site.

The hardest directional decisions occurred with the office design. In this sketch I was unable to resolve the issue; whether to reflect the direction of Pemberton Street to the north, or the direction of the adjacent house and the "desire line" across the northern edge. I was also concerned that the building present itself to those appraoching it, coming down Pemberton Street from Massachusetts Avenue. Salesmen and other visitors to the company would enter the offices at Pemberton Street and a parking area for several cars was provided there to minimize the impact on the neighborhood's street parking. I wanted the Pemberton Street facade to be welcoming to community visitors and wanted paths to connect both to the park and playground areas, and to a place from which to view factory operation (at the northwest corner of the building). I wanted trees and landscaping to

enhance this edge, not to mask the factory but to continue the vegetation and lines of trees in the existing parks. At the eastern edge of the building at Cogswell Avenue, trees were placed to soften the impact of the transport (shipping and receiving) areas.


9:30 wednesday Nov. 22d.
12:40 Thes. Nov. 27th
10:30 to
→2pm
TAPS
HEAT
TOOLS
Elevation
Expansion
SOUND
HEAT
range of separations
glass
solid wall
Privacy
Acoustical separation
Steam enamel
Elevator.
Plumbing
Heat
Elevator.

SKETCH 12

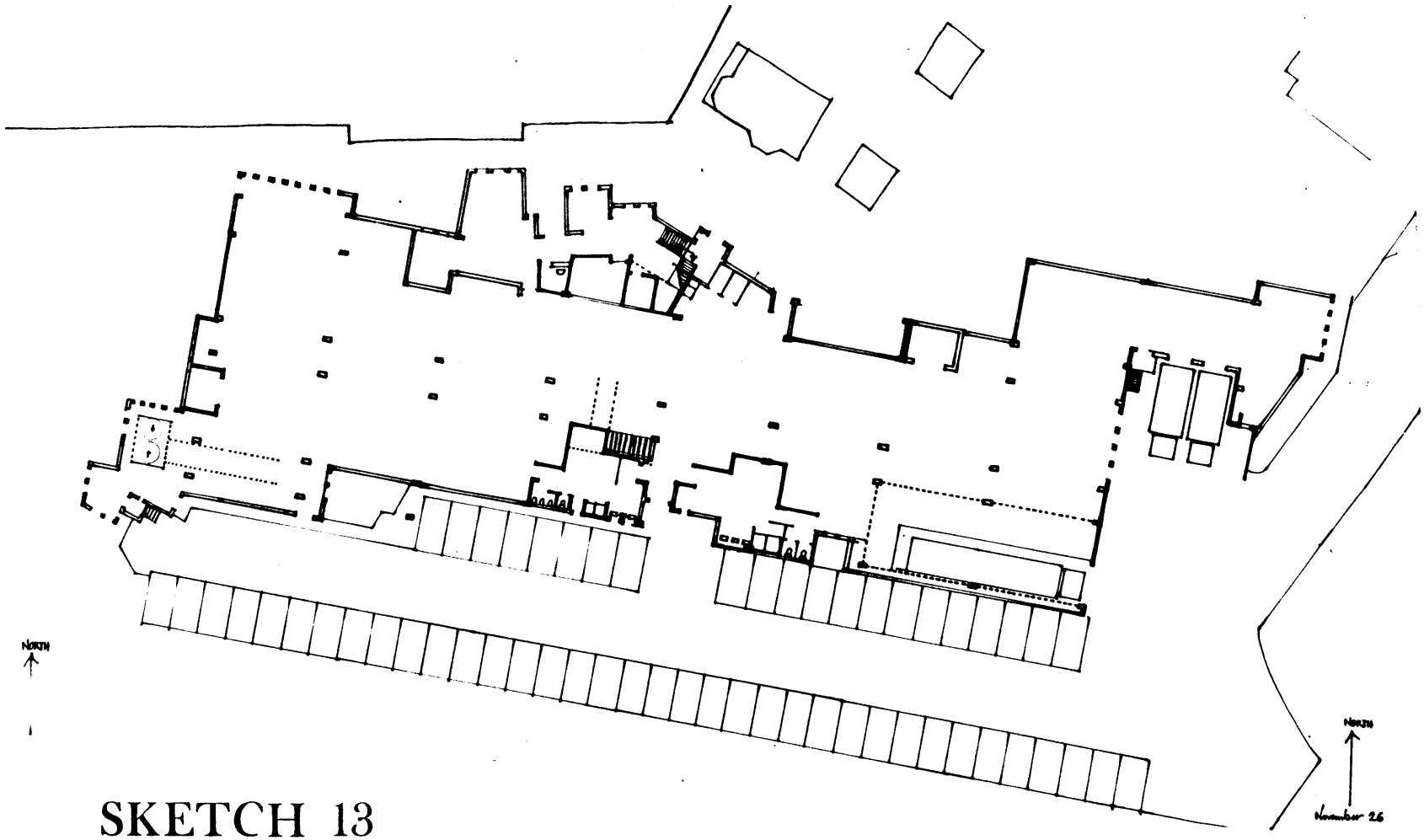
SKETCH 12

In this sketch I tried to define production areas in a general flow pattern. Steel arrives (by truck) at the eastern edge and moves toward the western edge first cut, then machined and then, finished the tools are carried up (by elevator) to be packaged and stored. Each order is assembled and sent down the other (eastern) elevator to the shipping area. The raw steel arrives in bundles twelve feet in length, but is cut down in the first "forming" process to lengths from three to twelve inches. The pieces are transported in small boxes.

I wanted the main entrance to the factory to be clear. I tried to do this by making the walls of the entrance a smaller scale than the adjacent factory walls. The truck loading areas were oriented to Cogswell Avenue, to reflect the direction of the street. This causes a bottleneck at the elbow bend in the site. The location of the entrance at the same point exacerbated this.

I considered the elevation along Cogswell Avenue if sawtooth roofs were used.

The decision to respect the direction of the street would have meant orientation of these sawtooth skylights to the northeast (not as good an orientation as due north).



SKETCH 13

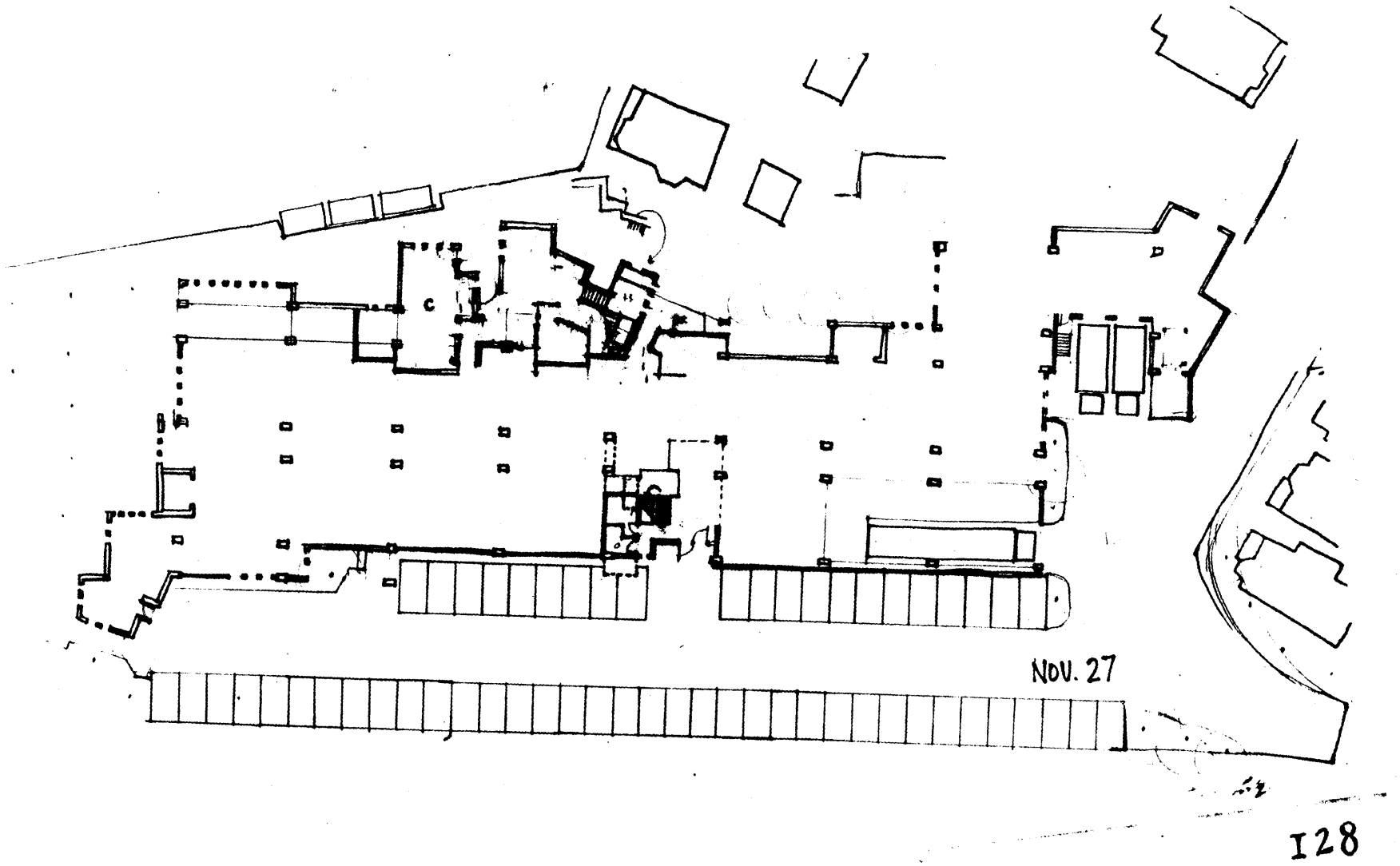
SKETCH 13

In this sketch I was primarily concerned with the impact of transport on Cogswell Avenue. The arrival of the raw steel occurs once per week, and can be scheduled for the least obtrusive time. There is daily shipping and receiving which occurs in a steady flow. The fact that these trucks might be kept running while waiting, led to the consideration of an acoustical barrier which might minimize the noise. (Only total closure might solve it completely and the frequent traffic makes such a solution impractical.) At this point I tried to tuck the loading areas behind a wall. This would hide them from view as well.

I wanted to further emphasize the "desire line" across the site, by making the visual connection possible between Cogswell Avenue and Pemberton Street. I set up the structural grid to follow the direction of the railroad tracks and parking lot to the south. The grid varies at the center of the building--a shorter span to indicate a place for circulation and/or H.V.A.C. systems.

I wanted the main entrance to the south to be a place where person working in all departments of the company could have social contact at the beginning or end

of the day. I put the locker rooms there, for all to use. I hoped the walls would provide some definition of the entrance space and the locker rooms could have natural light at the southern edge. This area could be a place for other collective uses: stairs to the upper levels and phones. And finally the large oil storage tanks are placed at the edge near the park behind a glass wall so the community can view these forms.



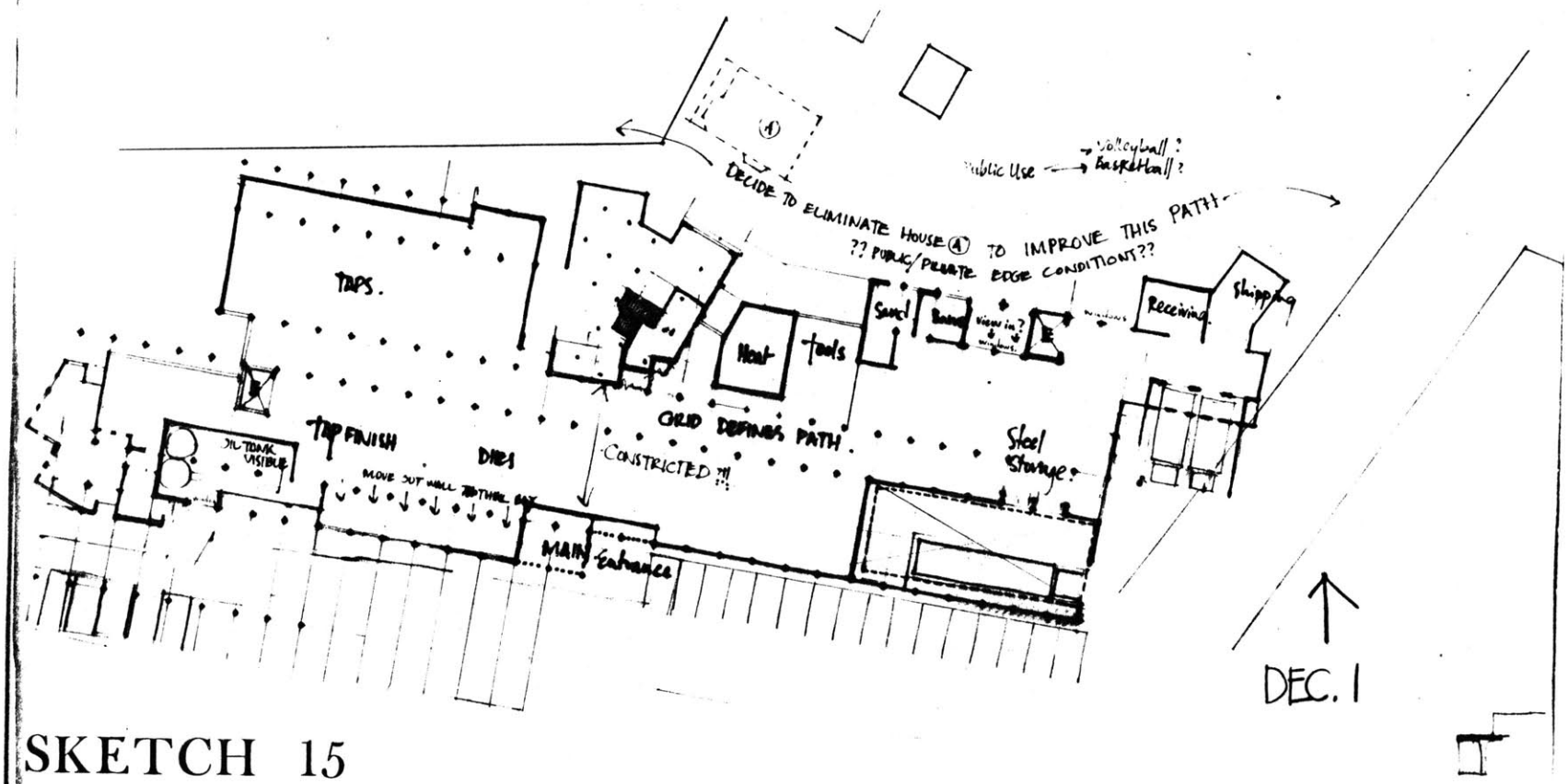
I28

SKETCH 14

SKETCH 14

In this sketch I have dealt with the directions of the walls in the office areas. The grid is carried to the northern edge of the building. Elsewhere the walls reflect the direction of the adjacent house and emphasize the "desireline" route. There is an entrance to the plant placed at the north to allow for easy access to the outdoor open spaces.

The cafeteria, "C," is placed at the Pemberton Street entrance. Here the industrial employees can have their lunch, see out to (and be seen by) the surrounding residential community. Here office employees can interact with production employees. The cafeteria space could be used at night and on weekends by the neighborhood and/or employees for meetings and social functions. It can be closed off from the plant for reasons of security (during off hours). Buy by day there is easy access to the plant. The locker rooms have been moved to the second level, so as not to interfere with potential future expansion of the overhead crane, along the grid. Small bathrooms and stairs define the main entrance.

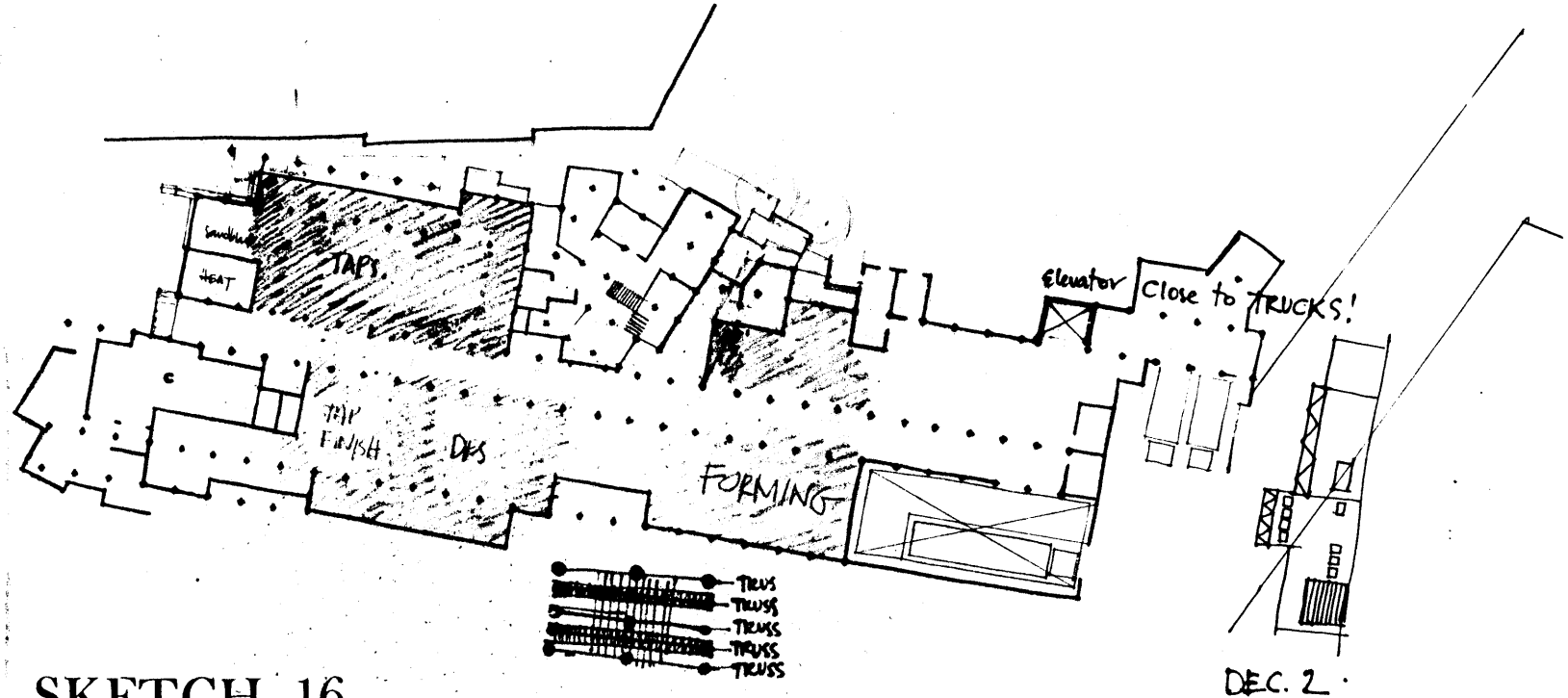

DECIDE TO ELIMINATE HOUSE ④ TO IMPROVE THIS PATH
?? PUBLIC/PRIVATE EDGE CONDITION??
Public Use → Volleyball ? Basketball ?
TRPS.
Heat
Tools
Receiving
Shipping
TOP FINISH
DIES
CONSTRICTED ?!!
GRID DEFINES PATH
Steel Storage?
MAIN Entrance
DEC. 1

SKETCH 15

SKETCH 15

At the suggestion of some critics I decided to remove the adjacent house near the offices. This was done to widen the pedestrian route between Cogswell Avenue and Pemberton Street, and to give it a more public quality. There is space for private (company) definition. People should feel they can walk there without being intruders on private land. A low wall or row of trees might define the edge of the path. An activity (basketball or volleyball courts) can be set up in this outdoor space. It would be used by the neighborhood and by the industrial workers. It would be a place to walk toward, a destination along the path.

In this sketch many of the smaller, defined spaces are placed at the northern edge. This is an attempt to isolate those areas along the southern edge where future expansion can occur. Locating most plumbing and smaller definition at northern edges makes future expansion into the present parking areas (or above them) easier. At this point I put a wall around the steel loading dock and crane. It did not seem important to heat the area constantly, when the crane is only used once per week.


TAPE
HEAT
TAPE
FINISH
DRS
FORMING
Elevator
Close to TRUCKS!
TRUSS
TRUSS
TRUSS
TRUSS
TRUSS
DEC. 2

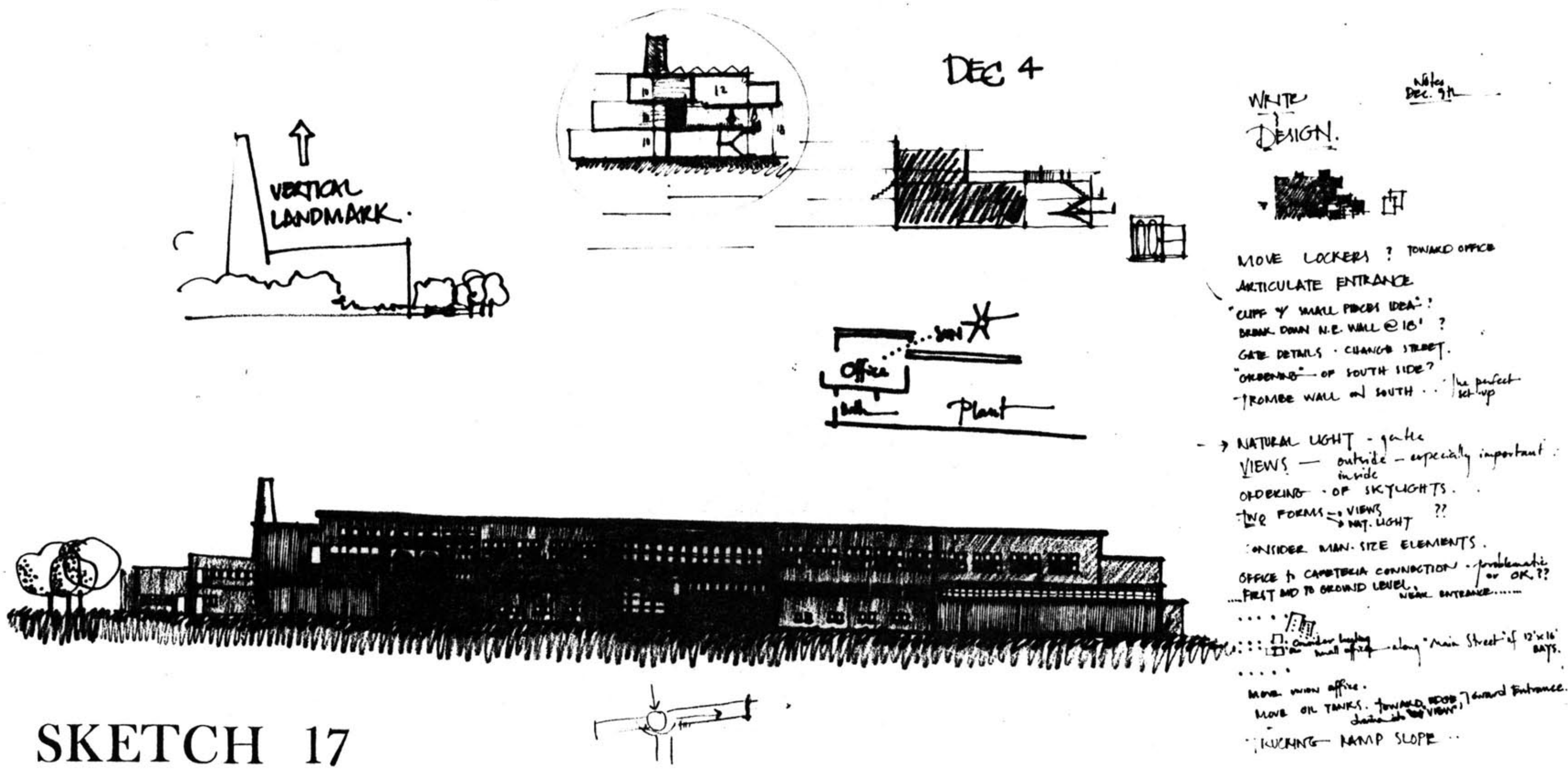
SKETCH 16

SKETCH 16

This small sketch illustrates further process organization decisions. The grid, which was earlier a wider span grid for openness, has been changed to a smaller span grid in order to support the heavy load of the storage areas above. The office spaces had spread out too much and production areas needed more space.

The cafeteria "C" was moved to the southwestern corner of the building. This was done to allow enough space for a kitchen, with access for food delivery through the parking lot. Neighborhood access to the cafeteria space for "off hour" gatherings is still possible, and is more directly connected to outdoor use in the parks. The heat treat area was moved to the western edge (from the earlier location near the center of the building) for more efficiency in terms of process.

A small schematic elevation of the Cogswell Avenue facade was done. There is a (yet unsettled) concern for the impact of this area on that street, and a desire that the crane/loading area be a separate massing element.

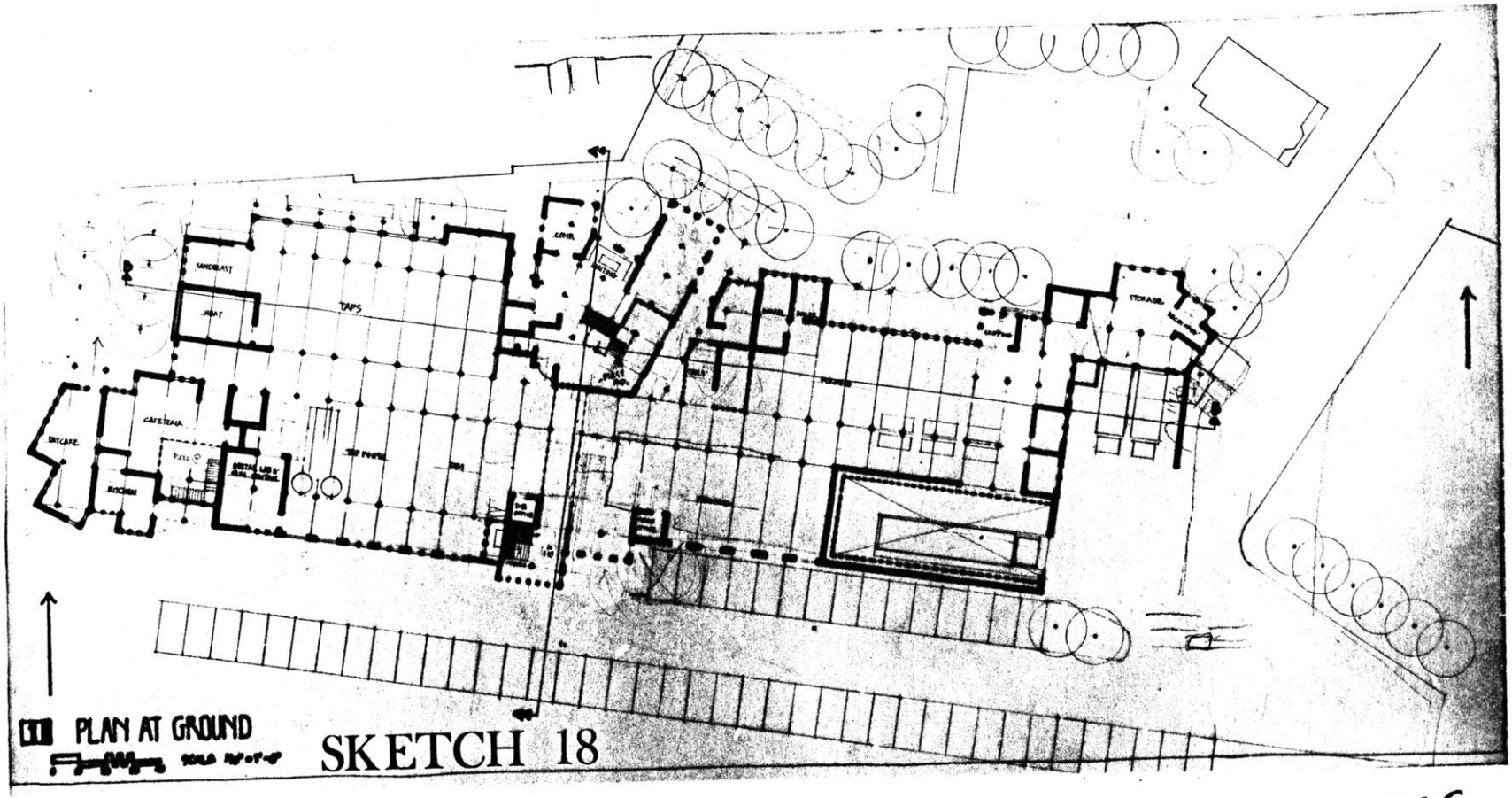

VERTICAL LANDMARK.
DEC 4
Office
Plant
WRITE
DESIGN.
Notes Dec. 9th
MOVE LOCKERS ? TOWARD OFFICE
ARTICULATE ENTRANCE
BREAK DOWN N.E. WALL @ 18' ?
GATE DETAILS · CHANGE STREET.
"ORDERING" OF SOUTH SIDE?
TROMBE WALL ON SOUTH · · the perfect set-up
NATURAL LIGHT - gentle
VIEWS — outside - especially important · inside
ORDERING · OF SKYLIGHTS.
TWO FORMS → VIEWS → NAT. LIGHT ??
CONSIDER MAN. SIZE ELEMENTS.
OFFICE TO CAFETERIA CONNECTION · problematic or OK ??
FIRST AID TO GROUND LEVEL, NEAR ENTRANCE
along "Main Street" of 12'x16' BAYS.
Move union office.
MOVE OIL TANKS. toward Entrance.
TRUCKING RAMP SLOPE

SKETCH 17

SKETCH 17

This sketch was an early southern elevation. I was concerned that the entrance area appear different from the manufacturing areas. I wanted the stairs at the entrance to be visible from the outside. There would be more glass at the entrance. At the other walls I wanted the windows to be high to allow for the deeper light penetration into the building. I also included windows of a lower level which could be opened by the users, and provide eye-level views into and out of the building. I included a smokestack to vent the heat treat furnaces. This element is not necessarily needed by the process and is there in large part to be a vertical element for the building form.

Section sketches indicate the integration of the three smaller (ten foot) levels of the offices with the two larger production levels. At this point I was considering a twelve-foot storage level and and eighteen-foot production level in the plant.



PLAN AT GROUND

SKETCH 18

SKETCH 18

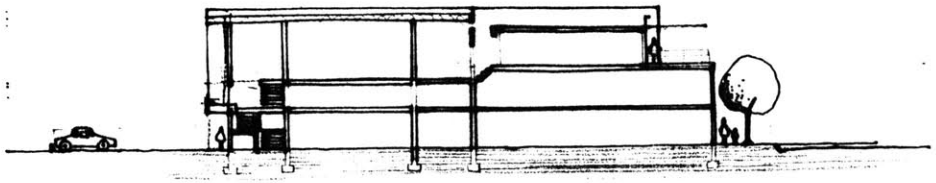
In this sketch there is an additional program element added: a daycare center. It is located near the cafeteria and kitchen to take advantage of the southern exposure and the park area. I thought that there might be some interaction between the daycare and cafeteria uses and that the kitchen could be shared. Daycare activities could move to the cafeteria space when it is not in use. The childcare service is to be used by the neighborhood and company employees.

Locating the daycare and cafeteria at the south-western edge of the site means employees will walk through the factory to have lunch. The path is marked by columns and perhaps by color changes and other interior design touches. Similarly there is a bridge at ten-foot level connecting the main entrance to the offices. In both cases, I wanted office employees to have contact with, and an overview of, the factory, and vice versa. The production employees can use conference and lounge areas in the offices for meetings. There would be visual contact between offices and the production and storage areas.

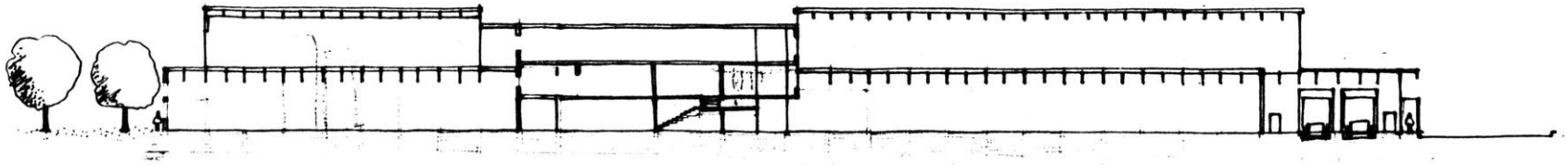
At this point I decided to use a second smaller span structural grid for the offices. I wanted to create the sense that this area was different from the factory area, not off limits, but providing further variety of scale and materials. The bays are ten feet by twelve feet. Some bearing walls occur where this grid "meets" the grid of the factory area.

On the advice of several critics, I decided, at this late point, to "buy" the houses opposite the truck loading areas on Cogswell Avenue. Rather than expect anyone to put up with the noise and traffic a reasonable and responsible action was to "buy" those houses for company use or demolition (as is the case for my design). It is a complex task to ascertain the point at which industrial uses cease to give variety in a residential area and begin to overwhelm the residential qualities. It became apparent that this area did seem to overwhelm rather than enhance the neighborhood.

I still wanted some definition at the main entrance and located the "die" and "forming" offices at either side of the entrance (like lions at the Public Library). The stairs to upper levels and the bridge at ten feet were to further articulate the entrance.



SECTION A-A
SCALE: 1/16" = 1'-0"

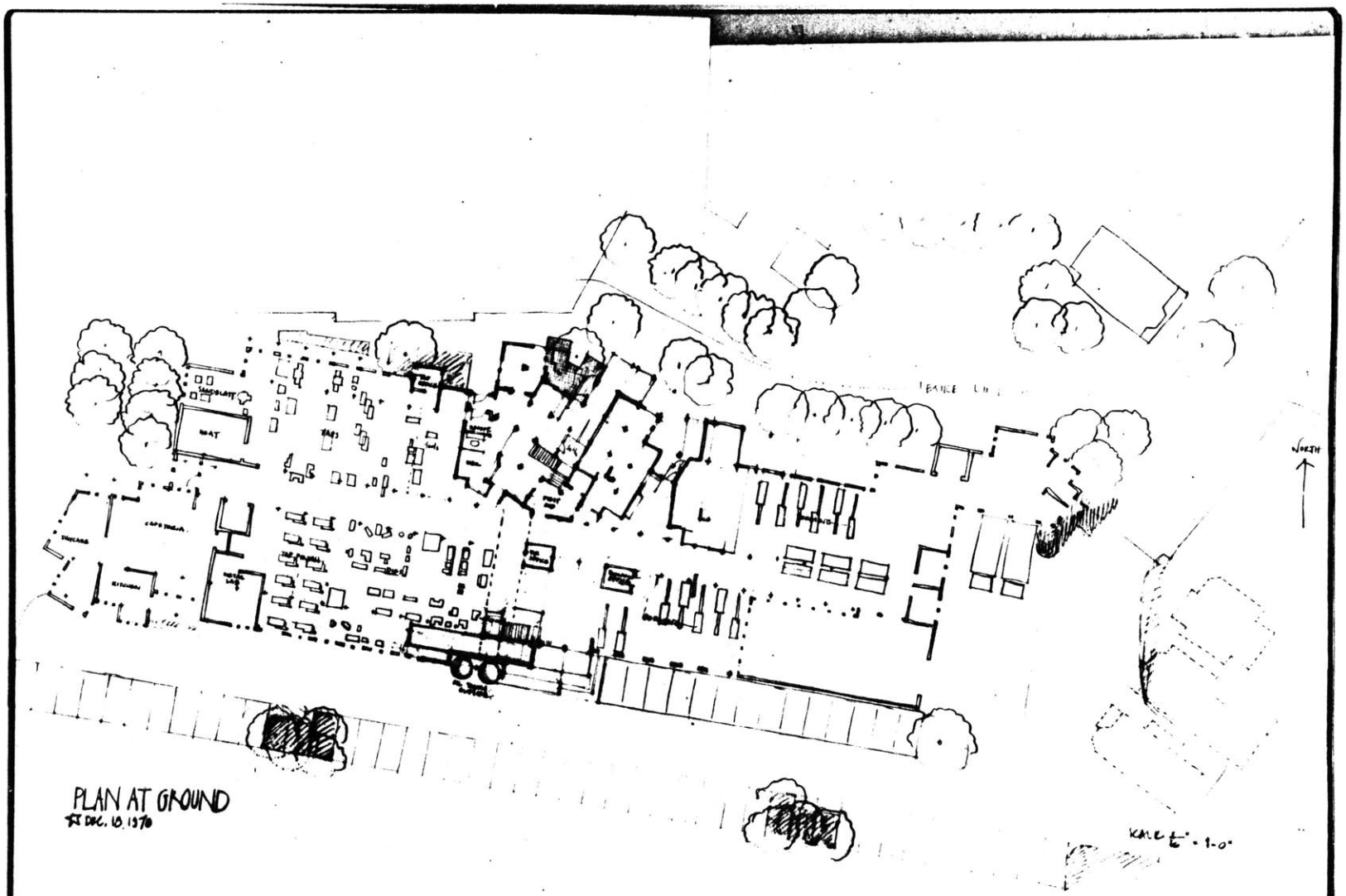


SECTION B-B
SCALE: 1/16" = 1'-0"

SKETCH 19

SKETCH 19

These simple sections are indicated on sketch 18. The need for storage area led to a decision to make the upper level of the plant an eighteen-foot space. The bridge at +10' level (section A-A) intersects the eighteen-foot high space of the production area. There is a small stair connecting the upper storage area (at +18') and the upper office level (at +20'). The stair at the main entrance goes up to the bridge (at +10') and the upper storage area (at +18'). The truck loading areas are recessed in lieu of raising the entire building above grade.



SKETCH 20

SKETCH 20

In this sketch the layout of machines in the production areas seems relatively unrestricted despite the small bays which were dictated by the need to support the heavy storage of the upper level. (In the existing factory, on which this design program is based, the bays are thirty feet by forty feet for the entire one-story structure.)

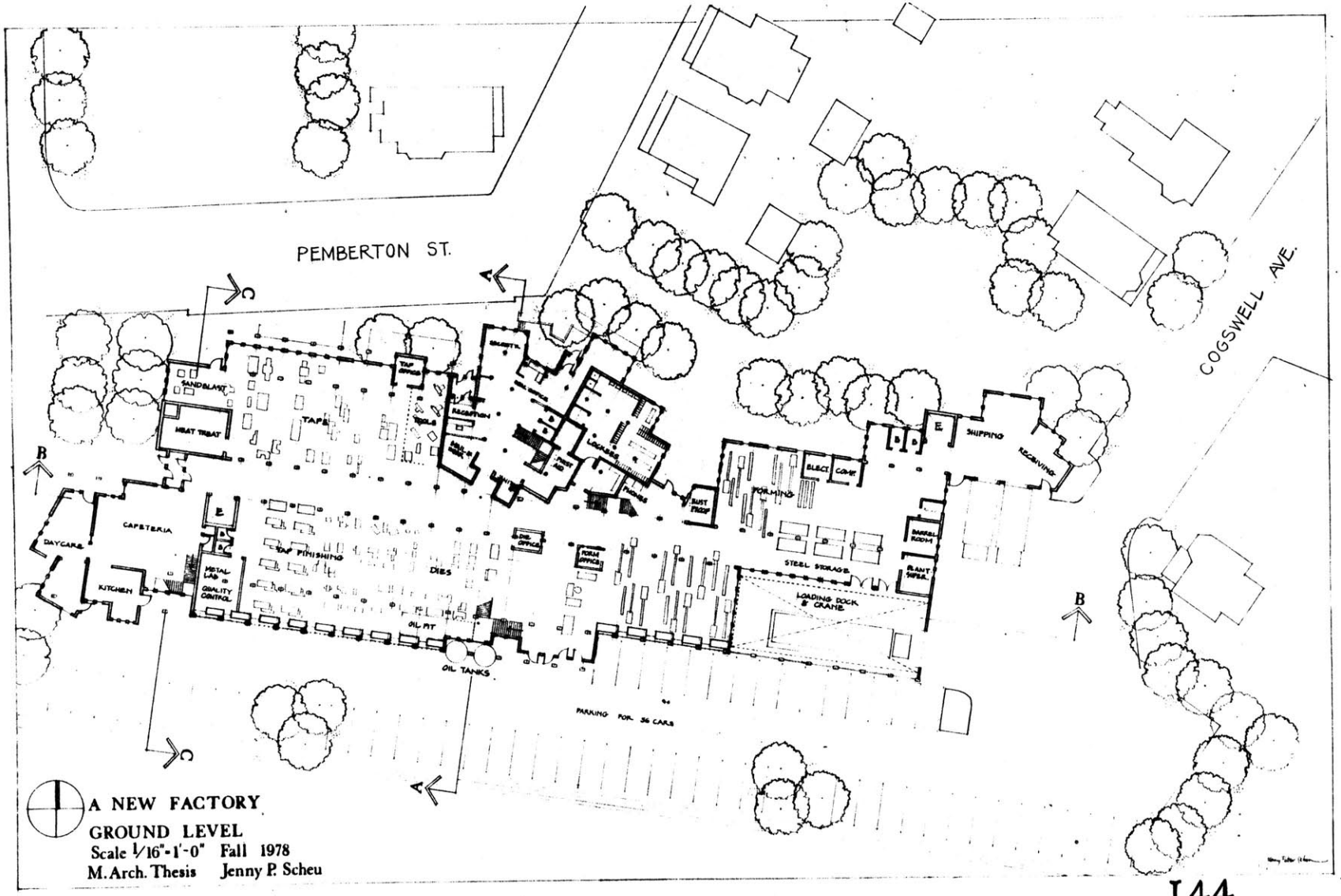
In this sketch the wall around the crane has been glazed to allow a view of the crane operation from the plant. The walls are still there so this infrequently used area can remain unheated.

At Cogswell Avenue, the curbs have been extended to indicate where the industrial area begins. This will mark an end to the residential street and can be closed off (with a gate) to vehicular traffic during the non-working hours. The large expanse of pavement in the parking and truck loading areas could be an excellent hardtop playground area when the factory is not in operation. It is conceivable that lines can be painted on these paved areas to indicate boundaries for street hockey and any other hardtop games. Trees have been added in a few places along the parking lot area for shade. They continue the line of trees established by the many

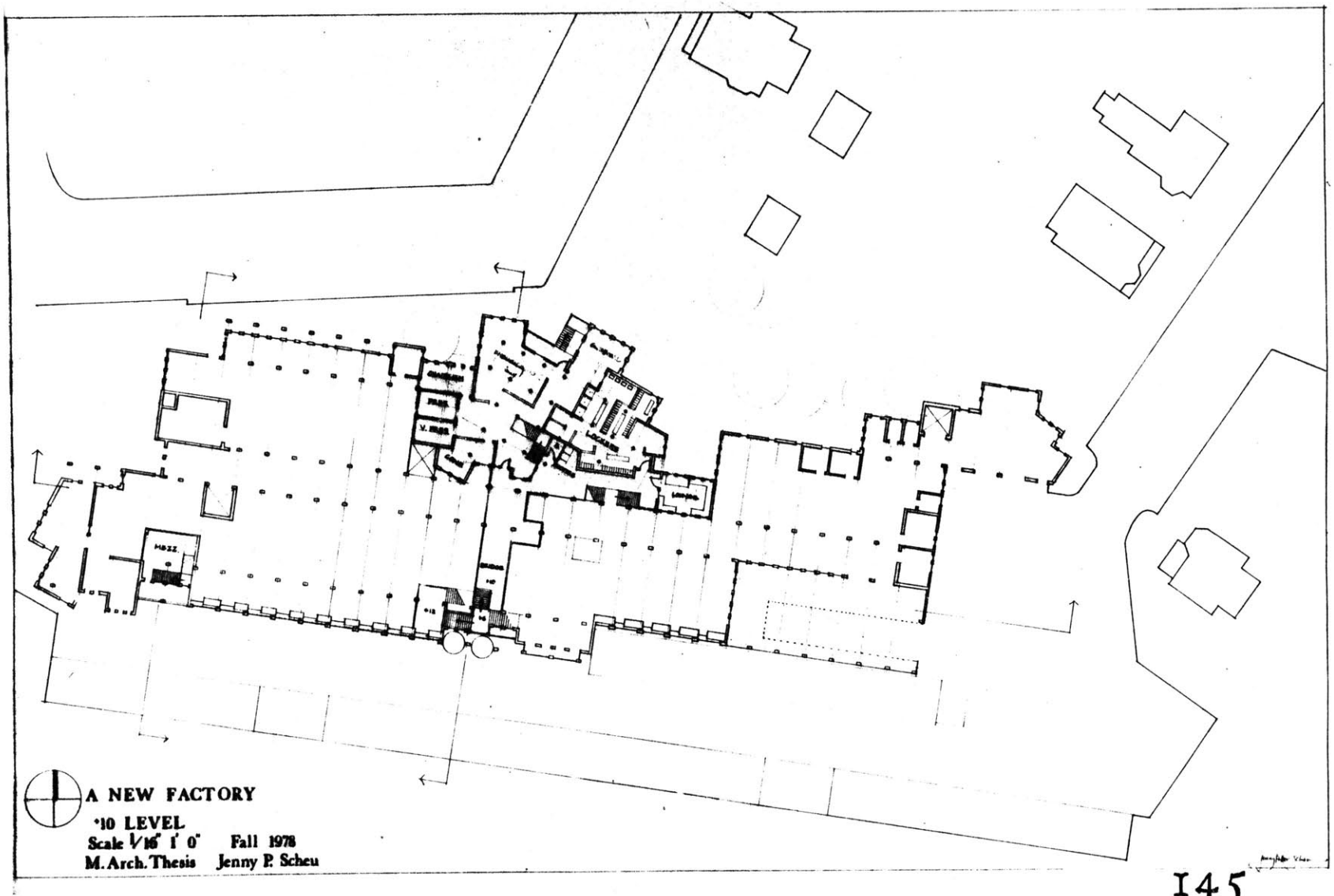
beautiful willows which run along the railroad tracks to the west of the site.

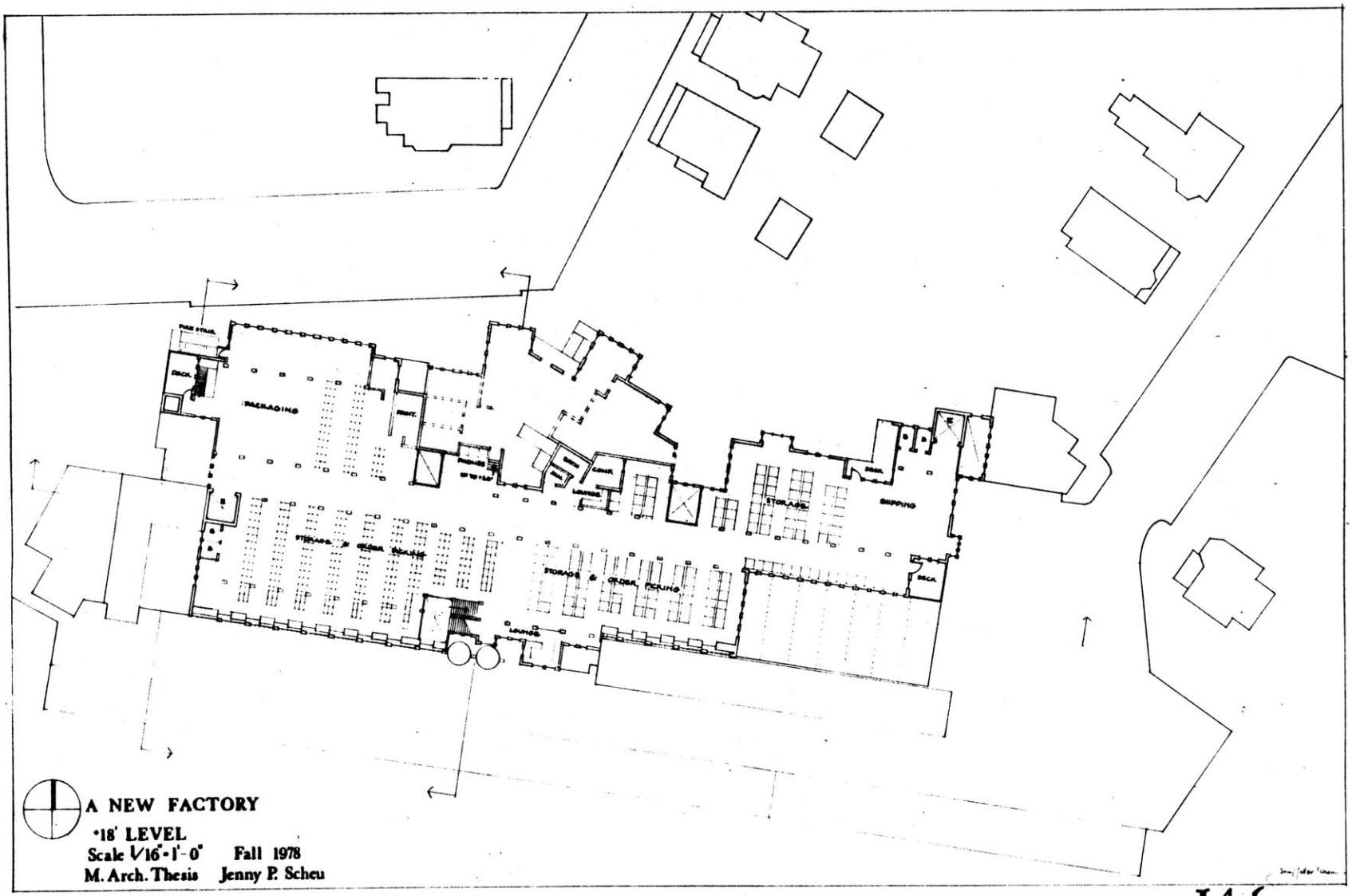
Concern that the main entrance be articulated has led to placement of the large oil storage tanks outside near the entrance. These provide strong vertical forms which help to mark the entrance. At the inside (and visible from the outside) the stairs to the upper levels are located.

After an interesting discussion with critics it became clear that the office area had become too different from the plant area and showed less concern for the integration of uses. We discussed locating the locker rooms and the first aid room at points between the offices and the plant at either side of the opening to the northern open spaces. I still wanted the lockers to get natural light and not be buried in the middle of the building. The tap office and forming office were moved toward the center area away from the main southern entrance. Here they are closer to the offices and the plant-office interface, but still not in the way of the circulation. The bridge (at +10' level) makes access across the plant possible, out of the way of the production traffic. This bridge also provides a high place from which to view factory operations.

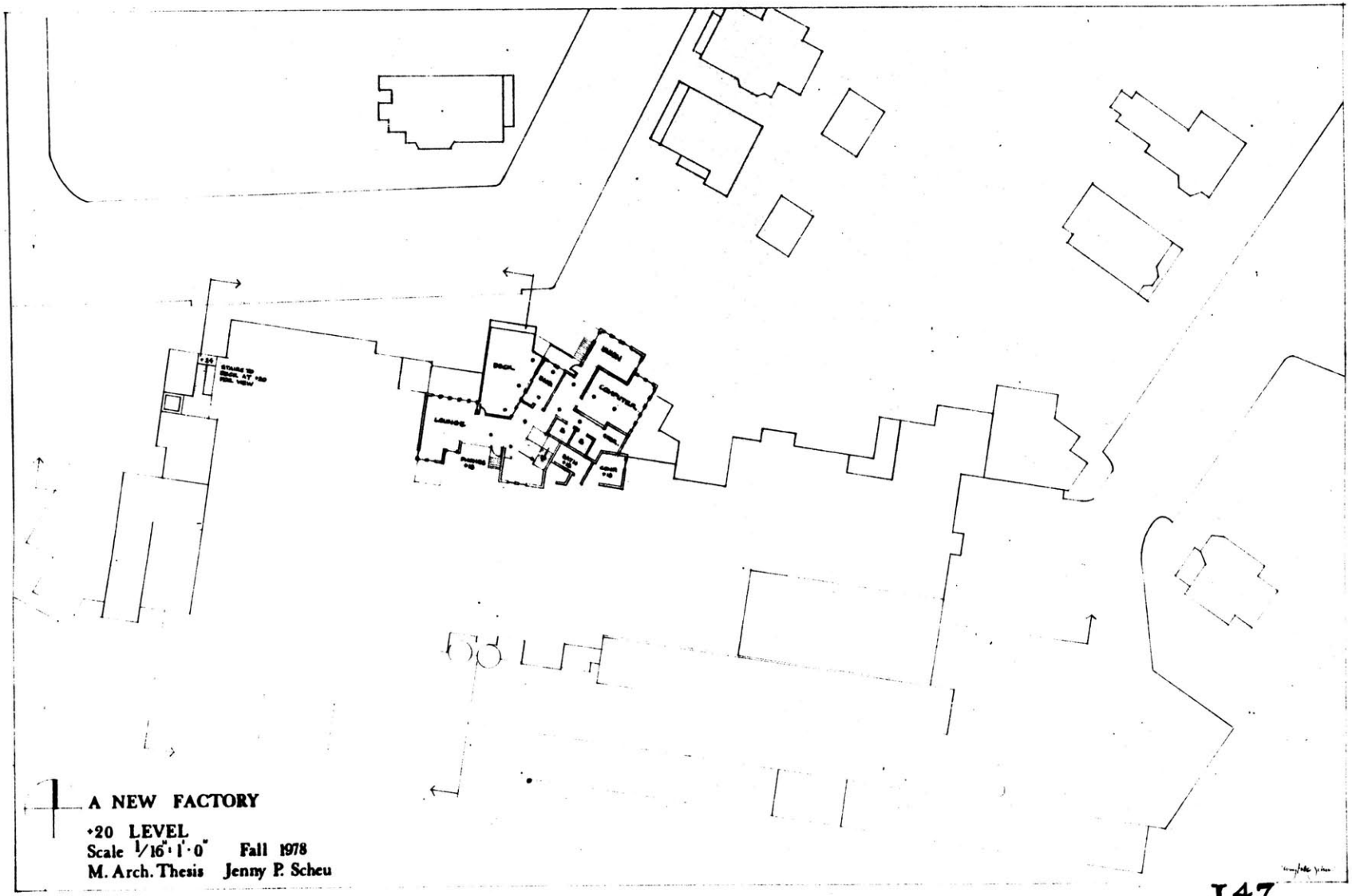


A NEW FACTORY
GROUND LEVEL
Scale 1/16"-1'-0" Fall 1978
M.Arch. Thesis Jenny P. Scheu


A NEW FACTORY
'10 LEVEL
Scale 1/16" 1' 0"
Fall 1978
M. Arch. Thesis
Jenny P. Scheu



A NEW FACTORY
+18' LEVEL
Scale 1/16"-1'-0" Fall 1978
M. Arch. Thesis Jenny P. Scheu

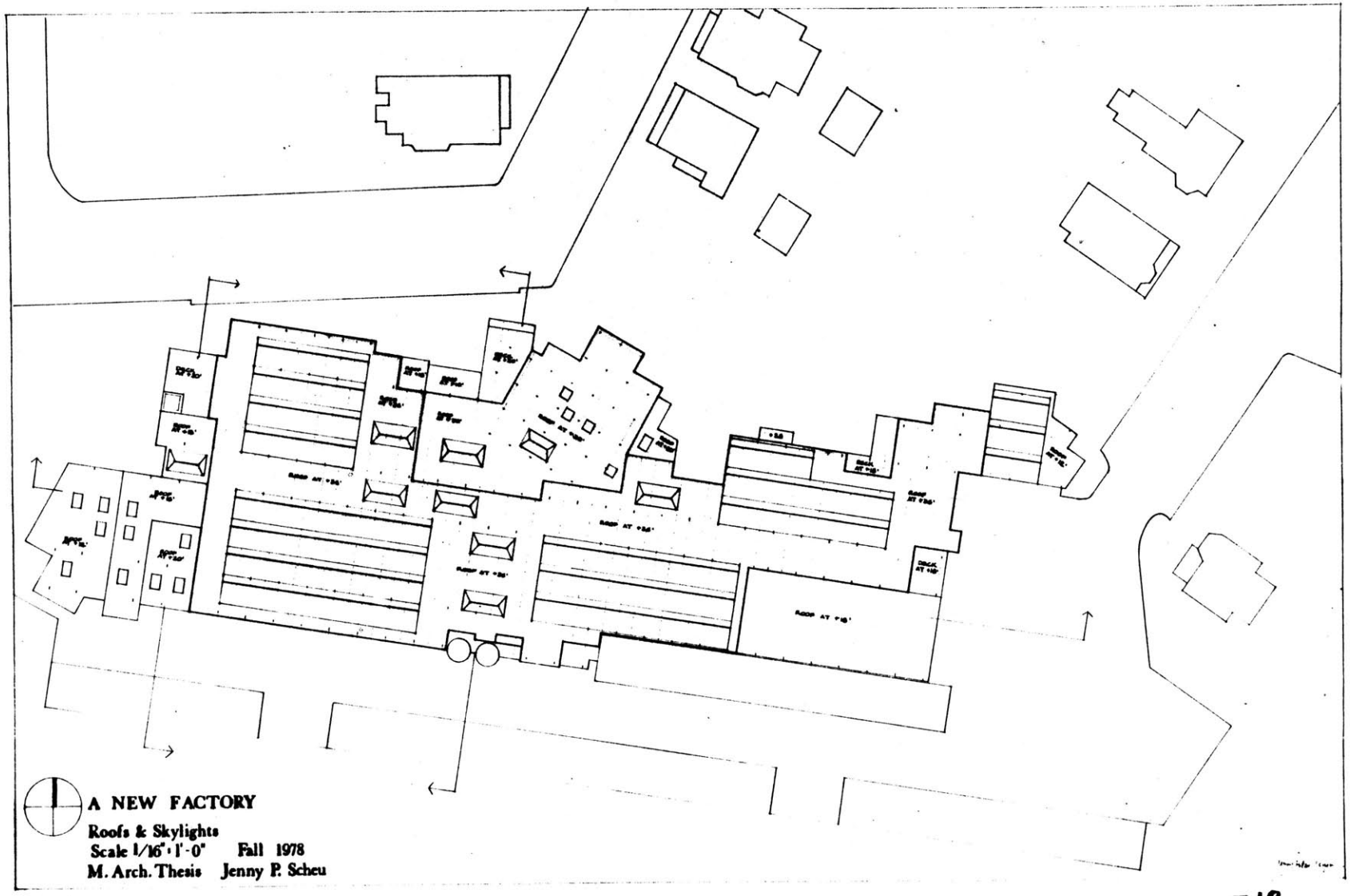


A NEW FACTORY

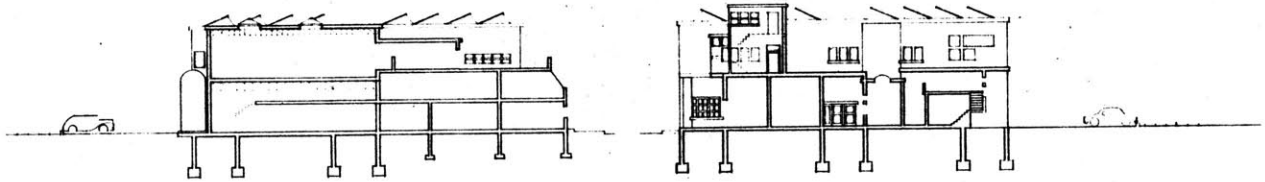
+20 LEVEL

Scale 1/16" : 1'-0" Fall 1978

M. Arch. Thesis Jenny P. Scheu

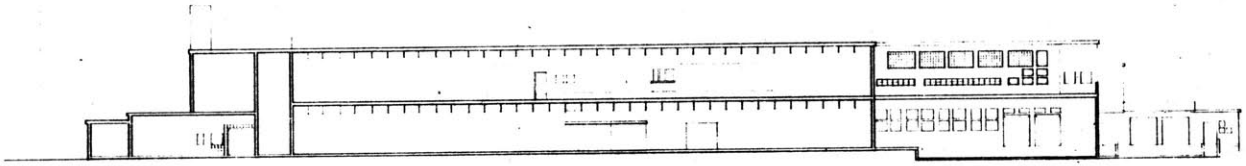


A NEW FACTORY
Roofs & Skylights
Scale 1/16" = 1'-0" Fall 1978
M. Arch. Thesis Jenny P. Scheu



SECTION A·A

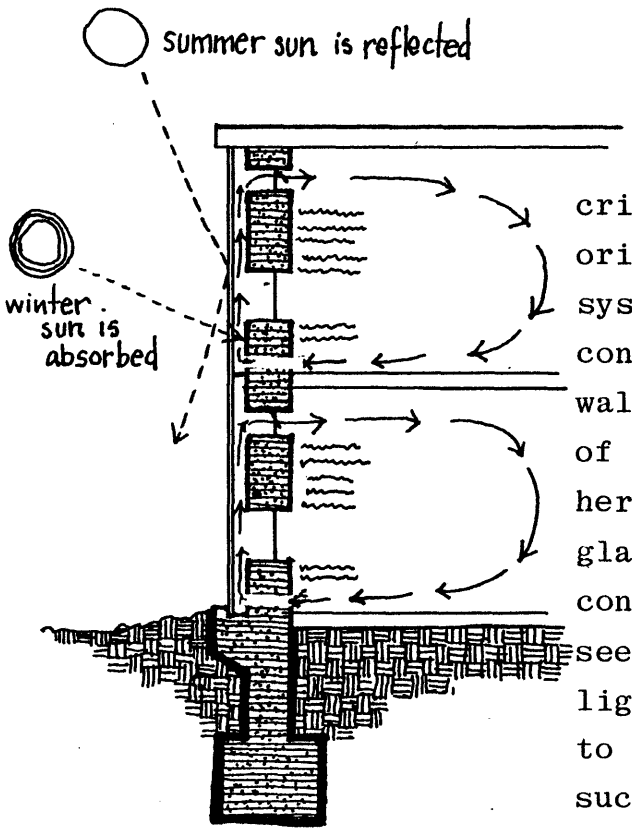
SECTION C·C



SECTION B·B

A NEW FACTORY

Three Sections
Scale 1/16"=1' 0" Fall 1978
M. Arch. Thesis Jenny P. Scheu



Trombe Wall

FINAL DRAWINGS

During the last design period I discussed with critics the opportunity to use the general north-south orientation of the building for a passive solar energy system. In these final drawings there is a schematic consideration of a "Trombe wall" system for the southern wall. From what I have read and heard, the construction of this wall to collect and store solar energy is plausible here. At the southern wall one would want to avoid over glazing to minimize glare and the construction of the concrete storage walls with occasional openings does not seem too great a conflict especially as there is natural light from skylights overhead. Further work would have to be done to test the applicability of the system to such a large building. The crane is placed completely outside the building at this point, with a roof overhead but otherwise unenclosed.

The following drawings mark a final point for the organization of spaces in this industrial design. In many respects, they are far from a final state. Done at sixteenth scale, they necessarily leave out many details which would be important in the construction of the building. They do represent the culmination of the

process I have detailed through descriptions of the previous twenty sketches.

I feel confident that the design work has allowed me to realize my intent of reaching a broad overview of the issues of industrial building design. Similarly I know that with more time, the details of my design would be demonstrated. The basic and most important decisions have been reached.

Human beings have a Promethean gift amounting to genius for deliberately altering their environments, and to deny or minimize this gift is to be ignorant. But this human genius can be more or less informed, more or less disciplined, more or less effective in achieving its goals. And this is what environmental psychology is all about: giving people informed, disciplined and effective means of coping with what surrounds them.

Albert Mehrabian

Science is not a mechanism but a human progress, and not a set of findings but a search for them. Those who think that science is ethically neutral confuse the findings of science, which are, with the activity of science, which is not . . . But human search and research is a learning by steps of which none is final, and the mistakes of one generation are rungs in the ladder, no less than their correction by the next. This is why the values of science turn out to be recognizably the human values: because scientists must be men, must be fallible, and yet as men must be willing and as a society must be organized to correct their errors.

J. Bronowski

EVALUATION:

The Role of An Architect

The architects whom I have talked to who have designed industrial buildings have many discouraging experiences to relate. There is a great need for consideration of those elements which humanize working places, but economics generally preclude such considerations.

One might hope for a more active involvement on the part of unions and organized labor to effect necessary physical improvements and changes. It is easy to understand why the unions are less than active in such reform areas.

First of all workplace reforms have generally been implemented to increase productivity. Money is spent for changes with the assumption that the return (in increased productivity) will equal or surpass the initial outlay.

One can make the extreme argument that increased productivity is almost (or should be) anachronistic in an age when supplies of irreplaceable raw materials are dwindling. E. F. Schumacher discusses this weakness in our economic system: "greed and envy demand continuous and limitless growth of a material kind, without proper regard for conservation, and this type of growth cannot possibly fit into a finite environment."[71]

Productivity can also be viewed in terms of who directly benefits. As it stands in our present economic system, the rewards of productivity accrue to those who own the industry. Improvements to a workplace may increase the value of the property which is not, in most cases, owned by the workers. When there is no worker ownership, it is easy to understand why workers and unions prefer to discuss benefits in terms of fewer hours of work and increased pay instead of physical changes and improvements to the working place. When there is worker ownership, productivity, growth, and physical change/improvements are encouraged and the rewards of such growth and changes are spread to a wider number of persons.

There have been some fine examples of very successful "profit sharing" organizations. E. F. Schumacher, in his book Small is Beautiful, describes one such company's success. He defines "four tasks" upon which the organization and operations of the company are based:

> The economic task: to secure orders which can be designed, made, and serviced in such a manner as to make a profit;
>
> The technical task: to enable marketing to secure profitable orders by keeping them supplied with up-to-date product design;

> The social task: to provide members of the company with opportunities for satisfaction and development through their participation in the working community;
>
> The political task: to encourage other men and women to change society by offering them an example by being economically healthy and socially responsible.[72]

Again we see that provision of better working environments is based in large part on changing organizational structure and ownership patterns. But clearly there are strong indications that the physical environment either detracts from, or supports, the organizational intentions.

The issues of the workplace are exceedingly complex. This complexity must be respected as there are no simple panaceas. This does not mean, however, that incremental improvements are irrelevant. Each time we (as designers) face the problems we will gain insights, curse the systemic intransigence, and see things of beauty. It is important to remember that we have skills to share and much to learn. ". . . We are designers, not managers or sociologists or psychologists or workers. However enthusiastic we have become about many developments in work and society, we are students of these developments, and see it as our obligation to clarify social intention through design. Our knowledge and ability to help comes

from our interest in providing environments supportive of human activity; therefore the thrust of our efforts is to explain the issues of work and society to designers, and to try to retain design as the reference for our efforts."[73]

Six months ago when I began to consider this project, someone suggested to me that I "be sure to choose an industry with lots of towers and ramps in the production process, or otherwise the form of the factory will be standard and boring." Others scoffed: "A factory? what is there to design?"

I feel sympathetic to these concerns to a point. I too enjoy the rich forms of large industry, the steel trusses and frames, pipes, large storage tanks, ramps, cranes, skylights, smokestacks, and the large machines. For me and many others a fascination exists with the power of industrialization and all of its forms and colors. Similarly, we admire the finest and sleekest products of our industrial age and they become bold and elegant inspiration for much design on a larges scale. While we are fascinated by this realm, our awe blinds us to an understanding of it and blinds us to our own abilities to affect these places. Products come to

us as if by magic. We are far removed from the simplicites and complexities of their production.

In his book Science and Human Values, J. Bronowski has commented that the true creativity of science does not lie with the facts (which are never fixed) but lies in the search for the facts.[74] We can carry this view to industry. Beyond a beautiful product lies an even greater beauty in the awareness of who made it, how it was made and for what reasons.

The discovery of these things has been tremendously exciting to me and has provided insights beyond the admiration of beautiful objects. It has strengthened my convictions that there must be more consideration placed on the design of the workplace in order to enhance these discoveries for others.

As much as I have admired the industrial forms, I have grown to feel that an architect's contribution to working places can (and must) extend beyond the design of an enclosure for a predetermined process.

This is not to say that I favor ignoring or minimizing the importance of process in industry. On the contrary, I favor an increased focus on the process in order to determine its implications for all those who work in the industry.

I have grown to believe that an architect must take a considerably more active role when designing for industry. She must become an advocate for all those who work there, providing those physical supports which will enhance the workplace experience and respond to the needs of all.

Gaining an understanding of the production process may be awesome at first. There may be "process engineers" who will have helpful information about the requirements of machines, the flow of goods and the relationships of the various departments.

But because a process is set up one way does not mean that it cannot be changed. Reluctance to change it may be because it is just easier to maintain the same set-up, not because there is only one way to set it up. Common sense is an invaluable tool for understanding process and effecting changes.

In the traditional pattern for architects in industrial design, management becomes the client by virtue of hiring the architect. In describing his experience of working with an architect, one middle management executive lamented the architect's lack of concern for a broad understanding of needs. The architect had based

the design on management's view of the needs of their employees. After useless spaces were designed and built, it became clear that the client (management) did not have an accurate understanding of employee needs. The architect must ascertain whether the client has a one-sided view of needs, and must seek to balance this view with the concerns of others who will use the building.

Getting accurate information requires energy and patience. It was not the intent of this thesis to clarify the specific ways that the architect can deal with the complex industrial client. Due to limited time and other constraints, solutions to (and understanding of) the very specific problems of one industry and its users were minimized in favor of an overview and a broad understanding. Specific focus on the design of a "tap and die" factory gave me a clearer picture of the questions an architect must be prepared to ask when designing for industry.

In his book Design Awareness, Robert Sommer comments that, "Victor Papanek is a good example of an advocate industrial designer" because he "is less renowned for what he has designed . . . than why he has designed. Following the modle of the advocate professional, he

finds his greatest satisfaction from teaching others how to create."[75]

I believe that an architect must be willing to learn from those in industry (and other professions) as well as being willing to share her own knowledge. She must be willing to acknowledge the expertise and creativity of others. The complexity of workplace issues suggests that teamwork may be the best way to reach design solutions. Working with a team of professionals and users, the architect must remain an adovcate for the needs of all. As a designer, she must continue to find delight and inspiration in the forms of industry while maintaining a full and clear understanding of the whole range of issues.

Recently I met a woman who is a consultant for industrial safety to a large corporation. She works to understand all aspects of the production process in order to determine potential health hazards and specific light and ventilation needs. Faced with tight budgets she must fight for the systems and the equipment she considers to be essential.

Once she faced an executive who wanted fancier furniture. She recognized the opportunity to use the

money for much needed ventilators in the factory and after a struggle successfully secured those funds for factory use.

She is paid by the management but she has established her own priorities and remains a strong advocate for all.

The role of the psychologist (or the industrial sociologist, if necessary) will be to point to those aspects of space which cannot be determined directly by knowledge about sequences of operations--or which may even lead one to question the rationale behind that knowledge. For it is precisely in an analysis of the perception and the appropriation of space that we can find the differences between the principle of functionalism (practiced by the architect, though he may temper it with aesthetic tendencies) and the rational study of the irrational in man . . . At all levels of the industrial hierarchy individuals will make special demands on space; these demands must be recognized . . .

Fischer & Moles

FOOTNOTES

[1]Jackson, J. B.: Lectures on the "American Landscape" given at Harvard University; September to December, 1976.

[2]Montgomery, David: Lecture entitled "Worker's Control in the U.S.: Past, Present, and Future," given at M.I.T. on November 27, 1978. Montogmery is an historian from the University of Pittsburgh.

[3]The discussion of F. W. Taylor is based on the lectures of J. B. Jackson at Harvard University in 1976, and readings from Peter Drucker in Technology Management and Society (Harper & Row, 1970) and Claude S. George in The History of Management Thought (Prentice-Hall., 1972).

[4]Ibid.

[5]Montgomery, David: My notes from his lecture at M.I.T. on November 27, 1978.

[6]Ibid.

[7]Drucker, Peter: Technology, Management and Society; Harper & Row, publishers, New York. 1970.

[8]Montgomery, David: My notes from his lecture at M.I.T., on November 27, 1978.

[9]Noble, David: America by Design: Science, Technology, and the Rise of Corporate Capitalism; Alfred A. Knopf; New York. 1977. p. 59.

[10]Bennett, Ralph: "Draft"; Harvard GSD; February 23, 1976.

[11]Hildebrand, Grant: Designing for Industry: The Architecture of Albert Kahn; The M.I.T. Press, Cambridge, 1974. pp. 1-2.

[12]Ibid., p. 21.

[13]Ibid., pp. 21-22.

[14]Silverman, Stuart: "Workplace Improvements as Defined by Worker Demands"; a paper at Harvard GSD; February 2, 1976. p. 3.

[15]Schrank, Robert: Ten Thousand Working Days; The M.I.T. Press; Cambridge, 1978. p. 255.

[16]Ibid., p. 225.

[17]Ibid., p. 226.

[18]Ibid., p. 226.

[19]Ibid., p. 227.

[20]Ibid., p. 227.

[21]Slezak, Michael: White Collar Workplace: Interior Form and Definition in Office Building Design; Master of Architecture Thesis at M.I.T.; June 1978. pp. 9-12.

[22]Silverman, Stuart: Paper at Harvard GSD; February 2, 1976.

[23]Ibid.

[24]Pincus, Allen: "Definition and Measurement of the Institutional Environment in Homes for the Aged";

[25]Fischer & Moles: "The Psychology of Industrial Space"; Industrial Forum; vol. 8; no. 1; 1977. p. 43.

[26]Ibid., p. 43.

[27]Schumacher, E. F.: Small Is Beautiful: Economics As If People Mattered; Harper & Row, Publishers; New York. 1973. p.272.

[28]Proshansky, Harold et al., Editors: Environmental Psychology: Man and His Physical Setting; Holt, Rinehart and Winston; New York. 1970. p. 182.

[29]Brill, Michael: My notes on his ideas of "claiming space" from discussion by Sandra Howell in a seminar at M.I.T. in October 1978.

[30]Myer, John and Mart: Patterns of Association; Cambridge; 1978. p. 32.

[31]Herzberg, Frederick: "One More Time, How Do You Motivate Employees"; See p. 178.

[32]Schrank, Robert: Ten Thousand Working Days; The M.I.T. Press; Cambridge, 1978. pp. 64-65.

[33]Nathan, Robert Stuart: "The Scheme That's Killing the Rat Race Blues"; New York Magazine; July 18, 1977; p. 37.

[34]Silverman, Stuart: Paper at the Harvard GSD; February 2, 1976. p. 6.

[35]Walton, Richard E.: "How to Counter Alienation in the Plant"; Harvard Business Review; November/ December 1972; p. 72.

[36]Ibid., p. 76.

[37]My notes from a conversation with Romaldo Giurgola, after his lecture on his work, at M.I.T. in May 1978.

[38]Intentions detailed on an information sheet by Mitchell/Giurgola, Architects; Circulated at the Harvard GSD conference on Working Place Architecture in 1976.

[39]Ibid.

[40]My notes from a conversation with Romaldo Giurgola, at M.I.T., May 1978.

[41]Mitchell/Giurgola, Architects: Information sheet from Harvard GSD conference. 1976.

[42]Schrank, Robert: Ten Thousand Working Days; The M.I.T. Press; Cambridge; 1978, p. 224.

[43]Story courtesy of David Noble at M.I.T. in December 1978.

[44]Walton, Richard E.: "How to Counter Alienation in the Plant"; Harvard Business Review; November/ December; 1972. p. 77.

[45]Ibid., p. 77.

[46]Ibid., pp. 77-78.

[47]Ibid., p. 81.

[48]Schrank, Robert: Ten Thousand Working Days; The M.I.T. Press; Cambridge; 1978. p. 76.

[49]Ibid., p. 77.

[50]Ibid., p. 78.

[51]Silverman, Stuart: Paper at the Harvard GSD; February 2, 1976. p. 9.

[52]Fischer & Moles: "The Psychology of Industrial Space"; Industrial Forum; vol. 8; no. 1; 1977. p. 44.

[53]Ibid., p. 44.

[54]Ibid., p. 45.

[55]Ibid., p. 49.

[56]Moir, Julie A.: Contemplative Place in Cities; Master of Architecture and Master of City Planning Thesis at M.I.T.; June 1978. p. 27.

[57]Fishcer & Moles: "The Psychology of Industrial Space"; Industrial Forum; vol. 8; no. 1; 1977. p. 49.

[58]Ibid., p. 49.

[59]Occupational Safety and Health Administration: Construction Standards and Interpretations; Volume III; United States Department of Labor; August 16, 1973.

[60]My notes from a conversation with acoustics consultant Bob Newman (of Bolt, Beranek, Newman) at M.I.T. in November 1978.

[61]My notes from a conversation with Chester L. Sprague at M.I.T. in October 1978.

[62]Goldstein, Roger Neal: Natural Light in Architectural Design: Element and Determinant; Master of Architecture Thesis at M.I.T.; 1976. p.13.

[63]Wells, W. P.: "Subjective Responses to the Lighting Installation in a Modern Office Building and Their Design Implications"; Building Science; Pergamon Press, Great Britain; 1965. vol. 1. p. 66.

[64]Ibid., p. 64.

[65]Nichols, K. W. : "Urban Office Buildings: View Variables";

[66]Goldstein, Roger Neal: Natural Light in Architectural Design: Element and Determinant; Master of Architecture Thesis at M.I.T.; 1976. p.73.

[67]Ibid., p. 29.

[68]Ibid., p. 83.

[69]Schrank, Robert: Ten Thousand Working Days; The M.I.T. Press; Cambridge; 1978. pp. 211-215.

[70]Bennett, Ralph: "Draft"; at the Harvard GSD; February 23, 1976. p. 4.

[71]Schumacher, E. F.: Small Is Beautiful: Economics As If People Mattered; Harper & Row, Publishers; New York; 1973. p. 247.

[72]Ibid., pp. 273-274.

[73]Bennett, Ralph: "Introduction to Student Papers"; at the Harvard GSD; February 25, 1976.

[74]Bronowski, J.: Science and Human Values; Harper Torchbooks, the Science Library; Harper & Row, Publishers; New York; 1965.

[75]Sommer, Robert: Design Awareness; Rinehart Press, San Francisco; 1972. p. 12.

BIBLIOGRAPHY

BOOKS

Banham, Reyner: Theory and Design in the First Machine Age; The Architectural Press; London, 1960.

Blauner, Robert: Alienation and Freedom; the University of Chicago Press; Chicago. 1964.

Bronowski, J.: Science and Human Values; Harper Torchbooks, the Science Library; Harper & Row, Publishers; New York, 1964.

Cherry, Mike: On High Steel: The Education of an Ironworker; Quadrangle, The New York Times Book Company; New York, 1974.

Drucker, Peter: Technology, Management, and Society; Harper & Row, Publishers; New York. 1970.

Fleig, Karl, editor: Alvar Aalto; Wittenborn & Company; Scarsdale, New York, 1963.

Friedman, George: Industrial Society: The Emergence of the Human Problems of Automation; The Free Press of Glencoe; Division of the Macmillan Company; New York. 1955.

George, Claude S.: The History of Management Thought; Prentice-Hall, Inc.; Englewood Cliffs, New Jersey. 1972.

Goldstein, Roger Neal: Natural Light in Architectural Design: Element and Determinant; Master of Architecture Thesis at M.I.T. 1976.

Gottlieb, Leonard: Factory: How Things Are Manufactured; Houghton Mifflin Company; Boston. 1978,

Henn, Walter: Buildings for Industry; Volumes One and Two; New York Hayden Book Company; Division of Hayden Publishing Company, Inc.; New York (originally published by Verlag Georg D. W. Callwey, Munich). 1961.

Herzberg, Frederick: Work and the Nature of Man; World Publishing Company. 1966.

Hildebrand, Grant: Designing for Industry: The Architecture of Albert Kahn; The M.I.T. Press; Cambridge. 1974.

Hoffer, Eric: Working and Thinking on the Waterfront; Harper & Row, Publishers; New York. 1969.

Jenkins, David: Job Power: Blue and White Collar Democracy; Doubleday Company, Inc.; New York. 1973.

The Legacy of Albert Kahn; Copyright by the Detroit Institute of the Arts. 1970.

Kidney, Walter C.: Working Places: The Adaptive Re-Use of Industrial Buildings; the Society for Industrial Archaeology and Ober Park Associates, Incorporated; Pittsburgh, Pennsylvania. 1976.

MacGregor, Douglas: The Human Side of Enterprise; McGraw-Hill; New York, 1961.

Marx, Leo: The Machine in the Garden; Oxford University Press; New York, 1964.

McCormick, Ernest J.: Human Factors in Engineering and Design; McGraw-Hill Book Company; New York. 1976.

Mehrabian, Albert: Public Spaces and Private Places: The Psychology of Work, Play and Living Environments; Basic Books, Inc.; New York.

Miller, Harry, editor: Management and the Working Environment; Hutchinson Benham; London. 1975.

Moir, Julie A.: Contemplative Place in Cities; Master of Architecture and Master of City Planning Thesis at M.I.T.; June 1978.

Myer, John and Mart: Patterns of Association; Cambridge. 1978.

Noble, David F.: America by Design: Science, Technology, and the Rise of Corporate Capitalism; Alfred A. Knopf; New York, 1977.

Occupational Safety and Health Administration: Construction Standards and Interpretations; Volume III; United States Department of Labor. August 16, 1973.

O'Toole, James, et al.: Work in America: Report of a Special Task Force to the Secretary of Health, Education, and Welfare; The M.I.T. Press; Cambridge. 1973.

Piercy, Marge: To Be of Use; Doubleday & Company.

Pogrebin, Letty Cottin: Getting Yours: How to Make the System Work for the Working Woman; Avon Books; New York. 1975.

Proshansky, Harold, et al., editors: Environmental Psychology: Man and His Physical Setting; Holt, Rinehart and Winston; New York, 19701

Richards, J. M.: The Functional Tradition in Early Industrial Buildings; The Architectural Press; London. 1958.

R. M. Schindler: An Exhibition of the Work of R. M. Schindler, (1887-1952); Copyright by the Regents of the University of California. 1967.

Schon, Donald: Technology and Change; A Seymour Lawrence Book; Delacorte Press; New York. 1967.

Schrank, Robert: Ten Thousand Working Days; The M.I.T. Press; Cambridge. 1978.

Schumacher, E. F.: Small Is Beautiful: Economics As If People Mattered; Harper & Row, Publishers; New York. 1973.

Seifer, Nancy: Nobody Speaks for Me: Self Portraits of American Working Class Women; A Touchstone Book; Simon and Schuster; New York, 1976.

Slezak, Michael F.: White-Collar Workplace: Interior Form and Definition in Office Building Design; Master of Architecture Thesis at M.I.T. June 1978.

Sommer, Robert: Design Awareness; Rinehart Press; San Francisco. 1972.

Sommer, Robert: Tight Spaces: Hard Architecture and How to Humanize It; A Spectrum Book; Prentice-Hall, Inc.; Englewood Cliffs, New Jersey. 1974.

Terkel, Studs: Working: People Talk about What They Do All Day and How They Feel about What They Do; Pantheon Book;s Division of Random House; New York. 1974.

Whyte, William F.: Industry and Society; Greenwood Press, Publishers; Westport, Connecticut. 1946.

ARTICLES

Bennett, Ralph: "Draft"; at the Harvard GSD; February 23, 1976.

Bennett, Ralph: "Introduction to Student Papers"; at the Harvard GSD; February 25, 1976.

Bennett, Ralph, et al.: "Architecture and the Workplace: Two Projects and a Film"; a handout at conference, Harvard GSD; February 12, 1977. (Includes Mitchell/ Giurgola information about the U.S. Volvo Assembly Plant Design.)

Davis, Gerald: "People in the Work-Place"; Building Research; April/June, 1972. pp. 3-8.

Fischer, G. and Moles, A.: "The Psychology of Industrial Space"; Industrial Forum; vol. 8; no. 1; 1977. pp. 41-51.

Kahn, Robert L.: "The Work Module: A Tonic for Lunch-pail Lassitude"; Psychology Today; February 1975. pp. 35-39, 94-95.

Kelbaugh, Doug: "Solar Home in New Jersey: Experiences of Building and Occupying a Trombe-Type Solar Heated and Cooled House in Princeton, New Jersey"; Architectural Design; London; Volume XLVI; November 1976. pp. 653-656.

Morton, David: Article on a New Barcelona (Perfume) Factory; Progressive Architecture; October 1978.

Nygaard, Kristen: "Trade Union Participation"; A lecture given at the CREST Conference on "Management Information Systems," at North Staffordshire Polytechnic; Stafford, England; July 11-22, 1977.

Parmenter, D. J.: "Relating Corporate Goals to Human Needs"; Quality Management & Engineering; June 1974. pp. 28-30.

Schein, Edgar H.: "In Defense of Theory Y," Article reprinted from Organizational Dynamics, and from a paper presented at the Western Electric Conference; Chicago, Illinois; on November 11, 1974.

Shuttleworth, Geoff N.: "Convertible Space in office Building"; Building Research; April/June 1972. pp. 9-15.

Skole, Robert: "Technology to Suit the Worker"; American Machinist; September 2, 1974. pp. 46-49.

Swart, J. Carroll: "The Worth of Humanistic Management: Some Contemporary Examples"; Business Horizons; June 1973. pp. 41-50.

Walton, Richard E.: "How to Counter Alienation in the Plant"; Harvard Business Review; November/December, 1972. pp. 70-81.

Wells, B. W. P.: "Subjective Responses to the Lighting Installation in a Modern Office Building and Their Design Implications"; Building Science; vol. 1; Pergamon press; 1965. pp. 57-68.

Zalewski, Waclaw: "New Trends in Polish Industrial Building"; Technical Digest; Monthly Review of Technology and Science in Socialist Countires; January 1963; volume V; no. 1. pp. 30-40.

The following student research papers are available from Ralph Bennett at the School of Architecture, University of Maryland. They were done by students in his seminar at the Harvard GSD:

Cody, Eric: "Innovations in Work Environment: Five Case Studies from the Volvo Group"; 1977.

Furakawa, Harry: "Architecture and the Japanese Large Firm Employment System"; February 1977.

Kuo, Emily: "The Architecture of the Workplace: The Automobile Factory"; February 1976.

Lauster, Charles: "Scale of the Workplace: Comparative Plans"; February 1977.

Silverman, Stuart: "Workplace Environments As Defined by Worker Demands"; February 1976.

The following articles were available through a seminar on "Workplace" at M.I.T.; September to December 1978; organized by Chester L. Sprague, Associate Professor of Architecture. I was unable to discern the publications from which they came:

Bechtel, Robert B.: "The Undermanned Environment: A Universal Theory."

Ford, Robert N.: "Motivation through Work Itself"; The American Management Association.

Nichols, K. W.: "Urban Office Buildings: View Variables."

Pincus, Allen: "Definition and Measurement of the Institutional Environment in Homes for the Aged."

Herzberg, Frederick: "One More Time, How Do You Motivate Employees".

QUOTATIONS

Bronowski, J.: Science and Human Values; Harper Torchbooks, Harper & Row, Publishers; New York; 1965. pp. 60-61.

Fischer & Moles: "The Psychology of Industrial Space"; Industrial Forum, vol. 8, no. 1; 1977. p. 48.

Hoffer, Eric: Working and Thinking on the Waterfront; Harper & Row, Publishers; New York; 1969. pp. 14, 16, 40.

Mehrabian, Albert: Public Spaces and Private Places: The Psychology of Work, Play and Living Environments; Basic Books Inc; Publishers, New York.

Myer, John and Mart: Patterns of Association; Cambridge, 1978, p: 27.

Piercy, Marge: To Be of Use; Published by Doubleday & Company; Poem by the same name, "To Be of Use."

Schrank, Robert: Ten Thousand Working Days; The M.I.T. Press; 1978. p. 82.

Shuttleworth, Geoff N.: "Convertible Space in Office Buildings"; Building Research Magazine; April/ June 1972. p. 9.