

IMPROVING ORGANIZATIONAL LEARNING  
WITH A DATABASE MANAGEMENT SYSTEM

by

Mark Frederick DeWitt

Submitted to the Department of  
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in Partial Fulfillment of the  
Requirements of the Degrees of

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ABSTRACT

This thesis is a discussion and a proposal for how an organization can make information more accessible between its divisions such that workers across the organization may share experiences, not just raw data. The thesis addresses how workers may pass experiences through time to their successors as well. These discussions take place within a metaphor of the organization as learning organism, as mediator, and as information processor. There are some suggestions for how the organization might use computing machinery for some of the information transfer, but the technology is not the main thrust of this study.

The organization under study is an actual private firm, herein known simply as the Company, which refers to itself as an investment builder. It develops, builds, owns, and manages real property, especially office and apartment buildings. The proposal contained herein is intended to help the Company to formulate the experience it has gained in its functions as an owner and manager of real estate so that development project managers may use it to advise architects during the design program and design review stages of the development process.

The recommendations to the Company include: the possibility of writing corresponding performance standards and prescriptive standards; the alternative of dovetailing the two kinds of standards depending on the definitiveness of the performance standards and collecting and organizing Company experience information; possible methods for maintaining the design program information system once in place. The thesis concludes with a discussion of the potential implications of the proposal for improving organizational learning within the Company.

Thesis Advisor: Dr. Donald A. Schon, Ford Professor of Urban Studies and Education.

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**PART I.**  
**BACKGROUND**

CHAPTER ONE  
INTRODUCTION



## Issues

Who knows more about architectural design, an experienced architect or an experienced office building operator? How can the architect know that the standard details which he uses for windows, sidewalks, fire stairs, etc. work in the intended fashion if he doesn't come back years later to check? On the other hand, the building manager, although she can tell you everything that is wrong with the design of her building after years of inspections and answering tenant complaints, is generally not aware of the design tradeoffs which the architect originally had to make; the problems she perceives may have been intentional sacrifices on the architect's part to the best overall design. Would it be possible for architect and building manager to combine their expertise in design?

Can a company or any organization improve its performance such that one could say that the organization, and not just the people in it, has learned something? How do organizations remain successful even after they have undergone one hundred percent employee turnover? "What is an organization that it may learn?"<sup>1</sup>

Without information, learning is impossible. To what extent can an organization increase its ability to learn by altering and/or artificially aiding the flow of information within itself and through itself? What strategies would effectively deliver the information needed to make better decisions? How, if at all, may one exploit the information processing power of a computer to further an organizational

learning effort?

#### Intended Audience

The above three paragraphs summarize the major issues which I shall address in this thesis: joining the knowledge of architect and building operator, the possibility of organizational learning, and the role of information systems as tools for organizational learning. This is not a thesis on how to design an office building from an architect's point of view, but rather on how design decisions are made and what kinds of contributions the various participants in those decisions are likely to make. I would therefore expect that this work might still hold some interest for students of architectural design, or of that specialty known as "design programming".

I present in this thesis an idea for an information system with a real client in mind, a Boston-area Company which is at the same time an investment builder and an owner/manager of real estate. The Company's real name does not appear here for reasons of confidentiality. I offer this piece of work to this Company not as a formal proposal but as food for thought which may later lead to action. The thesis is for anyone in the Company who has an interest in policy surrounding design review practices, and may also apply to other real estate firms which resemble the Company in structure.

This is not a theoretical treatise on the nature of organizations. I do, however, use some theories about

organizations to frame my discussion of this particular Company's management of the design and construction process for new office buildings. This thesis is therefore for students of organizational theory; I summarize the implications of organizational learning for the Company in the final chapter.

Finally, this is not a thesis on how to design a database management system on a computer through which the Company would share information with the Architect during design. It is rather a discussion of what kinds of information would be most valuable to share, one which precedes any determination about whether or not the Company needs an automated system to do it. However, I recognize that the ideas I describe here could well be of interest to a systems programmer in search of a different and challenging application.

### Approach

I begin with a sketch of the Company and its Development Management group. In Chapter Two, I describe the conflicting motivations of owner, architect, and contractor in the design process and summarize each party's preferences for the content of a design program. In Chapters Three, Four, and Five I try to incorporate all of those preferences into an idealized proposal for a design program information system which would help the Company learn more about design using its past experience with managing buildings. In Chapter Six I reexamine the idealized system of Part II in light of some more realistic constraints in order to

highlight both the strengths and the weaknesses of the ideas presented. Chapter Seven is a summary of the background issues of organizational learning which apply to this Company and which have been the basis of my thinking for this whole project.

### Sketch of the Company

This is the story of an organization and how it has grown. It is also a description of the organization's particular business and unique qualities, but the issues of organizational growth rate, scale, and transfer of knowledge over time should be of broad applicability to the study of any organization.

Two brothers founded the Company in 1946 as a construction firm. They remained strictly in the general contracting business for the first ten years or so and gradually established themselves as reputable businessmen. Around 1960, an opportunity arose for the brothers to invest in an office park project as well as build it, and they took it. Since then, the Company has built six more office developments and several residential apartment developments which it owns and manages itself. One of the divisions within the Company, Operations, is responsible for managing all of the finished developments which the surviving Owner and his partner own. The Company is therefore a developer, builder, owner, and property manager all rolled into one. This leads to interesting possibilities for the Company to learn from itself about building design, since the people who manage the

finished buildings work for the same Company as the people who set the design policy for new developments.

Not only has the diversity of the Company's activities increased, but its size and complexity have increased as well. Refer to the organizational chart in Figure 1 for a picture of the current structure of a former fledgling construction company which is now a medium-sized and quickly-growing real estate business. This chart is unofficial, the Company itself has not released an official organizational chart. Why not, when the organizational chart is so ubiquitous in American business? Either (1) the lack of a formal chart and the lack of hierarchy are holdovers from the days when the Company was smaller and did not need such tools to maintain control, or (2) upper-level management of the Company prefers an informal wheeling-and-dealing atmosphere between the divisions of the firm to a more formal, bureaucratic style. One question which I will leave open is: how much more can the Company grow before it is forced to impose more hierarchy on itself in order to survive?

#### **The Development Management Group**

The Development Management group (hereafter known simply as "Development") is a relatively new division of the Company; none of the projects which it has managed have reached completion yet. The Owner says he created Development to "depersonalize" or, alternatively, to

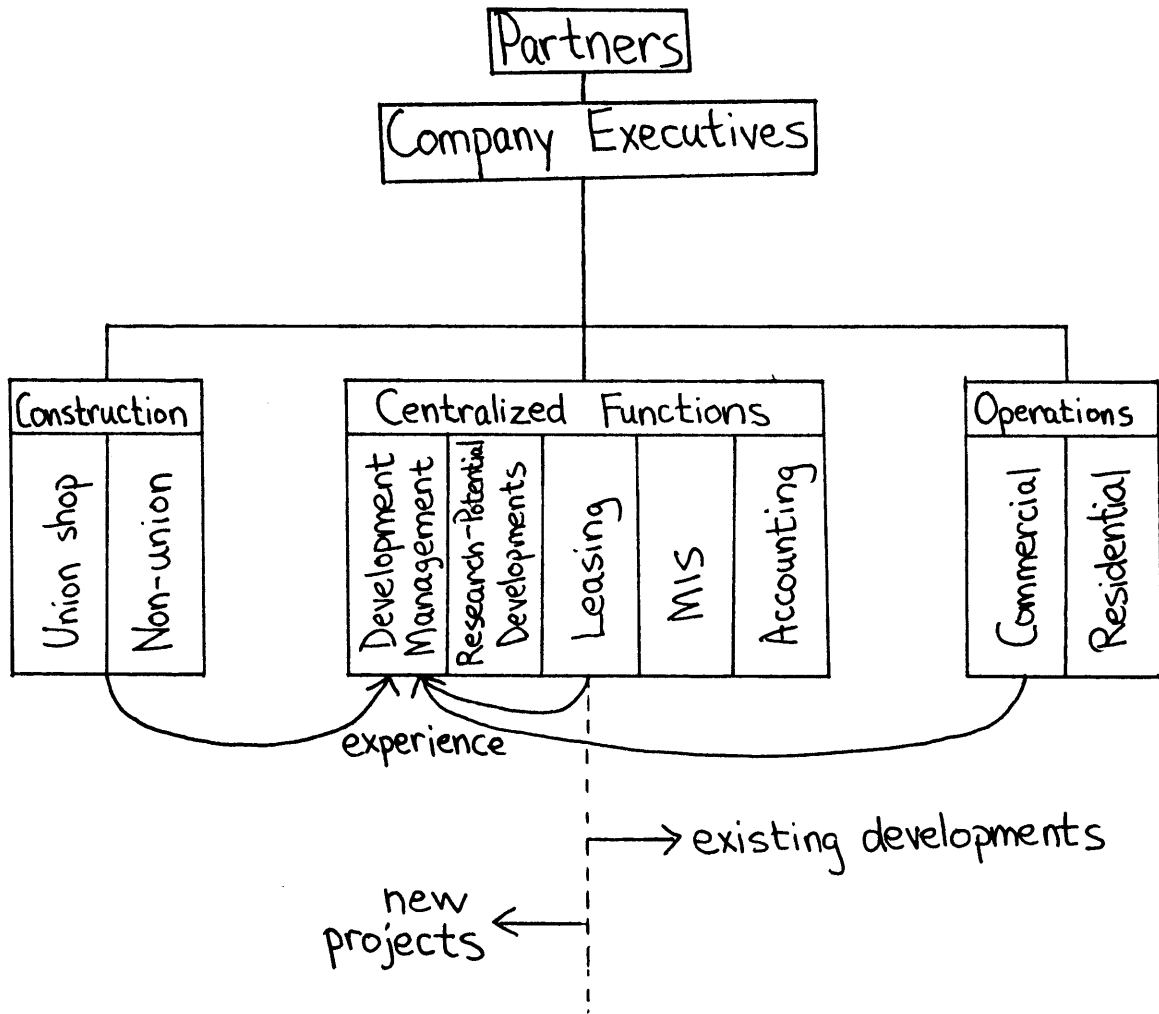


Figure 1. Organizational Chart of the Company

"rationalize" the design and construction process . What does this mean? Why is it important?

Back when the Company was smaller and still primarily a contractor, the Owner and his construction managers supervised everything themselves. The Owner spent a great deal of his own time on each project; I describe more fully the influence of Construction on projects at that time in Chapter Two, so suffice it at present to say that the advent of the Development Management group has changed the Company's design/construction process considerably. The Owner and his executives arrange the land purchasing and financing, and the Owner approves the retaining of the Architect. Development then takes over the management of the project, acting as the Owner's representative to the Architect and the contractors when they are hired (although one of the Company's executives usually shares supervisory duties with the head of Development). Development also represents the other divisions of the Company, and responds to their suggestions and requests concerning the project. When the Owner is not present, it presides over design review meetings, in which the Company gives the Architect its suggestions and criticisms of the design in the making. Development assigns a project manager to each project who serves as the Owner's representative on the project. When the building is ready enough for the first tenant to move in, Development hands over control of the building to Operations, although tenant construction continues for a another year or two afterwards.

Here are two project management processes, one without the Development group and one with it. How, if at all, is the new process more rational than the old? There are at least two reasons why.

Specifically, those managing the Company's development projects now have a more encompassing agenda and can make budget and scheduling decisions based on the life cycle costs of those decisions, not just the construction costs.

Generally, Development is now, under the Owner's tutelage, performing many of the functions which the Owner himself once performed in project management. In other words, the Owner is grooming his successor, but his successor is not a single person but is instead a combination of his executive vice presidents and Development. This transformation of an individual's knowledge into Company knowledge is a re-echoing theme of organizational learning which the Company is carrying forward on a number of fronts. In the case of property management, Operations, Leasing, and Accounting are all relating the sum of their experiences with property management to MIS, which is in the process of writing property management manuals for all of the Company's existing developments (see Figure 2). In building design and construction, the subject of this thesis, Owner, Operations, Construction, and Leasing all channel their ideas about project management through Development, which takes note of them and either relates them to Architect and contractors directly or records them in the design program (Figure 3).



EFFORTS AT COMPANY LEARNING

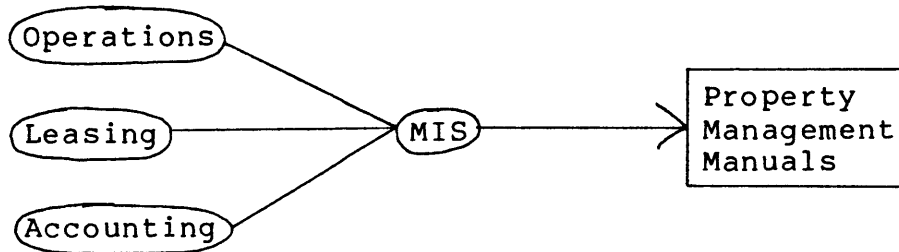


Figure 2. Learning about property management.

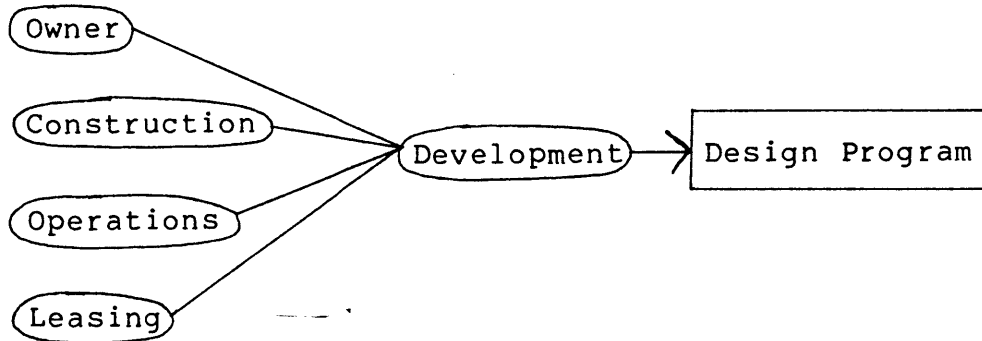


Figure 3. Learning about design and construction.

In this thesis, I will concentrate specifically on how Operations' experience with the behavior of buildings over time may be most effectively translated into Company knowledge (Figure 4).

#### CHAPTER ONE NOTES

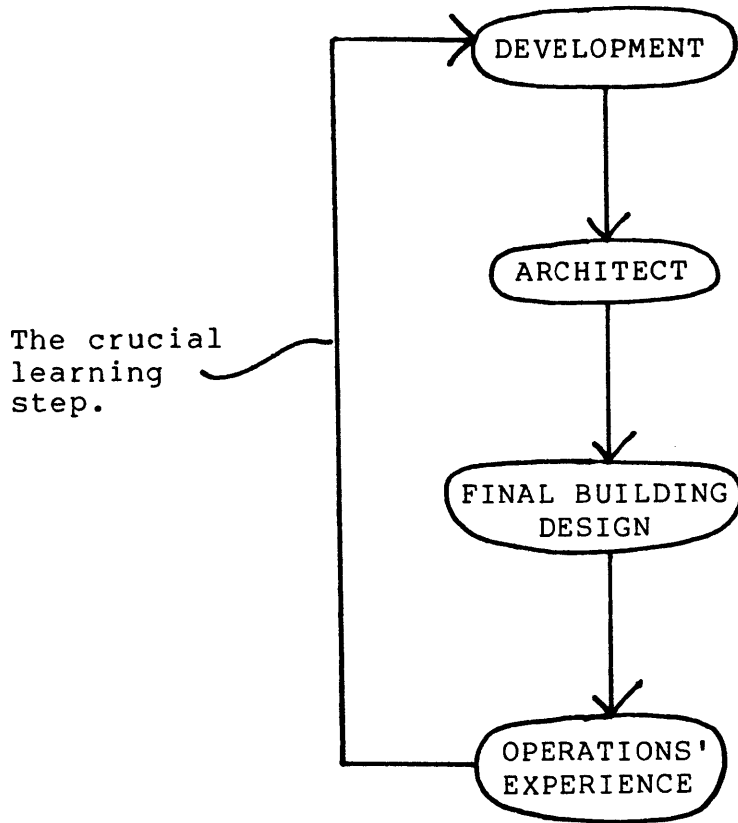
1

Argyris, Chris and Schon, Donald A.; **Organizational Learning: A Theory of Action Perspective**; Addison-Wesley Publishing Company; 1978; p.10.

2

Interview with Owner, March 30, 1983.

Figure 4. The Thesis Topic:  
A Transfer of Company Knowledge



An information flow diagram.

CHAPTER TWO  
NEGOTIATION IN THE DESIGN PROCESS

In this chapter, I will summarize the points of view of the three major actors on the design and construction process (Owner, Construction, and Architect) and report their preferences concerning the content of the Company's design program. I will then propose the forms these preferences might take, namely performance standards, anecdotes, "hard" data, and prescriptive standards.

In any design and construction process, there is always tension between the owner, the contractor, and the architect, each of whom needs the other two to conduct business but who at the same time has private interests which conflict with the other two. A finished building is invariably a product of negotiation between these three parties. As with any negotiation, the tension between interests can be healthy and produce a better product than if one of the three had absolute control (three heads are better than one), or conflict can in the worst case destroy the trust necessary for a productive working relationship. Before speculating on how the Company can utilize the bargaining nature of the business to better effect, let us look at the causes of the tensions which arise.

### **Viewpoints**

Before the advent of the Development group, the Owner and one or two other people from Construction would commit a substantial amount of personal effort and time into each new project, from the purchase of land right through to the completion of construction. This mode of operation was a

natural consequence of the Company's origins as a contractor. Staying on schedule and on budget were the primary considerations during design and construction, a practice which sometimes has unintended negative impact on the subsequent operation of the building due to hurried workmanship or installation of unreliable equipment. These problems arose through no bad intentions or lack of skill on the part of Construction, but only through pushing to the limit what every contractor must do to survive: minimize costs at the level of quality which the Owner desires.

Since Construction is a part of the Company, one could say that watching out for their interests is equivalent to watching out for the Owner's interests. This is only partly true. Operations also represents a part of the Owner's interests-- the role of owning and managing developed real property. As the Owner's representative in this sphere, Operations has begun in the last ten years to voice its concerns over energy costs, maintenance costs and headaches, durability of equipment and materials, and other matters of property management during design review for new projects. Operations wants to be able to keep its tenants happy, for it is much easier to renew a current lease than it is to lure a new tenant in and negotiate a new lease. A solid reputation for property management on the commercial office space market means a higher demand for the Company's product, which in turn means that it can charge a premium rent and generate more revenue. While operating costs are passed right on to the tenant, Operations still wants to keep them to a minimum,

because it can recover the savings by raising the base rent slightly and can use the additional income to finance special projects and long-term capital improvements.

The Architect's interest in design is less economic in nature, although he still wants to make a living. He is more motivated by gaining or maintaining credibility within the design community (external approbation) and by artistic satisfaction of a job well done (internal reward).

### Conflicts

How do the above viewpoints come into conflict? Consider one example of relations between Operations and Construction. If Operations won some concession during design review, Construction might try to avoid the additional cost by making a special deal later with a subcontractor which would have the effect of negating the improvement Operations was seeking. The result of this and other activities was that Construction and Operations could not pool their experiences so as to improve the Company's product. The most obvious source of conflict was money: Construction always tried to stay within its budget and keep first costs to a minimum, whereas Operations always pushed for equipment and design features which would lessen maintenance and operating costs. Other than the Owner, whose personal attention to any one project was limited by the number of the Company's other concerns, no one was in a position to consider life cycle costs.

The Architect's conflicts with both Construction and

Operations often have to do with tradeoffs between aesthetic considerations and practicality. Architect may want the perimeter fan-coil units to be a special color to complement the choice of carpet, but Construction will oppose the color choice if it is not one offered by the manufacturer; an order of custom-painted fan-coil units could triple the time necessary for delivery on site, a delay which could wreak havoc with Construction's schedule. Architect may try to place the public lobby's supply and return air vents in unobtrusive places if he can not make them fit into the decor, but Operations will do its best to put its foot down if such a placement of the vents does not allow proper ventilation and conditioning of the space.

#### Expectations of Design Program

The design program is a written document which Development draws up and gives to the Architect telling Architect what the Owner wants in his building. This fulfills the Architect's most basic informational need: to know as early as possible what his client wants. Program-writing by the Company is a recent development, however; previously an Architect only received recommendations via ad hoc memorandums and oral instructions. The program helps to organize the knowledge and preferences of different parts of the Company and to communicate them more clearly to the Architect.

When asked for their opinions on what a program should contain, the answers which Construction and Operations gave differed in content but not in style. Both were interested



in prescribing to the Architect, based on past experience, what they thought should go into a building, especially at the detailed level of which elevator manufacturer to deal with, which carpet to use, etc. Operations knows what stands up under years of use and Construction knows what dealers and manufacturers can help get the job done on time, so why should they not be specific and tell the Architect exactly what they want? I shall refer to this style of specification as a prescriptive standard.

The Architect, however, does not work this way. He wants as much freedom to create as possible while still making the building do what the Owner wants it to do. The more prescriptive the Company is about details in what Architect should design, the more limited is the scope of solutions which the Architect may present to fulfill the Owner's design criteria. The Architect would rather know how the building should perform than what things it should contain, because such information would give him more alternatives for a total design which stayed within the Owner's constraints. This approach to specification is aptly named the performance standard; I shall now describe the two approaches in more detail and then compare them.

## PERFORMANCE STANDARDS

### Rationale

A performance standard is a statement of a need which the Architect must meet. It is necessary for the Owner (or Development) to answer two questions in satisfactory fashion for a performance standard to have meaning:

1. What do I want?
2. How will I know when I have what I want?

The literature on performance standards describes the procedure for deriving them in a number of ways, but Wright's three-step process<sup>1</sup>, Brill's five-step process<sup>2</sup>, and Hack's six-step process<sup>3</sup> all boil down to the two questions above. Assuming that the Owner or his representative can sufficiently answer these two questions (an assumption which I will examine in the next section), he will be able to write a statement of need which makes no mention of proper form, only of proper function. A design program consisting largely of this type of information holds advantages for the Company as well as the Architect.

To the architect, performance standards express the scope for creativity with clarity. The standards state not only what the Owner wants, but also how the Owner will determine whether or not the design meets those wants. This gives the Architect the design objective but allows him the fullest creativity in accomplishing that objective. Contrast this to a prescriptive standard, which mandates the means one must use without necessarily stating the desired end.

For the Company, performance standards would serve as measures of the quality of design and as incentives for innovation. Since they employ physically measurable attributes where possible, assessing the quality of design could be largely a matter of applying the appropriate performance tests. The Company could either conduct these tests by actual experiment or consult past experience to evaluate the Architect's solutions to the problems placed before him. If Development does not tell the Architect (via the program) that he must use certain products, but instead describes what the products must do and mentions what has worked best for the Company in the past, it allows the Architect contribute as much as he knows about office buildings, which may include knowledge the Company did not previously possess. A program full of performance standards, once written, would require little revision from project to project; the only things Development would ever want to change would be minimum performance levels or product suggestions. A program which remains the same in basic content but still allows new ideas would grease the wheels of change-- people would see that replacing an old tried-and-true technology with a new one was not a risky change in Company policy (change in program) but rather a better way of doing something which is already part of Company policy.

### **Problems**

The two questions underlying performance standards (What do I want? and, How will I know when I have it?) are both difficult to answer; the first because of the abstract

thinking required to express a basic need rather than a known solution, and the second because of the complex and tricky nature of trying to identify criteria which are both pertinent and measurable. Let us look more closely at these problems in turn.

Performance standards may take on almost any level of specificity and still address themselves to performance: the Owner can say that he wants the wall surfaces in the building's public areas to "give the building a look of strength" or he can specify certain chemical and physical characteristics he wants to see in his wall paint. Development's initial goal should be to express each need in such a way as to be measurable and to avoid giving unfair advantage to any particular solution. Statements of need which are truly not solution-bound, most desirable if we are to encourage innovation, are extremely difficult to make: how would you describe the requirements for a washroom if you were not allowed to mention water anywhere in the description? Yet, even as there are other ways to wash your hands, there must necessarily be potential solutions to problems which we less-than-omniscient humans rule out every time we write even the most general (while still usable) performance standard.

The specificity problem also works in the other direction. Suppose the Architect knows a great way of washing hands with sand which will get the tenants' hands cleaner and be cheaper to maintain. How does Development

determine if the Architect's "sand washroom" is of the best possible design? Or, more likely, if the Architect does suggest the conventional soap-and water, shouldn't Development also have ready a whole set of performance standards for plumbing fixtures? In this instance, the answer is logically yes, but other cases are more ambiguous as to whether the most specific performance standard should address a material, a product, a system, or a function. If it is too general, then Development will not be able to evaluate the Architect's solution with it; if the standard is too specific, then it may preclude some fundamental innovation. How much does or should the Owner value innovation? See the next section for discussion of this question.

When one considers the second question (how do I know when I have what I want?), one must devise a testing strategy containing the following steps:

- 1) List all descriptive attributes of the stated need.
- 2) Decide upon an appropriate unit or scale of measurement for each attribute.
- 3) Define acceptable performance levels on each measure.
- 4) Designate an experimental test or some other objective test which will determine whether or not Architect's solution meets the acceptable performance level.
- 5) Identify those outcomes of the test which will clearly rule out a solution, those which will clearly support

it, and those which will entail a judgment call.

The most profound difficulty in the above procedure, one which John Eberhard claims has over the last ten years driven many back to using prescriptive standards<sup>4</sup>, is finding attributes which fully and accurately describe the stated need and in addition have some easily quantifiable measure; i.e. there is almost always an unwelcome tradeoff between measureability and relevance. This is even true for the most commonplace mechanical equipment; for some less tangible needs such as sociological or psychological requirements, performance standards present little advantage except as a way of thinking about needs. Especially on the level of materials, however, there are many existing industry standards, testing methods, and definitions of acceptable performance, and the Company would probably do well to use these existing standards wherever such specificity was appropriate.

Gary Hack<sup>5</sup> lists another step in the performance specification procedure which I would rather leave as another open question: How can I tell whether or not any performance standard is actually producing the behavior which fulfills the need I am trying to convey? Are there standards by which I can measure my performance standards?

## Dealing with the Problems

The three main problems with performance standards I discussed in the last section were:

1. Too specific (precluding innovation)
2. Too general ( inadequate guide for evaluation)
3. Tradeoff between measurability and relevance

Too specific-- How innovative should the Company be? This is a question of Company policy which periodically leads to internal political turmoil. Construction is the most conservative party to this issue; it transfers the last job's specs to the current one with as few changes as possible, because it has gained experience in doing things in certain ways and because it has working business relationships with some suppliers and subcontractors. Operations pushes for change on items which have been giving it problems but defends those building features which have worked well in the past. Leasing is concerned that the Company not lose its competitive edge on the market through being old-fashioned or insensitive to local market conditions and customs.

A compromise to these points of view might be to say, "We are willing to entertain reforms and improvements to existing technologies in our standards. However, we will leave to others the task of blazing the trail for truly revolutionary technologies, and reserve the right to reform our practices at a later date by providing for a rational process by which the Company may rewrite its performance standards." This of course begs the distinction between reform and revolution, but it is a start. An alternative

solution to the "too specific" problem also addresses the "too general" problem.

Too general-- Performance standards which are too general do not provide an adequate yardstick against which to measure the Architect's solution. In the last section, I noted that the Company might want to have both a performance standard for washrooms and a performance standard for washroom plumbing. This multi-tiered approach would be useful any time Development wanted to encourage the Architect to think about alternative approaches on a large scale but was reasonably sure of the form the Architect's solution would take. The more specific standard would apply conditional to the nature of the Architect's solution to the general standard. Note that while the specific standard solves the "too general" problem, the general standard concurrently solves the "too specific" problem by allowing the Architect more latitude initially. The main drawback of the multi-tiered system is that it increases the number of performance standards which Development must write, thus proportionally increasing the initial cost of such a system.

Measurability vs. Relevance-- This is a tougher nut to crack; there seems to be no general method for attacking the problem, even though it arises frequently. How does the Company measure the quality of its job applicants? In hiring some one straight out of school, surely her cumulative grade average is more relevant than her shoe size, but is it a sufficient indicator of how she will perform? What if the



placement department at her school told all of its students that grades were the only thing that mattered in getting a job? The Company would take a dim view of such a school whose graduates knew only how to perform to one measure, grades, since the behavior necessary for most people to get good grades is usually not sufficient for getting along in the business world.

The Company tries to select the employee who is bright enough to look past what her boss tells her to do and to do what her boss really wants. The Owner looks for the same quality in an architect. Note that there is some responsibility on the part of the Owner, however, to express his desires as accurately as possible (after all, the Architect is intelligent but not telepathic). Suppose the Owner wants the building lobby to be an inviting public space to casual passersby. Can he adequately relate to Architect this desire simply by stating the number of outside doors he wants? How relevant is the number of doors in the lobby to its quality as a public space? In this case, the Architect would probably ask for a more helpful measure.

If it tries to write performance standards, Development will run into this question periodically of whether or not it means what it says to the Architect. One thing to remember is that the relevance of any performance standard in the design is testable via experience: if by his response the Architect seems to have absorbed the intended message of the standard, then the standard is sufficient.

**The Incomplete Nature of Performance Standards**

A comprehensive set of performance standards for office buildings would contain a great deal of Development's expertise on the subject, but would it contain everything the Architect needs to know? No, no more than a textbook consisting of nothing but questions would contain everything a student needed to know about a subject. A good design program, just like a good textbook, would also include examples which would clarify the questions and suggest possible methods of solving them. Company experience data are what Architect needs to complete his picture of what the Company wants.

#### COMPANY EXPERIENCE

I have discussed why Architect prefers performance standards over prescriptive standards. I will now look at the other side of the issue and examine the contribution which Company experience, including prescriptive standards, can and should make to the design program. I will describe the nature of this Company's experience with constructing and managing buildings and what kinds of data the Company experience researcher (see Part II) should expect to get from Operations.

##### The Nature of Company Experience

The knowledge which Development seeks is diffused both over time (approximately 20 years' experience) and over distance (the furthest site is hundreds of miles away from the main office). Some of this experience is recorded already (accounting information, tenant complaints,

preventive maintenance, managers' log books if they keep them, the new general information manuals), but much of it is not.

The most challenging part of researching the Company's experience will be inquiring about that which Operations does not record. To do this, the Company experience researcher will have to talk to the first-line Operations personnel who maintain the buildings: the mechanics, the cleaners, the security guards, the site managers. The manager of a site typically has worked previously either on the physical plant staff or the clerical staff of one or more of the Company's sites.

### **Three Kinds of Company Experience Data**

Operations will have different kinds of information to contribute to the design program, and it will be more helpful if I attempt to explain what kinds of answers Operations personnel will give rather than recommend what the Company experience researcher should ask. I have divided my expectations of the information into three groups: anecdotal data, "hard" data, and prescriptions for the future.

#### Anecdotal Data

In order to succeed in property management, Operations pays careful attention to a large number of fine details, and the people who have those details at their fingertips are the site personnel. Collectively and sometimes also individually, their knowledge of their building is encyclopedic. The range and amount of what the site managers

know about the operation of their buildings could fill volumes, but those volumes probably would not be in alphabetical or any other order.

If the Company experience researcher holds a meeting of site personnel or interviews them and she asks them to relate their experiences, what they will tell her will be a succession of stories about their years on the job. She will hear about the time the window-washing rig came out of its track and was left swinging wildly against the building, the time the emergency water piping in the garage froze up and burst even though it was supposed to be dry, etc. These short vignettes will not necessarily follow each other in any order, only in the storyteller's stream of consciousness. Some of the stories will have morals to them, which the researcher should put in the prescriptive data file for later reference.

I shall name this time-honored practice of story-telling "anecdotal data". Anecdotes are difficult to categorize or fit into a formal information system, but they often contain the essence of what it is like to operate a building and why Operations prefers certain design practices over others. They are the chief form by which the researcher will be able to capture the history behind why Operations does things the way it does them today.

#### Hard Data

The "hard", factual data which the researcher might collect include: (1) Makes, model numbers, and other attributes of all current mechanical, electrical, and

plumbing equipment; and (2) materials, products, and methods used during the construction of each building. The two categories would provide an extensive catalog of products currently in Company use. Since the researcher would be able to identify categories and attributes much more easily with this information than with the anecdotal data, she may find it desirable to formalize the data structure and enter it into a computerized database management system.

#### Prescriptive Data

The Company experience researcher could organize this information product-by-product; each listing would contain acceptable and unacceptable types and model names of its product (see the next chapter for a more detailed description). These listings would be the Company's most informed statement of what should be in a building design. This data would take the form of a matrix and refer the reader to the appropriate anecdotal and hard data if he or she wanted the story behind the recommendation.

#### **Examples**

Building X was built, as are most modern office buildings, with a flat roof. Since a flat roof does not drain by itself, Construction had to install drains with runoff pipes at regular intervals across the roof. Steel beams, also placed at regular intervals, support the roof, and the drains were installed right over the beams. A year or two after completion of construction, Operations began to notice standing water on the roof after a rain, and this

ponding problem grew over time. Why weren't the drains working? Because the flat roof gradually settles over its structural support, over time creating slight valleys between the beams. This left the drains high and dry, since they were installed right next to the highest areas on the roof, the beams. The moral of the story is to install roof drains in the spots which it looks like the roof will settle most.

During design review, Operations usually insists on having electrical outlets in the walls every fifty feet. The casual observer might find this wasteful, since Operations could survive with fewer outlets by using extension cords. However, the fifty-foot rule arose precisely because extension cords had become a problem; as soon as a cleaning person would get far enough away from an outlet to need an extension cord, he or she would unavoidably wrap the cord around a molding, wall, or piece of furniture and leave a noticeable black mark. Operations also requests an outlet on each elevator so that the building porters can vacuum an elevator carpet during the day without having to put the elevator out of service.

These two examples of Company experience are at the same time anecdotes (roofs which do not drain, extension cords which leave black marks) and prescriptions (put drains where roof will settle, install public area outlets every fifty feet). Note also that the Company can document these experiences by collecting hard data from all of its sites (types of roofs and drainage systems, outlet frequency in public areas), data which may verify or contradict the

original anecdote. These examples illustrate the three kinds of Company experience data which the Company experience researcher must seek.

#### CHAPTER TWO NOTES

1 Wright, J.R.; "Performance Standards in Building"; Scientific American; March 1971; pp.16-25.

2 Brill, Michael; "Techniques for Developing Performance Specifications for Buildings"; National Bureau of Standards Special Publication 361, Volume 1.

3 Hack, Gary; "Environmental Programming"; Ph.D. dissertation; Department of Urban Studies and Planning, Massachusetts Institute of Technology; 1976.

4 Telephone conversation with John Eberhard, National Academy of Science; March 21, 1983.

5 Hack, ibid.

PART II  
AN IDEALIZED  
DESIGN PROGRAM INFORMATION SYSTEM



CHAPTER THREE  
DESIGN PROGRAM STRUCTURE

In this part of my thesis, I will describe how performance standards and Company experience may complement each other in the Company's design program so as to take both Operations' and Construction's experience into account. I will attempt to show that it is possible for the Company to apply its collective experience and at the same time allow the Architect plenty of freedom in the design process. In order to accommodate this tension between Architect and client, I propose that the design program consist of two parallel but distinct databases: a performance standards database and a Company experience database. I will describe structure of the design program, how the Architect and Company would use it, and how Development might create the program.

In attempting to describe here the design program structure I face the difficulty of having to use prose, a linear (one-dimensional) mode of expression, to describe a data structure which may have two, three, or more dimensions. In order to ease this task, I will refer to figures and use a physical example.

#### **A Notebook Analogy**

I have already mentioned that the design program would have a parallel data structure which would contain both performance standards and Company experience. Imagine yourself sitting at a table. Before you on the table are two rather large loose-leaf notebooks, one labeled "Performance Standards" and one labeled "Company Experience". Now open

Figure 5. The Notebooks

THE COMPANY'S  
PERFORMANCE STANDARDS BOOK

Table of Contents

	<u>page</u>
<b>I. SYSTEMS</b>	
A. Mechanical	3
B. Electrical	49
C. Structural	102
.....	.....
<b>II. COMPONENTS</b>	
A. Pumps	298
B. Fans	341
C. Transformers	380
.....	.....
<b>III. MATERIALS</b>	
A. Exterior Facade	715
.....	.....

SYSTEMS  
COMPONENTS  
MATERIALS

THE COMPANY'S  
COMPANY EXPERIENCE BOOK

Table of Contents

	<u>page</u>
<b>I. SYSTEMS</b>	
A. Mechanical	3
B. Electrical	49
C. Structural	102
.....	.....
<b>II. COMPONENTS</b>	
A. Pumps	298
B. Fans	341
C. Transformers	380
.....	.....
<b>III. MATERIALS</b>	
A. Exterior Facade	715
.....	.....

SYSTEMS  
COMPONENTS  
MATERIALS

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both notebooks to their tables of contents (see Figure 5). You will notice some striking similarities between these books. First, each has three large tab dividers labeled "Systems", "Components", and "Materials". Second, these tab headings are also the headings in the tables of contents, under which appear the specific building systems, components, and materials which are the subject matter of the design program. In fact, in comparing the two tables of contents, notice that not only are the main headings the same, but the individual items and even the page numbers are the same as well!

Has there been some mistake? You turn to page 37 of each book to check this coincidence (see Figure 6) and find that here the similarities of the two books end. The Performance Standards page holds a table which has a list of attributes running across the top and "measures", "tests", and "test results" running down the columns. The Company Experience page is less complicated, with only types, manufacturers, and an acceptable/unacceptable designation. You see now that the "coincidence" was actually a conscious effort to compile two very different kinds of information about an item so that it would be easy to refer from one to the other.

Each page in the Performance Standards is a complete performance standard. Each has a corresponding page in the Company Experience book for reference on what the Company has used or done in the past with respect to that particular

Figure 6. Comparison of page layouts.

System: HVAC		Performance Standards p.37	
Needs Statement: -----			
Attributes	Temp	Hum.	-----
Measures			-----
Tests			-----
Acceptable Test Results			-----

System: HVAC		Company Experience p.37	
	Types	Makes & Models	
Acceptable			
Unacceptable			
References:			

item. The division of the notebooks into systems, components, and materials is an attempt to provide for the level-of-specificity problem discussed in the last chapter.

Now let us look more closely at the information contained in the pages of each book.

#### **Performance Standard Page**

Consult Figure 7 for a more detailed example of a page in the performance standard database, this one a system-level requirement for thermal comfort in a typical office space. Notice that the attributes running across the top of the table fall into two main categories: design constraints, which are the physical aspect of a design solution which the Company feels are important to all building users; and management constraints, which describe the economic and logistical qualities of the system which are important to both Operations and Construction. Both sets of requirements are performance standards because both have the necessary measures, tests, and generally acceptable test results. There is no formal reason to distinguish between design (tenant-related) constraints and management (Company-related) constraints-- Development will probably weigh them equally and simultaneously during design review. The distinction does point out that Development must balance the needs and comfort of the tenant against the costs and headaches to the Company. Also, each set of design constraints will probably be unique to its corresponding statement of need, because the diversity of needs which the Architect must fill is so great. However, the list of management constraints will be more or

Figure 7. A Performance Standards Page

SYSTEM: HVAC

Performance Standards  
p.37

97

Attributes	Temperature	Humidity	Air Movement	Infiltration	Life cycle costs	Maintenance Accessibility	Manufacturer Reliability	Safety
Measures	°F (i) gradient from T-stat (ii) dry bulb (iii) mean radiant temp. (iv) time rate of change	%	CFM volume flow. FPM speed	CFM/ft <sup>2</sup> volume flow per unit area of exposed wall or ceiling. P, psi, pressure drop across wall	\$	differing degrees of difficulty, from open access to requiring partial destruction of equipment	Company experience, reputation	risk of injury
Tests	thermometer readings across location & time	on-site by approved instrument	by calculation and by physical measurement on-site	thermography and direct measurement on-site	First cost + energy cost + expected maint. cost + freq. of replacement = life cycle cost	determination by Operations Chief Engineer.	good or bad?	determination by Operations or consultant
Acceptable Test Results	winter: 70°F < T < 74°F DB summer: 76°F < T < 80°F DB ΔT ≤ 2F from T-stat. min < MRT < max  $\frac{\partial T}{\partial t} \leq \text{max}$	45% < h < 55%	0.7 CFM/ft <sup>2</sup>	CFM/ft <sup>2</sup> ≤ max @ some ΔP min < ΔP < max	positive net present value	Chief Engineer's OK	impeccable references, appearance as acceptable in Company experience	express approval by tester

Needs statement: Tenants should, in normal health, never feel either too warm or too cold in their spaces when wearing clothing appropriate to the season.

less universal: Construction will always be concerned about first costs, manufacturers' promptness and reliability, and safety, no matter what the product; Operations will always care about expected life, energy and maintenance costs, safety, and maintainability. Once Development develops a mutually agreeable set of management constraints for its performance standards, it can apply the same ones to almost every kind of item the Company want to include in its design program. Most of Development's work in putting together this proposal for a program, then, will be in writing design constraints for all of the various parts of an office building.

Once Development chooses these particular constraints (i.e. attributes), then it must proceed to enumerate measures, tests, and acceptable test results for each attribute. Measure, as I use the word here, actually means scale of measurement or index. An attribute may call for an objective measure, such as temperature in degrees Fahrenheit or area in square feet, or it may require a subjective index, such as a good, fair, or bad rating on a piece of equipment by the Lead Mechanic .

Similarly, the method of testing may be subjective or objective; you may measure temperature, humidity, and exterior wall insulating properties, but the real test of the comfort of a space is when the tenant moves in and gives his opinion. Physical tests are the easiest to envision and exist already in abundance, but subjective tests such as asking the mechanical staff for its opinion on the ease of



maintenance of certain equipment may be valid as a test when the attribute has no meaningful physical descriptors. After Development selects the tests, then it may either set a minimum result or range (absolute scale), or it may require Architect's solution to perform better than the current solution (relative scale).

#### **Company Experience Page**

This data structure (see Figure 8) is much simpler than that of the Performance Standard book, containing only information on equipment types, manufacturers (and perhaps also specific models), and a simple binary evaluation code (acceptable/unacceptable). Thus, there are only four kinds of Company experience prescriptive data: the acceptable types, the unacceptable types, acceptable manufacturers, and unacceptable manufacturers. (For most practical purposes, the reader should read "type" as "technology".) Information on both kinds of manufacturers will pertain only to those who make acceptable types of the item; information on the manufacturers of unacceptable types of equipment or materials is clearly not relevant.

If Operations feels that the acceptable/unacceptable choice is not descriptive enough, it may wish to rank in order its choices for acceptable types and manufacturers within the boxes. The references at the bottom of the page point to hard data (found in the General Information Manual) and related anecdotes (found in a Anecdotes Book) for the reader wishing clarification of the prescriptive standard.

FIGURE 8. COMPANY EXPERIENCE PAGE

M: HVAC

P.37

	Types	Makes and Models
table	<p>Perimeter: 4-pipe fan-coil units</p> <p>Core: Variable air volume, fans equipped with economizers, in-duct electric reheats, ducted supply air and plenum return</p> <p>Controls: digital energy management system with pneumatic back-up</p>	<p>You-Bet fan-coil units</p> <p>Sugarwell variable air volume systems</p> <p>Under Controls</p>
ceptable	<p>Electric resistance blast heaters</p> <p>ducted return air</p> <p>decentralized mechanical controls</p>	<p>Acme fan-coil units</p> <p>Outdove Controls</p> <p>Stuffyair fan-and-duct systems</p>

Also: Operations General Information Manual, p. 144.

Operations Anecdotes Book, HVAC section.

CHAPTER FOUR  
DESIGN PROGRAM FUNCTION

Any design program has two principal functions: it is a guide for the designer and an evaluation instrument for the client. Speaking figuratively, with these two notebooks on its shelf, any time the Company hired an Architect to design first-class office space, it would give him or her copies of the books (with slight modifications) as a statement of the Company's needs and wants for that project. The books would be so laid out as to make it easy for the Architect to refer to the performance standards book for design guidelines and to the Company experience book for ideas and for areas of possible improvement. Since this is a thesis on how the design program will benefit the client and not on how it will help the Architect, I will not speculate further as to how an Architect could best put this design program to use as he designs, but will only look at how the Company would use the program to evaluate the Architect's design.

#### **The Evaluation Process**

Assume that the Company has hired Architect and given him the design program. Once the Architect develops his preliminary design to where he has ideas for what he wants regarding the major building systems (exterior, structural, electrical, etc.), then he brings his responses to the systems requirements back to the Company for review. In this respect, design review would be similar to the way Development does it now-- an iterative process involving frequent (at times daily) meetings with most of the concerned parties present (Architect, Development, Operations,

Construction, Leasing, the Owner or other Company executive) which treats design problems from the most general to the most specific. The program and information system which I have been describing, however, is different in that it uses more information than is currently available and makes the process more orderly so that Development may make more carefully considered and consistent decisions during the design review period.

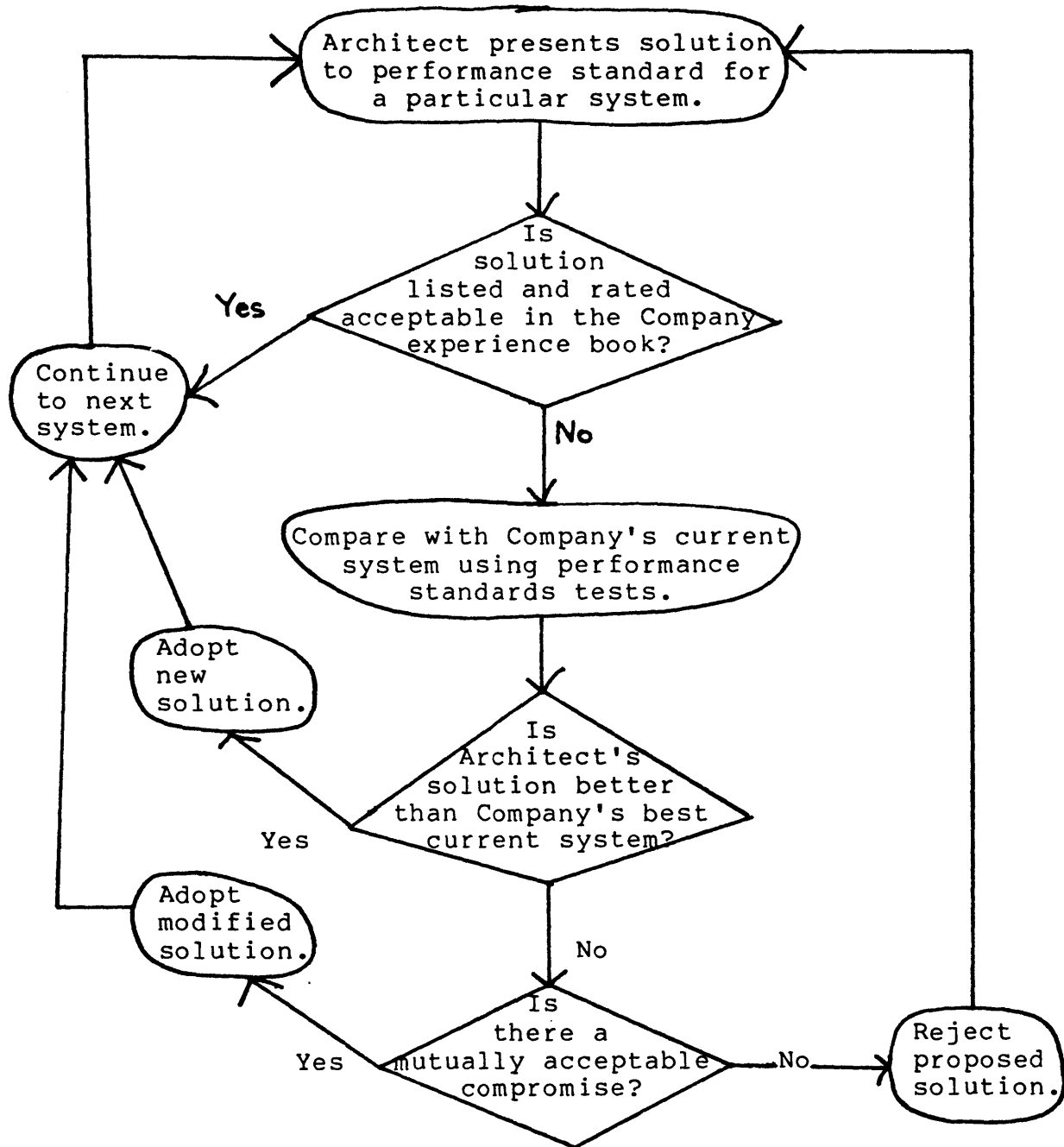
#### A "Run" of the Design Program

Please refer to the flowchart in Figure 9 for a map of the procedure I describe below.

Let us take the example of a building's HVAC (heating, ventilating, and air conditioning) system. Suppose the Architect has, in view of the configuration and location of the building and in consultation with his mechanical engineer, chosen a rather non-traditional HVAC system for this office building, perhaps employing a passive ventilating system which uses no air-moving fans. How should Development respond to such a proposal? It should evaluate the proposal using its performance standard and Company experience notebooks.

First of all, if Architect had suggested the already-acceptable variable air volume system (see Figure 8) instead of the passive system, Development would have accepted the solution automatically since Company experience has shown that such systems work well. Since Architect earnestly suggests an alternative, however, we must step carefully

Figure 9. Design Review using the Design Program



through the rest of the flowchart.

If Architect's solution does not appear as an acceptable type of solution on the page (record) of the Company experience notebook (database), then we must turn to the corresponding page (record) in the performance standards notebook (database) to apply the design and management constraints to Architect's idea and compare it to the presently favored system. For a serious comparison, Development should perform as many of the tests specified in the performance standards as possible to all currently accepted solutions plus Architect's solution, and where it is not feasible to perform these tests it should try to get appropriate test data from the manufacturer or from independent sources. These test results would comprise the bottom line for each of the alternatives (see bottom row of the performance standards page, Figure 7)-- they would be the answers to the questions which the attributes raise. How well will the system control humidity? Does it provide sufficient air movement? How much will it cost the Company over its lifetime? How safe is it to operate?

Once Development determines the likely performance of each alternative, it must make a choice. It may be in this case that the Company's variable air volume system dominates Architect's passive system in all categories of major interest, in which case Development's decision will be an easy one to make. On the other hand, what if the passive system showed itself to be less expensive in life-cycle cost and easier to maintain but at the same time allowing somewhat

wider fluctuation in temperature and humidity? One might expect such mixed comparisons to arise frequently, cases in which Development must make design tradeoff decisions. This design program information system will help Development make better decisions in these situations by illuminating the tradeoff issues via this thorough and methodical comparison of the alternatives.

Note that Development compares the bottom lines of each alternative on attribute-by-attribute basis, rather than trying to sum up each bottom line in some universal goodness/badness index before comparing. In other words, Development compares the projected performances of the alternatives as vectors rather than on a scalar index; this allows it to catch the full flavor of any tradeoff issues and to weight the importance of the various attributes as it sees fit. Note also that many of the "test results" used for these comparisons will not be results at all but best guesses as to how products will behave over time. Development must also account for the uncertainties (and accompanying risks) involved in these estimates.

Using the performance standard to compare the Architect's solution to the status quo, Development may approve Architect's suggestion, or it may negotiate some compromise solution, or it may simply tell Architect to go back to the drawing board. This process would then be repeated for all other systems, and then down through the more specific components and materials levels as necessary.



It is important to start at the most general (systems) level, since most decisions at that level influence the kinds of components and materials the Company will need to put together a working building.

As Development and Architect work together to flesh out the design, Development will also be assembling the construction specs; the construction specs and the Architect's drawings together comprise the bulk of the construction documents on which contractors will bid for and execute the job. At this point, the manufacturer information in the prescriptive standards will prove its usefulness, helping Development to write the construction specs, to evaluate bids from contractors (if Construction is not to be the general contractor), and to review final product selection by the sub-contractors in much the same way as it reviewed the Architect's solutions above.

Development may also find the performance standards database useful when it supervises the actual construction of the building as a guide for quality control inspection, especially to the extent that it is possible for Development to run the tests described in the performances standards on-site.

Despite some problems, the design program information system described in these last two chapters is a constructive response to the question which triggered this thesis: How can the Company close the feedback loop from property management experience to better design? This has been a look at how Development could structure such a system and what it

would do once the system was in place. In the next chapter I describe how Development might best go about compiling the design program.

CHAPTER FIVE  
DESIGN PROGRAM CREATION

Putting together the performance standards and the Company experience necessary to the design program as I have described it will be a big job, probably entailing a few person-years of labor. This chapter describes how Development should proceed if it is indeed interested in such a program. Realizing that this project would on average get a rather low priority on Development's day-to-day docket, I will attempt to suggest an approach which will allow the design program system to be useful even when it is only partially completed. Indeed, Development may decide in midstream that going into further detail in the program would not be worthwhile; if so, the work it has done up until that point should not have to go to waste.

For simplicity's sake, I will assume that Development assigns two full-time staff people to this project, a performance standards writer and a Company experience researcher. In practice, there are a multitude of ways Development could choose to devote human resources to this project, but I leave such personnel issues for Company management to resolve.

#### Performance Standards Writing

I have three basic recommendations to Development for how to tackle the performance standards project:

1. Start with the most general systems requirements and complete all of those before moving on to subsystems, components, etc.

2. Build on work already done by the Company and

others.

3. Involve other divisions of the Company and outside expertise when identifying the attributes which will be most helpful in evaluating design.

Starting with the most general systems first has two advantages: it allows Development to wrap up the project at any point with something to show for its effort, and it brings out the interactions between decisions about different parts of the design. If the performance standards writer begins by writing a standard for human support services, continues by studying elevators, bathrooms, and signage, and then descends into the performance of the sink fixture materials in the bathrooms, he may discover when he goes back to the most general level to write a standard for water delivery systems that he will have to go back and make substantial changes to his bathroom performance standards due to the constraints he has placed on water delivery. Thus, the performance standards writer should slice away at the project one level of specificity at a time, not one substantive area at a time, because it will give him a clearer understanding of how design considerations of the various building systems, components, and materials interact.

Since its inception, Development has already compiled two design programs for office developments. They are a mixed bag of performance and prescriptive standards and are of smaller scope than the information system I propose in this thesis, but they are a good start. There have been a

couple of notable attempts by government agencies to write performance standards which the writer should at least peruse<sup>1</sup>. He will also find some help in devising performance tests if he consults such professional organizations as the American Society for Testing and Materials (ASTM) and the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), which have published many voluntary-compliance standards for their respective industries.

The last of my recommendations is for the performance standards writer to involve a group of representatives from other divisions of the Company at appropriate points in the project. The writer will undoubtedly consult with other divisions individually on a daily basis, but when he needs to generate a wealth of ideas in a hurry, or when he encounters a controversial issue on which he needs a clarification of Company policy, a group meeting would be most effective. This is so not only because many heads are better than one, but also because the rest of the Company will take the design program more seriously if it participates in its creation.

#### Company Experience Research

I refer to the person responsible for creating the Company experience database as a researcher rather than a writer because the nature of her work will involve more fact-finding and less writing from scratch. My recommendations to the Company experience researcher are:

1. Start at the most specific system level and work up by level of generality.

2. Build on work already done, especially Operations' General Information Manuals and Leasing's Building Standard books.

3. As much as possible, visit finished developments, construction sites, etc. and collect information from Company personnel face-to-face, rather than by correspondence.

Why start at the most detailed level and work up, which is the opposite of what I recommended to the performance standards writer? Because that is the way that Operations' personnel think about their work. They deal with the specifics directly and have no use for abstract categories unless those categories have some functional significance. For instance, the concepts of plumbing and electrical systems are useful because then it is easy to tell that the dripping faucet is probably not the cause of the flickering fluorescent lights. However, the concept of a "transportation system" is not important to a mechanic; he just wants to know what kind of elevator the building has. If a mechanic has to make a repair, he will try the most local solution first and then, only if that does not work, will he look for more fundamental causes of the problem. If a custodian notices a flickering fluorescent light, she will replace the tube. It occurs to her that this is the third time in the past month she has replaced that particular tube, so she notifies the mechanic, who replaces the fixture. If there are still problems, the mechanic will have to go back

both to check the fixture and see if there might be something wrong with the whole circuit. This is the way Operations' personnel must and do think about their jobs, and if the Company experience researcher is to record Operations' knowledge as faithfully as possible, she must write it down as her subjects think about it-- from the ground up.

The researcher should use any information about Company practices which is already in collected form, although she may want to spot-check these sources for accuracy.

The Company experience researcher's main source of information will be on-site data collection through interviewing and direct observation. While collecting data for Operations' General Information Manuals last year, I found that mailing out forms for the site personnel to fill out and send back takes months and even then does not get the answers to the questions asked. Interviews or group meetings with all of Operations' site managers or mechanics will be most helpful for gathering anecdotal and prescriptive data; the participants at such meetings tend mostly to swap stories about past problems with the buildings, stories which often have morals to them such as "don't use those any more" or "the installer has to tell us these things before he leaves the job."

The researcher should be familiar with all of the different types of construction materials, details, mechanical equipment, etc. so that she may observe directly and record the hard data with a minimum amount of time and misinterpretation of what Development is seeking. Once she



knows the make-up of the building, then she will interview Construction and some of the site personnel to elicit ratings of the building's components relative to past products or experience at other sites.

### **Uniting Performance Standards and Company Experience**

Recall my earlier description of the two notebooks on the table, whose tables of contents appeared identical, item for item, page number for page number. Ideally, there should be a one-to-one correspondence between the performance standards database and the Company experience database-- if there is a page in one book containing the Company's experience with lawn sprinklers, there should be a page in the other book containing a performance standard for lawn sprinklers. What is so important about a one-to-one correspondence between databases? First, from a logical point of view, it seems senseless to have one without the other. If the performance standards writer can think of a building need for which he should write a performance standard, then chances are that the Company's existing buildings are already meeting that need in some way, no matter how limited or unintentional, and therefore there would already be some Company experience concerning that need which the Company experience researcher should explore. Conversely, if there is some product with which the Company has had significant experience in the past, that product is likely to appear in some design in the future, and therefore the performance standards writer should write a performance

standard for it to help Development evaluate that product.

Second, if Development decides it wants to automate its design program information system, a one-to-one correspondence between the two databases should simplify the systems programming task somewhat. Recalling the notebook analogy from Chapter Three, one can see that the two notebooks represent the two databases and that each page in a notebook represents a record in that database. If the subject matter of record N in one database corresponds to the subject matter in record N of the other database for all N, then any systems programmer would be able to exploit this property when designing his searching and sorting routines.

Note that the advantages of automating the design program increase as the size of the databases increases, so Development must decide if it wants to use a systems program from the outset of the project to handle the information or if it wants to wait until the amount of information collected warrants the expense of writing a systems program for a computer to handle it.

The design program procedure in Chapter Four does not require a computer for Development to carry it out effectively, but automation may make the system cheaper and easier to use, depending on the depth of the program. If Development were to decide to use a computer, there would be other advantages besides speed of processing. In the performance standards a systems program might also compare constraints on an attribute across the whole set of performance standards to see if the constraints have been

written such that satisfying one requires violating the other. This checks the internal consistency of the design program. Development can also have more flexibility for organizing the data with an automated information system.<sup>2</sup>

### Maintenance

One of the main virtues of this design program is that it is to be reusable. In order for this to be practicable, Development must do two things:

1. Update the Company experience databases regularly.
2. Update and tailor the performance standards for each project.

To update the Company experience database, Development could simply review it with Construction one year and with Operations the next to see what changes or additions might be necessary. While such updating is vital if the design program is to continue to be useful, Development probably does not want to devote even one person full time to maintain it. It must hire a Company researcher willing to work herself out of a job.

The tasks of maintaining the anecdotal database and the prescriptive database are quite similar. Development may obtain new information for either one by voluntary reports from Operations, by requesting reports from Operations (not recommended), holding annual meetings with the managers and/or the mechanics, and external sources of information on new products (trade magazines, architects, etc.). The hard database, which would be on a computer, could be made with

some expert software work to update itself by tapping into the Company's other information systems such as accounts payable, tenant complaints, preventive maintenance, and energy. However, the systems programmer would have to modify these other systems substantially just to allow the design program information system to read them.

Development might find more unsolicited anecdotes arriving from the existing sites if Operations creates a spot for such activity in its currently successful management incentives program, by which Operations adjusts a site manager's annual salary according to his or her site's performance in budget preparation, site inspection, energy conservation, and other areas over the course of the year.

Development must both tailor and update the performance standards database for each project in order to make it work. Tailoring means making changes to the standards based on the peculiarities of the current project, temporary changes which take into account local climate, market conditions, municipal design controls, etc. without affecting the ongoing database which Development would use for the next project. Updating means making permanent changes to the performance standards, based on changes in the Company's expectations of how a building should perform. Development will be responsible for maintaining both databases, but clearly will not be able to maintain them without the cooperation of the other divisions of the Company.

## CHAPTER FIVE NOTES

1 See

**Guide Criteria for the Evaluation and Design of Operation BREAKTHROUGH Housing Systems, Report 10200, 4 Volumes; National Bureau of Standards; Washington, D.C.; 1970.**

and

**The PBS Building Systems Program and Performance Specification for Office Buildings ("The Peach Book"), Third Edition; Office of Construction Management, Public Buildings Service, General Services Administration; Washington, D.C.; November 1975.**

2

**Fenves, Steven J. and Wright, R.N.; "The Representation and Use of Design Specifications"; National Bureau of Standards Technical Note 940; Department of Commerce; Washington, D.C.; June 1977; p.30.**

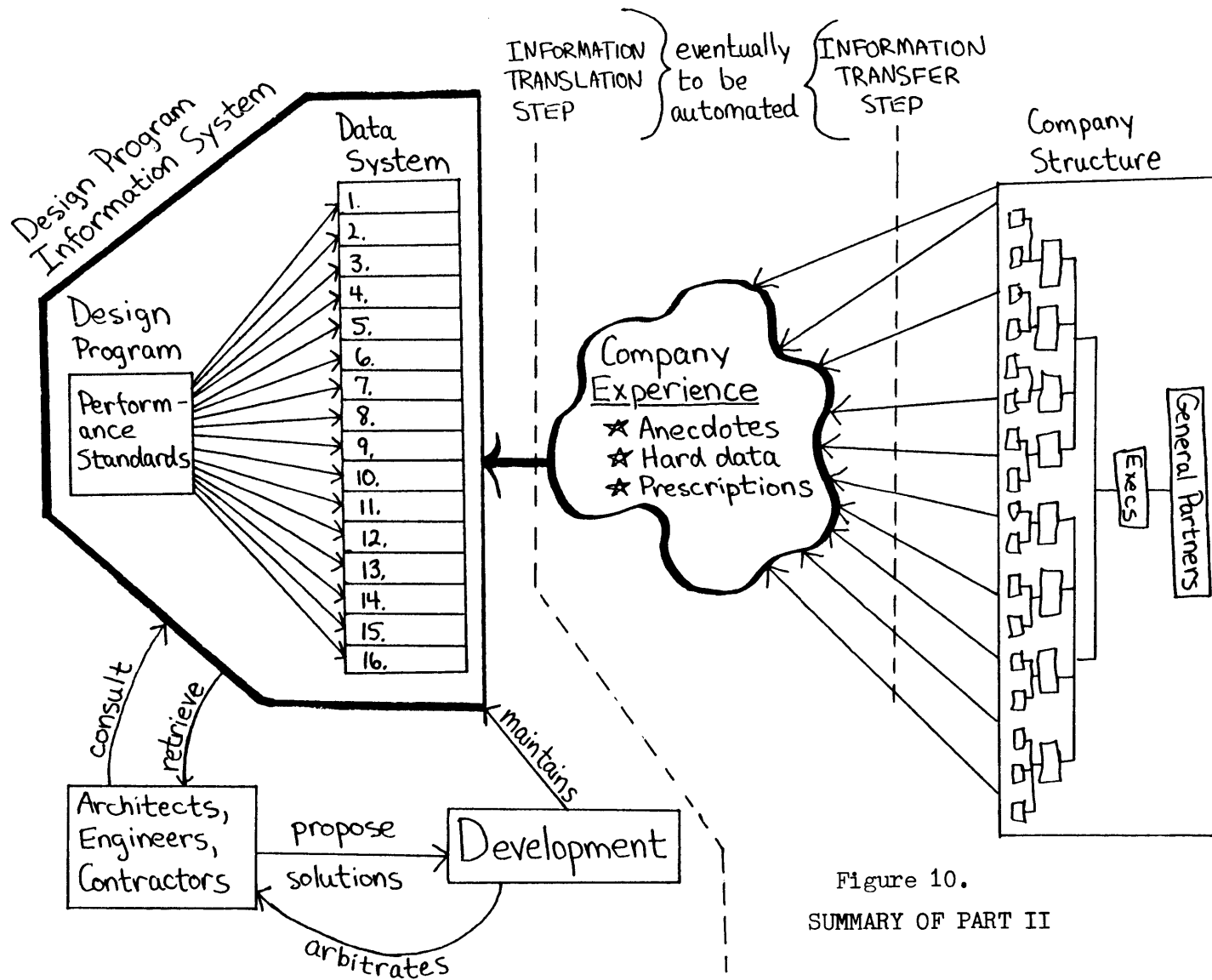


Figure 10.  
SUMMARY OF PART II

## IN SUMMARY

Please refer to Figure 10 for a graphical summary of Part II. Information originates from within the Company structure and is transferred into a pool of Company experience which contains anecdotes, hard data, and prescriptions. The information transfer step is the subject of Chapter Five, while the nature of the Company experience pool I described in the last part of Chapter Two.

I have not said and will not say much about the information translation step, by which Development organizes the collection of Company experience into a usable design program information system. This step is both important and challenging, but it is beyond the scope of this thesis.

The system's structure, the topic of Chapter Three, consists of a set of performance standards connected by pointers to a data system containing the Company experience sorted by the sixteen divisions of the Construction Standards Institute index or some other specification method. Once the structure is in place, designers may consult the system, retrieve the information they need, and consequently propose design solutions to Development. Development then mediates an actual design solution using the design program as a guide as explained in Chapter Four. It is Development's responsibility to maintain the design program information system.

**PART III**  
**IMPLICATIONS FOR THE COMPANY**



CHAPTER 6  
A REASSESSMENT  
OF THE  
DESIGN PROGRAM INFORMATION SYSTEM

Part II, as its title states, contains an idealized model of a design program information system. In it, I attempted to combine the strengths and cancel the weaknesses of performance standards and prescriptive standards using a comprehensive structure and set of procedures. In order to develop the ideas in Part II (parallel databases, performance tests, a formal appeals procedure, self-updating systems), I made a number of strong assumptions, not all of which are reasonable from the Company's perspective. I will now examine the following assumptions in light of the Company's present size and the nature of its typical working relationship with Architect:

- 1) Ignore costs and time delays imposed on construction.
- 2) Architect allocates his effort equally over all parts of the building design.
- 3) Results of performance tests are binding on the parties responsible for failure of those tests.
- 4) Wherever Architect encounters a prescriptive standard in the design program, he will suppress his own ideas unless the Company openly invites him to express them.

I will also speculate briefly on how the Company could, in relaxing these assumptions, modify the idealized system to meet its needs.

#### **Time and Money**

The costs of developing and maintaining a full-blown

version of the idealized system would probably be quite large, and would only be justified if the scale of the Company's operations were much larger than they are now. How much of a system does Development need to manage its projects, given the Company's present size and anticipated rate of growth?

Does the Company really need both to write a performance standard and collect Company experience on every system, component, and material which goes into a building? Some information will not be worth the cost of collecting it. If Development is going to be selective in its data collection, how will it decide what is important to know and what is not? This is a question which Development already faces in deciding what to include in its present design program.

One example of the cost of data collection is the suggestion for a self-updating hard database which would periodically tap into the Company's other information systems and retrieve the information which Development wanted. Writing the self-updating systems program will be relatively easy; the difficult part will be to modify the Company's existing information systems so that Development's computer system may read them directly and so that the information of interest is easily extractable. Operations currently keeps manual records of tenant complaints and equipment maintenance; it would have to develop a centralized computer system from scratch for them. Accounting information is already handled by computer, but the current practices for

recording descriptions of purchases in Accounts Payable do not allow for detail sufficient for Development's purposes. To illustrate how long such computer system development can take, the Company's new commercial lease master system has been in design and development for two years and is still in the debugging stages. Development must consider the existing state of the Company's information systems and estimate the value of what information it could get before it decides how much sophistication in data automation it needs.

During construction, time is money. The suggestion in Part II to use the tests in the comprehensive performance standards as a quality control tool in construction implied that every system, component, and material would have to pass inspection. The delay and expense which such intense inspection would impose seems out of proportion with the probable benefits. Again, from a rational economic perspective, what Development should do is inspect those areas where the expected cost of redoing something exceeds the cost of inspecting it. Furthermore, quality control standards should be aimed at the sub-contractors, not at the Architect, since they are the ones who do the installation work. This means that the quality control function might be better be performed by prescriptive standards such as the Company experience data and the construction specifications, since these do not require expensive testing, but a comparison between items which are already within the experience of Operations and of the sub-contractors.

## The Architect's Creativity

The Architect, although he may express a preference for performance standards in all facets of design, does not give equal attention to all parts of the building when he is designing it. He naturally devotes more time to those areas which are of professional interest to him, whether they be the public lobby, the exterior design, or an innovative energy conservation strategy, and less creative effort on things like janitors' closets, bathrooms, and fire stairs.

With the items on which he does not like to spend a lot of time, Architect keeps in his records a prescriptive set of solutions, from which he picks the solution appropriate to the situation. In these instances, Development would not need to give Architect a performance standard at all but instead would substitute the Company's solutions (where they exist) for the Architect's. Performance standards fulfill their design guideline function most effectively at the system level, because it is at that level of specificity he spends the bulk of his creative effort. Please note that using the performance standards at this level for quality control is as unviable as using them during construction, not only because of the impracticality of testing but also because the attribute measures at the systems level are the most descriptive and the least measurable, compared to components and materials levels. Therefore, performance standards are still valuable, but mainly as design guidelines concerning the most global design issues, where statements of need by the Company are by

necessity the most qualitative and sometimes vague. The point is that writing performance standards for everything in an office building is not only expensive but unnecessary.

### **Legality**

How useful are performance tests on the job? Can passing on-site tests be considered a binding contractual obligation? If a certain detail fails to pass a performance test, whose responsibility is it to correct the error? Architect? Construction? The installer? The manufacturer? Whoever Development finds at fault? What if Construction runs the same test and gets a conflicting answer? Development should consider the risks and costs of litigation before it makes any widespread use of performance tests in the contract documents.

### **Communication between Architect and Client**

One of the supposed advantages of performance standards is that they foster innovation by specifying the design problem in explicit terms rather than by specifying the solution itself. The idea of writing a performance standards for everything was to invite the Architect to suggest alternatives to current Company practice by giving him the criteria by which Development would judge his suggestions.

Will innovation cease without performance standards? The evidence indicates that it will not. Although the Company was founded in 1946, Construction certainly does not still use 1940's construction technology. There are many

other factors which can lead to innovation, such as trade magazines, competitive pressures from the marketplace, and a desire to cut costs. So, the question then becomes, will performance standards increase the quantity and quality of innovation? The answer to this is not at all clear given the scarcity of actual experience with using performance standards, and could itself be the subject for a thesis, but it is a question which every potential user of performance standards must face.

If in the design program the Architect receives only a prescriptive standard with no performance standard and no formal method of appeal to Development, will he then keep his ideas to himself? Of course he will not. Architects are not shy about communicating what they consider to be superior design ideas; it is what they must do to survive in their profession. Therefore, the design review process as depicted in the flowchart in Chapter Four is probably too formal to be practical.

#### **Possible Modifications to the Idealized System**

The challenges in this chapter to some of the assumptions contained in Part II are challenges most strongly to the matching performance and prescriptive databases concept and to a design review process modeled somewhat after a municipal zoning variance process.

It may be more realistic for Development to build its performance and Company experience databases so that they dovetail rather than mirror each other. Where the Company was sure of what it wanted, and especially at the materials,

components, and sub-systems levels, it could put just a prescriptive standard in the design program as shown in Chapter Three, with a reference to the Company's anecdotal and hard data for the Architect interested in the reasoning behind the standard. The prescriptive information could also be used during the writing of the construction specs and subsequently as a guide to quality control on the construction site. On the most general systems level, where the Architect puts most of his effort and where every building is unique, the Company could write a performance standard to express its expectations to Architect, with a reference to the Company experience data which would include anecdotes, hard data, and a list of unacceptable past solutions. See Figure 11 for a configuration of the performance standard and Company experience databases different from that which I described in Part II.

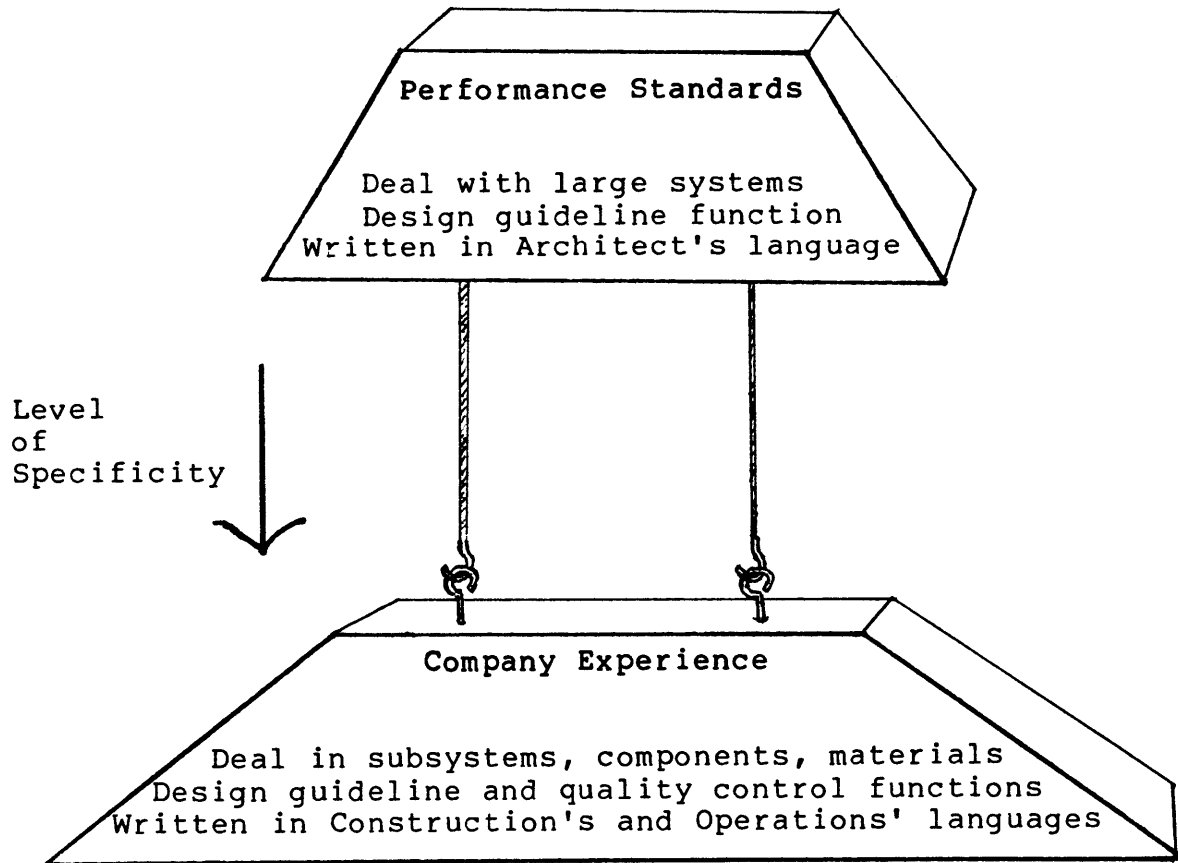
For those items which Development chooses to write performance standards, the flowchart in Figure 9 might still be a reasonable guideline to follow. For the ones which have only prescriptive standards, however, Development may wish to eliminate the formality and evaluate Architect's suggestions by some simpler rule of thumb such as: does your solution do everything ours can do and more?

There are more modifications to the idealized design program information system which would probably increase its usefulness to the Company, but a more detailed discussion of them is beyond the scope of this thesis. However, if Development decides to try to revise its design programming



practices using some of the ideas presented here, research into further modifications is the logical next area of inquiry.

Figure 11. A revised relationship between databases.



CHAPTER SEVEN  
IMPLICATIONS FOR ORGANIZATIONAL LEARNING

The previous chapter concerned the practical implications for the Company of the ideas presented in the form of the design program information system. In this the concluding chapter, I shall step back and examine the potential ramifications of design programming and other Company practices mentioned in the first chapter on the Company's ability as an organization to learn from itself and adapt to its environment.

### **The Company as Information Processor**

One may define an organization as, among other things, a system for allocating tasks among many people.<sup>1</sup> In the process of dividing tasks, specialization is almost inevitable and certainly evident in the Company organizational chart in Chapter One. Once a specialized division forms, it begins to accumulate specialized experience and knowledge about its domain within the organization's sphere of activity. Meanwhile, other divisions are accumulating their knowledge and experience in their own domains, and it becomes the responsibility of those higher up in the organization's structure somehow to incorporate all of this information into the decisions they must make which affect the Company as a whole.

This compartmentalization of the Company is at the same time a solution and a problem. It is a solution because it leads to more efficient performance of specific tasks. It is a problem because creates the necessity for coordination of information between divisions. There is usually no one

best way to divide up tasks because responsibilities always overlap; similarly, information needs also overlap and divisions must constantly request information from each other. If a division (Development) needs some information (each existing site's ratio of occupancy to number of restrooms) which is within the domain of another division (Operations), there is no guarantee that the other division will have that information available. Operations, or any other division, will only collect the information it needs for itself unless a higher authority instructs it otherwise. Even if it has collected the information, it will usually only furnish it by special request, unless it receives a directive such as "send us a report every month" or "notify us immediately of any change in status".

The Company has not ignored the information coordination problem; it has centralized many functions which cut across divisional boundaries, including accounting, MIS, and commercial leasing. These have not eliminated the problem, however, as Development found when it was trying to estimate how many restrooms it wanted in the design of a new building. What would be the best strategies for Development as one division of the Company to pull out the information it needs from the domains of other divisions such as Operations and Construction?

One possibility is for Development to take an active role and collect all of the data itself. Since Development's data requirements are never-ending, the active approach would probably lead to institutionalized organizational self-

inquiry, an "Office of Company Wisdom" as it were. The Office's duty would be to interview personnel in the various divisions of the Company periodically and to ask them what they had learned since the last interview. Not only would people grow weary of a Company experience researcher hounding them about what they have learned, but the very existence of a centralized Office of Company Wisdom could become a volatile political issue. Division personnel might withhold some information from the Office if they thought that it might be used against them later by another division in a budget meeting or other setting. Those who hold information, hold power; to whom would the Office of Company Wisdom be accountable? In addition to its political problems, maintaining the Office would be a substantial additional overhead expense.

A better strategy for Development to gather data from other division's domains would be a passive approach, whereby the information it needed would come back automatically from the other divisions. With the hard data of Company experience, I suggested in Chapter Five that the hard database could be programmed to update itself if the other information systems in the Company were (1) also on computer, and (2) designed to serve, among other things, Development's data needs. For anecdotes and prescriptive data, I suggested using Operations' management incentives program to elicit reports of notable incidents from the existing office developments.

## The Company as Conflict Resolver

There is another problem with task specialization when a particular division's goals or interests diverge from those of the whole Company. The example in Chapter Two of the first cost/operating cost conflict between Construction and Operations illustrates this point succinctly. Construction's bias towards first cost as the determining economic criterion and Operation's bias towards operating costs conflicted both with each other and with the Company's most compelling interest, life cycle cost. This is where the Company must perform another basic organizational function, that of government.<sup>2</sup> It must regulate a division's behavior when that division acts in a manner which benefits itself but harms the Company. The Company must also resolve inter-divisional disputes.

Assume that all interested parties in the Company's design process have stated their preferences about design openly. How should the Company reconcile these preferences? Typically, when such conflicts arise, the parties involved choose either to negotiate and compromise, or they can choose to fight until one of them prevails to impose its agenda on the others. Compromise solutions are preferable to embattled solutions because they contain an aggregate wisdom which surpasses the knowledge and skill of any single faction.

What can the Company do to insure that when internal conflicts arise they will result in compromise solutions rather than in competition for influence? With respect to design issues, the Company could and probably has established

mutually agreeable ground rules for design review, such as who should participate at what stages, what constitutes permissible evidence during debate, and what criteria should be used to evaluate the design (various deadlines which the Company must meet, life cycle cost, effect on Company reputation, etc.). This style of negotiation commonly employs a mediator, someone in a position of trust who listens to all sides and tries to bring them together. The Owner formerly acted as mediator in design review, a duty he has conferred on Development. In other areas of conflict within the Company there may be other mediators, but design is Development's responsibility, a responsibility to reconcile the preferences of Operations, Construction, Leasing, Architect, and the Company executives such that the Company gets the best design possible.

#### **The Company as Wisdom Accumulator**

The Company is now thirty-seven years old, and has been growing at a steady rate since it moved from construction into investment building. It has emerged as a successful real estate development firm not only in terms of profits but also in terms of industry reputation and employee loyalty. Many of the Company's most competent employees are those who were with the Company when it built its first office development in the early 1960's. Perhaps not today or tomorrow, but gradually over the next ten years, the Company will enter its second generation, as those responsible for its initial success retire or leave for other reasons.



What is it that these people know that makes them so successful? Certainly they possess an abundance of practical how-to knowledge, the ability to execute their everyday duties with skill and dispatch. They have the intelligence and experience to perceive when the state of their expertise in something becomes obsolete and to re-educate themselves. The Company policy-makers have a good past record of knowing when and how to adjust the goals of the Company, depending on the local economy, business environment, changes within the Company, and government activity.

How might the Company inherit the knowledge of these people for the future? I will describe three possible methods, all of which the Company is already pursuing: apprenticeship, institutionalization of function, and documentation.

The word "apprenticeship" probably conjures up images of a tradesman or small merchant grooming his son or one of the neighbor's sons slowly over a period of years to grasp all of the intricacies of the trade or business. It is a personal approach, one which requires of the mentor less reflection on what he does than the other two methods because the pupil learns by doing and watching the master at work--the exchange of the most difficult concepts takes place at a non-verbal level. Although the Company is orders of magnitude larger in size and complexity than a blacksmith's shop, the Owner has still perceived apprenticeship as a valuable tool and has chosen his stable of executives accordingly.

There has been talk within the Company surrounding how to "institutionalize" this person or that person, as if somehow the Company would be able to appropriate the heart, mind, and soul of the individual being discussed as well as his or her knowledge. This implies that the person's intelligence and personality can be artificially recreated and acted out by an organization or subset of the organization, and is negatively construed by some as a message that "no one is indispensable".

I would offer another interpretation of institutionalization as an organizational technique-- that is, an institutionalization of function, or what the Owner refers to as "depersonalization" (see Chapter One). This is the process by which the Company may take a particular function which a central figure performs and relegate it to a new or existing division of the Company as part of its domain. This is precisely why Development was born; the Owner wished to assign his functions as design review mediator and development manager to a division in the Company, and he decided that the best way to do that was to create a new division. The Owner's intention was obviously not for Development to replace him, but to assume primary responsibility for two of the many functions which he performed himself.

The idea of documentation is simple: write down what you know so that the next person has the benefit of your experience. If the next person also writes down what he or

she learns, and so on down the line, what will result at some time in the future will be a constantly up-dated manual on how to perform your job. The design program information system which I outlined in this thesis is at its base a plan for a large documentation project; the notebooks comprise a manual for the Architect on how to design a Company office building. Another documentation is already taking place within the Company among Operations, Accounting, Leasing, and MIS, an effort to produce a set of Company property management manuals.

Of the above three tools for accumulating Company wisdom (apprenticeship, institutionalization of function, and documentation), none is comprehensive. They differ in the kinds of experience they capture, however, such that when the Company uses all of them at once, they may enable the Company to learn a wide range of its employees' expertise.

#### CHAPTER SEVEN NOTES

1

Argyris, Chris and Schon, Donald A.; **Organizational Learning: A Theory of Action Perspective**; Addison-Wesley Publishing Company; 1978; p.14.

2

Ibid, p.13.