NISTIR 4802

# OFFICE WORKSPACE FOR TOMORROW
# DOT WORKSHOP (November 13-14, 1991)
# TRANSCRIPT OF PROCEEDINGS

**Edited by:**
**Arthur Rubin**

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards
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Building and Fire Research Laboratory
Gaithersburg, MD 20899

Prepared for:
Department of Transportation
Office of the Secretary of Transportation

NIST

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July 1992

## Abstract

This report contains the proceedings of a workshop conducted November 13 and 14, 1991 for the Department of Transportation (DOT). The workshop was held to assist the Department in planning a new Headquarters Building. Eighteen experts, representing various disciplines associated with building design and use, participated in a workshop, and prepared papers prior to the meeting. The present report consists of the edited transcript of the meeting - presentations and discussions. An earlier report (NISTIR 4801), contains the prepared papers.

Workshop presentations covered the following topics: workstation design process, programming tradeoffs, workstation standards and criteria, ergonomics, human resource issues, leading edge workstation design, impact of new technologies on office and workstation design, lighting, environmental technologies, information and data systems, building design, facility management, forecasts of the office-of-the-future. These issues were discussed by panel members and with representatives from the Department of Transportation and other federal agencies.

## Keywords:

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**Disclaimer**

Many workshop participants alluded to commercial products and systems used in buildings in their submitted papers and during the workshop proceedings. The identification of these products in this report does not constitute an endorsement by the National Institute of Standards and Technology (NIST), the Department of Commerce, nor the Department of Transportation.

## Preface

The November 13-14, 1991 workshop was conducted at the request of the Headquarters Building Acquisition Project Office, Office of the Secretary, Department of Transportation (DOT). The DOT is in the process of planning a new Headquarters Building to house the senior staff of the Department. With the completion of an initial programming activity, identifying the staff members to be housed in the new building and estimating the space required to accommodate these employees, they determined the need to obtain more information on a variety of issues, before proceeding with some of their detailed planning activities. In particular, they wanted to foster an open discussion on trends in office design, office system technology, systems furniture design, workforce composition, and workgroup interactions. Another important topic to be addressed was the influence of workstation standards on the building module, and conversely, the influence of the building module on workstation standards. The tradeoffs associated with each approach were to be explored.

The workshop was not intended to be a problem-solving session. Rather, it was meant to generate discussions of issues which have an impact on the design considerations for the new Department of Transportation Headquarters Building project.

In preparation for the workshop, participants were asked to prepare papers on a variety of topics to be addressed during the meeting. These papers are contained in NISTIR 4801. The present report consists of an edited transcript of the workshop proceedings, including discussions among participants and question-and-answer sessions among participants and workshop attendees.

**Workshop Title: OFFICE WORKSPACES FOR TOMORROW**

Place: Washington Plaza Hotel, Washington, D.C.

Time: November 13 and 14, 1991.

Moderator: Kreon Cyros (MIT Facility Mgmt Lab)

Conference Recorder: Forrest Wilson

**Workshop Schedule - Wednesday, November 13, 1991**

9:00  - Registration

9:15  - Welcoming remarks by DOT; short general description of meeting purpose. (Melissa Allen)

9:35  - Overview (Moderator - Kreon Cyros).

Workstation Design Process

9:55  - Programming tradeoffs (Tim White)

10:20 - Forecasting and computer modeling of tradeoffs (Marshall Graham)

10:45 - Open discussion

11:00 - Break

Workstation Standards/Criteria; Ergonomic considerations

11:15  - Workstation environmental factors - (Alan Hedge)

11:40  - Human resource issues (Cecil Williams)

12.05  - Open discussion

12:20  - Lunch

1:20   - Leading edge workstation design - (Lee Bloomquist)

1:45   - Open discussion

2:00   - Impact of new technologies on office and workstation design

       - Voice communications, security & safety systems, video conferencing - (Peter Valentine)

2:25   - Information and data systems, networking; present and future - (Herb Rosenheck)

2:50   - Lighting issues for open-plan offices - (Mike Hooker)

3:15   - Break

3:35 - New environmental design and control approaches - here and abroad - (Vivian Loftness)

4:00 - Environmental technologies from an engineering practices viewpoint - (Valentine Lehr)

4:25 - Open discussion

Building design issues

4:40 - Effect of workstation concepts on building design - (Robert Cioppa)

5:05 to 6:00 - Open discussion of all topics covered during the days proceedings.


**Workshop Schedule Thursday, November 14, 1991**

Facility management (end user) experiences

8:40 - Citicorp - (Steve Binder)
9:10 - Metropolitan Life Ins Co.- (Edward Toran)
9:40 - General Accounting Office - (Martin Duby)

10:10 - Open Discussion

10:25 - Break

Looking ahead toward the electronic office

10:40 - What will the office of the future be like? - Officing (Duncan Sutherland)

11:05 - New information technologies - (Don Avedon)

11:30 - Human resources issues and the office of the future - (Gilbert DeCouvreur)

11:55 - A forecast of information technology developments and possible impacts on workstation design - (Amy Wohl)

12:20 - Open discussion

12:40 - Lunch

1:40 - Questions to be addressed by the panel - (Prepared by DOT)

3:30 - Adjourn (Wrapup statement by Melissa Allen, DOT)

# Introduction

Designing a modern, well equipped office building requires the expertise of many diverse disciplines. The workshop was designed to obtain the views represented from as many of these disciplinary areas as feasible in a two day session.

The first topic addressed is the "design process". Tim White discusses programming tradeoffs associated with design decisions made on the basis of workstation standards or on building modules. Marshall Graham describes the use of forecasting tools, including computer modeling, to analyze organizational functions, space requirements, workstations, and variations in module and workstation sizes.

Workstation standards and criteria are then examined from the standpoint of the end-user. Alan Hedge describes the ergonomic considerations of workstation design, especially environmental considerations of thermal comfort, air quality, and individual control systems. Michael Hooker deals with an environmental issue that has been one of the greatest sources of complaint among building occupants - lighting. Cecil Williams then describes the special needs of the future workforce, focusing on issues such as accommodating the aged, minority groups, the disabled, and the need for special facilities in buildings such as child-care and exercise facilities.

Lee Bloomquist then forecasts the evolution of workstation design from the furnishings used today to the likely configurations to be available when the DOT headquarters will be ready for occupancy, estimated for the year 2000.

The impact of new technologies on office and workstation design is the next subject to be treated. Peter Valentine describes new voice and communication systems and video conferencing, while Herbert Rosenheck discusses information and data systems, and networking today and in the future. Vivian Loftness presents an overview of new technologies and design approaches in the United States, the United Kingdom, France, Germany, and Japan. Finally, Valentine Lehr examines environmental technologies from an engineering practices viewpoint, stressing feasibility issues.

Building design is then examined from an architectural standpoint. Robert Cioppa describes the evolution of the office and the impact of technology on present and future office and building design.

The next issue addressed was the experience of the private and public sectors in designing high technology office buildings. What worked and what didn't work, and why? Stephen Binder summarizes his experiences at Citibank, with corporate responsibilities for real property management. Similarly, Edward Toran discusses the impact of technology on the design of offices, and facility management issues at Metropolitan Life. Martin Duby then describes his work at the General Accounting Office (GAO), which is in the process of modernizing a building, housing approximately 5,000 people, primarily professionals.

The last group of papers forecast the future of the "electronic office". Duncan Sutherland provides a unique view of the "office of the future". Don Avedon describes new information technologies and their implications for workstation and office design. Gilbert DeCouvreur examines human resource issues that will impact how office work will be performed in the future. Finally, Amy Wohl forecasts information technology developments and their likely impact on future workstations and offices.

1

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## PROCEEDINGS

## WELCOMING REMARKS BY THE DEPARTMENT OF TRANSPORTATION

**MS. ALLEN**: Good morning. I would like to welcome you to this conference on the Office Workspace for Tomorrow. My name is Melissa Allen. I'm the Deputy Assistant Secretary for Administration at the U.S. Department of Transportation.

I would like to begin by giving you some background on why we at DOT are cosponsoring this conference; where we are in terms of our own project; and why we believe that this panel of experts, who have kindly agreed to come and teach us some things, is very important to what we are doing in the Department.

The Department of Transportation employs about 12,000 people in the Washington, D.C. headquarters. This figure constitutes both civilian and military employees who are currently housed in three major buildings in downtown Washington. We hope that sometime around the year 2000 we will have a new headquarters building for about two-thirds of those people. The other third will be housed in renovated federal space, some of which we currently occupy.

One question we have been asking is how does a federal agency best accommodate its workforce in the year 2000?

An article in the Washington Post this morning described a study performed at the Research Triangle Park in North Carolina on how the federal government should accommodate employees who will be the core of our workforce into the next century - the disabled, employees with demands on their time, such as children or elder care; employees who need or want to work at home, employees who need flexibility. At Transportation, we are very sensitive to the affecting people in the workplace.

So, we are faced with these challenges and the need to get information to our employees - to those helping to plan this project, and to our senior leadership in the Department - about what has to be done for planning this building of the future.

We have been working with our contractor - 3D/International, (3DI) and their subcontractors, to plan and program for the space needs for the building. But having identified those space needs, our question is what do we do now?

What I would like to see come out of today and tomorrow's sessions is information. This is not a decision making process for us. I would like to have both sides of the issues posited. We do not have to come to an agreement on anything.

One of the motives for this conference is that I - as a person with a background in financial management, not in buildings or technology - challenged both 3D/I and my staff as to why one plans a building around a workstation which is designed now, when in the year 2000, everything may be entirely different. I asked, "How do we know we are doing it the right way?" The answer was, "Well, that is the way the profession does it. I said "Show me." So, we have a conference today and tomorrow.

Much of your audience are federal employees from the U.S. Department of Transportation. They are either involved in managing our current facilities, in the design for our future facility, or people like myself who are at decision making levels and who have to say "yea" or "nay" to the recommendations being made.

We also have members of the General Services Administration, which is the federal government's space owners and planners. We have guests from the Department of Defense, and others from private industry who are our contractors and are helping us with the challenge facing us.

To further describe our building project, we are talking about a facility to house approximately 8,000 employees. It will be 1.7 million occupiable square feet. We anticipate that about 85 percent will be open space, and about 15 percent will be closed offices. Much of the 15 percent closed space will go to political appointees, senior managers, and lawyers.

The building's space program is based on the GSA standard utilization rate of 125 square feet per person; people will have about 80 square feet to live in. That appears very cramped for those of us with spacious offices and it sounds spacious to those of us who share offices and are squeezed in. So, it is a different environment than the one we are in now.

We as a Department are probably not that different from other federal agencies. Our "Preliminary Program of Requirements" indicates almost 340,000 square feet is needed for conference and work team areas, and 250,000 square feet is required for files and storage. We are a very paper intensive agency right now. Our communications and technology people are trying to pull us out of that era but for now we are a paper intensive agency. So, there are a lot of changes facing us.

As I said earlier, we do not wish this conference to be a problem solving activity. Rather, we want an opportunity for information gathering. You panelists will be speaking to people with various backgrounds. Many of us are not technically oriented, but some of us do have technical backgrounds. So, don't be hesitant in using technical jargon, but please explain it to those of us who are not familiar with it.

We hope there is ample opportunity for discussion during breaks, at lunch, and perhaps after the session ends this afternoon and tomorrow, so that we learn as much as possible. So, without further ado, I would like to turn it over to our moderator. Thank you all for coming and for spending the time to educate us.

# OVERVIEW

**MR. CYROS:** My name is Kreon Cyros. I am the Director of the MIT Office of Facilities Management Systems. We are people who use space. We have a problem of managing 9.1 million gross square feet of space for 8,600 students and a billion dollar a year budget, focused in on the world of research. That does not keep space static, unfortunately. It keeps space very dynamic.

We are trying to understand what we have, how we use it, what it will look like tomorrow, and above all, how to pay for it. Your sons, daughters, nieces and nephews cannot afford the tuitions projected for university life not only today, but tomorrow. One of the issues as users of space at MIT is to figure out how we can avoid everyone else's mistakes and do as much right as possible most efficiently and effectively.

One way to accomplished this is through vehicles such as this, discussing issues, hearing what others think about problems. I come from a corporate culture - yes, universities have a corporate culture - where we believe better ideas exist outside of MIT. Part of my role is to listen and speak with people like yourselves and bring back the best ideas and plant them as seeds amongst our administrative and faculty people so we can make best use of our spaces.

I am pleased to be a moderator at this group because moderators learn more than anyone else. Everyone else is concerned about what they are going to say at the time. I can listen carefully while others concentrate on formulating questions. Please be brief in your questions, but ask a lot of them.

I am a tough police person. My mission is to stay on time, and that is a near impossibility because of the expertise sitting on both sides of this table. You have experiences and knowledge that are invaluable to the process that Melissa Allen is seeking.

I would like to bring our next speaker to the fore. He is Tim White, a professor in the School of Architecture at Florida A&M University. He also worked for the Center for Building Technology, National Bureau of Standards (now the National Institure of Standards and Technology) as a visiting research architect and as a visiting professor at the Oxford Polytechnic in Oxford, England. He is a registered architect in Florida and Arizona He has a practical emphasis in master planning, facilities programming and schematic design and building evaluation. In his present position he has coordinated the graduate program in teaching design, graphics, facilities programming and building evaluation. He is an author and a lecturer as well.

# WORKSTATION DESIGN PROCESS PROGRAMMING TRADEOFFS

MR. WHITE: I am going to lead off today by looking at the relationships between building shell design and workstation planning. (slide)

> **Managing the relationships between building shell design and workstation planning.**

Specifically I am going to be looking at a particular issue: (slide)

> **QUESTION: What are the tradeoffs when we allow building planning to dictate workstation planning and when we allow workstation planning to dictate building planning?**

What happens when we allow each of those things to basically "have its head" and to primarily dictate matters to the opposing or the companion situation: building in relation to workstation, workstation in relation to building shell design.

If we look at this particular question, it has three primary components: (Figure 1)

> **QUESTION ELEMENTS**
>
> **Building User**
>
> **Workstations**
>
> **Building Shell**

**Figure 1. Major components in workstation/shell tradeoffs**

Those of you familiar with the way buildings get delivered will probably agree that in terms of project planning, we typically move from the requirements of building users to workstation requirements and then to the building shell requirements. But in terms of constructing the building, oftentimes the building shell goes up first, before specific workstation configurations have been considered. Then building users are faced with adapting to both the building and the workstations.

So, we will be looking at the dialogue or the interrelationships between these components, primarily addressing the relationship between the workstations and the building shell.

We can begin by recognizing that each of three elements has criteria that must be met within its own domain. (Figure 2)

```
+-----------------------------------------------------------------+
|                        ELEMENT CRITERIA                         |
|                                                                 |
| Building User-------------------- Job Performance               |
|                                                                 |
| Workstations-------------------- Standardization/Flexibility    |
|                                                                 |
| Building Shell ----------------- Economics/Technology/Context   |
+-----------------------------------------------------------------+
```

**Figure 2. Criteria for design elements**

The users are obviously concerned with their own job performance, that is, the activities they perform within the organization or institution where they work.

The workstation designs are affected by the need for standardization for manufacturing purposes and also with flexibility and interchangeability, which are primary attributes and advantages of adopting a workstation approach in a project.

The building shell also has its own criteria which are unique as a component in this process. It has to satisfy certain economic, technical and contextual issues. So, we must recognize that each of the three components has its own set of criteria to satisfy, in addition to relating to the other elements in the situation. Let us now begin to look at the relationships that occur among these elements. (Figure 3)
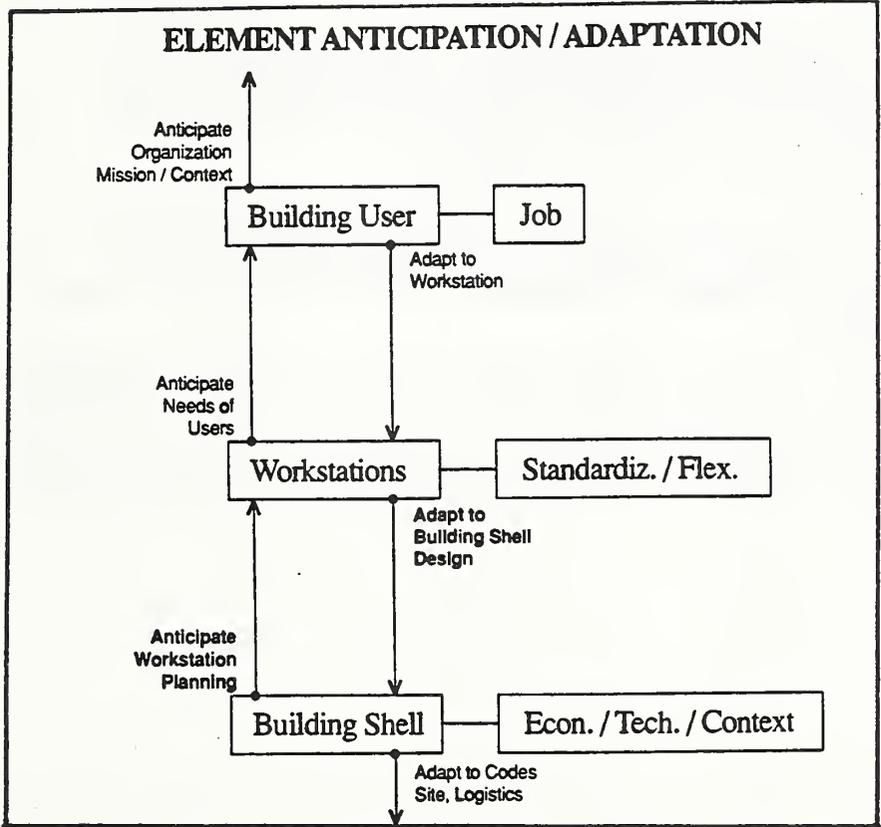


**Figure 3. Adaptations necessary among planning elements**

The building user, for example, anticipates the overall mission and context of the organization where he/she works, and performs the job within that framework. At the same time, the building user must adapt to the workstation to the extent that adaptation is necessary.

Workstations are designed to anticipate the needs of the users. Even though there is standardization, workstations attempt to anticipate as many of the building users' needs as possible. But we also have to recognize that there is never a perfect match. There are always idiosyncracies on an individual user level, that cause some degree of misfit when users move into a workstation system.

We have the same kind of relationship happening between the building shell and the workstations. On the one hand, building shell design attempts to anticipate workstation planning. The building shell tries to anticipate what the workstations will need so that the shell is planned to allow the workstations to be the way they need to be.

There is never a perfect fit however. There is always some adaptation that the workstations must achieve in order to fit into the building shell. Many times the building shell is already constructed before configurations of workstation plans are actually established.

Then the building, in addition to meeting its own criteria, has adaptive roles in the project beyond itself. We are going to concentrate on this dialogue here; the interrelationship between the workstation and the building shell.

As we will see, to the extent the workstations adapt, they tend to back away from some of their criteria, and to the extent the building anticipates, it tends to back away from some of its criteria. Thus, we have tradeoffs between the need of the workstation and the building shell. Tradeoffs become defined as a reduction in the satisfaction of the criteria of each of these components within its own situation.

To illustrate the tradeoffs, we start with an assumption that the building is going to be totally subordinated to the workstations. In other words, the workstations are going to be planned exactly the way they need to be, and the building shell is going to be designed around that. (Figure 4)

**TRADEOFFS:**
**BUILDING SUBORDINATED**

Anticipate
Organization
Mission / Context

Building User —— Job

Adapt to
Workstation

Anticipate
Needs of
Users

Workstations —— Standardiz. / Flex.

Anticipate
Workstation
Planning

Building Shell —— Econ. / Tech. / Context

Adapt to Codes
Site, Logistics
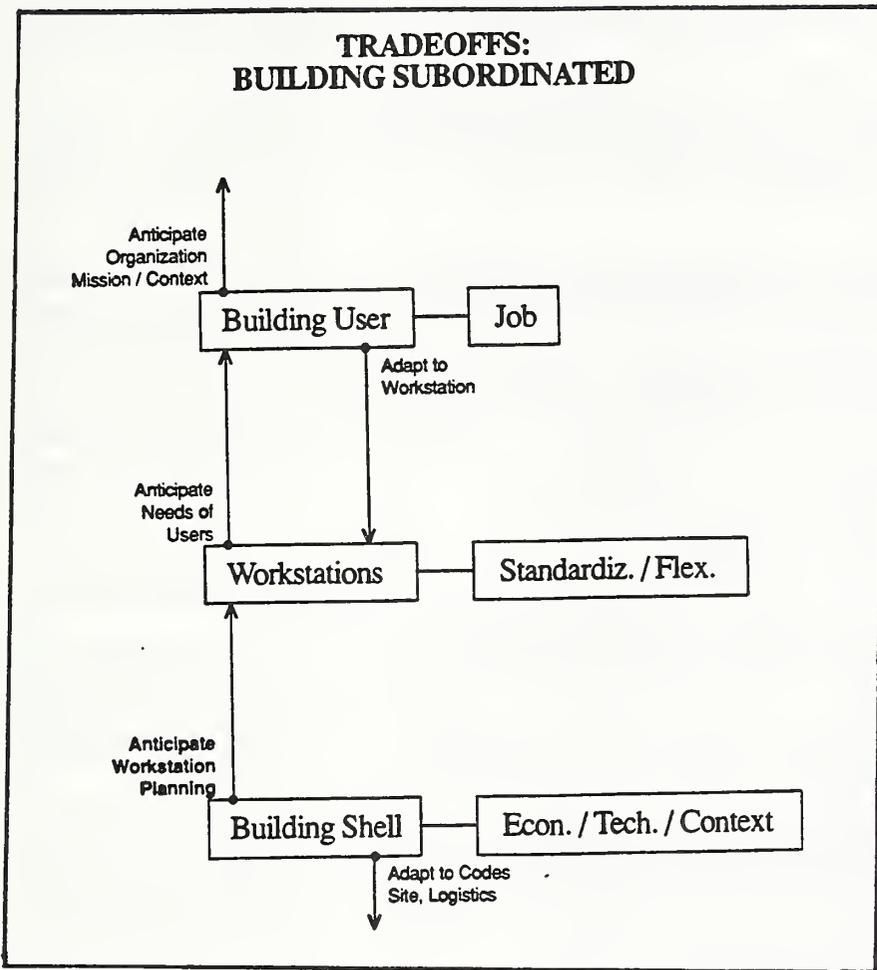
**Figure 4. Tradeoffs: Building subordinated (Diagram)**

A number of things tend to occur which, in effect, result in a reduction of the satisfaction of the building shell criteria when there is little workstation adaptation to the building shell. In this situation the shell is totally subordinated to the workstation configuration. Again, these are tendencies and do not apply to any particular project. So, when the building shell is subordinated to the workstations, you tend to get the tradeoffs indicated in figure 5.:

```
┌──────────────────────────────────────────────────────────┐
│  TRADEOFFS: BUILDING SUBORDINATED                         │
│                                                            │
│  1. Unequal square footage on the various floor levels in │
│        order to accommodate the workstation block diagram, │
│        resulting in a more complex building shape, increased│
│        building skin, increased floor levels and less      │
│        economical construction.                            │
│                                                            │
│  2. Inappropriate overall building shape and mass in       │
│        relation to the image, goals and code regulations   │
│                                                            │
│  3. Irregular structural bays resulting in inefficient     │
│        spans and dimensional coordination problems among the│
│        structure, ceiling grid and exterior wall modularity.│
│                                                            │
│  4. Structural clear spans that use the structural         │
│        material uneconomically and that increase the       │
│        building's floor-to-floor height.                   │
│                                                            │
│  5. Difficulty coordinating the idiosyncratic layout of    │
│        ceiling lighting, air grilles, sprinklers and sound │
│        speakers.                                           │
│                                                            │
│  6. Decreased building net-to-gross efficiency, due to     │
│        less efficient circulation system.                  │
│                                                            │
│  7. Incongruity between interior wall partitions and the   │
│        structure-ceiling-exterior window modularity.       │
│                                                            │
│  8. Particularized building design that doesn't            │
│        accommodate future workstation changes.             │
└──────────────────────────────────────────────────────────┘
```

**Figure 5. Tradeoffs: Building subordinated (Table)**

Now, there is a lot of density in that list.

MR. CYROS: *We have a question.*

VOICE: *I would challenge one item. I would think when you design from the inside out, you would design it for the maximum efficiency in terms of utilization of space.*

MR. WHITE: *I am assuming that you are going to have an orientation toward configuring the workstations in a way that doesn't consider the orderliness of the perimeter of the workstation cluster, and therefore you will tend not to resolve workstation patterns out to clean edges. You are likely to have ragged edges, and have wasted space in those configurations.*

MR. LEHR: *I think that would also relate to the building core. This scenario would not allow you to have an orderly core in an architectural sense, but the problems are segmented to a certain extent.*

MR. WHITE: *If you can plan the workstation patterns by having clean shapes with manageable edges, then you are right. This problem then tends to go away. But if you are*

*concerned only with workstation-to-workstation relationships and allow that to evolve to whatever overall shape you get, and let that be what it wants to be, then you get a ragged edge, and these problems tend to happen.*

VOICE: *I have one other comment or challenge to your statement; one would design a building to reflect the particular snapshot. I don't think you do that anymore. At the very least, we design so that workstations can be flexible and adaptable to change.*

MR. WHITE: *I agree. That is going to be the on next list. What I am doing, remember, is taking an extremist position first. If we totally subordinate the building to the workstation then we tend to have compromises with the building shell. What we will see later is there is a give and take. Each system relaxes some criteria, to make the marriage between the workstations and the building happen in the most graceful way.*

*But the question posed for me in this presentation was, "What are the tradeoffs if you allow each of these systems to have its way in a complete sense?". That is what I am looking at here.*

VOICE: *How far does building subordination go? Does it go to the design of the building as far as column spacing?*

MR. WHITE: *Yes. I am thinking about column spacing, exterior skin configuration, placement of elevators and all other planning decisions about the building shell. The building is trying to get out of the way of the workstation system as completely as possible, to allow the workstations to be what they need to be.*

Let's turn the question around and examine what happens when the building does what it needs to do and makes very little gesture toward accommodating the workstations. Now we are going to look at what happens when the shell is a given, and its planning hasn't paid attention to the workstations. Now the workstations have to adjust, in terms of fitting into the shell. (Figure 6)

**TRADEOFFS:**
**WORKSTATIONS SUBORDINATED**

Anticipate
Organization
Mission / Context

Building User — Job

Adapt to
Workstation

Anticipate
Needs of
Users

Workstations — Standardiz. / Flex.

Adapt to
Building Shell
Design

Building Shell — Econ. / Tech. / Context
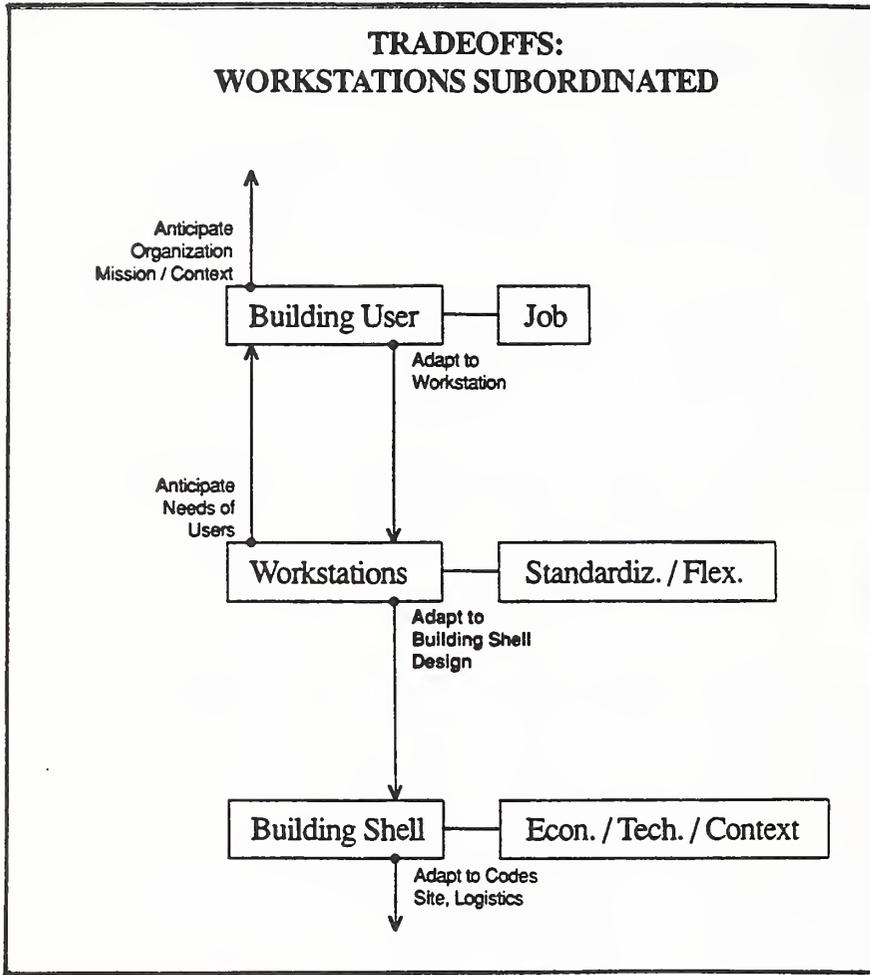
Adapt to Codes
Site, Logistics

**Figure 6. Workstation subordinated (Diagram)**

Now the workstations are in a totally adaptive mode. We are going to look at what criteria the workstations tend to neglect in that building-workstation relationship. (Figure 7)

## TRADEOFFS: WORKSTATIONS SUBORDINATED

1. Individual workstations that suffer from obstructions or whose configurations are compromised because of fixed building elements.

2. Inappropriate furniture in a workstation in order for it to fit in an inflexible building area.

3. Mismatched lighting/air grille grid with workstation layout.

4. Compromised auditory and visual privacy due to building constraints on workstation layout.

5. Insufficient user access to natural light and exterior views.

6. Separated functional zones that should be adjacent.

7. Complicated circulation paths within the workstation layout.

8. Difficulty establishing the identity of organizationally related workstation zones.

9. Reduced flexibility in achieving the optimum overall workstation layout.

10. Compromised locations for shared spaces.

11. Reduced flexibility in changing the workstation layout over time.

12. Wasted floor areas that cannot be put to any programmatic purpose.

13. Workstation layouts that tend to bury users too far from workstation zone edges.

**Figure 7. Tradeoffs: Workstations subordinated**

Again, these things don't happen in every project, but they tend to happen if you let the building shell dictate workstation planning. In most design projects, the goal is to balance the building-workstation relationship.

On the one hand, the building shell tries to anticipate workstation needs. The shell is designed to enable the workstations to satisfy as many criteria as possible. On the other hand, workstation flexibility is used to adapt to the building shell design.

This kind of compromise by each component results in some diminishment in the satisfaction of its own criteria. In most projects, this is the most desirable situation, because then buildings and workstations are able to satisfy more total project criteria.

What are some of these accommodative and adaptive strategies? These are some things that building designs will often do to accommodate workstations: (Figure 8.)

---

**BUILDING ANTICIPATION OF WORKSTATIONS**

1. Clear floor areas that are simple in shape and reasonable in proportion.

2. Floor configurations that ensure that all workstations are within reasonable proximity to exterior windows.

3. Minimal free-standing interior columns.

4. Floor-to-floor dimensions and exterior window heights that allow appropriate natural light access to all workstations.

5. Use of atria that ensure adequate natural light to large floor areas.

6. A ceiling grid pattern that provides sufficient density of lights and air grilles to serve any workstation pattern.

7. Clear separation of task lighting (at the workstation) and general ambient lighting (ceiling, uplighting at walls and columns).

8. An exterior window pattern that need not influence the layout of the workstations.

---

**Figure 8. Building anticipation of workstations**

Basically this is an attempt to divorce the building system from the workstation system, so that the two systems coexist but touch each other to a minimal degree, so that each one can satisfy its own criteria to the extent possible and negotiate to a minimum degree with the other system.

Now we turn that around and look at some things that permit the workstations to adapt to the building shell. (Figure 9)

## WORKSTATION ADAPTATION TO BUILDING SHELL

1. Deliberately violate the geometric mandates of the building (fracture the patterns) in order to create new precedents that are sympathetic with workstation criteria.

2. Shift the orientations of individual workstations in order to manipulate the dimensions of workstation clusters.

3. Manage the workstation-to-workstation relationships and overall patterns to fit workstation clusters into available space.

4. Locate flexible activity space at the edges of the workstation clusters to minimize the friction with the building at those points.

5. Use perimeter circulation as a strategy for mediating between the building and workstation patterns.

6. Choose workstation systems that offer the most flexibility for alternative patterns and grouping configurations.

7. Match discontinuities in the workstation patterns (files, conference areas) with building obstructions (walls, columns).

8. Generally, hold workstations away from exterior walls, windows, interior walls and columns.

9. Match the floor areas needed for the block diagram with the available building floor areas.

10. Fill odd-shaped floor areas with flexible activity zones (lounge, waiting).

11. Avoid dependence on ceiling for task lighting by providing task lighting at each workstation.

12. Employ workstation grid shifts to slide around building obstacles.

**Figure 9. Workstation adaptation to building shell**

Oftentimes when you lay out a workstation pattern, one of the first things you will do is uncouple the relationship between the workstation and building geometries. You will turn workstations on angles, and try not to set them up as "slaves" to the building geometry. You will shift the orientations of individual workstations, turn them, and manipulate the dimensions of overall clusters so they fit more easily in the building.

You will locate flexible activity space at the edges so you have more flexibility in relation to the building, to minimize the friction with the building at that point.

You will choose systems that offer the most flexibility for alternative patterns - systems that allow the maximum amount of configuration exploration.

You will match discontinuities in the workstation patterns with building obstructions - for example, recognize that workstations are not extruded patterns that are the same for an entire floor. They change and shift from function to function and from furniture type to furniture type. You must interrupt the workstation pattern for files, conference areas, and so forth. So, often it is useful to match the discontinuities in the workstation patterns with the discontinuities in the building shell.

You will fill in odd shaped floor areas with flexible activity zones that do not have a lot of demanding geometry; for example, lounge and waiting areas.

These last two lists are examples of how each system tries to anticipate and accommodate the other system. Again, the overall strategy is to uncouple the systems and produce a building that does not have a high degree of integration or hand-in-glove fit with the open office workstation system, so each one can satisfy its own criteria without having to pay too much attention to the other system.

MS. WOHL: *Would you agree that the list you just had up - the workstation adaptations to the shell and your number two list - the tradeoffs that you could make for workstations within a fixed building, would also be a good checklist when moving into an existing building or renovating space in a building rather than build from scratch? It struck me that was a useful list even when not building from scratch.*

MR. WHITE: *Yes. It becomes especially important when you do not have the option of adapting the shell to the workstations.*

MS. LOFTNESS: *I have a question in terms of what you define as shell versus workstations. It is an interesting dichotomy, but for the lights, the HVAC, the workstation - whether you are tied to the shell, makes a big difference on which side of the line you fall.*

MR. WHITE: *Sure. That is a good question too. We were talking before we started the session today about the continuing trend to take more out of the shell and to call more of what used to be called "building scenery." We talked earlier about a radio system that eliminates a lot of the wiring in the building as an example of how less is embedded in the shell and more is considered "flexible scenery" so that you are tied less to the hard building and more things are considered to be maneuverable and changeable.*

*I think the trend is for the workstation to absorb more and more, and maybe eventually people will just put on suits and clothes that mediate between human comfort and the ambient environment and we will not even have buildings.*

VOICE: *How does this apply with regard to new construction as opposed to renovations? Are there any tradeoffs in any of that?*

MR. WHITE: *Yes. I think that even new construction tends to fix the building shell before space planning occurs. So, for all practical purposes for most projects, the reality is the same. The shell is sitting there and the workstations have to somehow accommodate to it, whether in renovation or a new building. My guess is in a project this big, that this will be the case.*

*The real opportunity for anticipating workstation needs is in new construction. Can the design of the shell anticipate as much as possible what the workstations are going to need?*

*You just have a more established set of givens in a renovation project because you don't have the option of manipulating the shell design.*

MR CYROS: The next subject that we will cover is forecasting and computer modeling of tradeoffs by Marshall Graham. Marshall is the President of Graham Consulting. He has been involved for a number of years in management consulting, facilities planning and management. He has been an innovator in the facilities field in general. Marshall has futurist concepts. He thinks about things before other people do. Some ideas go "down in flames", and others have been taken over by industry and have proven to be correct. Marshall has been an advisor for me at MIT as a technical advisory board member for a number of years.

## SPACE PROGRAMMING - FORECASTING STAFF AND SPACE REQUIREMENTS AND COMPUTER MODELING OF TRADEOFFS

**MR. GRAHAM:** I am going to present an overview of a process for analyzing staff and space requirements for facilities planning, and will describe several computer modeling techniques that can be used as part of these analyses to forecast staff and facility requirements during the space programming of the planning process.

At DOT you have already completed some basic programming activities. I do not know how much variation from this early work will be permitted as the building evolves. We understand you have used office planning guidelines from GSA to determine the kinds and amounts of space planned for each group to be housed in the building. However, some of my comments may be useful to the planning team as you continue to refine the development of the building.

I will include several figures as part of this presentation, to show you some modeling approaches found useful in the past. (Figure 10)

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**PROGRAMMING AND MODELING**

A. The Planning Process

B. Programming (organization, forecasting and standards)

C. Space Size Standards (Computer Gaming)

D. Space Requirements Report

E. Initial Space Planning (vertical stacking and basic floor layouts)

F. Summary

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**Figure 10. Programming and modeling**

Programming and modeling should be considered to be a process rather than an end result that occurs at one time. We understand that the building being planned by the Department of Transportation may not be ready until the year 2000, or somewhat earlier. During this time, many changes will take place in the organizational structure; the way people operate; some concepts of automation; and new technologies. As changes take place, modeling the programming data will be essential as a continuing process until the time when the DOT and its planning team will have to "lock in" the organization, staffing and space requirements information, so building construction can be completed, and your staff can be moved into the new building.

I will talk about the planning process, or programming, which is related to the organizational structure and the forecasting techniques for people and space. By the way, just because the building is being planned for government agencies does not mean that forecasting is not an integral part of determining how many people, and what kind of people, should be in the organization, as would be done for business operations.

The planning process discussion will be followed by a consideration of the use of space size standards (figure 10, item C). We talked about standards earlier this morning. At that time we discussed the relationship of the workstation to the building shell - the effect that workstation sizes and dimensions might have on the size and dimensions of the shell of the building, or the effects that the shell may have on workstation sizes. Therefore, I am going to omit detailed information about office space standards, but later will show some of the effects that these standards have on total space, and on the gaming process.

Under item D of figure 10, Space Requirements Reports, I will describe the several types of space requirements reports that should be prepared for presentation to department heads, middle, and top management. Reports are essential parts of the planning process, regardless of the concept of the future, sometimes called the paperless office. We know that the paperless office does not exist, and so space requirements reports and ongoing progress reports should continue to be produced from now until you move into the building, and even afterward. In this way they become an important part of the entire planning process.

I will not cover item E in figure 10, which is concerned with organizational unit adjacencies, and how they can fit within a building structure, both in vertical relationships and in floor plan layouts. (Figure 11)

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**The Planning Process**

- Planning has developed into a strategic science.

- Business and administrative practices have improved.

- Advanced statistical tools have been developed.
  - Decision support systems (DSS)

  **Major Factors in the Planning Process**

- Organizational Structure
- Staff forecasting
- Office space standards
- Miscellaneous (support space)
- Alternate standards and space requirement comparisons
- Space requirements report
- Department adjacencies

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**Figure 11 . The planning process**

Items A through D of figure 10 cover most of the major factors in the planning process. These include organizational structure, staff forecasting, space standards, determining all types of miscellaneous space - space for equipment and special purpose functions. Computer gaming provides the planner the opportunity to evaluate variations in standards, numbers and types of staff and to see how these variations impact space requirements. (Figure 12)

**Figure 12. Staff forecasting - trend analysis**

Figure 12 shows several ways of forecasting staff numbers for an organization. In the past, when I first started in this business, an organization would often simply tell the architect or the space planner how many people they employed. This number was then multiplied by an average number of square feet per person, and from this total, the building size was determined. Many horror stories exist about buildings planned this way.

Various forecasting approaches are used to trend historical growth patterns and extrapolate these data for the future. They are used to: determine how many staff members there will be in the planned building; the kind of positions needed in each organizational group; how positions will be related to the organizational structure; the position classifications of staff members in each organizational unit. Then, using various statistical techniques, the staffing levels would be determined.

Figure 13 describes another approach to forecasting. Although these other approaches have been useful in the past, I have used another one for many years. I call it "controlled totals."

**Staff Forecasting - Controlled Totals**

Apply a system of staffing control totals to all segments of the company. This method can be used for either micro or macro planning.

1. Determine the total projected numbers of staff for the total organization, using one of the techniques in Figure 12.

2. Then, using this number as a control total, determine the projections for the next hierarchical level of each organizational division, based on:

   - Past trends of division's performance
   - Size proportion of each division to the total company staff, and
   - Expected sales or operating performance patterns or changes.

3. Next, using the control total for each of these divisions, determine the total staff projections for each department within the division.

4. Give the supervisor of each organizational unit, his or her control total of staff.

   - Totals will be the allotment made.
   - The supervisor then distributes the staff positions among job categories needed to operate the organizational unit.

**Figure 13. Staff forecasting - control totals**

In this technique, instead of trying to forecast the staffing for each small operating unit, as many have done, and adding the results of these projections to get subtotals of divisions, and then a grand total for the entire organization, it works the opposite way.

You start with a forecast of the grand total for the entire organization. That forecast is determined using various business and statistical approaches, including some of the methods mentioned earlier. The total numbers of staff are then estimated by including data about operating performance patterns within organizational types, new activities that may be added, existing activities that may be eliminated or moved to other agencies, and management practices that may affect staffing levels. Among the data to be reviewed would be the federal budget, providing short term information about trends for the agency under study. In business organizations, other information would include sales trends, past and projected, marketing activities, and changes taking place in the business climate of the nation and/or region served by the company.

Once the total number of staff members for the organization has been forecast, this figure is used as a control total for the total planning process. The next step is to move to the second hierarchical level of the organization and do the same thing. However, at

this level, additional information must be examined - e.g. how each subgroup fits into the overall structure of the agency and into the entire organization.

In the next steps, one continues to move down into the organization, level by level, and develops information to permit the determination of control totals for each subgroup, and finally of individual operating units.

As a final step, the control total for each operating unit is given to the unit manager, who structures the staffing of his or her unit with the numbers and identifies the staff members needed to carry out the business plan within the department budget.

An example of the beneficial use of this technique took place 25 years ago in planning the Sears Tower in Chicago. At the start of the project, the President and Chairman of Sears would not agree with the concept of control totals, especially since this required the use of confidential business plans. They wanted individual department managers (93 of them) to decide how many people they needed - to be determined by consultants during individual interviews and department visits. Then these data would be combined to get the grand total of staff members to go into the new building. Forecasts were targeted at six, 5-year increments, for a 30 year projection. At the start of the project, Sears had about 6,500 national headquarters staff members located in the Chicago area in departments targeted for relocation to the planned building. The 30-year data were also to be used to determine the size of the new building, to be named Sears Tower, and now the highest building in the world.

An architect had not yet been selected. Using this approach, the total number of staff members for a move-in date (five years from the start of planning) came to 12,000. This represented an increase in staff of almost 100 percent in a 5-year period. The data presented by each department head also showed that after move-in, the increases in staff would be flat, so that after 30 years, the total number of staff in the building would still be 12,000.

This was absolutely ridiculous!

Top management of Sears was then convinced to permit the approach of control totals to be used. In using the revised approach, it became obvious that although the grand total of the staff in 30 years might be 12,000, there would be incremental increases in each growth period, representing a gradual growth to this figure. This incremental growth also represented a challenge in planning how the building would be used in the interim periods, before Sears would inhabit the entire building.

So, the concept of control totals is useful and should be considered when planning these kinds of spaces.

Figure 14 defines some of the elements needed for the development and use of space standards.

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**Concept of Space Size Standards - Repetitive Spaces**

Office Space Size Standards - Factors to be considered:

- Sizes of workstations should be related to the needs of occupants.

- The working environment should be comfortable and pleasant for occupants.

- The amount of space should permit the most effective functioning of staff during their working day.

- The sizes of workstations should reflect the image of the client, consistent with the ability to pay for that image.

- Sizes and types of work areas or offices should be similar in all divisions for similar position categories with similar work to be performed.

- The increasing proportion of professional staff and knowledge workers among employees merits consideration.

- An adequate office environment is an important prerequisite in hiring and retaining staff.

- Sizes and types of offices should permit flexibility for furniture and changes in organization, staff types or numbers.

- Standards should permit future decisions as to:
  - Type of furniture
  - Design concepts within offices
  - Design concepts for total space
    - Arrangement of offices or workstations

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**Figure 14. Space standards**

By using a limited number of office sizes, as different position classifications are assigned to offices, or as departments are reorganized, or locations changed, there will be less need to make structural changes to the space (i.e., to remodel the walls, HVAC, lighting and flooring). Instead, changes can be accommodated by moving staff to similar offices. Modifications can be made to furniture and furnishings for varying levels of staff positions, rather than to structural space elements. Experience has proven that this approach reduces the life cycle costs of facilities.

Minimizing the number of office size standards has been made possible in many companies by the fact that there has been a narrowing of the size differences of office space standards for different levels of staff members.

The average size of office space for clerical staff has increased from 38 to 65 square feet. At the same time, the average area for middle management and upper level executives has gradually been reduced.

In many new offices there has been an attempt to establish a single size of partitioned workstation for clerical and junior and middle manager positions. This approach has met with varied success, often depending on the overall atmosphere of job and company satisfaction.

As a result of increased building space costs - both rental and construction - there is a trend to reduce the amount of space used by companies. These attempts have focused on office size reduction and other space saving techniques.

The next stage of the planning process is report preparation. Unfortunately, in today's business world, report preparation still invokes a process that results in lots of paper. (Figure 15)

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**Space Requirements Reports for Managers**

The results of the space analysis should be generated as a computer printout, either on the CRT screen or on paper.

**Levels of Reports**

Because they are computer-based, these reports can be generated in varying levels of detail for the three major levels of management - supervisor, middle management, and top management.

**Supervisory Level**
 Detailed reports

**Middle Management**
 Summary by division or department groups
 Division cost/benefit results for alternative data

**Top Management**
 Broad scale summaries showing growth patterns
 Total organization cost/benefit results for alternative
  data

Summary reports for top management should be designed to
 relate both to space as an end product and to business and
 financial operations.

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Figure 15. Report preparation

We know that the DOT planning team has many reports for the operating units expected to occupy the proposed new buildings. However, I want to define some reports that should be provided. These reports are easy to produce because of the computer capabilities now available to planners and space forecasters.

In addition to the hard copy reports, an interactive, on-line system of planning documents should be made available to the DOT. In this way, the DOT staff can employ computer gaming (playing the "what-if" game) without the assistance of consultants. This gaming process is possible without hard copy documents. It might include changes to the data or the requirements in some of the following ways:

- Changes in departmental staffing.

- Changes to the percentage increases of organizational units to change control totals at any of the levels described above.

- As control totals might change, the individual numbers of staff carrying out each function within the organization would automatically change, also resulting in changes to the space requirements for the unit, for the department or division of which the department is a part, and finally for the total organization.

- Changes to office space standard sizes.

- Changes to space-type assignments for staff positions.

- Changes to circulation factors, both for intradepartmental space (within departments) and for interdepartmental space (between departments).

For the formal, written documents produced for DOT, three levels of reports should be considered.

First would be detailed reports, containing the details of every operating unit. These reports should show every line item, file cabinet, and special purpose type of space that would be required for properly housing and performing the operations of the unit. This report would be given to supervisory-level people, such as the heads of the individual departments or small operating units.

These staff supervisors should then review the data for accuracy and for completeness.

The second level of reports would contain consolidations of the first level detail reports for review and use by middle management staff of the department. Since these reports are a consolidation of groups of departments, they should contain less detail than the first level of reports. However, if middle level management requires the more detailed first level reports, they should be readily available. These detailed reports could be used by middle management to validate decisions reported in their consolidated, second level reports.

To repeat, with computer technology where it is today, it is easy to consolidate the data contained in the primary level reports into consolidated summaries, and if the data are put on-line in the department, it would be easy for middle level managers to review these data and validate information about staff types, numbers and types of equipment, and special purpose spaces itemized by the department supervisors who report to them.

Finally, for top management, the same kinds of consolidated reports would be prepared, but consolidated even further. For this level of management, the reports should be concise and be annotated by graphics. In this way, a few pages of data can show top management the trends of divisional groups and the likely end-result for overall facilities planning. Data in this form can provide the basis for top management to make major decisions about the final facilities planning.

Several levels of middle management consolidations may take place, depending on the structure and depth of the organization. For example, at DOT, after the data are summarized for each major agency (Coast Guard, FAA, Highways, etc.), a final consolidation is needed for DOT, consisting of the totals and analyses of the information about the numerous agencies of which the Department is comprised.

As part of the development process in producing the information for staff, function, and space forecasts, there are several types of business analyses that are useful. These analyses are needed even for government agencies, although they may vary from those used for business organizations.

- Forecasts of staff might be related to the levels of
  government services potentially affected by changing
  social and technical trends that might affect specific
  units of an agency.

- In examining the types of special purpose spaces being
  planned, reviews of changes in trends and technology that
  might affect the operations of the agency should be
  considered.

- In addition to using the GSA guidelines for space standards
  for offices and workstations, DOT planners should collect
  comparative information from other government agencies and
  the private sectors for comparison to the DOT staff
  positions being planned.

In the private sector, it is often possible to relate facilities planning and construction costs to cost/benefits that may result. These cost/benefits are often related to opportunistic increases in income that may be possible as a result of the improved working conditions that new space may afford.

Comparisons should also be made between cost factors associated with leased space and space purchased or constructed by the organization. Although in the DOT situation, the decision has already been made for the government to construct the space, information about the alternative opportunities is good to have.

Cost benefit analyses also provide an opportunity to evaluate the results on the basis of many alternative gaming decisions, such as: alternates in terms of highs, lows, changes in standards, changes in numbers of people, different projections, and forecasts (in terms of where the business or organization is going.)

Figure 16 provides examples of computer generated reports of staffing and space requirements data.

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**Space Requirements Reports - Examples**

1. Tabulations and graphs of personnel estimates

2. Position categories by office type and space standards

3. Comparison of present and proposed space standards with other companies

4. Detailed and summary department reports

   For staff space:

   - Number of staff for each class of position
   - Space standard category and space size
   - Total space for each class of staff position
   - Subtotal of space for all staff members

   For Miscellaneous space:

   - Number of items not included within a staff office
   - The amount of space for each item
   - Total space for each line of special items
   - Subtotal of space for all miscellaneous items

   Circulation space:

   - The intradepartment and interdepartment circulation space

5. Summary department report

   - The total amount of space for the planning years
   - Subtotals for organizational groups
   - The grand total of all space

6. Comparison report for alternate space standards

7. Area per employee

8. Miscellaneous reports

   There can be many other reports made available to management, using the database of information prepared for the space requirements analysis process.

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**Figure 16. Space requirements reports**

Examples of these detailed reports appear in my prepared paper, (NISTIR 4801) together with a discussion of how they are used.

# OPEN DISCUSSION

MR. BLOOMQUIST: *What percentages of the cases where you have used this technique have you continued to acquire the data after the project is complete?*

**MR. GRAHAM:** *In about 20 percent of the cases we were asked to continue to monitor these forecasts. Maybe we were lucky to have been asked to continue in the best cases, but in many of those we tried to monitor, we were fairly consistent with the actual pattern of staff increases. In the case of Sears, for example, our forecast was within one percent of the changes made over a period of 15 years.*

*However, after that period, the forecasts then fell apart. The economy took a downturn about seven years ago, and all signals were off. About that time, a complete change has taken place for Sears. The Sears Tower building has been on the sales market. They are planning to move much of their staff from the Tower to new buildings in the suburbs. I have lost track of the numbers completely.*

*For about 15 years, in 5-year increments, we were within about one percent of the forecasts developed using the control total system. If the original totals presented by department managers had been used, we would not have been nearly that accurate, and the building size may have been different from the one that was built.*

*Political or economic changes may make it difficult to make accurate forecasts, no matter which techniques are used. For example, we worked on a project in Mexico - Banco Nationale de Mexico (BANAMEX). Before they changed their plan of moving most of their employees from Mexico City to another area about 45 miles away (Queretero), we were within 1-2 percent of the initial planning numbers, that were two years old. The government nationalized the banking industry.. Therefore, the numbers of staff to be housed in buildings in Mexico City underwent a drastic change, and so the projections were ineffective.*

*There have been other cases that fell within about a 5 percent accuracy range. Of course there have also been inaccurate forecasts, but they usually can be explained. For example, a company may merge with another one, absorbing large numbers of staff members. Or a decision may be made to move an entire group from another location to the building being planned.*

MR. CYROS: *We now we have an opportunity for the next 15 minutes until our break to have an open discussion.*

*This morning, Tim White talked about programming tradeoffs and workstation design processes. We had some questions then, and you may wish to bring up some of those issues again. We have just heard from Marshall on forecasting and computer modeling of tradeoffs.*

VOICE: *One of the problems we in government have, particularly those of us in the civil service, is we are talking about a building that is either going to be occupied one or two administrations later. Sometimes it is difficult for us to forecast what the Congress and a new administration might think we ought to be doing.*

MR. GRAHAM: *That factor created an interesting project for us a number of years ago. A new administration had come into being in Washington. A new agency was being formed (ERDA), to be made up of many elements of the Atomic Energy Commission. The GSA leased a building in downtown Washington that was empty, and they intended to move*

*much of the staff of the new agency into the new building as soon as Congress approved the Director of the agency. They did not know how many staff members could fit into the new building. In addition, they knew neither the staff levels of the new agency nor their space requirements.*

*However, GSA was asked by the nominee to head the new agency, that as soon as he was confirmed, the agency should rapidly plan to construct, and move the staff, to the new building in downtown Washington D.C.*

*I believe that it was the first time for the government that a computer was used to determine staff and space requirements, forecasting, and modeling. At the time our company was the only one with that capability and we were awarded the contract to perform this work.*

*We completed the staff and space requirements program in about seven days for about 1,200 people to be moved into the ERDA building. The building was then designed very rapidly. Everything was fine, we thought. However, about eight years later, a new administration came into power. I heard afterward that the new administration decided to dismantle the entire agency and move staff back to their old organizations and facilities.*

*Yes, changes in administrations can wreak havoc for governmental organizations and their facilities, and can make the staff and facilities forecasting process even more difficult than it would ordinarily be.*

MR. CYROS: *I spent yesterday at Texaco in Houston at a board meeting of facilities people that they gathered from their world sites. One issue I was asked to address concerned space standards. Another was out-sourcing. I have been commenting on these issues, based on work being done at MIT.*

*Corporate culture is changing in this country. Whether or not you recognize it, it is changing. The issue for users of facilities, planners and designers is to: 1) understand that it is changing; 2) understand what that means.*

*Although corporate culture changes may take another decade before getting picked up by government, I strongly suggest that you think seriously for the year 2000 about what impact that is going to have. We are shifting to 'mean and lean' corporations. The downsizing we see in this country feels good to many corporations. It was, and still is, painful for a lot of corporations. But they are learning new ways of doing things.*

*The second thing I would like you to think about is that when downsizing occurs and corporate culture changes, you want to look at how work will be done and, as Melissa pointed out, where work is going to be performed.*

*I have been suggesting that space standards tomorrow may not be what they are today. We may no longer have the benefit of the "perk" of space. As I rise through the organization, I get a bigger office. I suspect it is the quality of space that will be the perk as one rises up the totem pole. We may find project space where you will bring teams together to tackle a problem, bring experts from various agencies together, much like a military operation, and then return to your quality small space.*

MS. WOHL: *In a world in which computing becomes highly mobile and very easily connectible, with no need to take time or energy to forge those connections as you need them, the perk might be having all of those tools readily at hand, and he or she with the most clout might be the person with the nicest tools.*

DR. TORAN: *I have a question for Melissa (Allen), something that sounded to me like a discrepancy. The whole idea behind this new building was to bring all those people together and as Mr. Skinner (Secretary of DOT) is quoted as saying, "We are in all of this together." Yet, we hear that we go into the new building right away with the thought of still having other buildings. So, where is the concept?*

MS. ALLEN: *That is the political reality of Washington in terms of the budget process. When we multiplied the GSA space standard by the number of people, we arrived at a 2.4 million occupiable square foot building. We could not afford a 2.4 million occupiable square foot building. We could afford a 1.7 million occupiable square foot building. You divide the 1.7 million by the space standard, and you come up with 8,252 people exactly fitting in the new building, and the balance sitting in the old ones.*

DR. TORAN: *Yet, in the material provided by DOT, it appears that you want to bring together in one place your top management people. But if you bring together lawyers, decision makers and political appointees, do you still believe you will have 85 percent open space?*

MS. ALLEN: *We anticipate that we will. That is a goal that the Secretary of DOT set for us. I think the change you are talking about will happen in the Department.*

*One thing that happens in government is the perk of space. I am now in a 300 square foot office simply because of my title. I need much less, but because of my title I have it. We are going to have to convince the people to downsize.*

*I am interested in Marshall's (Graham) gaming ideas because I have been challenging the space planners on their planning approach. I am trying to get around 8,252 people in this building. They are allowed a given amount of space. In terms of equity you would like to strive for a minimum number of variations. For example, I don't get 300 square feet because of my rank.*

*Can't I simply take a number and see how many office variations I can get, and how many people can fit in the building, and then simply work around Tim's point of separating the two issues. I need an adaptable but independent shell, and I design the workstations and the clusters of workstations in the year 2000?*

*The example we talked about earlier is the FAA, which has reorganized recently, significantly enough to make obsolete much of the information gathered in our programming effort.*

MR. CYROS: *You don't think that is unusual, do you?*

MS. ALLEN: *Oh, no. It happens all the time. So, the challenge is can I take a statistical sample and keep running through it until I find the optimum values?*

MR. GRAHAM: *Well, as opposed to creating a building size by the control total method, you are talking about dividing established building sizes by an overall size standard, and arriving at 8,252 people. That is an overly simplistic approach. It can show how many people can fit into the entire building, if no thought is given to the facility needs of each department.*

*I am sure you have more data from your early programming effort. But this is why programming should be a continuing process, and one that considers the specific needs of the individual members of each departmental unit, rather than establishing one finite level of program.*

*Loading this information into a database will allow you to look at the variations in position titles within different organizations and provide more concise totals of office space sizes. These might then be modified from the point of view of amenities, particularly as a result of new technologies and modifications in technologies that might be applied to each departmental segment. Five or ten years from now, we may not have computer terminals in the present sense. We might have flat screens. We may not need the same size desk for a computer terminal.*

*But looking at these special needs, it is possible to consolidate numbers of different position titles and classifications - cutting across agencies - resulting in the fewest number of variations in sizes of workstations, using furniture and design amenities to provide variations in office types for different staff levels.*

*It would be very interesting to see whether DOT could do the entire new building complex using only three workstation sizes. That would result in two things. It would provide not only the ability to move groups around flexibly, but the opportunity to develop the kinds of spaces Kreon described - task oriented spaces - and even beyond that, to look at position levels that might not be in offices at all. For example, could any of the staff members be housed in alternative office space, such as the home office and other out-of-building approaches to officing?*

*Maybe DOT should end up with 5,000 or 6,000 people housed in the proposed building - and 3,000 people working in other alternative kinds of workspaces.*

MR. BLOOMQUIST: *Melissa (Allen), in our paper I mentioned three references. One is by DeMarco, another by Jones, and the third by McCue; they address your question.*

*I suggest also that you look at the type of workers. Stephen Roach (also referenced) divided white color workers into two groups: knowledge workers and support workers. I am not going to argue for that. But if you divide it that way, there may be different requirements for space.*

*The first three references apply to knowledge workers. DeMarco and Jones refer to databases and productivity that correspond to space - with reference to software programmers. Then our question is, "Does that apply across different kinds of knowledge workers?"*

MR. DUBY: *We use what we call occupancy objectives - 750 people to a floor. We have three standard office and workstation sizes. For your operation, you may want to consider that kind of standardization. Your bosses change every 18 months, and you have to minimize the risk of costly changes by coming up with that kind of an approach.*

*You say my building occupies 8,000. The culture is changing. We feel we have one workstation size that fits all, and that is basically the approach we are taking. I will discuss that tomorrow during my talk. But I think you can design to that.*

**MR. CYROS:** I would like to turn this meeting over to our next speaker. The subject area is going to be workstation standards/criteria, ergonomic considerations, environmental factors and the like. Dr. Alan Hedge is an associate professor in the Department of Design and Environmental Analysis at Cornell. For over 10 years, his research and teaching activities have focused on issues of office design and workplace ergonomics as these affect the health, comfort, and productivity of workers. He is conducting research on issues of indoor environmental design, especially in air quality, ventilation and lighting in offices. Like all good professors, he has published widely.

## WORKSTATION STANDARDS/CRITERIA; ERGONOMIC CONSIDERATIONS WORKSTATION ENVIRONMENTAL FACTORS

**DR. HEDGE:** Today I would like to give you some perspective on the research and design issues in which I am interested. In my written paper (NISTIR 4801) I have tried to set down some issues we are currently studying at Cornell. But before describing this research, let me provide a perspective on who I am, and what I do.

I am really not interested in buildings. I am neither an architect nor a designer. I am interested in people and try to understand how we can create environments with fewer problems than we encounter in many current buildings. From that perspective, I regret to say that the area of environmental design has the scientific status of alchemy.

When examining the environmental design literature one finds that virtually nothing can be systematically extracted to give guidance for future actions. In the absence of such guidance, we blindly continue to make all sorts of decisions about what spaces should look like, postulating what technology will and will not do, and seldom stop to ask, "What has worked What has not worked Can we interpret that information in terms of processes that affect human beings?"

An often overlooked point is that while buildings and technology change quickly, the basic human processes governing our biological composition and behaviors remain relatively invariant over time. So, the factors that affected the comfort and well being of the Romans are not vastly different from those that affect you and I, and yet, the buildings are vastly different.

If we are ever going to make progress in environmental design, we must shift our focus away from technology and look at people as well - understanding how various aspects of the environment impact both technology and people.

This morning we spent a lot of time discussing workspace standards because those are the geometric building blocks of space planning. However, they have virtually nothing to do with human behavior.

I have something I call "Hedge's First Law" - work expands to fill the space available. If I give my assistant 10 square feet of space, within a week it is not enough. If I give him 100 square feet, within a week it is not enough. If I give him 1,000, within a month it is not enough. It does not really matter. You have to define a critical limit, below which you cannot go - to accommodate a worker performing a particular job.

My presentation will not address some of these issues because I have been asked to talk about some of my workplace environment research I want to share with you what I think are the main issues that concern workers today; they are summarized in my prepared paper (NISTIR 4801).

Workers are concerned about environmental issues dealing with air quality, thermal comfort, lighting, computers, ergonomics of workstations and electromagnetic fields - all of which are influenced by furniture - space standards, layout, work needs of groups, work needs of individuals, and the degree of personal control given an individual over his or her workplace.

It is important that you not take any one issue, solve that problem in isolation, and expect that creating the best workplace consists of putting these individual pieces together. Our traditional design process cannot be expected to create sensible environments in which everything is properly integrated.

I have been asked to focus on the indoor environment. My research tries to make environmental design a little more scientific by examining some major issues concerned with lighting, air quality, and thermal comfort. My acoustics research has been limited during the last five or six years. However, ten years ago it was perceived as a major problem in open plan environments, and may well be an issue if your building is predominantly using an open plan design.

Let me describe some of our findings. The Steelcase/Harris Survey conducted several years ago looked at the health problems reported by office workers. This survey has recently been repeated, and shows the same pattern of problems. The most severe problem among office workers was eyestrain, which was reported by 44 percent of workers in 1977 and 47 percent in 1991.

We have surveyed 4,479 workers in 27 buildings, and also have found eyestrain to be the most common symptom, affecting 55 percent of workers. Our data show that eyestrain is linearly associated with computer use. The longer people use computers, the more they report eyestrain problems.

Specular glare on computer screens correlate with eyestrain. It does not matter whether the glare source is artificial light or daylight, the effects are the same. A crucial determinant of glare is how the light is distributed in a space and how that light distribution impacts the visual tasks of workers. In one of our projects we compared different lighting solutions that supposedly reduce problems of glare and eyestrain.

I do not have the time to describe our work in detail, but basically there are four lighting solutions for reducing glare. Task lighting was mentioned earlier. Task lighting is a non-issue as a solution to screen glare problems because if the ambient lighting design is appropriate, task lighting is unnecessary.

Most lighting problems in offices arise from the different visual demands of paper and computer work. Some people advocate very low light levels for computer work, and this may necessitate task lighting to read documents.

You have to think not just of horizontal illumination, but vertical illumination as well. People respond not to illumination, but to luminance differences in the environment. If you change the light distribution in a space, you can achieve an acceptable compromise lighting solution for paper and visual work that also accounts for changes in screen orientation and the use of flat screen technology. Down-lighting solutions, whether parabolic lights or paracube lights - can create glare problems because of screen orientation relative to the ceiling light source.

We have compared lensed indirect uplighting and parabolic lighting against traditional down-lighting. We found that by redistributing the lighting in a space, a relatively glare-

free environment can be achieved using lensed indirect uplighting, without compromising space flexibility. Workers tell us that parabolic lighting works less well to reduce glare, and fixing lights in a ceiling grid restricts the flexibility of the space layout. The study was performed in a Xerox facility. An example of traditional lighting in this building is shown in Figure 17. The parabolic lighting appears in Figure 18.



**Figure 17. Traditional lighting**          **Figure 18. Parabolic lighting**
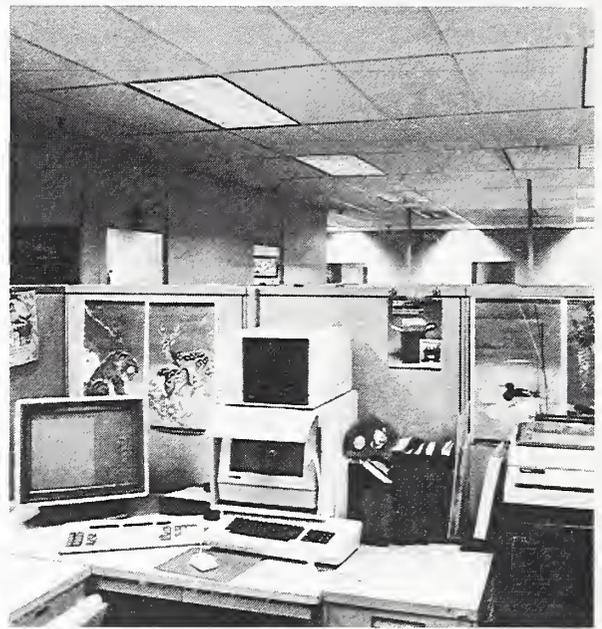
Parabolic lighting tries to reduce screen glare by reducing the light coming from the luminaire at shallow angles to the ceiling (<45 degrees) and increasing the proportion of light directed straight down. In effect, this creates fluorescent spotlights and very directional lighting. If you put a computer screen in the wrong position then you still have glare problems. Parabolic lighting creates a darker ceiling because of the way in which light is distributed. (Figure 19)

**Figure 19. Parabolic lighting at workstation**

We have found that lensed indirect up-lighting offered a better solution for glare problems. With this lighting the ceiling appears brighter than the floor. The design of this system also utilizes the finding that people judge the environment to be brighter if they can see the light sources, than if they are not visible. If you can see a bright ceiling, that is more like a natural day where you step outside under a bright sky, and the floor is darker in luminance terms. Then you will estimate that there is much more light in this environment. Lensed-indirect light providing about 45 footcandles at the workstation will make the space appear brighter than parabolic lighting which gives 75 footcandles at the workstation.

During studies over a 15-month period we found a dramatic effect on things like complaints of eyestrain when lighting systems were changed. After this time however, there were no differences. That intrigued us. We found that during the 15 months, more than half the people (100 workers or so), with the down-lighting had manipulated the lights, taken tubes out, switched fixtures off, or whatever, to improve the lighting environment.

When we looked at workers' estimates of productive work time lost as a result of lighting problems, there was a significant difference between the down-lighting and up-lighting systems. Even though workers did not report more frequent symptoms under parabolic lighting, they did report more lost time with this type of light. The same was true for reports of visual health. (Figures 20 and 21).
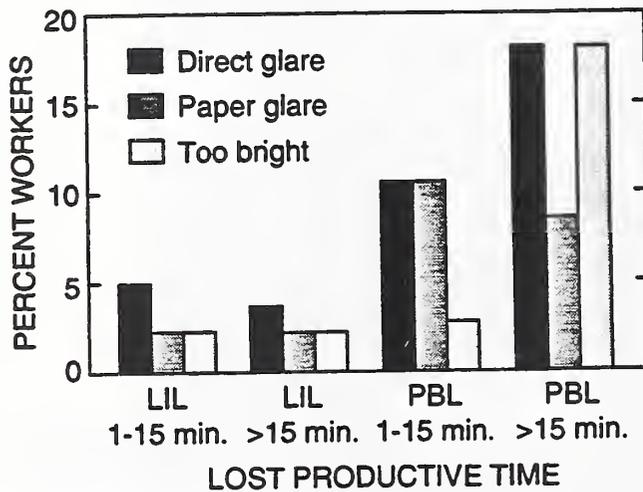
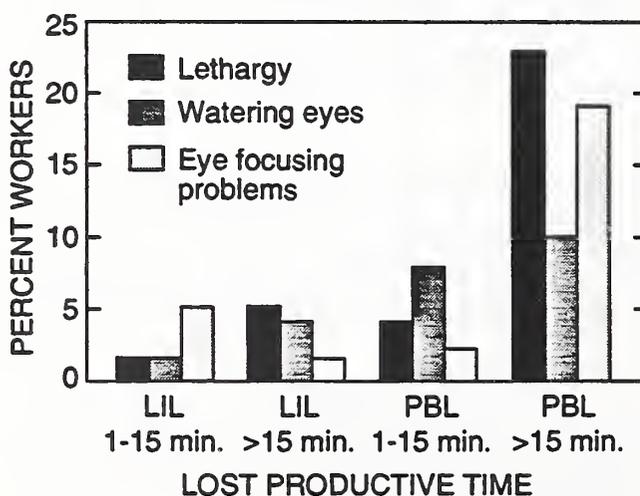**Figure 20. Lighting quality findings**



**Figure 21. Visual health findings**

In responding to the desire to improve the quality of light distribution in a space, it is not sufficient to simply advocate that buildings should have more windows. Windows are a major glare source. The European directives for computer use now require that you don't position a computer facing a window or backing onto a window. That poses problems with the geometry of many buildings. Although the principle is very good, in practice, it is not a sensible ergonomic recommendation, and trying to implement it for every worker makes no sense at all.

Now, let's look at thermal comfort issues. We have a tendency to design ventilation systems that work wonderfully in empty spaces. If you bring cooler air into that space, it mixes very nicely - smoke tests confirm such findings. But then designers often place furniture in a layout that disrupts air flow around the space. To overcome this, one hears all kinds of silly suggestions such as raising partitions from the floor to get more air movement, but research shows that this approach does not work.

We must rethink how to create more comfortable thermal conditions. I am not advocating any products or solutions. One proposed solution has been to re-think the design of air distribution systems. Instead of bringing it through the ceiling, bring it through the floor and then personalize the air control in a very "low-tech" way and get greater flexibility and possibly improved comfort. If you have a raised floor for cables - why not bring air under the floor as well?

The basic principle is to bring in cooler air at the floor level where workers desire cooling. The problem is that the computers, which are proliferating in offices, also produce considerable heat.

Various systems are available. One is German, the Krantz system, which uses a pressurized plenum and swirls the air up through diffusers.

Another one is the Tate task air system that uses a fan with speed and four directional controls. It swirls the air upward. Assuming you do not have back problems, you can easily reach down and adjust the control. (Figure 22)

**Figure 22. Tate air system**

In studying task ventilation we have found that people respond fairly favorably to this system. Task ventilation systems do not look very different from a normal office with an overhead air supply. But one nice feature of task ventilation is that if you design a space to be used for a group meeting area and an individual area, you can put more task air modules in the group area to supply more air where body heat raises the temperature of the space and workers require more cooling, while in the individual area you can supply less air. The units resemble little car grilles. You can adjust them as you would a fan control. (Figure 23)

**Figure 23. Adjustable air flow system**

People respond fairly favorably to task ventilation systems. They like the idea of adjustability and control, but seldom use it. That is an important point, and you do not need very sophisticated control over your environment. You want to feel that you can control your environment when you wish to do so, and that is often sufficient to change the perception of the environment. But I am not suggesting a dummy control.

Many engineers credit people with little intelligence saying, "Oh, we fixed the ventilation by putting dummy controls in this place." Those are ephemeral solutions. People usually are not that stupid. When they realize what has happened they become more alienated from their organization.

Another system developed is the Personal Environment Module (PEM) by Johnson Controls; Vivian (Loftness) is going to talk more about this system. It gives the worker control over a much greater variety of things - air speed, air direction, air temperature (using radiant heat panels), task lighting and white noise. Individual adjustments are made by means of a central control unit, using sliding switches. (See figures 24 and 25)
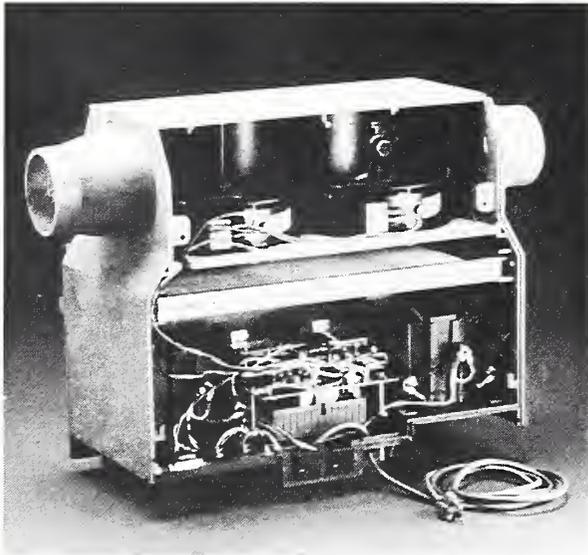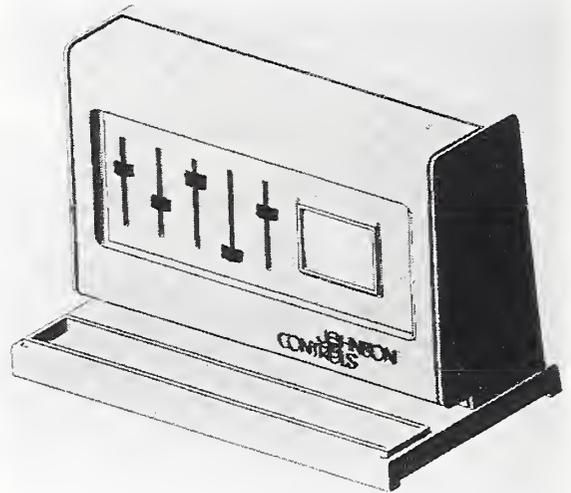
**Figure 24. PEM (inside view)**



**Figure 25. PEM (controls)**

The PEM has an infrared sensor on the control unit. So, when you leave your workstation, the system can shut down and it can go to a "base" operation. When you return, the movement detector senses that you have done something, and the system returns to the preset level.

These movement detectors are very nice, but there is a problem I found in some lighting work we have been doing, where the lights are controlled with movement sensors in offices. When you are writing or working on the computer, you often do not move much and the lights sometimes are turned off as a result.

Finally, I want to touch on air quality because this is the hot issue that I am involved in at the moment.

Ventilation systems are not the solution to air quality. You have to look for a combined solution. We have to control pollution sources in buildings, and people are a major source. Unless you have buildings with no people in them, you will always have an air quality problems.

Dilution ventilation is often proposed as a solution. However, this approach has its disadvantages. With dilution ventilation you bring lots of outdoor fresh air into the building. Most cities don't have outdoor fresh air. The last thing you want to do is bring it into the building.

One thing we have been exploring is to think of a building as a shell that provides basic environmental conditions for a person. Then the individual's workstation is 'fine-tuned' to suit his or her needs and preferences. Let's think about this as tantamount to giving each worker a mask to filter all the "nasties" out of the environment. When you do that, you can develop some interesting ideas of how to provide air filtration for workstations.

We have been testing a pod based system. This can be a single workstation or two or three or four or five or six clustered around a core, with filtration built into the center, which is continuously cleaning the air. This type of air cleaning is called breathing zone filtration. (Figures 26 and 27)
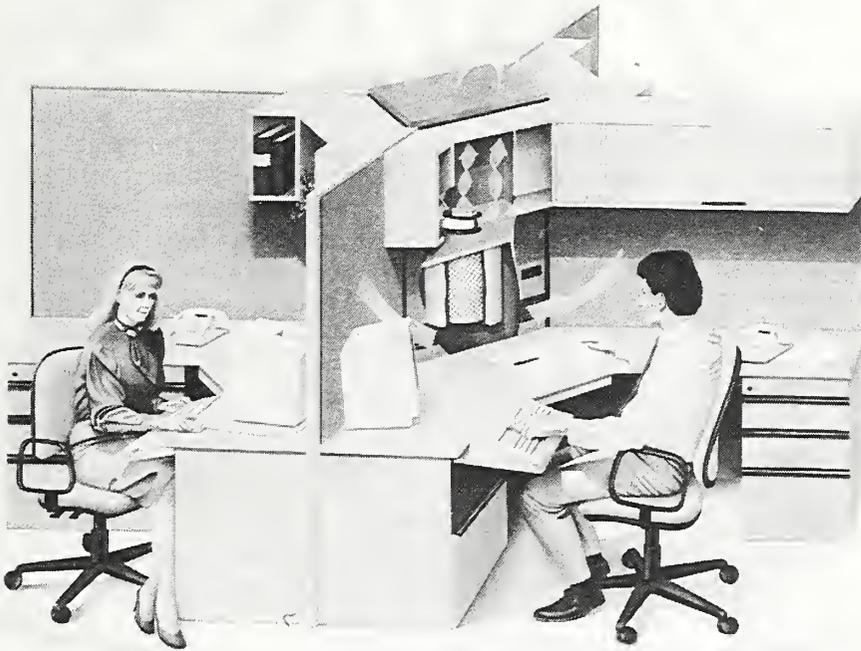
Figure 26. Localized air cleaning system



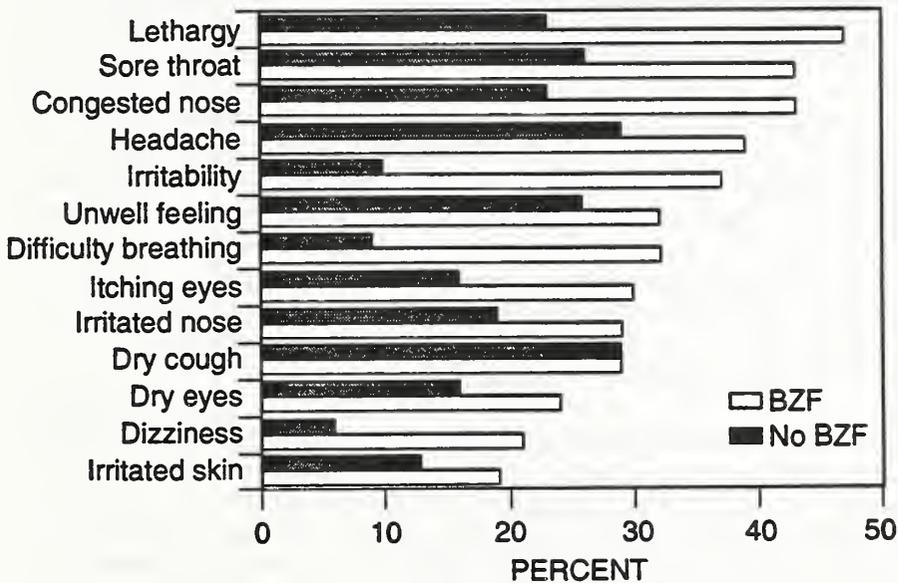## IMPROVEMENTS IN SBS SYMPTOMS

Figure 27  Research findings using localized air system

Although you may think volatile organic compounds (VOCs) are the major problem in buildings, the vast majority of epidemiological evidence suggests that is not the case. There is much more evidence now accumulating on the role of particulates. Breathing zone filtration will remove particulates and VOCs.

In one study. we examined the effectiveness of a breathing zone filtration system by determining the prevalence of sick building syndrome symptoms among workers with and without such systems. Within a two month period, significant improvements in symptoms were apparent among the workers using breathing zone filtration, as compared with those not using the system. I think we will see a trend toward creating workstations that do much more air cleaning and provide better individualized comfort.

One last point. We tend to think of people as dumb biological organisms who must be provided with optimum comfort at all times and everywhere. The body does not work like that. The body is a homeostatic system that needs variability. If you provide any sensory system with constant information - noise, temperature or light, for example, the system adapts to that level and eventually the system is fatigued, resulting in a state of discomfort.

We need buildings that are actually much lower "tech" than we often assume, but in which we give individuals much greater options for controlling and manipulating localized conditions. That does not require an all-purpose computer controlled system.

The reason that Europeans like little offices with operable windows is not that such windows are sophisticated ventilation devices. They are not. But Europeans desire that degree of control and will tolerate much more variation in temperature than will someone in an air conditioned office.

The other thing we must realize is that all the environmental conditions interact as do the building, the shell, the furnishings, and organizational factors. We are finding strong evidence that these factors affect the levels of stress in workers and stress has many adverse health and performance consequences.

One thing stress does is to change our perception of the environment. It changes our sensitivity to environmental conditions. Our most recent studies show that it changes the functioning of the bodily immune system, thereby changing our susceptibility to the health disorders associated with building occupancy, commonly reported by occupants.

I urge you to spend less time worrying about space standards, but think "inside out." Think about the need to create a quality environment for your employees, and then work out from there. Do not always strive for the highest technological solutions. Often very simple, low cost solutions, work much more effectively.

MR. CYROS: Our next speaker is going to talk about human resource issues. Dr. Cecil Williams is the corporate psychologist, the Director in the Corporate Development Group of the Herman Miller, Inc. in Zeeland, Michigan. Previously he was Director of Health and Wellness from 1986 to 1991. He also spent six years with Herman Miller subsidiaries, the Herman Miller Research Corporation and the well-known Facilities Management Institute. I have had the pleasure of introducing Cecil over a number of years and often refer to him as one of the deans of facilities management, particularly based on the his work at the Facilities Management Institute.

# HUMAN RESOURCES ISSUES

**DR. WILLIAMS:** I want to change our focus just slightly from what we have covered this morning thus far. We have talked about buildings and interior systems, and although the previous speakers have talked about people as being central to building concerns, it falls to me to focus on people issues a bit more, rather than on building issues.

In the global economy of the 1990's and beyond, human resources, not buildings, will be the competitive edge both for individual companies and for countries and governments. Because of the economic competition of the information explosion, the quality and innovativeness of human resources will actually spell the difference of that competitive edge.

In the United States, we have the potential for having the highest competitive edge in the sense that a good part of our history and our growth as a country have been because of the mix of people, the melting pot of the U.S. We continue to have that rich mix of groups - ethnic groups, racial groups, the global experience - that still surpasses that of our major competitors. So, we have to figure out some ways of utilizing that mix if we are going to survive in the kind of information competitive global environment that we have.

One of the things that is interesting, however, is that offices must become better at addressing new ways of organizing work, accommodating technology, and expressing the personal values and aspirations of the people who work in them. If not, we will be unable to capitalize on that mix and therefore, likely to lose our competitive edge. Our focus must always remain with the question, "How do we release or free the potential of our employees?"

We know that when work processes or physical places come before people, the results are stress, job dissatisfaction, poor mental health - and failure is inevitable. Therefore, building design or machine capability will not be the dominating feature of the effective workplace. Human productivity requires a more holistic perspective than simply crowding more people into a designated shell.

As we look at the history of office design, we find very little change. If you look at the offices of today and compare them with the offices of the early 1900's; there may be more technology; they may be classier looking; but basically, they could be exchanged for one another.

I think there is a message in that, because surely there is more technology. We are able to manage much more information. However, the nature of office work still involves getting people together to solve problems, providing products and services in ways that remain fundamentally unchanged from decade to decade.

But the organizational attempts to utilize human resources will probably affect office design more than the technology or building sciences because the real changes have only been in the handling of information. My point is that our technology still has not brought us to more effective utilization of each other in problem solving.

The attempt to release workers, to use the vast amount of information available to them, has led to an effort to decentralize workplaces, to push decision making farther down into the bowels of the organization rather than keeping it concentrated at the top.

I think the trend that we are seeing in workplaces also mirrors the collapse of dictatorships and collectives around the world.

The trend in office design is clearly toward a decentralized, customer-oriented model, where continuous learning, flexibility and change are the hallmarks. We are already hearing about self-managed teams, autonomous work groups - many growing out of the quality of worklife movement of the 1950's and 1960's.

This change in hierarchy and organizational behavior will have enormous implications for the configuration of workstations. There will be a need for more project rooms where people can be assembled in teams working together rather than in individual offices. Offices will be clustered with removable partitions to provide an opportunity for privacy and to work together at will.

There will be greater access to information linked to ever larger and larger networks, but not limited by where there happen to be electrical plugs, because of building design.

"Movable", "collapsible", "portable" will become more descriptive of the furniture needed for these spaces.

Teams will need to understand how to learn and practice together. How can work teams become more like athletic teams or art ensembles, such as dance troupes, orchestras, etc? Those are groups that know how to learn new things together. I think currently in most of our work groups, we learn things individually and then we try to figure out some way of sharing that information, but it is almost shared on a one-to-one basis rather than team learning. I think that is an enormous challenge for us in the future.

There will continue to be greater participation or democratization, as we might want to call it, at all levels of management - including space design. I think that this workshop, as evidenced by the number of people in this room participating in the design of the new DOT building, is an example of larger and larger participation in building design and management.

Because of the need for more highly developed skills required for good team participation and the declining birthrate in the United States, the 1990's and beyond will have the tightest labor market in decades. The number of white males, for instance, is beginning and will continue to decline in the American workplace, and we will be recruiting people who did not work in the 1970's and the 1980's. Probably this list is familiar to all of us. The people whom we will be recruiting will be the elderly, the people who have retired early, immigrants, women, minorities in greater numbers, and the handicapped.

It has been said that the Americans With Disabilities Act (ADA) of 1991 might be the most significant piece of legislation ever to affect the workplace. Attention to the requirements set forth by the ADA will lead to greater awareness of the need for accommodating workspaces for the handicapped.

As a result of these regulations we will see more furniture where the work surfaces will raise and lower according to the various handicaps of the individuals being asked to use those work surfaces. We have talked a lot about computer usage and computer screens. We will need to be better able to access them, whether they are flat screens or the kinds of devices that we use today.

We obviously will have greater wheelchair access. I think most architects and designers are looking for ways of integrating these special requirements into design so they do not call attention to a person's handicap.

Accommodation must be made for the hearing impaired. We are likely to see more need for sound amplification of telephones and computers. This has many design implications, especially for open offices.

We have already heard about lighting, but we are going to need to be aware of the different lighting needs of people who are visually handicapped.

One of my major interests as a psychologist is what will happen when we have to accommodate a greater range of people with intellectual and emotional impairments. I do not know whether there will have to be a "shrink" for every 300 employees or whatever, but it is a challenge that confronts us as a result of the ADA legislation.

What about the impact of the aging workforce?

This is another group we hear a lot about. Soon, it is going to be very difficult for organizations to allow older employees to retire because we are unable to replace their skills. This is going to be a crisis. We will be recruiting more of the retired into the workplace.

In spite of having an aging workforce in the 1990's and beyond, the U.S. will have a younger population than either of our major competitors - Europe and Japan, whose work population's are aging at a faster rate than is the case in the U.S.

Another paradox, however, of the older worker is that the elderly have a per capita income higher than the average American. They comprise one-sixth of the population, but own one-third of the household net worth in the U.S. and 40 percent of the financial assets. So, the competition for these people will be very keen to entice them back into the workforce. I believe that one major inducement is a good and healthy work environment.

We need to think about accommodating the elderly workforce in new ways. Many of the younger members of this population, the 45 to 60 age group, will need assistance in caring for elderly parents. Historically, when life expectancy was the late 50's and early 60's, when workers reached that age, they rarely had to worry about aged parents. Now, most of us in that age bracket have some responsibilities for elderly parents.

More and more we see organizations and governments trying to deal with those issues by providing elder care at the worksite. A report published about two years ago indicated that over 300 private firms had made arrangements for employees to deal with the elderly in some way. (This number is likely to be larger today.)

We need brighter lighting probably because people have poor eyesight as they develop cataracts, etc. You are probably familiar with the use of bifocals and trifocals, and what happens at the end of the day while working at a computer screen all day long. You clutch your neck, trying to accommodate the inexorable passage of time in your body.

More attention needs to be paid to ergonomics. Finally, after about 25 years, we now hear a good deal about ergonomics, partly because of increasing health care costs.

Another need for the elderly is voice amplification, which I mentioned before. The hearing acuity in most of us begins to decline at about age 40. So, you can imagine the difficulty we are going to have as we continue to age. This is a particular problem in a truly bullpen type arrangement, containing a lot of ambient noise. It is often difficult for the elderly to comprehend the information they need - sound from a telephone, or even from a one-to-one conversation, because of the interference of the ambient noise from other conversations. Again, I am not suggesting that we do away with open offices, but these are challenges that must be met as we try to cope with those issues.

We also need better signage - primarily larger signage. There are some designers who think the smaller, the better. I read a document published by my corporation last spring. It is an example of what happens when you use gray type on gray paper. It is wonderful from a design point of view, but not very effective for someone like me - a member of the aging population.

Another thing we need to examine is the use of bright colors. It is harder for the aging to discriminate between colors unless they are bright. I think rather than the dull grays and beiges that dominate our offices today, we will begin to see more bright colors to help differentiate areas, particularly in signage.

More attention is being paid to health issues. We will continue to emphasize the need for quality health. Many companies and governments, as you know, provide facilities on site for exercise with tracks, swimming pools, machines, etc. We, at Herman Miller, are setting aside space for those kinds of activities.

We need to be aware that stress will continue to exist in the information intensive environments where we work. Should we provide meditation rooms or cool-off rooms? I have known some companies who have developed them. They are quiet places where people can go to get away from the hubbub of the office.

A group of us were talking recently about how few people take a lunch break. Who do we go to lunch with? We choose a colleague, and continue to discuss business while eating. We may need to think about some ways of doing stress reduction at the worksite.

There will be a greater demand for healthy food in cafeterias. What are the implications for that? Will there be a greater need for refrigeration to care for fresh foods?

Another trend that will continue is more women in the workforce. In the figures given to us from the DOT - women comprise about 48 percent of the 8,000 staff members currently employed. The prediction is that by the year 2000, there will be 61 percent of women working outside the home and will constitute about 41 percent of the total workforce.

The first facility management issue that comes to mind when I think about implications for women in the workforce are the toilets. Every woman here understands that it takes them more than twice as long as men to access and use a public bathroom. Most buildings do not accommodate these different needs.

Many of the 61 percent of working women will be heads of households with small children. Already there is a trend toward organizations providing on-site day care. I wonder whether there can be some overlap between the elder care and the infant care.

More women in the workforce has contributed to the creation of a changing management philosophy - we are moving from being in control of a process to facilitating a process. So, more managers will become coaches, teachers, etc, rather than controlling, directing - those things we learned about in the 1940's and 1950's.

Let me close by saying I think we are going to continue to see greater diversity in the workforce. We will have to provide buildings and offices to accommodate that diversity, to release the potential that is there, for us to maintain the competitive edge that we think we have at this point.

## OPEN DISCUSSION

MR. CYROS: *We now have time to talk about or raise issues of the previous two speakers, the workstation environmental factors by Dr. Alan Hedge and human resource issues by Dr. Cecil Williams.*

MR. BLOOMQUIST: *I have a question for Alan Hedge about thermal comfort. What does the research indicate about the correlation of cognitive performance to thermal comfort? I recall seeing a patent from one of our Japanese competitors where the HVAC system provides warm air for the feet while cold air is blown to the head. What research is behind that?*

DR. HEDGE: *There are a couple of issues here. There is work going back quite a while - done by Fanger, that looks at the difference in vertical distribution of temperature on perceptions of comfort. It defines the maximum temperature discrepancy between the feet and the head before people report thermal discomfort. Now, that looks at various things like the effects of warm ceilings, cold floors, or the effects of warm floors, cold ceilings.*

*Issues relating that to real environments tend to focus on the fact that women in the workplace may report more thermal discomfort problems because of wearing less clothing below the knee than men do, and they may perceive air movement around the feet differently than men because of that.*

*How does that affect cognitive performance?*

*There has been some work by David Wyon, which examined the relationship between task performance in terms of things like keyboarding rates in relation to temperature; the work tends to have looked at the effects of overheating. That is, when you raise the temperature, what is the adverse effect of that on keyboarding performance?*

*Other work examines what happens when the temperature of extremities varies. There are some quite good models, for example, showing the relationship between the hand temperature and finger dexterity. That has been developed for use in cold climates when military people have to manipulate objects like guns. That is quite well-known. The predictive equations are fairly good.*

*But in relation to cognitive performance, I am not sure, because cognitive performance relates to things like quality of decision making. There is some relationship between thermal conditions and interpersonal interactions, and that might be construed as affecting cognitive performance. There is probably some work relating it to specific tasks like reaction times, but that is a fairly trivial measure of cognitive performance.*

MS. LOFTNESS: *The studies of thermal comfort and gradations are more physiological than cognitive at this point. The problems are widespread. They have to do with excessively conductive floor losses. They concern the fact that women do not wear as much warm clothing as men; having thinner shoes and not wearing heavy wool socks. Radiant floor systems and floor distribution systems are able to cope with the thermal discrepancies and the needs of the lower half of the body versus the upper half.*

*There are also issues of clarity, and people being able to think and stay awake when their head is cool. I think there are more physiological phenomena that drive the discussion of having more thermal control.*

*One issue you might be alluding to is the raised floor example; a Tate floor system blows cold air at the leg versus blowing cold air at the head. One issue that Johnson Controls was trying to resolve was to bring cool air at the work surface and not blowing at the leg.*

DR. HEDGE: *I want to comment on a couple of things.*

*One is that in a raised floor system you do not have to blow cold air to create the illusion of coolness. The air coming out of those floor distribution systems can be as warm as 76 Fahrenheit, and by varying the rate at which the air blows over the skin, you can create the sensation of coolness. That is what happens when a person turns a fan on. It does nothing to change air temperature, but it creates a change in perception.*

*In addition, although there are pretty good physiological models relating to rates of heat loss, because the skin detects the rate of conduction of heat through the skin, it does not detect actual temperature. That is why the floor tile and a piece of wood at the same surface temperature feel different to us - the rate of heat loss is different between them.*

*But there are cognitive components concerned with expectations. If you go to the beach, you expect to get warm, and because the air temperature may be very high, you don't expect your mental processes will seize up. In fact, you will react much more negatively if you go to the beach and it is cool.*

*What we see in offices where people have very crude control over temperature, such as being able to open a window or open or close a door, is that they are more likely to respond behaviorally by doing those things or taking clothing off, or tolerating the variation in temperature and saying, "Boy, isn't it warm in here today" and continue with their work, than in a building where people expect an optimum temperature. I think there is a cognitive component that we have only just started to understand.*

*My general comment on the Japanese is that they often miss out on the cognitive components and are very focused on the physiological and mechanical issues.*

MS. LOFTNESS: *Something was not raised in the discussion, although Alan alluded to it - natural ventilation, operable windows and access to the outdoors. The outdoors may be quite polluted, but the indoors is twice as polluted when the outdoors is polluted. One problem of getting colds in airplanes has to do with closed cycling. Even in the best mechanical systems, the cycling is closed.*

*The Swedes now have a standard that demands operable windows - clearly stating that the reason is not to improve thermal comfort, but as a fail safe measure for mechanical system failure. I think that is a major issue.*

DR. HEDGE: *If you live in Los Angeles and are in a "smog day", the last thing you will do is open your windows, even though you may get more pollution indoors. Or, if you are allergic and there is a lot of pollen blowing around outside, you are not likely to open all the windows.*

*We cannot look at one or the other. The solution is not outdoors or indoors. It is how you blend those interacting environmental conditions together to create conditions that are devoid of as many hazards as we can identify. We have the air cleaning technologies within spaces to ensure this result.*

*For example, I have an allergic child and know the effects of using air cleaning technology in his room has been very dramatic compared to all other control technologies. I do not open his window on days where there are a lot of allergens in the environment. A lot of things are being removed by that air cleaning technology. I think we are going to see more progress in this direction.*

MS. WOHL: *You have alluded, Alan (Hedge), to several things that are more in the nature of perceptions and illusions which are useful in the workplace. For instance, you mentioned that when you use indirect lighting to wash the ceiling with light, that smaller amounts of illumination are perceived as greater amounts of light. We also know, for instance, that using white noise can actually mean that a larger amount of noise present in the workplace is perceived as a quieter place in which to work.*

*Are there other useful illusions that we can employ in the workplace that would allow us to use less space, or make more economical uses of workspace, and still have people perceive that they are working in comfortable spaces?*

DR. HEDGE: *Let me address the two examples first before I answer, because there are fundamentally different processes that relate to the lighting and the acoustics issues.*

*The sensory systems of the body are comparative systems. They relate a background level, a reference level, which is constantly varying, to the level of external stimulation. You can create situations in which the internal level becomes so noisy that people think things have happened that have not occurred or situations where you reduce the amount of internal stimulation and maximize the external stimulation so they can detect things happening.*

*For example, people say, "It is too noisy in here. So, let's make it more quiet and I can hear better." That is one way to reduce background noise and try to improve discriminability.*

*The situation you are talking about is using sound masking. One problem with noise is that people do not react to the decibel level unless you are at the thresholds of pain or of hearing. They react to the intelligibility of the sound source. So, a conversation is much more distracting at a given decibel level than a pneumatic drill or music at the same level.*

*The point about sound masking is to try and break up that intelligibility so that the ear adapts to that constant level, but it is not really constant, because it varies within a range. The person adapts to that level, and that becomes the reference level above which you try and discriminate sounds.*

*With lighting, we do not see illumination. Illumination is simply a measure of light falling over an area. What we see are luminance differences, brightness differences. A piece of paper looks white whether it is under moonlight or under bright sunlight, and yet, the level of illumination is phenomenonally different. The eye adapts to different levels of illumination.*

*The point about indirect lighting is that the perception - we can call it an illusion - works so the eye is better adapted to photopic vision, so our visibility improves when we distribute light in that way. The equivalent would be the ease of reading a piece of paper under an overcast sky. Under an overcast sky you cannot see the source of the light because it is very diffuse, whereas on a bright sunny day, reading that same piece of paper is very directionally sensitive because of shadowing. If you hold it in the direction of the sun, it may appear to be very glaring. That is the problem in most buildings. Very bright light sources are mounted in ceilings, and people are very directionally sensitive to that, which changes the luminance pattern. So, there are different processes at work.*

*I do not want to give the impression that by using illusions we can trick people into thinking the workplace is great. Instead, if we think about how the body functions, and how physiological and psychological processes interact, we can get a much better fit between the workplace and the needs, requirements and capabilities of people. To date we have not been very good at doing this.*

DR. DeCOUVREUR: *The tendency in large government buildings in Canada is to have very high air recirculation rates, to cut down the cost of heating and air conditioning. Are you aware of any study that tries to relate air recirculation rates with, let's say, overall discomfort and effect on productivity? Discomfort in the broad sense.*

DR. HEDGE: *Yes. A number of studies been published in the last year have looked at the effects of air recirculation on things like sick building syndrome complaints and perception of environmental conditions. They have not looked at productivity, which is very difficult to measure.*

*In general, those studies - one is being done in Montreal by Menzies and others - have shown that as you increase outdoor ventilation rates, increased complaint rates can result. Ventilation systems are often the source of the things that building occupants complain about, and blowing more air through the ventilation system can have the reverse effect of what you expect.*

*That is why I challenge ASHRAE on the concept of dilution ventilation. Conceptually it makes sense. In practice, unless you are very careful, it is disastrous to just rely on that approach. I think you need to look at the three issues I spoke about earlier.*

AFTERNOON SESSION

MR. CYROS: Our next subject area that we will be discussing is leading edge workstation design. Our speaker is Lee Bloomquist who is Principal Engineer at Steelcase. He is now focused on understanding office environments that help knowledge workers work more effectively. He is dealing with how academic research, producing knowledge that can be applied to understanding the workplace and designing office environments for high productivity. That also includes research about the knowledge that individuals produce in their interactions within social and physical environments and about the knowledge produced at social and organizational levels of aggregation. Currently Mr. Bloomquist creates computer simulations that assess the benefits of various office layouts. I am particularly interested in this subject, as I am all, and I would like to turn this meeting over to Lee.

## LEADING EDGE WORKSTATION DESIGN

MR. BLOOMQUIST: Dr. Rubin gave me a large list of topics which are addressed in my paper (NISTIR 4801). I would like to start with the first topic and proceed with the rest - if we get through the first one. I would also like to invite an interactive presentation, so that after each slide you can ask questions. (Figure 28)

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**TRENDS IN WORKSTATION DESIGN**

- Size
- Materials
- Flexibility
- Wire Management
- Seating

**WHAT FUNCTIONS AFFECT WORKSTATION DESIGN IN THE FUTURE AND HOW?**

- Visitor accommodation
- Type and amount of furnishings; effect on workstation size

**EFFECTS OF TECHNOLOGY ON WORKSTATION COMPONENTS**

- Design and configuration
- Size
- Accessibility

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Figure 28. Trends in workstation design

The first issue on my list is "trends in workstation size." I was talking with Dr. Williams from Herman Miller over lunch, and it seems that workstation size is one common assessment we work to in supplying furniture. Essentially, in the process of designing a building and laying out furniture, decisions can be based on workstation size - it could be Steelcase, Hayworth, Herman Miller, or other furniture. You do not have to make the decision about which manufacturer just yet.

These data are from the Department of Labor. The graph shows that non-manufacturing productivity (which we can take as a proxy for the service sector, comprising considerable white-collar and knowledge work) has seen essentially no increase since about 1970.

I will now take an unusual perspective for me - that of the customer. I am not going to be a supplier of office environments. What are the customer's problems today?

Recently in a popular news show on TV, economists were reported to say that productivity has recently increased. Then - in the same breath - they say, "But, unfortunately, that is because companies are laying off a lot of people" - because productivity is, in the model, "output" divided by "input." The various disciplines that roughly agree on this measurement are economics, sociology and industrial engineering. So, to increase productivity they decrease the number of people who are "costs" on the "input" term of the productivity equation. There are many issues here.

But when these data about lagging productivity surfaced a couple years ago (the first time I saw it was part of a presentation on the MIT Management in the 1990's study) the big issue was, "We have put in billions of dollars in computers alone during this time period. We did not get any payoff from productivity." Also, a couple of furniture companies grew to the size they are today during that time. Where is the productivity?

Well, that is my basic problem if I am a customer of Steelcase today. It is also a theme addressed in the document the DOT issued for this workshop. I read the word "productivity."

Well, what happened from 1970 on (the period of in increase in non-manufacturing productivity in figure 29) was that computers were used by "indirect" users - for example, payroll. You and I are "indirect" users of the mainframe computer. Our payroll check was processed by this computer. A hierarchical organization was developed in organizations to support the technology of the computer, and it did batch processing. It turned into one of the most conservative (in my opinion) bureaucratic hierarchies in business today - the MIS organization. Then PC's came on the scene and everybody started to do word processing, Lotus spreadsheets, and so on. So, the question is, "Why didn't any of these things result in increased productivity?"

Now people understand that you have to redesign the social or business systems, and then apply computer automation to that. So, one company, for example, managed to eliminate - I think it was 300 or 400 jobs from a business process - because they did that. This is what our customers are doing today. We anticipate they are going to start re-engineering. (Figure 30)

This is a business decision because what can happen next is that project leaders will negotiate with furniture manufacturers to agree on a price. This business process achieves an optimal price for the customer, and is one factor that determines the trend in what workstation size has become. First, everyone must fit their workstation into the layout drawing before they negotiate on a price.

We have been asked to think about how workstation size will change in the future. That is very much a problem, then, of how we still give the customer an optimal price, an optimal benefit - using the business process just described, say, when one manufacturer wants to offer a size that no one else can match.

Again, why is the workstation the size it is? Well, it just evolved that way. There was a force tending to keep it the same size it is, which is the business process. But there are also financial pressures for reducing the size.

When you look at a workstation, you say, "Well, there are plenty of counter-examples to needing that much square footage; people in space capsules - the Apollo mission. A little round coffee table with a cover was sent into space with three people in it. They achieved good performance. They didn't die because of limitations on space. And people in Japanese offices will put four people in the same space that I occupy in my workstation." So, there are plenty of counter-examples to the space used by current workstations.

So, it is not an issue of ergonomics, it seems, or comfort, health, or safety - or any of these issues. It is the life cycle cost issues that tend to make everyone want to squeeze the square footage down. But what is the one key measurement that we can argue that balances something else against life-cycle costs - that says the size of the workstation should be different than what it is?

I am going to say that is productivity. (Figure 29)

## PRODUCTIVITY
### Output Per Hour in U.S. Manufacturing and Non-manufacturing Sectors

Manufacturing

Non-manufacturing
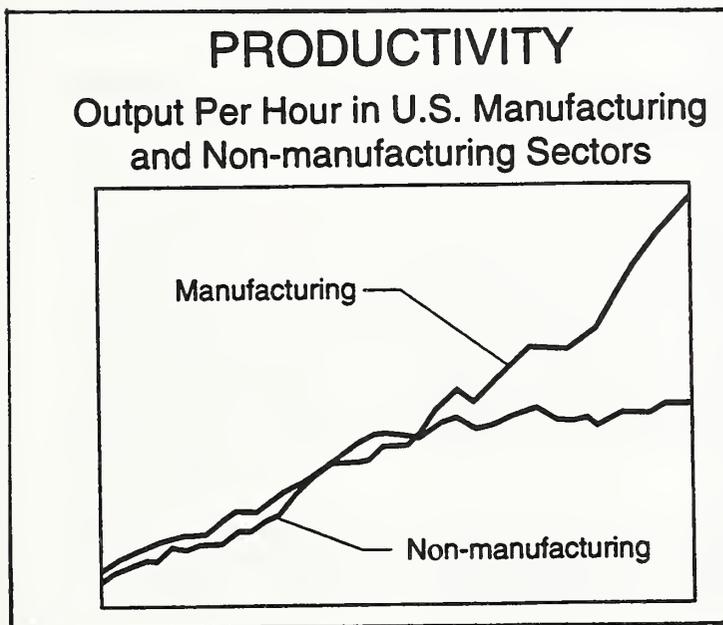
Figure 29. Productivity graph
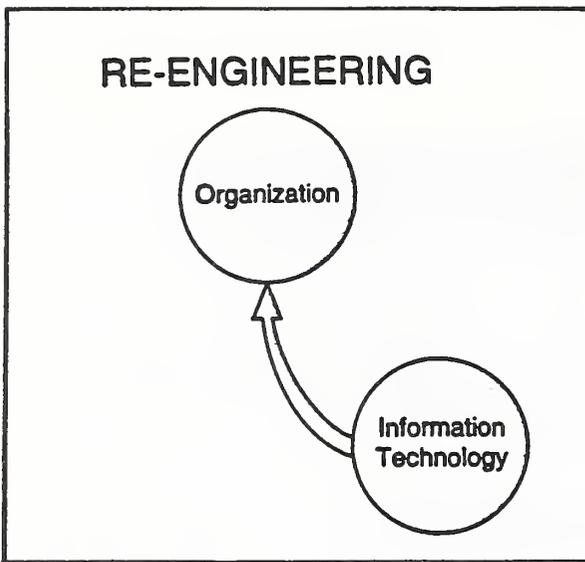
Figure 30. Re-engineering

There is a new element in the system. Before, the evolution of the organization was not intentionally considered with the design of the computer systems; and changes in the organization took place independently as well.

What is happening in re-engineering is that computer technology is being used to "empower the organization to evolve itself." When re-engineering an organization you use computer tools. You model your processes using a modelling technique that has been used in software development - things like "structured analysis and design technique" (SADT), etc. Those modeling tools live in computers. So, in essence, you are empowering organizations to use the computer to reorganize themselves more efficiently.

This is going to happen quite a lot, but there is a missing element. (Figure 31)
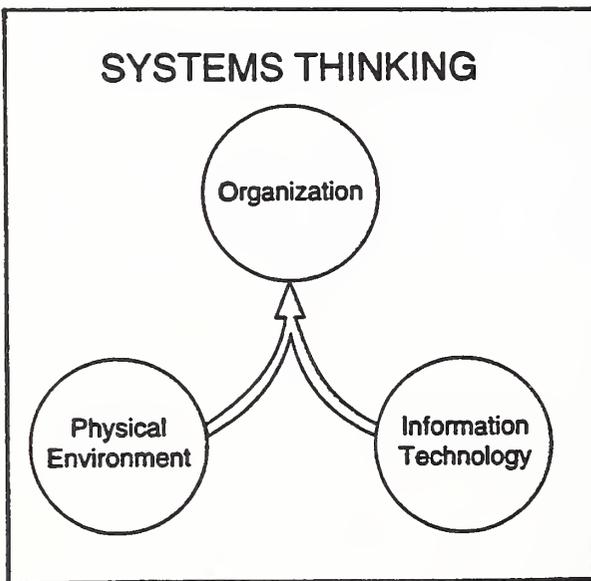


Figure 31. Systems thinking

In our paper we refer to a project by George McCue, 1978. I think this reference applies to your building because they measured productivity. They measured the productivity of software professionals - programmers who created software. Of all the knowledge worker professions, the software profession is the most studied, the most observed, with respect to productivity. In that building they observed an 11 percent increase in productivity attributable to the physical environment.

In the future, the physical environment must have to be part of the re-engineering effort. This is an example of systems thinking that Peter Senge talks about.

What American industry today is saying - what our customers are saying - is when they commit to re-engineering, they are committing to a constant reorganization. Bigger reorganizations might happen here and there, but American companies are going to be constantly changing.

With respect to facilities, the traditional method of assigning physical space for workstations is to get an organization chart and then map it onto the physical space. Well, what do we do when the organization chart is constantly re-engineered? A new practice is required in order to solve this. This new practice must be part of the re-engineering effort.

This is a challenge to our industry - to Herman Miller, Steelcase, and others - how to respond to customers' needs during this process of re-engineering, continual reorganization, organization charts constantly changing.

For example, the book, "Product Development Performance," (also referenced in our paper - NISTIR 4801) shows that matrix organizations in Japanese and German car companies achieved higher productivity than the traditional hierarchical organization in the American car company. Now, let's try to understand the problem the re-engineering people are facing. Who does the re-engineering? In a matrix organization you have a number of functional "silos," and then cutting across those, you have product-specific teams and groups led by a product specialist.

Who does the re-engineering in that matrix organization? Is it the people in charge of the products or those in charge of the function? Very interesting questions. Where do they all sit? Are there two places to sit? Things like that.

Dr. Williams and I had a luncheon meeting and we informally agreed that there was a need for our industry to come up with a productivity measurement - just as in the manufacturing industry interchangeable parts were enabled by a measurement technology (micrometers); and in the Civil War that helped the North create an enormous number of weapons. This advance provided the precision necessary to make interchangeable parts. It shouldn't be the case that Herman Miller has a ruler, say, based on the king's head size, while Steelcase has one based on the dimension of the king's foot. A standard system of measurements was a pre-requisite for the Industrial Revolution.

Today we have people like Erich Bloch, former director of the National Science Foundation, testifying before the Senate, "... in this global business environment - in this competitive world - knowledge will become a new critical commodity."

Facilities are a complex issue and many opinion surveys have been undertaken to evaluate facilities, but we have no objective measurements to financially justify expenditures, e.g. "Yes, it is okay to put this much money in facilities, this much in space, things like that." We have no such measurements.

A number of interesting, related problems have surfaced recently. You probably have heard about the problem at Stanford University, where funding was appropriated for research and questions were raised about how overhead expenses were allocated. Well, part of the problem concerned the researchers' needs for facilities. They weren't able to justify facility expenses with financial productivity measurements to the Congress or the National Science Foundation. So, they included these costs as part of their research expenditures.

This creates a fundamental problem because we intuitively know - we feel - that we probably need more than that 85 square feet. But it is just an intuitive feel, and the problem is, how do you financially justify that?.

You need a system of measurements, and the following figure is what a scientific approach to that system might look like. This is what is needed so that we can change from the space standards we have today to a different method of building assessment. (Figure 32)

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**PRODUCTIVITY: A SCIENTIFIC APPROACH**

- **Tools for observing the behavior of the system**

- **Tools for modeling hypotheses on what makes it more effective**

- **Tools for measuring to validate hypotheses**

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Figure 32. Productivity - A scientific approach

We would like to get beyond, as happened in one building, the approach of getting a number of workstations that satisfied the physical space - one from each of a number of manufacturers - and having employees vote on the one they preferred. The only objective assessment was the space they occupied.

Since we are entering an era when you can compete for global wealth based on knowledge, we need a system of measurements that apply to knowledge-productivity. I think it is incredibly important.

This system of measurement will allow us to assess the tradeoffs between space if we start from the shell of the building. We do not have that today. All we have are things like the Harris Survey, which we commission - opinions. How do you feel about your office, and other questions which provide some value. This is a big issue. I know some people in the audience have strong opinions about it.

MR. CYROS: *Perhaps we would like to get some of those opinions out. I have some, but I would prefer to go to the audience first.*

MR. GLENN: *I'm with NHTSA, and have been doing some informal surveys of existing workstations at FAA and various other places. Worker productivity is an issue I am concerned about.*

*In informal discussions I have asked workers one question. Are you happy in the workstation? The answers are so-so. But we have not factored in quality of space. If we are to keep our good employees and put them in less space, we have to address that as a major issue.*

MR. BLOOMQUIST: *There is something else too. There is a great deal of current work on research facilities, such as at Xerox Park, where they are studying collaborative work. We have sponsored some of this work. It is interesting because when you look at product development in corporations, some of the most important work is done up front, by teams with very little management involvement, because at that early stage there is very little that management can get their hands on. Big money decisions are not involved. There are not a lot of plans in place, but this is the concept level of development. In software, if you catch a mistake early, it costs you 10 cents. You catch it later, it can cost you ten million dollars. The work done up front is the most valuable.*

*This is what leads to thoughts about collaborative spaces, which we would then research to try and understand how they provide value. Now collaborative space is being used for knowledge work.*

*Returning to the example of re-engineering or matrix management where you have a person who is multiplexed between different tasks or even jobs. He is doing re-engineering. He is developing his product, and is also involved in learning. If he is doing all three collaboratively, what happens? Do we have a collaborative space for each team because that has value? Do you need three times the office space?*

*There are some fundamental issues here, especially when we talk about the virtual office. Nobody has studied what will happen when we physically fragment our organizations into satellite offices.*

MS. WOHL: *Why do you assume that you have to physically move all these people? A great deal of work has been done and information is available on collaborative work supported by computers. The Xerox Rooms Project and Coordination Technologies Together Project and some other things are available. They show that virtual workspaces are effective; people can work in three or four ad hoc teams, divorced from geography. They can work for half an hour a day on one team where their specialty is required, and then spend most of their work day in their permanent physical location. While doing this, they can participate in a computer conference somewhere else, for another part of the day. Why do you think they need three physical desks to do that?*

MR. BLOOMQUIST: *This is knowledge work we are talking about - not processing orders in this distributed fashion.*

MS. WOHL: *Maybe it is processing orders. Why make that differentiation?*

MR. BLOOMQUIST: *Has anybody measured the effectiveness of what has happened in terms of generating knowledge when you have several people in a physical space and they are distributed? What are the measurements?*

MS. WOHL: *No one has told me yet how you measure the value of knowledge work except for some work Paul Strassman did when he first went to Xerox. He first looked at PIN numbers trying to figure out if you looked at how well managed firms used information technology, if you looked at the differences in revenues generated, could you tell whether information technology was making a difference. He never convinced anybody that it did.*

MR. BLOOMQUIST: *I agree with you. Nobody has told me how you measure knowledge work either.*

MS. WOHL: *However, I am thoroughly bored with this productivity argument because there is so much bad economic theory built into it. I am really distraught - and I am an economist by training and background. When you compare different time periods and look at a computer that sold in 1980 for $6,000 and was a 48K machine that might process a screenful of text at a very slow speed and do something very uninteresting - while today, for $2,000, you can buy a machine, 100 times as fast, and can put elaborate graphics on the screen, and do much more complicated tasks, you better be very careful at using dollar-for-dollar measurements between those two things. You are assuming that the outputs are equivalent; they are not. What you are looking at is pure junk when you make that kind of comparison. It doesn't mean anything.*

DR. HEDGE: *I have been wrestling with this productivity issue for a decade. I think it is the wrong focus for a number of reasons. One, is that the curve is flat for non-manufacturing because we cannot measure it, and therefore the measure never changes.*

*We need to distinguish among a set of issues when we look at total effectiveness. The issue with productivity for knowledge workers is the same as the one for creativity. We have no good measures until the end of a person's life, and then we may get a handle on what they achieved.*

*There are things we can measure, a series of dimensions. We can measure a person's performance in terms of fairly trivial mechanical tasks, and that is what some companies do when they track keyboarding performance. But this performance does not tell us much about quality unless you are looking at trivial things like error rates.*

*Once you examine knowledge work and team work, you are looking at the effectiveness of decision making. Unfortunately, the effectiveness of decision making cannot be simply quantified because it depends on whether you are making a tactical or a strategic decision. It may be that an organization thinks it has done the best job possible in designing a new headquarters building, and in 20 years it may turn out to be the biggest white elephant ever, and you have to ask, "What went wrong? Why didn't things happen?" We do not factor those things into our equations.*

*We need to look at issues like retention and recruitment of individuals because they effect overall organizational productivity. It is not an individual performance issue. We need to look at long-term and short-term health costs because they impact on an organization's output here.*

*This output over input equation works well if you are counting widgets. When you get to knowledge work, it becomes highly misleading to think that you can quantify productivity.*

MR. CYROS: *We are getting into a dynamite open discussion. I am going to stop the questions, but I want you to retain them. We have some hot issues here, and I want Lee to finish his material so we can return to them in the open discussion.*

**MR. BLOOMQUIST**: We have to move through the rest of the list very quickly. (Figure 33)

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**TRENDS IN WORKSTATION FURNITURE DESIGN**

- Size
- Materials
- Flexibility
- Wire management
- Seating

**WHAT FUNCTIONS AFFECT WORKSTATION DESIGN IN THE FUTURE & HOW**

- Visitor accommodation
- Type & amount of furnishings; effect on workstation size

**EFFECTS OF TECHNOLOGY ON WORKSTATION COMPONENTS**

- Design and configuration
- Size
- Accessibility

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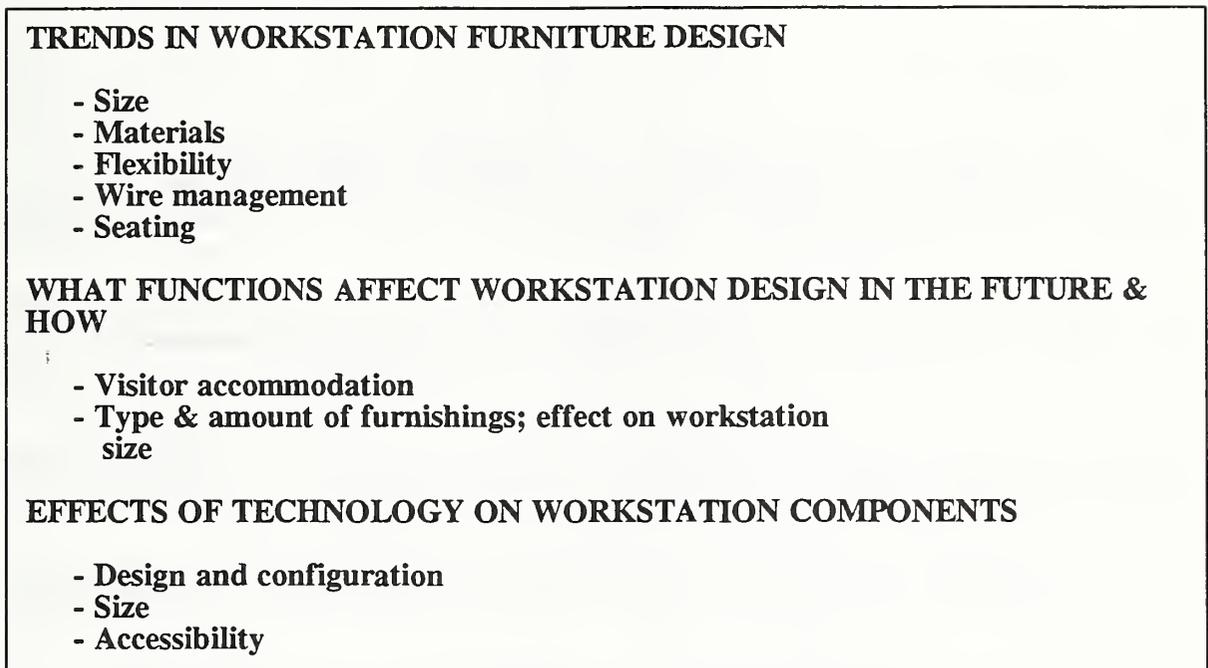
**Figure 33. Trends in workstation furniture design**


Materials have to be recyclable. No question.

Flexibility has to be driven by user reconfigurability.

A new architecture of wire management is needed. We have destroyed the value of systems furniture by sewing it into the building with power and cabling, and then we have sewed it together. We have destroyed the value of the flexibility. We need a new wiring architecture. There is a two-hour presentation on that.

Seating. In our research, we have run into a dilemma - there are tradeoffs between aesthetic appearance and function, where function provides adjustability and so on. This results in problems because the market has been so strongly influenced by aesthetics.

What functions affect furniture design in the future?

Visitor accommodation. One-sixth of the time, on the average, knowledge workers spend in working, they are meeting in a dyadic communication - communication in pairs. We expect that in the future those pairs will be communicating by means of a computer, and they will need to access and operate the computer. So, we need to match that with furniture. We need a dyadic workstation.

The effects of technology on workstation components.

Herman Miller with Unisys at the last NEOCON presented some architecture where a copper bus was used to plug in computer components. This was an example where industry would have to agree on standards. How do we get the computer industry to agree?

## OPEN DISCUSSION

MR. VALENTINE: *We have to deal with the difference between our desire to do something with technology and our ability to use it effectively. From a pragmatic standpoint, the cultural issues within an organization can dramatically impact our ability to achieve the theoretical benefits of new technology.*

*Amy, I do not disagree with you but we have a client - a major insurance company leasing some 2 million square feet across the United States - about 30 percent is used for file storage. They have a long-term plan of getting into image transfer.*

*The problem is not the unavailablility of the technology, or their ability or desire to gain productivity and reduce office rent. But the workforce in that industry is not ready to accept the technology. In the estimation of the company it will take between five to seven years to get there. They are well behind the curve, but they certainly have the desire.*

MR. BLOOMQUIST: *Amy, I don't think I answered your question fully. You asked what about the research that has been done, etc.*

*The National Science Foundation has funded 11 experiments in computer supported collaborative work. Steelcase has been involved with one of them at the University of Michigan. It is the only one that is attempting to understand the effect of the physical environment.*

*Steelcase and Xerox Park have been funding research of distributed collaborative work, examining technology and physical spaces. It has led to the observation of - I am going to coin a term here - situation coordination, which is related decision making and things like that.*

*We are trying to understand these things. I agree with you that there are a lot of connotations to the word "productivity", that resurrects the ghost of Frederick Taylor. Those connotations come full force when we use this word.*

*The competition for global wealth is in the field of knowledge, and that is the output. Before I can measure anything, I have to observe it. I don't even know how to observe it yet.*

*Coming from the other side of the issue, there is the paradigm of infrastructure and wealth that our nation is based on. It leads to the fact that, for example, the behavioral sciences and the National Science Foundation funds 12 percent of proposals, whereas physics can fund about 40 percent. Why? Because it is probably weapons related. This is a paradigm of defending wealth that is generated in a physical means.*

*When we move to an age where countries can choose to compete for wealth based on knowledge, then - say, a developing country decides, "I have some oil. I am going to go out there. I am going to compete for global wealth. [I am referring to the articles by Stephen Reich, referenced in our paper.] I know that it is difficult to outproduce the United States in farming because they have a good infrastructure. They have an extension service. They have cities. They have elevators."*

MS. WOHL: *You are referring to the Singapore syndrome. Singapore went from being a third world country to an international center in eight years by deciding to do that.*

MR. BLOOMQUIST: *Right. They needed an infrastructure to compete. What is the infrastructure in the age where global wealth is generated by knowledge? It is the infrastructure we see in Japan's efforts to sell technopolis to Australia. It is this distributed set of satellite offices, intelligent homes, intelligent neighborhoods, intelligent buildings, intelligent complexes, intelligent cities. That is the infrastructure by which a country can choose to generate wealth from knowledge. It relates to the physical environment we are talking about here.*

*So, a developing country can ask, "Should I invest in a complicated physical infrastructure where I am going to have port cities and things like that, or a transportation infrastructure, or in an infrastructure that will help me compete in the knowledge area. Oh, by the way, there is a vendor for that."*

*"Now, who is going to bid for, say, the phone systems in that building? How is Steelcase going to make a sale when it is a total systems package? It is an architectural package."*

*Dr. Rubin's research and his publications on intelligent building and technology lists an enormous number of products that are offered under such an integrated financial deal. What would be the means of exchange in such a financial deal?*

MR. CYROS: *I would like to get more people talking about leading edge workstation design. There is a reference to McCue, 1978, a design for software knowledge work increased productivity by 11 percent. A very small systems development group reports to me. It is a $350,000 a year function. The way you get increased productivity is not to have people punch a clock. If they want to go from a 386 to a 486 computer, you give it to them. If they want to work at home, that is fine with me.*

*What is important is that I, indeed, can measure productivity. I can tell you how long it takes to get how many workable lines of code in the old days. I can tell you how long it takes to go from a concept of what I want that information system to do, to a tested alpha site, or a beta site, and then into production.*

*There is a lot to be said about productivity in the workplace. I agree with you it is difficult to measure.*

MR. BLOOMQUIST: *We have nothing that correlates the quality of the facility to the qualitative research. But that is still part of the problem. It is still a justification problem.*

*What is the relation of productivity to leading edge workstation design as it relates to trends in space, size of the workstation. The problem is the business system assessment of square footage. How do you change that? The only way we are going to change to a new standard for space would be by some objective means. We need some measurement other than square footage.*

MR. CYROS: *Some measurement for?*

MR. BLOOMQUIST: *For the output of a knowledge intensive organization.*

MR. SUTHERLAND: *I think you just gave us a very, very good operational definition of the subject we are talking about, which is leading edge workstation design. Because what you just told me is absolutely antithetical to what I have heard up to this point. You said that as an enlightened manager, it is anything that works for that team, if they want to work at home, if they want to work weird hours, if they want to work in their car or on the beach or anywhere else.*

*What we are here confronted with is a "one size fits all" office strategy which to me is probably as comfortable as a "one size fits all" shoe. I do not see how we are going to reconcile, what I happen to believe, the view that you establish purposely or otherwise, this flexibility to respond to the individual and idiosyncratic nature of work with the traditional approaches to the office which deal with putting people in these little physical boxes and assume that somehow a miracle is going to occur. That, to me, is the real issue of advanced workstation design.*

VOICE: *They are advocating total quality management. Yet, they are telling you to put people in boxes. If you do that you need some kind of little mini-conference rooms or tables designed to facilitate that kind of interchange. You have to design a management information system, local area networks, that will facilitate the ADP side, and then link all your administrative activities on a centralized basis, to serve the interchange between information at all levels.*

MR. CYROS: *You should read a paper by Dr. Philip Stone published in the Harvard Business Review in 1989. Robert Luchetti co-authored it. It discusses productivity in the workplace by trying to understand how we perform work.*

The next topic of discussion is voice communications, security and safety systems, video conferencing, and the like. The speaker is Peter Valentine, who is President of COMSUL, Ltd. He also has overall marketing responsibility for the organization. He has extensive business experience in the financial community, which has been augmented through his 17 years with COMSUL, with a thorough understanding of the technical issues involved in today's telecommunications environment.

# IMPACT OF NEW TECHNOLOGIES ON OFFICE AND WORKSTATION DESIGN, VOICE COMMUNICATIONS, SECURITY AND SAFETY SYSTEMS, VIDEO CONFERENCING

**MR. VALENTINE:** I am going to present a little different view than originally planned - the one in my paper.

I will not try to discuss all of the systems coming in the marketplace. Having scanned Amy Wohl's material, she is gong to cover that very well tomorrow.

Instead I will talk from a pragmatic standpoint, describing our experience in terms of a competitive swimming dive, about two and a half on a scale of three, i.e. integrating technologies into the workspace, and our planning and design efforts. Then I will talk about integrating technologies at the desktop level, and Herb Rosenheck will discuss connectivity and networking issues.

I first want to cite the difficulty of moving technology into the workspace. Up until the last year and a half or so, the technology portion of workspace and architectural planning, were treated as stepchildren. Technology planning was not deemed to be a critical strategic planning element. There was an assumption that the vendors, the mechanical and electrical, or the utility, would provide all of the necessary information for project completion in these areas.

Within the last few years, there has been a general recognition on the part of investors in occupied space that technology represents a significant portion of workspace costs and investments, and one needs to consider how to provide an orderly process to bring needed technologies to the workspace. There is also a recognition that the technologies are going to change.

We are struggling with two, three, or four issues here. One is the ability of the workspace to accommodate all of this "baggage" called technologies, understanding that this baggage changes dramatically.

The other interesting thing about technology issues at the individual workspace level is organizational behavior. One thing learned from our experience is that although most organizations believe they have great top-down control of how to make decisions and develop methodologies for providing workstation technology, we often find an equal amount of bottom-up growth of technology at the individual level. I am not sure why this happens. I suspect it has to do with individuals perceiving they will be better empowered and better able to take care of their career path, if allowed to select differing technologies.

In a typical large organization - in banking or insurance - if a small group of people comes to an MIS manager and says, "There is a group of six of us that needs to be networked; we would like you to build us a LAN network," and the MIS director says, "I got you covered in 1993," it takes them about 15 minutes to go to Businessland and buy something to fill their needs. You also see wires taped on the walls and on the floors. There is a heck of a lot of technology growth from the bottom up.

The next issue is connectivity - signal transportation. This information allows the interacting and integration of networks, LANs, both horizontal and vertical wiring, inter-organizational connectivity, and access to remote databases.

Third, is the need for a common language between the people involved in technology and those trying to define the building process - to better understand how to define a common goal without confusion. In our practice we spend 25 to 30 percent of our time being interpreters. We need languages to flow from planners to designers, from designers through specifiers to vendors, and from vendors to implementation teams. So at the end of the day when you move into a space, it in fact works.

One way of thinking about technology (not in terms of how elegant the particular devices are today) is that the routines we go through in our daily lives do not change much. As one panelist said earlier, if you think about what we do in our workspace, i.e. the routines we carry out, we get information, we manipulate it, and pass it on to other people. If you examine what was considered to be high "tech" in the 1960's and earlier vs what is happening in the 1980's and 1990's, and what it will be in the future, you will find the devices may change dramatically, but the routines don't change.

What we are concerned with in planning to integrate technologies into the workspace are: understanding the impact on users, user training, career pathing, cultural and personnel issues, the impact at the workstation and finally, the work that needs to be done.

Technology integration is primarily concerned with flexibility. We need to provide a flexible building or workspace product that, for lack of a better imagery, I think of as a sandbox.

By that I mean that on Monday we may want to bring buckets and shovels to the sandbox, and on Tuesday or Wednesday we will bring little jeeps and trucks there. It makes no difference, because eventually major changes will be made in the types of toys the users bring to the space, whether they come from top-down, or from bottom-up. We still need to understand how to make that space as flexible as possible.

Another way of thinking about flexibility from an investment standpoint is to accommodate technology. We can put anywhere from $2 to $20 a square foot into a workspace to achieve the needed flexibility, whether it is a raised floor or another design.

The question with any organization is, "If you were to draw a line and say here is $2 a square foot and here's $20 a square foot, where do we need to be on that line with this building, with this project, with this organization?"

To protect the integrity of the building investment and still achieve the productivity levels desired for the user and the investor, to ensure that the space does not have to be continuosly redone, we must determine what level of investment will achieve the desired level of flexibility.

Some trends converging in this flexibility issue are the development of more free addressing and "just-in-time" offices, used by some major accounting firms. Generic spaces, not identified with particular individuals, are becoming popular. For example, the Arthur Andersen Company in San Francisco has spaces where a consultant comes in during the week and is assigned a temporary space. He or she, using a portable computer, places it on a desk, and plugs in.

My paper (NISTIR 4801) contains a specification for integrating technology into a workspace and furniture system process that we produced for I think, UNOCAL's headquarters, Carnation's headquarters, and a few others. I would like to get some

feedback on this document. It is based on information from four or five different practical jobs that we worked on. It covers issues of surface, space sizes, power, cable distribution, cable management and storage.

**MR. CYROS:** Our next speaker will be Herbert Rosenheck. He is the President of Technology Planning Associates (TPA), which is a consulting consortium of specialists that provide information systems and telecommunications strategic planning. Prior to Herbert's establishment of TPA, he was Vice President and General Manager of the TRW Information Services Division, responsible for the development and operations of one of the nation's largest computer network systems.

# INFORMATION AND DATA SYSTEMS, NETWORKING, PRESENT AND FUTURE

**MR. ROSENHECK:** Many organizations reside within the Department of Transportation. While not necessarily requiring functional dependence on each other, inter and intra-communication within individual organizations are needed. As such, the building design should reflect not only the people requirements but the communication and computing tools required to communicate with each other, in and outside the building.

It is assumed that multiple data centers could be located within the building in addition to terminals, local area networks and related peripheral equipment. Technology allows data centers to be located anywhere - not just within the centralized building complex. Rapidly changing communication technology trends indicate very high speeds and capacity can be transported to remote locations at cost-effective rates, including voice, data, text, and images (documents, video, etc.) in analog and/or digital form.

Computer speeds and capacities are continuing to increase exponentially to support the increasing population and the capabilities of electronic devices. While the present ratio of devices to people may be relatively low, future trends show that the ratio will move toward a 1:1 ratio in the near term and 2:1 in the longer term. The more advanced users of computer/communication systems have already achieved the 2:1 ratio.

In addition to workstations, there will be need for special purpose conference, project, meeting rooms, work areas, and video conferencing rooms, each requiring special purpose connectivity to current and future devices such as computers, terminals and peripherals. These will require a variety of means to achieve network interconnectivity within, and external to, the building.

Whether data center(s) are housed in the building or not, at a minimum a centralized network control center (NCC) should be provided to service all incoming and outgoing communication transmissions and network management control, consolidating these needs for all the organizations housed in the building. The NCC would provide centralized management control covering physical connectivity, application interface and protocol compatibility for dissimilar local and wide area networks such as token-ring, Ethernet, SNA, etc., provided by multiple vendors. Other communications may include radio network transmission facilities for functions such as the Coast Guard.

Anticipating the current and future technology applications and standards will be the key building design factors, including functionality, space, electrical, environmental, etc. Given the life of a building of 50 years or more, the facility will require a great deal of planning regarding what is not known versus what is known. The type of media and devices, topology, speeds, connectivity, device migration, distribution strategies, and user requirements are essential elements in the overall building design. Flexibility is a key issue. The more flexible the design, the greater the chance to achieve the adaptability to future technologies.

Control of the design of most future applications will be in the hands of the users, not MIS management. However, to be effective, the telecommunication internetworking will require the attention of highly technical support teams to ensure proper connectivity, common services, etc. Therefore, this expertise should be included in the building design team during early planning and design, as well as the on-going development and construction phases. Long-range planning in conjunction with the end user, computer and communication functions is needed as well.

It is unlikely that the DOT organizational missions or cultures will change drastically before move-in. Therefore , one or more independent data centers housing mainframes, and/or special purpose interfaces and internetworking will probably be located within the building. While the raised floor requirements for newer technology require less space to accommodate the computer "footprint," there is the need for increased air conditioning to reduce the heat generated by high speed compact electronic components, and the migration of applications requiring additional capacities for storage and added computer capabilities. As the downsizing of mainframes take place, the distribution of devices increase among the end users requiring an increase in central storage and internetworking. In short, everything tends to grow in terms of physical hardware.

There is a trend within the industry, to reduce the data center operational costs by automating the operations - called "lights-out." The level of automation will dictate the degree of operational staffing ranging from zero to current staff levels.

There are various scenarios regarding the data center location, including placing it elsewhere on the site, at a remote location or to outsource the data center functions to an outside vendor.

Future growth will also take place regarding special purpose data center support equipment such as uninterruptible power (UPS), HVAC, distributed power, water cooling, etc. The ratio of raised floor for computer systems to the related support equipment space required is about 2.5:1. IBM has forecast a 1:1 ratio. This trend could be reversed when new kinds of electronic materials such as superconductors are developed. Otherwise, in the future we could see the use of cryogenics or other type of cooling techniques in addition to air and water.

Special consideration and planning may be required for mission critical operations, encompassing backup and recovery of computer and communications operations at a hot-site, underground fiber, microwave towers and/or satellite redundant transmission to bypass telephone company services.

Distributed personal computers, workstations and peripherals will also generate considerable heat, as well as a much higher consumption of electrical power - perhaps from 6-10 watts per square foot beyond base-building needs. At a minimum, the building electrical wire should provide for this amount of distributed electrical capacity.

While the marriage of computers to communications is embryonic, the building design can be impacted primarily due to the distribution of devices, interconnectivity of local area networks, inter-networking of wide area networks, mainframes, minicomputers, terminals and workstations.

Telecommunication speeds of up to 1.544 million bits per second are now commonplace, with individual devices transmitting currently on both wire and fiber optic cable at speeds from 1,200 to 14,500 bits per second. New standards and protocols can now accommodate digital network speeds of up to 100 million bits/second to support multimedia transmission as well as facilitate the building network backbone. New technological developments will have increased transmission speeds by a factor of 10 in the not too distant future.

The industry is trying very hard to interconnect heretofore unique protocols in ways which permit them to communicate with each other. The U.S. government has been a catalyst, causing communication and computer manufacturers to conform to a network interface standard. The TCP/IP protocol was supported early on by them. It now appears to be the forerunner of a universal standard. Also, the industry is becoming commodity oriented, providing a greater opportunity to successfully interconnect diverse systems.

These system developments have a major impact on building design - the architectural core/shell as well as the interior. Strategies need to be developed for the technical approaches to distribute wire/cable via raceways, risers, ceiling, walls, floor, raised floors, cellular decks and closets. They will provide pathways for twisted-pair cooper wire, fiber optic cable, coaxial cable for the connectivity of devices to internal and external building telecommunications systems. They will require physical and logical connectivity to support older and newer devices as well as the future technology.

Distributed wire/cable closets will provide the hub for connectivity of local area networks and ultimately, the wide area networks via high/low speed telecommunication services, microwave, satellite, etc. This rapidly changing technology requires that the building provides flexibility and adaptability at the workspace, as well as at other locations throughout the building.

Currently, the maintenance of wire/cable and connectivity of voice and data lines is expensive and requires a long period to accommodate to user needs and changes. Costs are directly related to the migration of equipment and people. New techniques allow for smart wire/cable hubs to physically manage these connections and changes. The objective is to perform moves, additions and changes (MAC's) to telephone and data networks with a minimum of manual effort, and at a low cost per MAC. Whenever possible these MACs should be accomplished from a central location and via automated techniques.

Many office design features are interdependent - open landscape work areas, wire/cable management, device connectivity, work surface, accessibility to wire/cable, and connectors. Standardized connectors used on the wire/cable distributed to the workspace is an important issue to be planned for early in the design phase. When possible, a common connector should support local area networks, telephones, computer terminals, personal computers, peripherals, etc. - one for wire and one for fiber optic cable. Also, coaxial cable is either being replaced or signals are being translated via devices/baluns from coaxial to twisted-pair copper wire. The quantity of each type of wire/cable receptacle should also be identified, based on the planned requirements for the whole building, including special purpose rooms and work areas.

Major industry participants have introduced "wireless" transmission products to the marketplace. This capability appears to be niche oriented for special application situations. The high cost/device connections within a building, in addition to the transmission speeds and connectivity capabilities available, are major negatives. However, in the future, devices such as laptops and notebooks, utilized by certain branch facilities or field location personnel in remote areas, may utilize various media technologies including radio bandwidth, satellite, telephone or cellular technology for transmission media.

MR. GRAHAM: *Considering the research and products by Motorola and others - would you make a guess as to when we could do away with building wiring and do all the good things you are talking about - multi-media, etc - using techniques other than wiring - where wiring would be redundant?*

MR. ROSENHECK: *At present the wireless techniques within buildings are still too expensive. There are a limited number of uses, although they are progressing fast. So, I would not rule them out.*

*However, at a much more rapid rate, wire and fiber is becoming cheaper, much cheaper than it has been. You can get wire today at five to seven cents a foot. Fiber is coming down rapidly from one dollar a foot. We are talking about installed prices.*

*I think wireless techniques will be used primarily for wide area nets. We will see that, in addition to satellites and telephone networks. It will be seen as one more media, not a replacement. The reason is that we will learn how to use the copper that is already installed.*

MR. VALENTINE: *You have to consider the embedded base and the investment in current technology that would not automatically be replaced by the media you are talking about. There is a cost associated with that.*

DR. DeCOUVREUR: *We experimented with wireless inside buildings for three years or more, before putting it on the market. It is a wireless interconnection scheme with a throughput of 9.6 kilobits. It operates in cellular radio frequency bands, plus or minus 90 megahertz, using spread spectrum technology. It has been tested for six months and has worked very well. Motorola is in the field testing stage with a wireless LAN at a higher bit rate and higher frequency. One place in Canada is undertaking a feasibility study of a high capacity wireless LAN with a target equalling a frequency band of around 40 gigahertz.*

MS. WOHL: *Things are going to be much smaller and much more portable than you are contemplating here. So you are going to see the move to wireless happen faster than you think.*

MR. CYROS: Lighting issues for open-plan offices will be discussed by Michael Hooker of Michael Hooker Associates. Mr. Hooker has been responsible for lighting designs for merchandising, museum, commercial, government, hospital, laboratory, industrial and entertainment facilities, as well as for major television, theatrical and convention events. His achievements include the design of both electrical lighting and daylighting systems, as well as interior design and audio-visual video and acoustics systems engineering.

## LIGHTING ISSUES FOR OPEN-PLAN OFFICES

**MR. HOOKER:** I thought I knew what I was going to talk about, but after listening to the speakers this morning and this afternoon, I am in a quandary.

A million seven hundred thousand square feet? That is incredibly vast. Do you realize it is going to take you several days just to walk around this building?

**MS. ALLEN:** *It is a fitness facility.*

**MR. HOOKER:** Let's get to the point. The problems associated with lighting this building, which my colleagues have explained to you are associated with the CRT - sitting for long periods of time looking into at a VDT screen.

But the problem I am concerned about most is not so much to design the lighting for the CRT screen and how to solve the eyestrain problems because those are easy. We have a phrase in our office. "It's not rocket science." It is really easy. I always talk about mother's laws of lighting. We all learned these. Do not sit facing the sun when you read a book. Read with the light over your shoulder.

I have heard about planning modules which incorporate amenities rather than function. I have heard nothing about planning based upon the work task. I am very concerned because I cannot believe that in the DOT all managers do the same things, that a Coast Guardsman who is a manager does the same thing as an FAA person, the same thing as a DOT person. I am just speculating, but I imagine that there are lots of old blueprints that they have to look at. This requires a very different condition. Maybe we should be talking about workstations developed on the basis of the worker's needs.

I will return to what Tim White said this morning. He talked about the functions of the building shell, the workstation, and the user. I thought about this all morning. Do you know where I want to put lighting? With the user, because it is a user's problem. We are forgetting the user.

We are talking about systems of conformity. I do not know if you can tell this, but because we are here and you can see me, you can probably guess that I probably would not enjoy working in an office with a lot of conformity. Yet, you are going to put me, as one of those knowledge people that you want to put a price tag on, into a situation where my workspace looks, feels, tastes and smells like everybody else's for as far as the eye can see. If you have ever walked in a space this big, that is what it is like, as far as the eyes can see, miles upon miles of these spaces.

That is my concern. How do we aesthetically solve the problems? I think the technical problems are all very simple, and we are going to deal with those in a moment here. But I want to throw down a gauntlet to you folks and say we have to solve the aesthetic problems, and we have to consider individual needs - as we talked about, we do not have to go to meetings anymore. We can do this all by computer.

Wait till we get to virtual reality. I put my helmet on. I spend all day in this helmet off in virtual reality. How do I ever become part of a team? I do not have to talk to you. I can type. I can look, and there I am.

What about the team? What about the idea of the teams of old? You ate your meals together. You slept together. You lived in the same building. You worked together as a unit. That is gone in this kind of computer age that we are talking about, and those are my concerns that the building has to respond to that.

Interestingly enough, one of the ways that we can do this best is through lighting. I think that lighting provides an easy way to start tying individuality together and worker comfort together.

I was telling people at lunch about the rose that I keep on my desk right next to my computer terminal lit with a spotlight. Everyone in my office gets a flower of their choice, lit with a spotlight next to their computer terminal, because it provides contrast brightness. It has a very technical function. It is there not because it is pretty, not because I like flowers, but because it provides a brightness. Yet, it is a human touch.

Now, planning discussions oftentimes include concerns for technological advancement. I guarantee you that all the technologies that we are talking about will become obsolete by the time this building is built, and we are going to be talking about a whole new set of problems technologically. But I cannot really address what the computer industry is going to do or what the organization is going to do, because I do not think any of us knows that. What I can do is talk about lighting systems.

Over the past few years, significant changes have occurred in lighting equipment, in the areas of lamps, ballasts, fixtures and lighting controls. Annually, new fixtures are introduced with changes in the photometric performance and in the aesthetic appearance of the fixtures. While these changes are of prime importance during the period of specification or the engineering of the system, they have not made any changes significant to lighting design. The conceptual means available to us as a project team in designing a building have not changed in the last 40 years. We still point the light up or we point the light down. The conceptual means do not change.

I am not worried about what happens in the next 10 years in terms of lighting, and I do not think you should be concerned either. When it is time to buy the "stuff," buy the things that are right at that time. What is more important is to decide now whether you should point the light up, whether you should point it down, or whether you should point it sideways. How do you want the light to work?

Actually what is significant are the changes in lighting design technology and how we design lighting. That is what has really changed and that is what has had the greatest impact on our environments. It is not the hardware. It is the design software that has changed.

Twenty years ago, predicting how a lighting scheme was going to work was virtually impossible. We had mathematical equations that were totally meaningless. We had empty rooms. We could not figure out what was going on. So, we had the wisdom of the ages. I think of the old electrical engineer who says if you think you need 12 lights, put 16 lights in and you're safe and you are covered. Thank you. Goodbye. Next room. That is the way we used to do things. Then we got scientific. We developed computer models.

But up until a year ago, literally the last 12 months, even the best of the computer analysis available to us would still not tell us what was going to happen underneath this table. Believe me. I am concerned about what the lighting looks like underneath this table if, in fact, I am going to sit back where that is in my field of view.

Today we have finally reached the point where computer modeling is very good. We can model all the partitions in the spaces and actually get a readout. With the right kind of analytic tools available today and by moving light fixtures around a little bit, you can have a very different result. I believe that all of these schemes can be made to work, and we need to go backwards and reexamine hardware. Rather than throw out the old, we need to reexamine it because the old is going to give us some new answers given the new technologies and the new understanding of design because, remember, we did not know what we were doing 20 years ago.

The research in lighting has changed dramatically in the last 20 years. Ten years ago, we were all talking about something called equivalent sphere illumination. A handful of people actually understood what equivalent sphere illumination was, but everybody talked about it.

Then for reasons unknown to 99 percent of us, it got discarded. We got something new, relative visual performance. On the other hand, if you do studies of relative visual performance, do you know what you find out? It doesn't matter what you put up. It does not matter because people are adaptable. People will work well in any lighting condition.

Look, you are working just fine. You are taking notes in this room. I am looking over this way, and I sure don't think that is a great lighting solution on that side of the room. I am sorry, but they are working fine. Yes, there is lots of glare, but people are looking at their pages and are moving them around. That is what studies have shown us. The research has shown us that it does not really matter, that people will adjust.

So, in the meantime we have new standards enacted. We mentioned the San Francisco ordinances. They include lighting. What these all are trying to do is attempt to boil something down to the obvious. Visual acuity, performance and comfort are tied intrinsically to the intensity, color, distribution and pattern of light, and having that appropriately balanced and composed within the environment. We heard about that word "balanced" and luminous contrasts before. .

Now, the configurations typical of the modular office - multiple size workstations, 200,000 square feet of filing, support areas, conference areas, reception and lounge areas, and traffic paths indicate to me that probably you are going to want some kind of a modular approach to the lighting system design.

Each area that I have mentioned -- and we all have been talking about the workstation, but there's a lot more areas that we are talking about in this building -- poses unique lighting problems which first must succeed on a micro level, and then must be integrated together at a macro level without creating lighting and aesthetic problems within the whole. In other words, the lighting for the filing area cannot mess up the lighting for the CRT and the workstation, and that is where the problems really are.

Each alternative will affect the lighting quality within its area. The lighting system will also affect the acoustics of the building. So, when you make a lighting decision, you are also making an acoustical decision. Of course, stating the obvious, it will also affect the aesthetics of the building.

When we plan this office, we are often trapped into a false sense of design security as each discipline plans their system using the terms "modular" and "planning module." It has been my experience that projects succeed or fail in their ability to respond to the

breaks in the planning module because buildings are rarely really modular. There is always a little twist. When you break the twist, that is when you make it or break it. That is where the failure point is. Something happens over here. There is an extra bay window, and the ability of your system to respond to that extra bay window that is not part of the module is going to be the difference between a success and one that is not.

For example, it is dangerous to carefully plan lighting for a group of CRT workstations and not to carefully consider the impact of adding a conference area or support zone. Those things are inevitably added at the time of installation. To be truly flexible the design must respond in a number of different configurations, most of which are not truly modular.

Visibility and visual comfort are functions of contrast and color. I generally recommend the criteria for luminance contrast and criteria for color hold considerably higher importance than criteria for illumination or even luminance levels. If an environment is balanced in terms of luminance, much lower levels of illumination will still allow for equal visibility of task material and equal or, in many cases, improved worker performance. Improvements in performance are attributed to the lower levels of glare and its accompanying eyestrain, and to the psychological factor of the environment being more comfortable to work in.

This morning we saw a slide of indirect lighting, and we heard about this example. It seemed like there was less light there and it seemed to work just as well. You produce the same illusion, as we were calling it, with any kind of a lighting system. We could do it in this room. I could have set the level of these overhead lights a lot lower, and you wouldn't know it. You don't really know what the level is as long as we keep these walls nice and bright.

To balance the luminance contrast, to create this balanced environment, we use a two-pronged attack. We illuminate specifically not only the obvious work surfaces, but we also illuminate the surrounding vertical and horizontal surfaces. We vary the level of this illumination also by changing the reflectance in the texture of the material. And the texture of the surfaces that we use plays a very important part in how we respond to a surface, what kind of depth it has.

We have heard a lot about eyestrain. Eyes rest at 17 to 20 feet, using our standard conforming observer. Well, I am sitting in my little 10' by 10' workspace. What do I have to look at? To rest at 20 feet, I cannot do it at 10 feet. I have a partition. I have to look toward the ceiling to get 20 feet away. What am I now looking at? The lighting system.

I have a problem with that, particularly with some of the schemes when we talk about. We like the indirect lighting system with suspended tubes. Now I'm going to look at this very bright ceiling. I am trying to rest my eyes here. I am not sure that is the answer either. I am not certain.

Someone asked me at lunch, what is the right answer. I don't know. I think it is a combination of all of the systems.

We have four basic approaches we can use and that is it. We can recess lensed and parabolic fixtures. We can hang the fixtures from the ceiling, point them up, point them down, point them up and down, or down and up, and we can mount them in the furniture. As I have said before, I strongly believe that if the proper planning is done, all options can be made to work. For every horror story you have heard about a

furniture integrated system, we can show you one that worked. Generally I think the difference is how you plan the project and how you coordinate systems.

Now, the majority of the office environments will consist of workstations, housing the individual, a computer, a chair, a minimal desk with an overhead cabinet, a surrounding low partition, and little else.

Typical paper tasks require significant illumination levels in excess of 35 foot candles. Notice I said in excess. I remember when I was first involved in office lighting the typical design called for 150 foot candles in offices . Wow.

Do you know what? There is a threshold. You hit 35 foot candles, and it does not matter. You can see. As a matter of fact, we have all read number 2 pencil on a wet napkin at 60 miles an hour going down the highway with very little light. We have all done that. There is a nice little knee to the curve of performance. You hit 35 foot candles, and you can see it. After that 35 foot candle point, we are talking a whole other set of issues which have not got to do with acuity, but with the psychology of whether or not you think you can perform brain surgery at 35 foot candles, or do you feel more secure with 200, very bright and lots of glare.

This morning we mentioned task lights. I think task lights are very important, although most task lights on the market - particularly those designer types, that are supposed to be put in private offices - do not do you any good. They are probably more of a detriment to your environment. Maybe we should eliminate them.

Generally, I think a good task light and a carefully chosen task light, is an integral part of the workstation. I strongly believe that you let it be as adjustable as possible. I like the kind on the arms with a dimmer on them. Do you know why? Mostly so that the worker can tailor it to what he or she needs. I like a lot of light. So, I crank it up. You don't like any light? You turn it off. You want glare? You shine it in your face. You don't want it, you want to tuck it away and light the edge of it or light your girlfriend's picture, you aim it at the wall. Whatever you want to do. You now have something personal in this very autistic world of a big office.

Probably the most important thing you have to select is the color of the lamp and the lamp type. There is a lot of research that has been done in Europe that significantly shows that overall light levels - the illumination level - is less significant than the color rendering ability of the lamp.

I have tested this. I have measured this, and firmly believe it. I just don't know quite what the metric is yet as to how far I can do it. You take a room that you would normally have, like a 2 by 4 luminaire, with three lamps in it. I buy the premium, super high quality color rendering lamp and use two lamps in that same room. I do not need reflectors. I do not need energy saving devices. I just need a good lamp with good color, because we do not live in a black and white world.

The last thing I want to touch on is daylighting. It is very important that as we isolate the worker, that we somehow or other get them back in contact with the natural world, the outside. We give them outside awareness.

The key to solving the daylighting problem, outside of the adjacency issue, is the ability to control and maintain the luminance balances we were talking about before. The way we do that is by carefully selecting our glass, both for its transmission value and its color. Then we control the lighting with daylight controls.

But I will postulate that we should not do it the way you think of daylighting controls - the sun comes in, the lights go down, the sun goes down, the lights go up. What you have to do is you have to orchestrate the lights so that as the sun comes in from this side of the room, the lights on the opposite wall go up. They rise. Then as the sun shifts across the sky, the lights cross - fade, so that the lights on that side go down and the lights opposite the window go up. That way the room stays balanced all through the day, the same brightness. You can walk around with your light meter, but you will still see the daylight shaft because of the color difference if you have done your glass right. You will still see that shaft of daylight, but you can walk around with your meter and the brightness can be equal by raising the intensity in some case and lowering it in others. So, I suggest that that is certainly a different option that I have used very successfully.

I think that the building module is totally affected by lighting, and I would feel that it would be a shame to respond to this problem by creating a planning module, a building module or a workstation module, and then having the lighting applied to it. I think that is the typical way, and it is a reactive process.

I propose you think about a proactive process where lighting, HVAC, acoustics, thermal; all these disciplines go out and look at a micro level. What does it take to light a workstation? What does it take to heat it? Bring those together in the project team before a planning module is discussed. Break it apart, modify it. Then go back to the micro level and back and forth. You are going to do this several times.

My guess is that by the time you are done with the process of forward, backward, forward from the discipline level to the macro level, you will come up with a solution that will not look anything like what you think, but ultimately will solve what I think are probably the most important problems, addressing the needs of the individual worker.

**MR. CYROS:** Our next topic is new environmental design and control approaches, both here and abroad. Bringing that subject to the fore is Vivian Loftness. Vivian is a principal of VLH Associates and adjunct associate professor at Carnegie Mellon University in Pittsburgh, Pennsylvania. She is also an international energy and building performance consultant for commercial and residential building design and has edited and written numerous publications on energy conservation, passive solar design, climate and regionalism in architecture, as well as design for performance in the office of the future. During the last 10 years, Ms. Loftness has been researching and developing design directions in relation to total building performance into the field of building diagnostics.

# NEW ENVIRONMENTAL DESIGN AND CONTROL APPROACHES

**MS. LOFTNESS:** I am going to try to cover many topics that merit consideration in the design of the new DOT headquarters.

One possibility is that you just design beautiful, sunlit, green open-air parking lots and let people drive to work in their mobile offices and form work clusters as required.

More down to earth, however, is the evolution of today's office into a healthier, more effective workplace. I would like to spend a few minutes describing a university-industry research group [Advanced Building Systems Integration Consortium (ABSIC) at Carnegie Mellon University] which has been evaluating international advanced workplaces. The field evaluation team is multi-disciplinary. (Figure 34) The approach for field evaluation and effective workplace design has three key elements:

---

### INTERIOR SYSTEMS: MAJOR CHOICES AND DIRECTIONS

**For spatial quality**

- Chair
- Worksurfaces
- Workgroup configurations & size
- Cable management
- Furniture reconfigurations
- Intangibles

**For visual quality**

- Ceiling task-ambient
- Ceiling ambient
- Task lights
- Daylight
- VDT units
- Furniture systems
- Window controls

**For acoustic quality**

- Office equipment
- Ceilings, walls and floors
- Mechanical systems

---

For thermal and air quality

- Central system
- Overhead air supply
- Underfloor air supply
- Individual controls
- Windows
- Interior finishes
- Office equipment

New concepts

- Service hubs
- Conference hubs
- Small to large conference shifts

**Figure 34.  Interior systems**

1. The workplaces must be designed for total building performance with the individual at the center.  The issues are spatial quality, with which most space planners are very comfortable, as well as thermal, air quality, acoustic and visual quality, and the long-term life of the building - with which many space planners are less comfortable. (Figure 35)

**TOTAL BUILDING PERFORMANCE**

* Spatial quality
* Thermal quality
* Air quality
* Acoustic quality
* Visual quality
* Building integrity

**Figure 35.  Total building performance**

2. The building systems must be effectively integrated to achieve each of the following performance qualities. (Figure 36)

| Recognize the CRITICAL COMPONENT INTEGRATIONS for PERFORMANCE | | | | | | |
|---|---|---|---|---|---|---|
| Component/ Assemblies: | Spatial Quality | Thermal Quality | Air Quality | Acoustic Quality | Visual Quality | Building Integrity |
| Structural | ● | ● | | | ○ | ● |
| Enclosure | | ● | ○ | ○ | ● | ● |
| Interior | ● | ● | ● | ● | ● | ● |
| Mechanical | ○ | ● | ● | ○ | ● | ● |
| Struct-Encl. | ● | ● | ○ | ○ | ○ | ● |
| Struct-Int. | ● | | | ● | ○ | |
| Struct-Mech. | ● | ◉ | ○ | ● | ● | |
| Encl-Mech. | ● | ● | ○ | ○ | ● | ● |
| Encl-Int. | ● | ● | ● | ● | | |
| Int-Mech. | ● | ● | ● | ● | ● | ● |

● Primary Relationship
○ Secondary Relationship

**Figure 36. Critical integration issues**

The difficult part of trying to reach those objectives is that performance is not system specific. A common misconception is that thermal quality is provided exclusively by a mechanical system. Thermal quality is as much determined by the enclosure as it is by the interface of the interior systems with the mechanical system, e.g. the locations of diffusers and partitions.

3. To achieve thermal quality requires a new process in design.

Instead of having decisions made by individual disciplines, a mechanical engineer for mechanical systems, an architect for exterior envelope systems, an architect/interior designer for interior systems, you have to change your alliances and responsibilities. To achieve optimum performance, you do not segment the building, with each component designed by disciplinary experts. (Figure 37)

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## Old Alliance of Disciplines with Components

| | Structure | Enclosure | Interior | Mech. HVAC | Mech. Elec. | Mech. Lighting |
|---|---|---|---|---|---|---|
| Architect | | ● | ○ | | | |
| Interior Designer | | | ● | | | |
| Mech. Engineer | | | | ● | | |
| Struct. Engineer | ● | | | | | |
| Elect. Engineer | | | | | ● | ○ |
| Light. Designer | | | | | ○ | ● |
| Energy Consult. | | ○ | | ○ | | |
| Acoust. Consult. | | | ○ | | | |

● Primary Responsibility

○ Secondary Responsibility

**Figure 37. Traditional building disciplinary and component responsibilities**

Rather, you need a process to ensure thermal quality by involving the architect, interior planner and mechanical engineer at the same time. (Figure 38)

## New Alliance of Disciplines with Performance

| | Spatial Quality | Thermal Quality | Air Quality | Acoustic Quality | Visual Quality | Building Integrity |
|---|---|---|---|---|---|---|
| Architect | ● | ● | ● | ● | ● | ● |
| Interior Designer | ● | ● | ● | ● | ● | ● |
| Mech. Engineer | ○ | ● | ● | ○ | ○ | ● |
| Struct. Engineer | ● | ○ | | ○ | ○ | ● |
| Elect. Engineer | ● | | | | ● | ● |
| Light. Designer | ● | ● | ○ | ○ | ● | ● |
| Energy Consult. | ○ | ● | ● | | ● | ● |
| Acoust. Consult. | ● | | | ● | | ○ |

● Primary Responsibility

○ Secondary Responsibility

**Figure 38. New alliance of disciplines with performance**

A shift is occurring in the traditional design process. As an architect and as a teacher of architects, I am aware that architects are trained to be premier decision makers, to make many decisions that ultimately can negatively impact the environmental quality and longevity of a building, because we are not sufficiently informed about key issues of facilities management, mechanical engineering, lighting design, and telecommunications. So, we need a new process to achieve systems integration for total

building performance. The following three conditions constitute the foundation on which we have performed our international case studies of advanced workplaces.

The key issue in defining the office of the future is moving beyond what most people think that the office of the future is about - hardware. Many interior planners will design modern offices in the traditional manner on the assumption that hardware can just be introduced on top of existing layouts and furnishings.

The first surprise came when people started 'stuffing' this hardware into the workplace. (Figure 39)
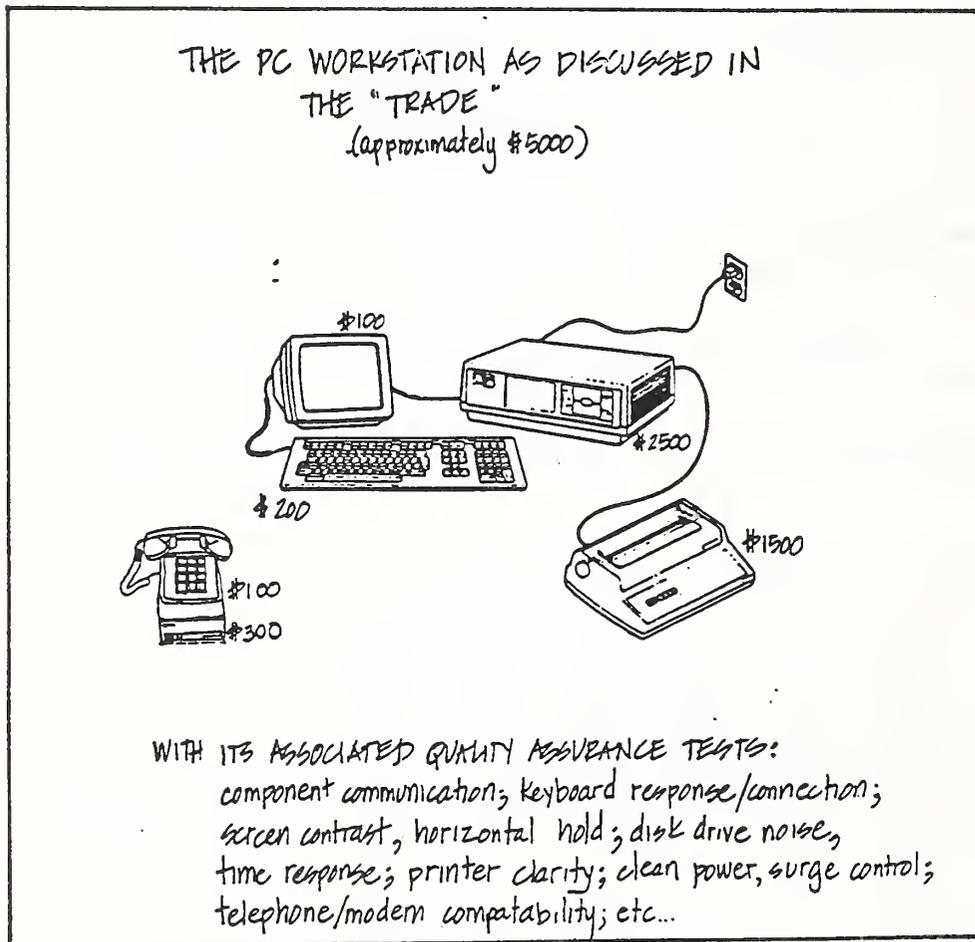
THE PC WORKSTATION AS DISCUSSED IN
THE "TRADE"
(approximately $5000)

$100

$2500

$200

$1500

$100

$300

WITH ITS ASSOCIATED QUALITY ASSURANCE TESTS:
   component communication; keyboard response/connection;
   screen contrast, horizontal hold; disk drive noise;
   time response; printer clarity; clean power, surge control;
   telephone/modem compatability; etc...

**Figure 39. Typical workstation hardware components**

They knew the hardware cost anywhere from $2,000 to $10,000. They did not know that the networking required for the hardware and the connectivity that Herb Rosenheck and Peter Valentine discussed, also costs $10,000 per workstation. (Figure 40)

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**THE TOTAL COST OF A PC**

Based on 100 personal computers shared by 300 users

| | Annual $ cost (PC) |
|---|---|
| Hardware ($5000 system amortized - 3 yrs) | 1,667 |
| Software | 1,200 |
| Technical support (2 people/$80K) | 800 |
| General support (1 person @40K for every 50 users) | 2,400 |
| Diskettes (100 diskettes per user annually) | 900 |
| Other supplies (papers, ribbons) | 180 |
| Maintenance | 300 |
| Total Annual Cost per Computer | $7,447 |

Source: Nolan, Norton & Co.

**THE PRICE OF NETWORKING**

Based on annual costs on a 40 computer, local area
network, excluding the cost of personal computers

| | Annual $ cost (PC) |
|---|---|
| Hardware and software installation | 567 |
| Startup planning and analysis | 823 |
| Systems management | 2,708 |
| User training | 2,812 |
| Unproductive time | 1,800 |
| Total Annual Cost per Computer | $8,700 |

Source: Ferris Corp

From the Wall Street Journal, Friday, June 12, 1989, "Uncovering the Hidden Costs"

**Figure 40.  Costs of PC and networking (1991)**

Yet, one component is missing, and it is a critical one.  That is the price of the environmental setting needed to accommodate the  hardware.  If you take this ever expanding office automation hardware and stuff it into workspaces, you generate problems - acoustical, lighting, thermal, glare from windows, and spatial concerns.  These environmental management issues and their appropriate responses require another layer of investment which should not be shortchanged.  And, the process should not be a linear one.  You should not buy $7,000 worth of equipment, then the connection, the cable network, and finally, the environmental equipment.  Instead, you should plan it all together, with a full design team. (Figure 41)
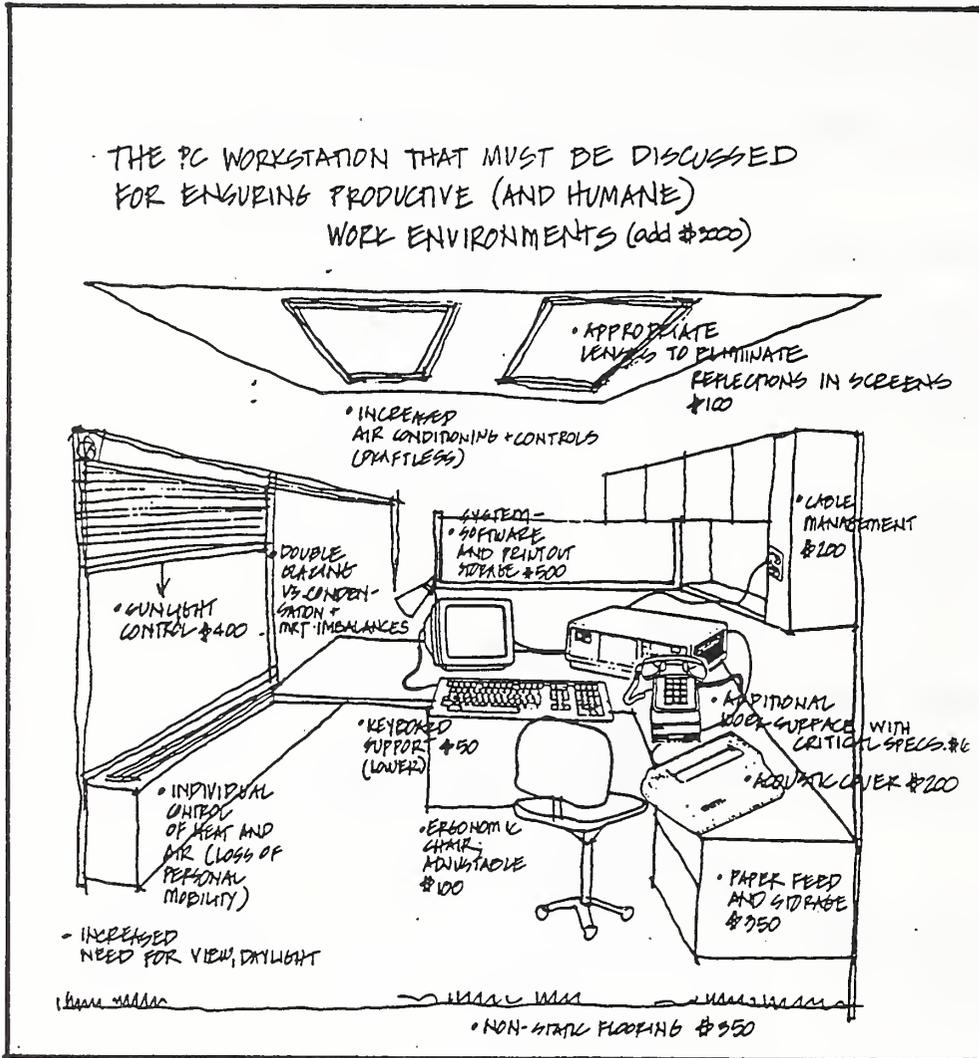
**Figure 41. The PC workstation for ensuring productive (and humane) work environments (add $3,000)**

## WHERE DO WE GO? HOW DO WE APPROACH TOMORROW'S WORKPLACE?

I will now discuss some positive steps we can take. Our work is being funded by nine U.S. building industries. We have studied advanced buildings in Japan, Germany, the U.K., France, and the United States. The study has resulted in a list of 15 recommended major design changes. The list is evolving - it is neither comprehensive nor final. Our prepared paper discusses of all fifteen (NISTIR 4801). Now, I will focus on four of them. (Figure 42)

MAJOR DESIGN CHANGES IN THE OFFICE OF THE FUTURE

1. Distributed HVAC/PLEC systems
2. Distributed vertical cores for HVAC/PLEC
3. Innovative horizontal distribution of HVAC/PLEC
4. "Fresh air architecture" - HVAC, windows, materials
5. Thermal balancing envelope and multiple interior zones
6. Daylight/artificial light balancing
7. Introduction of moveable tether, pigtail services for conditioned air, light, power, sound
8. Introduction of individual controls for temperature, air, light, sound
9. Introduction of new workgroup concepts: open, cluster, closed
10. Introduction of new workstation concepts
11. Innovation in shared facilities and services
12. Innovative team facilities management
13. Architecture/CAFM for iterative learning in occupancy
14. Innovative process: design by a team of peers
15. Resource management

**Figure 42. Major design changes in the office of the future**

The commission I received from Art Rubin was to look at the workstation module. Many of the design changes are whole building issues and design process issues, but in this talk I will concentrate on those issues affecting the workstation module.

One major design change, which Michael Hooker and Alan Hedge addressed very clearly, is the introduction of movable services for conditioned air and light as well as data and power connectivity.

A second issue has not yet been treated in detail. That is the introduction of individual environmental controls. We (ABSIC) feel very strongly that the HVAC in the office of the future is not what we see in this room. (Figure 43)

HVAC IN THE OFFICE OF THE FUTURE

1. Zoning and spatial flexibility
2. Central vs distributed thermal and ventilation sources
3. Vertical distribution: air, water, none
4. Horizontal distribution: ceiling, floor, furniture, supply/return
5. Environmental load management and load balancing
6. Split ambient and task conditioning
7. Terminal units: tethers, diffusers, satellite, and individual controls
8. Resource management and EMCS
9. Air quality management

**Figure 43. HVAC in the office of the future**

It is not what you have in your offices today. It employs a new concept of zoning and spatial flexibility. In the traditional mechanical engineering plan you have, if you are lucky, nine zones, maybe 14, in an entire building. (Figure 44)
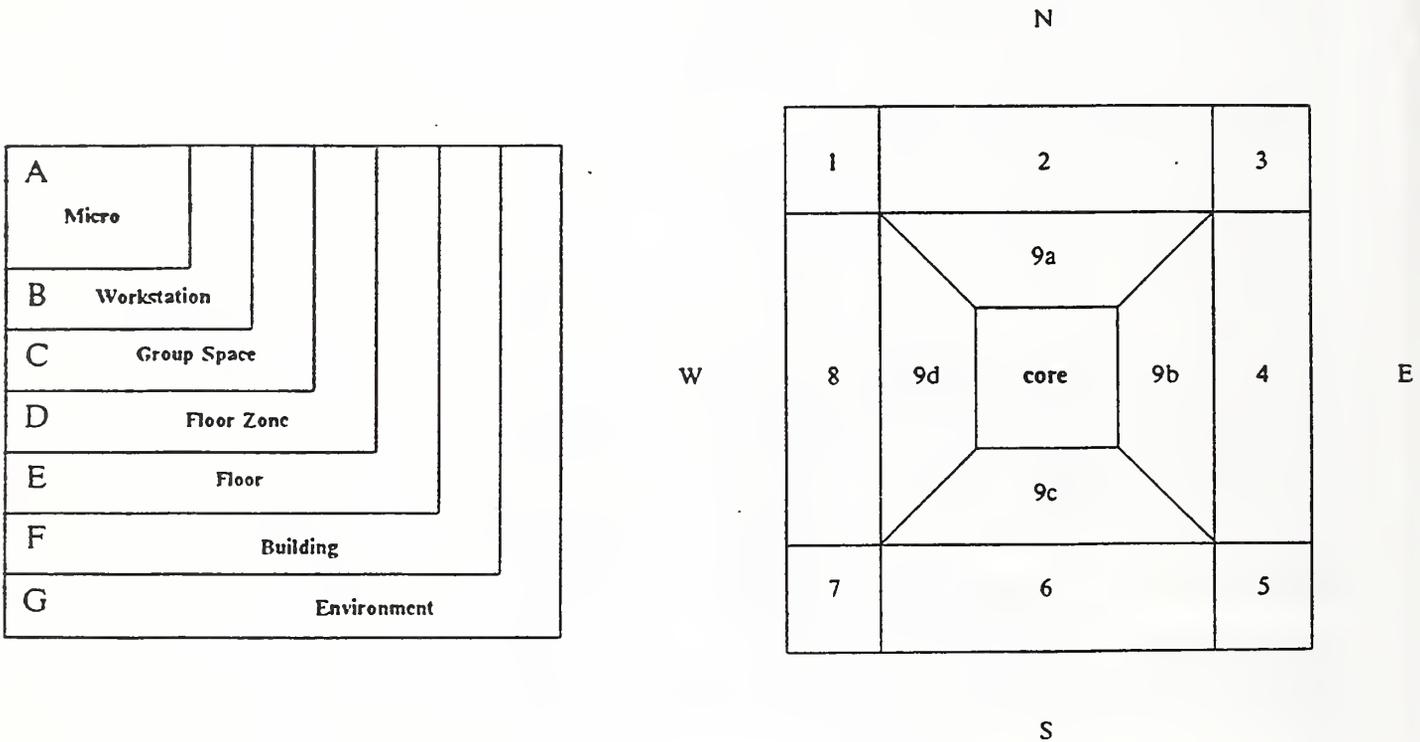


**Figure 44. Building hierarchy**

Giant switches that turn on banks of light and banks of air and cooling are incapable of responding to change and variation of uses occurring within those large zones.

Instead, we have to look at micro environments, workstation environments, and work our way outward. So, building zones are a key issue. Ultimately we should probably aspire to have one zone per workstation. The system would provide for individual environmental control for each workstation, such as designed by Johnson Controls, which has an air handling mixing box fan unit at each desk. (Figure 45)
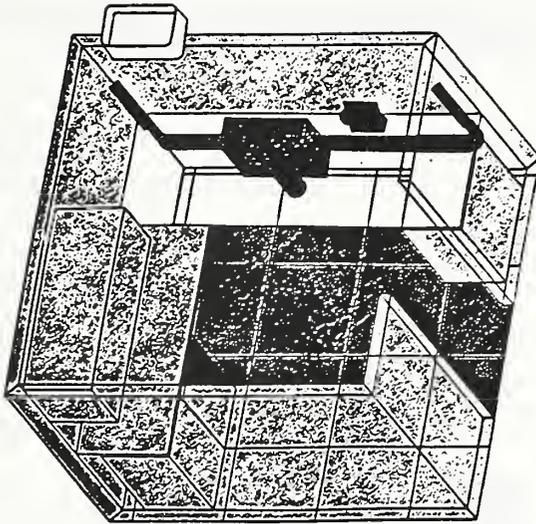
**Figure 45  Johnson Control Personal Environment Module (PEM)**

The cost of this might be as high as $2,500 or as low as $500 per workstation.  Yet, this is insignificant compared to the cost that a facilities manager absorbs in responding to numerous complaints about offices being too hot, too cold or too drafty.  Providing a zone per workstation is a different design approach, and requires that building modularity addresses HVAC early in the design process.

A third major design change concerns telecommunications.  Data, voice, and power have to move up vertical chases, into satellite closets and rooms, out into horizontal plenums, and finally into workstations. (Figure 46)

---

**TELECOMMUNICATIONS - DATA, VOICE, VIDEO, POWER: MAJOR CHOICES AND DIRECTIONS**

1. External connectivity
2. Vertical chase
3. Satellite closets/rooms
4. Horizontal plenum
5. Horizontal network
6. Workstation peripherals
7. Service hubs
8. Conference hubs

---

**Figure 46.  Telecommunications**

There are important modular issues that must be considered and decided at the outset, along with layout and furniture decisions.

I would like to dispel one misconception - that raised floors increase floor-to-floor height.  Raised floors have nothing to do with floor-to-floor height.  Systems integration has to do with floor-to-floor height.  We studied a broad range of buildings and the amount of clear headroom varies widely.  It does not depend on whether it is 12 feet 6 inches, or 13 feet, or 17 feet, from floor to floor, but rather on how effectively the

mechanical, structural and interior systems have been integrated. (Figure 47) So, if you want to reduce floor-to-floor heights, don't ignore raised floors, address how to interface the structure and the HVAC.
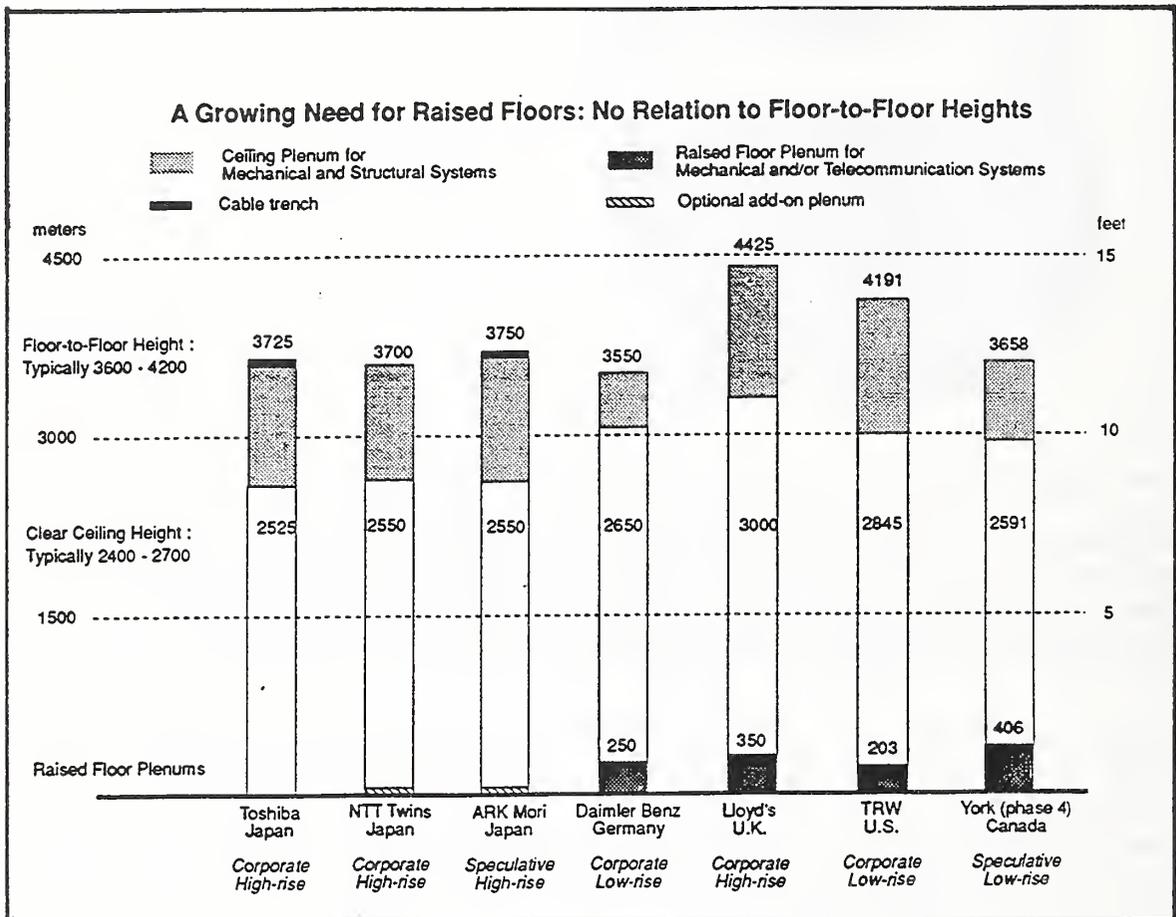
## A Growing Need for Raised Floors: No Relation to Floor-to-Floor Heights

| | Ceiling Plenum for Mechanical and Structural Systems | | Raised Floor Plenum for Mechanical and/or Telecommunication Systems |
| --- | --- | --- | --- |
| | Cable trench | | Optional add-on plenum |

| meters | | | | | | | | feet |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4500 | | | | | 4425 | | | 15 |
| Floor-to-Floor Height : Typically 3600 - 4200 | 3725 | 3700 | 3750 | 3550 | | 4191 | 3658 | |
| 3000 | | | | | | | | 10 |
| Clear Ceiling Height : Typically 2400 - 2700 | 2525 | 2550 | 2550 | 2650 | 3000 | 2845 | 2591 | |
| 1500 | | | | | | | | 5 |
| Raised Floor Plenums | | | | 250 | 350 | 203 | 406 | |

| Toshiba Japan | NTT Twins Japan | ARK Mori Japan | Daimler Benz Germany | Lloyd's U.K. | TRW U.S. | York (phase 4) Canada |
| --- | --- | --- | --- | --- | --- | --- |
| *Corporate High-rise* | *Corporate High-rise* | *Speculative High-rise* | *Corporate Low-rise* | *Corporate High-rise* | *Corporate Low-rise* | *Speculative Low-rise* |

**Figure 47.  Raised floor systems and floor height**

In contras, we are strong believers that raised floors provide tremendous spatial and environmental flexibility.  Indeed, if you have evolving workplaces and technologies, raised floors merit serious consideration.

A fourth major design change deals with work group configurations.  Many new ideas are being tested, and some have been discussed today.  DOT seems to be committed to a vast, open plan.  This may be the worst possible choice for workgroup planning, though with 8,000 people and 1.7 million square feet, it appears inevitable in the present plan.

Internationally , there has been an evolution in the concept of open planning. (Figure 48)

---

**FUTURE WORKSTATIONS: SPATIAL CONCEPTS**

1. Vast open plan
2. Cluster open plan
3. Closed office
4. Free address or group address
5. "Caves + coves"
6. Workstation on wheels
7. Home, road & plane offices
8. Campus and village
9. Box or universal workstation

---

**Figure 48. Future workstation spatial concepts**

The Germans have moved very heavily into what we might term cluster open planning, which limits the workgroup to 30 to 45 people. When exiting a stairwell or an elevator, no more than 30 to 45 workstations are visible, so one is not overwhelmed by a vast sea of desks. There has also been a trend in Europe, clearly not the Orient, into closed offices. So, do not be so hasty to commit to 85 percent open plan space.

There are examples of "free address" or "group address" systems, where individuals do not have assigned workstations. For sales forces, it works quite well because as much as 60 percent of the people are typically out of the office, and those who do work there have access to larger, high quality workstations. They can check in, set up, and key in, at any available workstation, which is well-equipped and comfortably fitted-out.

Caves and commons are manifested in the Steelcase research facility. Here, small private offices are combined with large commons, where people share work areas for team decision making. There are workstations on wheels. The Finns have tried that in the regional office of DEC. Another approach is working 'on the road' or at home. For example, Peter Valentine's organization functions by using networked home offices. Then there is campus and village planning, used in several European countries.

Finally, there is a workstation configuration that might be called a "box" or "universal footprint" that I understand that you are considering in combination with the open plan. We are convinced that if one is reduced to an 8 foot by 8 foot box that is your own, it must contain high quality environmental and physical amenities.

I would like to borrow from Duncan Sutherland a graphic from "Officing" which deals with distances and weekly communication. (Figure 49)
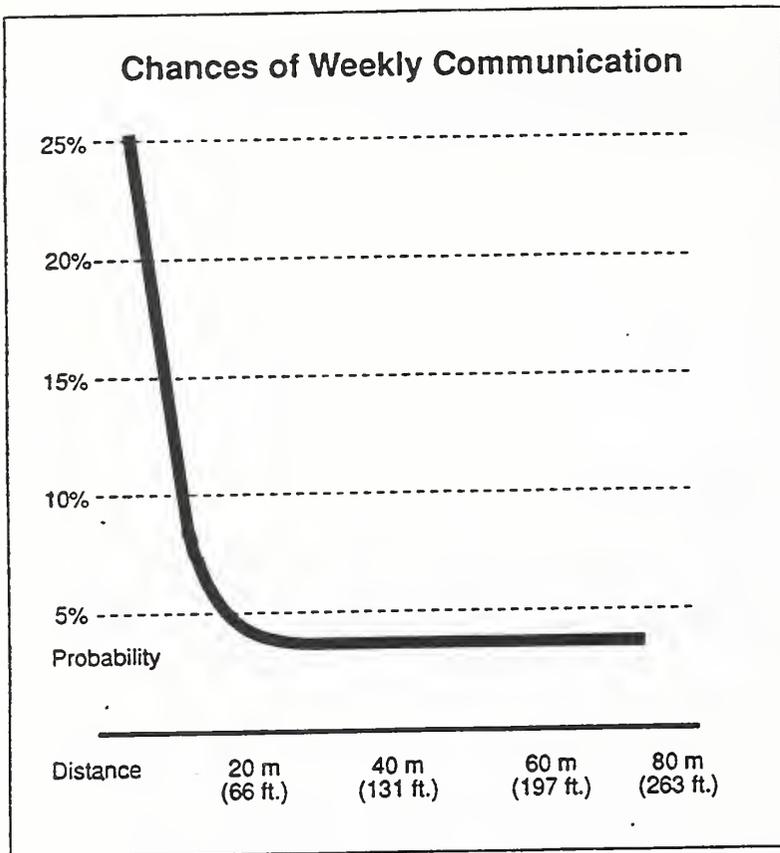
**Chances of Weekly Communication**

25% ┤
20% ┤
15% ┤
10% ┤
5% ┤
Probability

Distance | 20 m (66 ft.) | 40 m (131 ft.) | 60 m (197 ft.) | 80 m (263 ft.)

**Figure 49. Chances of weekly communication**

The assumption that putting 8,000 people on one piece of land will encourage communication is somewhat fallacious. Indeed, after 100 feet, you lose your chance of weekly communication, and possibly even monthly communication.

Another issue is the comparison of space per worker (Figures 50, 51). I understand that you are planning for 125 square feet per person in terms of net square feet. If you make international comparisons, there is pressure on America to reduce space usage. On the other hand, one of the few commodities that America has is space. We are one of the few highly industrialized countries with adequate space. So, the one thing we probably should not throw away, is space.
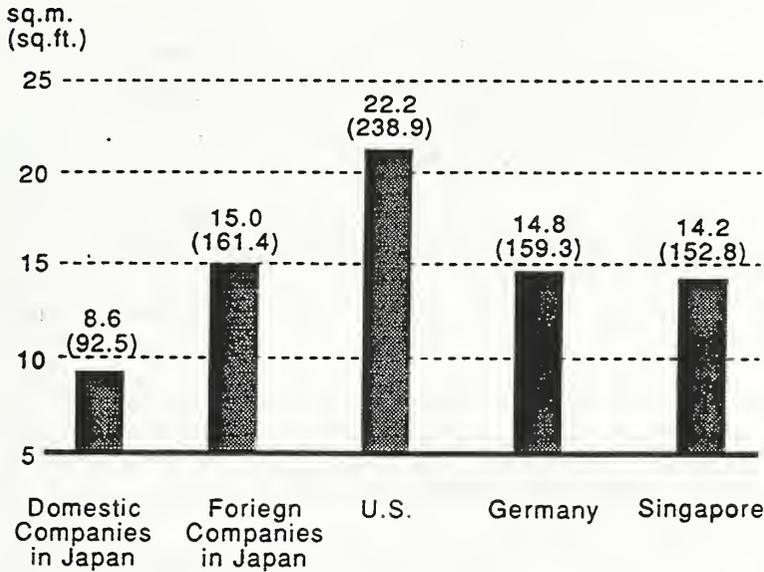
**Comparison of Space Per Worker**

sq.m.
(sq.ft.)

| | |
|---|---|
| Domestic Companies in Japan | 8.6 (92.5) |
| Foriegn Companies in Japan | 15.0 (161.4) |
| U.S. | 22.2 (238.9) |
| Germany | 14.8 (159.3) |
| Singapore | 14.2 (152.8) |

Figure 50  Comparison of space per worker (NOPA 1988)

**Percentages of Open and Closed Office Layouts**

| | Open Space | Open Space + Partitions | Open Space + Private Space | Private Offices |
|---|---|---|---|---|
| Domestic Companies in Japan | 60.5 | 25.6 | 10.8 | 3.1 |
| Foreign Companies in Japan | 26.1 | 17.4 | 54.3 | 2.2 |
| United States | 14.5 | 53.2 | 8.1 | 24.2 |
| Germany | 8.3 | 41.7 | 25.0 | 25.0 |
| Singapore | 12.5 | 37.5 | 43.8 | 6.3 |
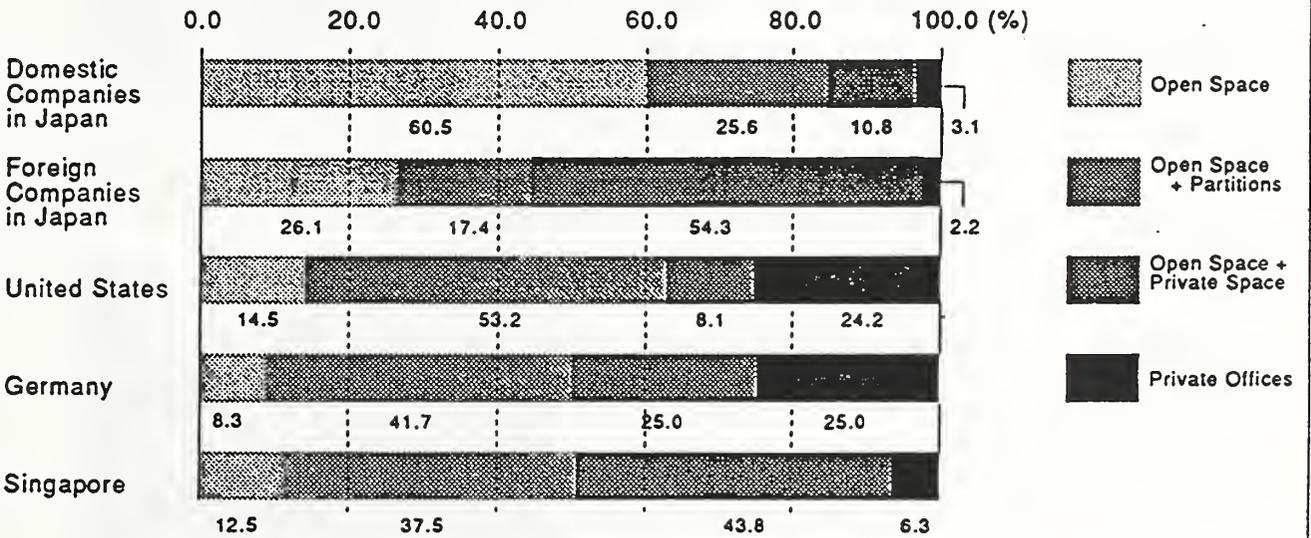
Figure 51.  Percentages of open and closed offices (NOPA 1988)

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Space also is probably one of the most critical commodities to allow organizational and technological change. You shouldn't design a tight-fit building. You should not squeeze every square foot out because if you do, you cannot accommodate technological and organizational change.

To summarize the first part of my talk, lots of system coordination and adaptability is an absolute requirement. Team decision making is needed. Space planners should not make decisions by themselves. Facilities managers, HVAC designers, telecommunications experts and space planners must work together in making decisions. (Figure 52)

---

**TO ACCOMMODATE ORGANIZATIONAL AND TECHNOLOGICAL DYNAMICS**

**REQUIRES:**

- "LOOSE FIT" SPACE

- LOTS OF SYSTEM COORDINATION AND ADAPTABILITY

- QUALITY PRODUCTS

---

**Figure 52. Design requirements**

The workstation module should be determined not only by spatial needs but by other factors as well - connectivity, thermal quality, acoustics, lighting, etc.(Figure 53)

---

**WORKSTATION MODULES - ESTABLISHED FOR:**

**Spatial needs** - worksurface and storage workstation connectivity

**Thermal quality** - HVAC zone size and control

**Air quality** - split thermal and air ducted air to the desk
- access to window

**Visual quality** - lighting zone size and control daylight and task light

**Acoustic quality** - workgroup size ceilings, walls and partitions

**Mechanical, electrical, structural, enclosure and interior systems interface and access**

---

**Figure 53. Workstation module requirements**

For example:

- Air quality.  Are you going to duct air to the desk?
  Are you going to have openable windows?

- Visual quality.  What is your lighting zone size and
  its control?  How do you interface with daylight?

- Acoustics.  What is your workgroup size?  Will it have
  acceptable acoustical conditions so you can avoid a
  white noise system.

Now, I would like to provide you with some examples of what is happening on the world scene.

In Germany, the headquarters of the Colonia Insurance Company houses about 2,500 people in a relatively large building complex. (Figure 54)  The company moved from downtown Cologne as a result of a fundamental change in their philosophy about facility use.  They decided not to do build a high rise building in which people communicate vertically, but pursued a cluster planning approach, resembling a campus or a little village.  At the village center is a lake, a garden, and eating facilities. Employees exit from their "house" or unit - they go outside to enter another "house". The original assumption was that people would resent the lack of internal connections, but they enjoy it and make excuses to go outside.



**Figure 54. Colonia building**

The building plan of each house demonstrates cluster open planning. (Figure 55)  The wings do not house more than 45 people.  Each house contains a center social space, housing shared services such as the post office.  In the middle of the site, central to the houses, is a dining facility and the main shared conferencing room.  The entire village is a fresh air facility. (Figure 56)
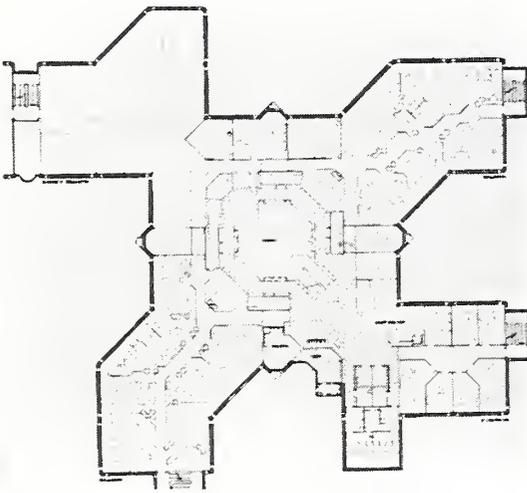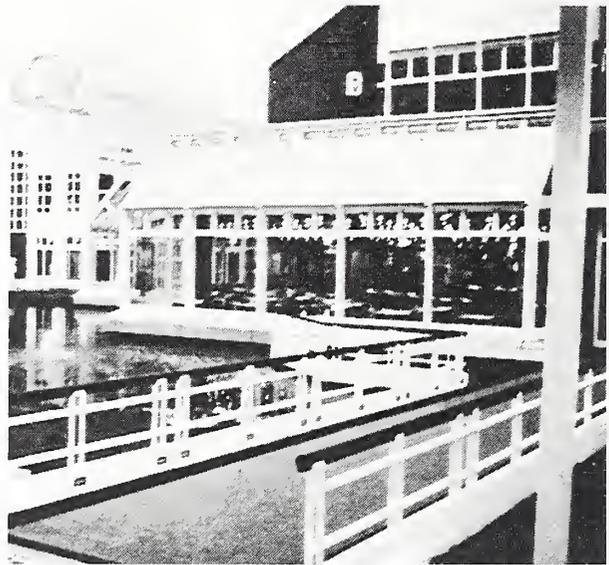


Figure 55.  Colonia building plan



Figure 56.  Access to fresh air

In the early planning, the employees were asked to identify the most important design feature.  The answer was, "We want access to an operable window."  So, the entire building was designed around operable windows.  This design directive obviously reduced the height and depth of the building and reconfigured the mechanical system.

A green light on the wall signals that windows may be opened, because the air conditioning is off. (Figure 57)  When there is a demand for air conditioning, the signal light goes off.  People are very responsible and close windows when necessary, because they know that the mechanical system will be "fighting" the open window.

A second innovation in the same project is a modular ceiling grid, which can be easily coordinated with variations in the spatial layout. (Figure 58)  On a pigtail system (like Christmas lights) one can add new fixtures as needed, for repositioning desks or setting up conference areas requiring more light.  Fixtures can be eliminated also, if that is required.  So, there is considerable flexibility, using lightweight easy to move fixtures.
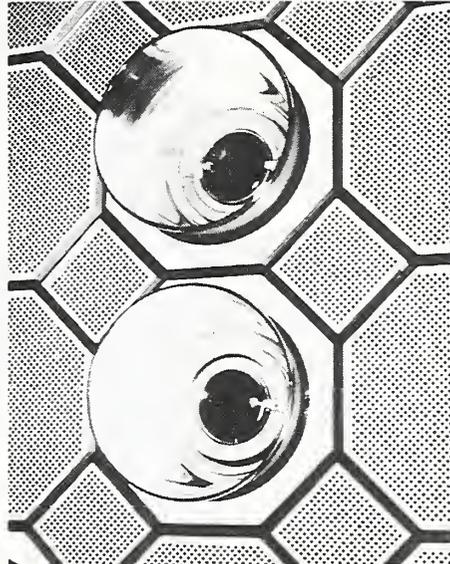
**Figure 57. Open window signal  Figure 58. Modular ceiling grid**

There is a raised floor system with a ducted air distribution system to ports in the floor. The conditioned air supplies can also be moved quite quickly.  In this open plan design, desks can be reconfigured easily by moving ports with ducted connections to match a new furniture layout. (Figure 59)
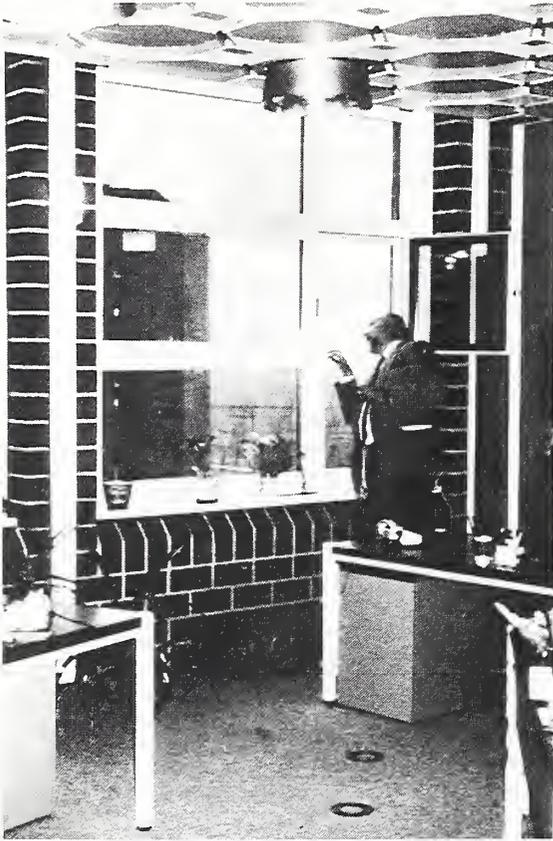
**Figure 59. Ducted air supply**

MR. SUTHERLAND: *How deep is the floor?*

MS. LOFTNESS: *I think it is 18 inches in this case.*

The raised floor is also used for the telecommunications network, with drop-in boxes providing multiple power and data ports, as well as telephone connections. These also are movable - a bit more complicated to move - but movable. (Figure 60)
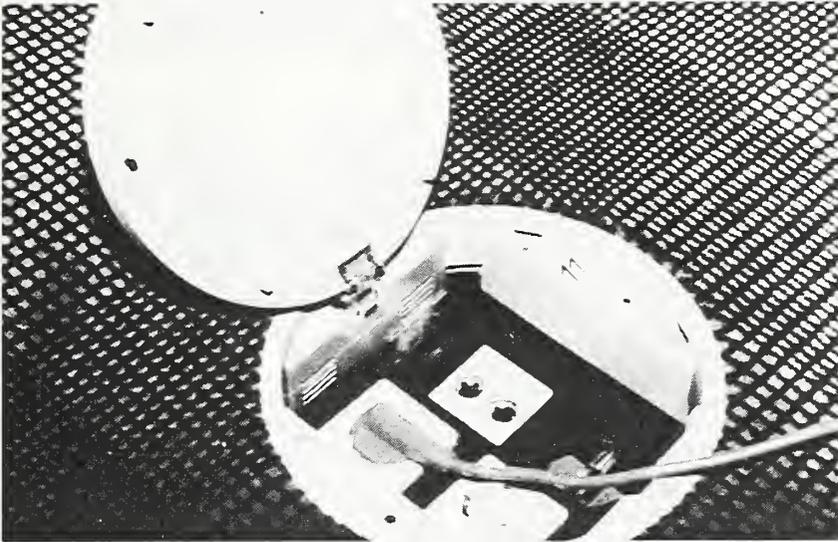
**Figure 60. Floor access**

To support these rapidly changing workgroups and the operable windows, Colonia has distributed mechanical systems, clustered in a mechanical room at the roof for easy maintenance and control. Each wing on each floor has its own mechanical system, allowing the staff to work flexible hours. The system also allows them to locally cool areas containing equipment, with a separate demand cycle.

The rooftop mechanical room and the vertical chases frame a central atrium, which functions both as a central core and central service area. The building contains an open stairway to encourage people to use stairs rather than elevators and to improve communication, because one passes more people on stairs than one encounters in a closed elevator. (Figure 61) This area also contains the post office and secretarial stations where employees pick up faxes and mail and coffee. (Figure 62) The coffee area - opposite the mail center, has a balcony to the outside so one can go outside and have a private conversation while enjoying the fresh air. (Figure 63)
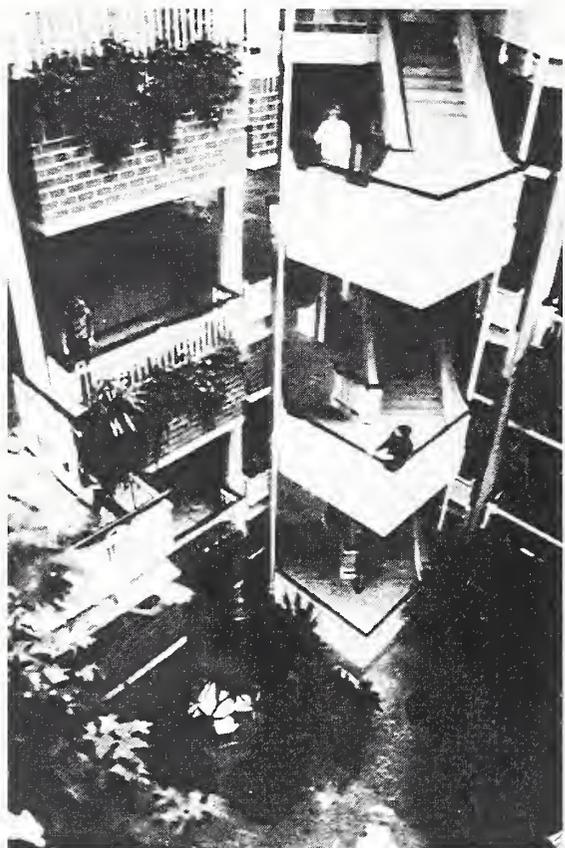
**Figure 61. Open stairway**　　　**Figure 62. Office service area**

The quality of the environment is evident. (Figure 64)  A very interesting design approach was employed for this building; creating a very humane and exciting work environment.  Colonia is very pleased with its design approach.
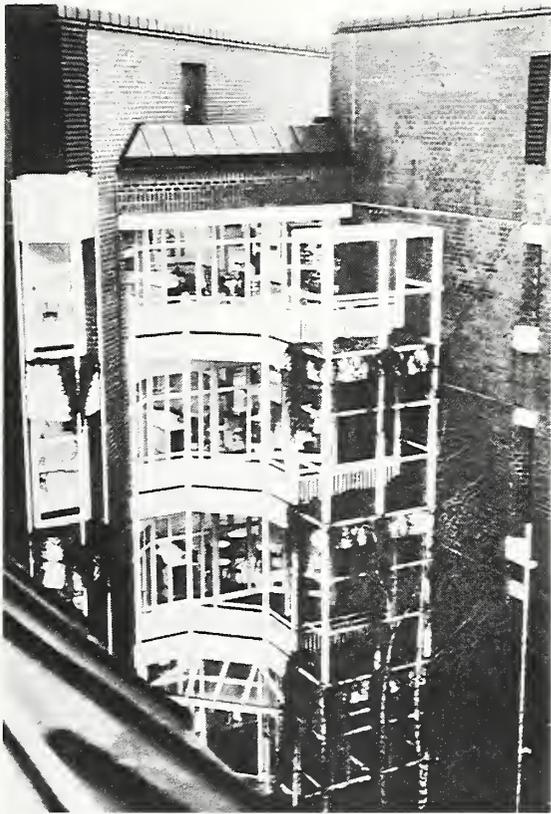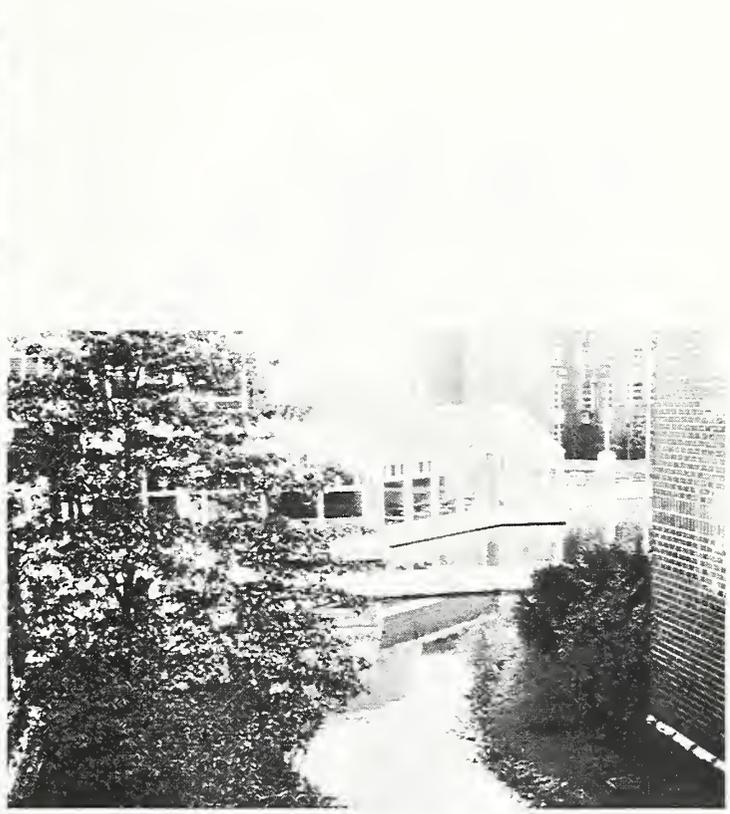
**Figure 63. Access to outdoors**      **Figure 64. Building exterior**

Moving to another part of the world, the Umeda Center, in Osaka, Japan, has a very different approach to the workstation module. (Figure 65) They decided to employ a 10 foot by 10 foot working module. In this case, the module includes everything - lighting and HVAC control, sprinkler and speaker systems. (Figure 66)

# UMEDA CENTER BUILDING
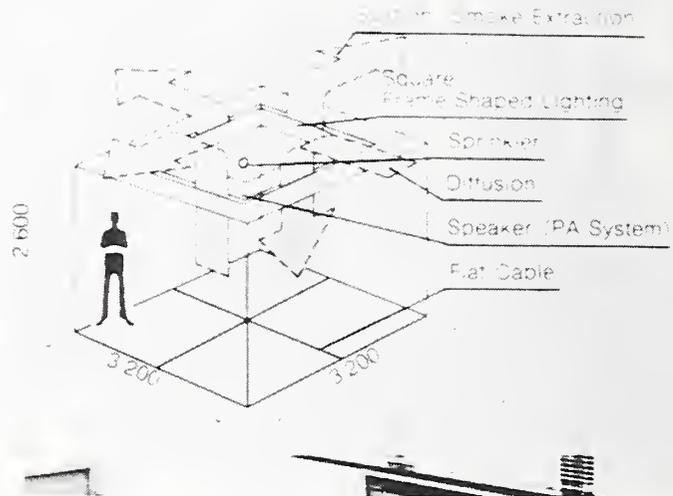


**Figure 65. Umeda Center**



**Figure 66. Workstation module system**

They used a mockup workstation, where the glass is symbolic. (Figure 67) It demonstrates that if one wanted to close off one central workstation, it would have its own HVAC and lighting capability. That is a very important evolutionary concept. If you decide on 85 percent open plan today and want to change to a 60 percent open plan, the work required to change that 25 percent into closed planning will be substantial, because the HVAC zoning will not be designed for it. So, the Umeda Center employs high density zoning, one per 10 feet by 10 feet - essentially one per workstation.

**Figure 67. Glass enclosure for workstation**

Figure 68 shows how this environmental flexibility has been achieved. Twelve distributed heat pumps are on each floor, at the building's corners, with direct access to outdoor air. Hot or cold water is distributed through a ceiling network to distributed air units. The building also contains a ducted fresh air system going to each fan coil box. Temperature and air speed is controlled for the individual or group, by a computer network. Sitting at the desk, an employee can turn the supply air and lights on or off, and set the air temperature. (Figure 69)

New Type of Air-Conditioning System that
Functions Independently in Each of Four Zones

**Figure 68. Heat pump distribution**



**Figure 69. Individual control of lighting and temperature**

Figure 70 shows a conference room, just set up in the open area. Since it has independent lighting control, the localized thermal management can be easily controlled from any location.

In this advanced office project, the designers appear to have made one mistake, committing to flat cable technology. (Figure 71) They have had difficulties because of the inability of the network to handle the rapidity of change, and increased demand. The boxes are real "tombstones," sitting above the floor so people trip over them. (Figure 72) Furthermore, they do not have sufficient outlet capacity - consequently a 'bundle of stuff' is on the floor. (Figure 73) In retrospect, it is unfortunate that they did not employ a raised floor technology.
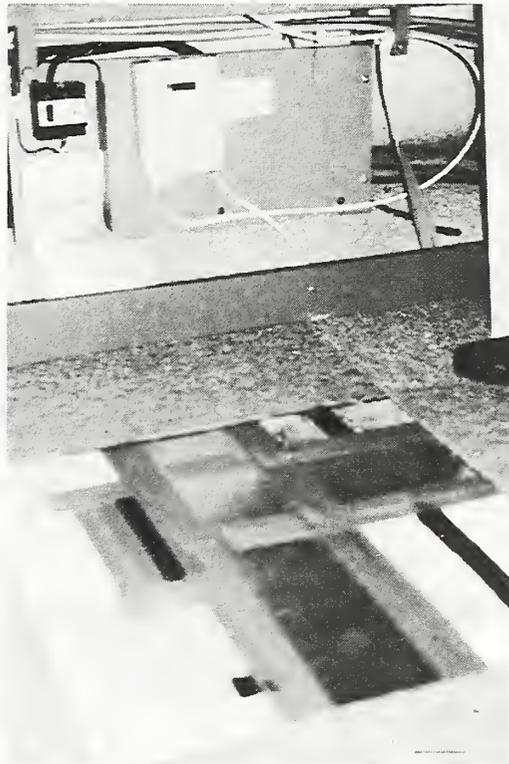


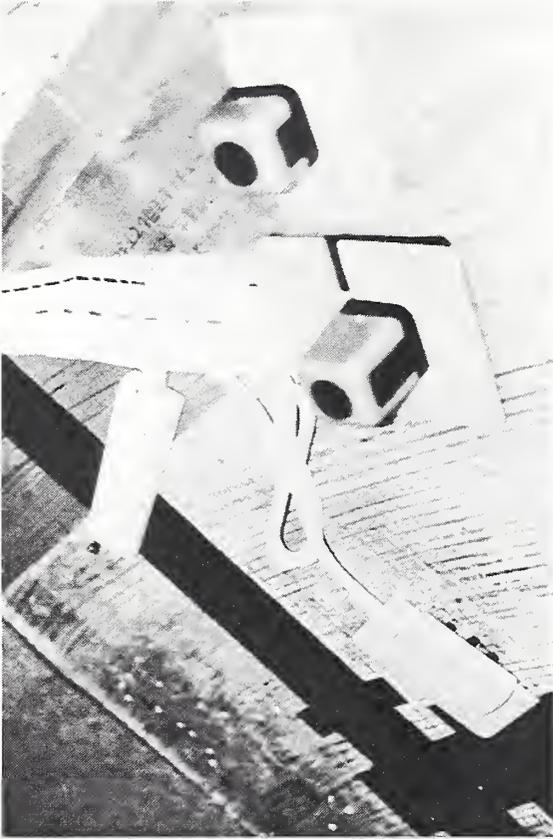**Figure 70. Conference room**     **Figure 71. Flat cable installation**
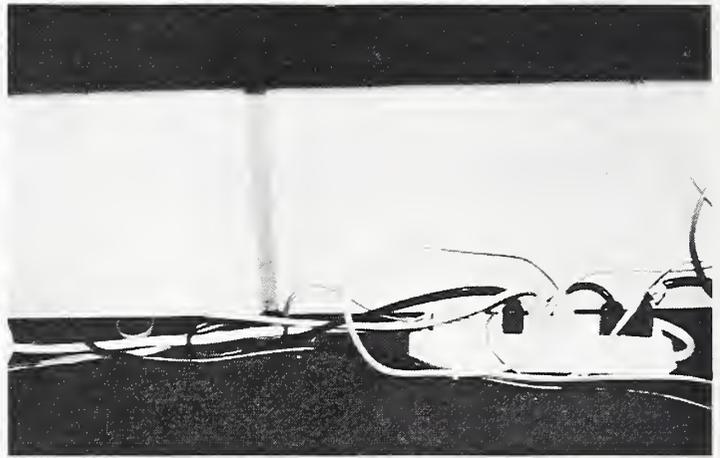
**Figure 72. Cable access**

**Figure 73. Wiring hazard**

Nonetheless, the Umeda Center is a delightful workplace, built as a significant investment. It is very much an open plan building, as are most Japanese offices, but it is at the forefront of office design in several ways, by employing adaptable settings and servicing methods. (Figure 74)

Returning to Europe, in France we saw some very different design solutions for the flexible workplace. The Ministry of Finance houses close to 8,000 workers. (Figure 75) It is located near the Seine, a bit outside the heart of Paris. This project is also a low rise campus. When asked, employees indicated that their greatest desire was access to an operable window. This had an important effect on planning. The building is low rise, and has cutouts for open air courts (not glassed-over), that provide everyone with access to views and fresh air. (Figure 76)

Figure 74. Umeda Center lobby
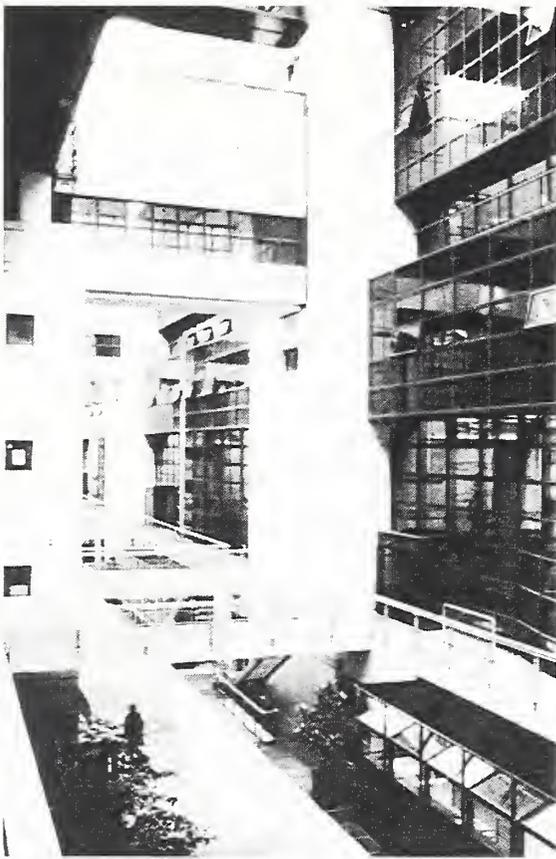


Figure 75. Ministry of Finance

**Figure 76. Central court Paris**

The operable windows are continuously used. (Figure 77)  The windows have an electronic connect to the perimeter fancoil units to control the interface with the mechanical system. (Figure 78)  In the mechanical configuration, they separated the thermal management from fresh air management, which is a very interesting concept. The thermal management is a perimeter fan coil, somewhat similar to those used in hotels. (Figure 79)  As soon as you open a window, the fan shuts off.  So, you must close your window to have that fancoil running.  As to "set-point" temperature, the individual has quite a bit of control: plus or minus two degrees Celsius (about 4 degrees Fahrenheit), and fan speeds can be adjusted.  People have been very happy with this individual thermal management.  In addition, the total building energy use is very good.
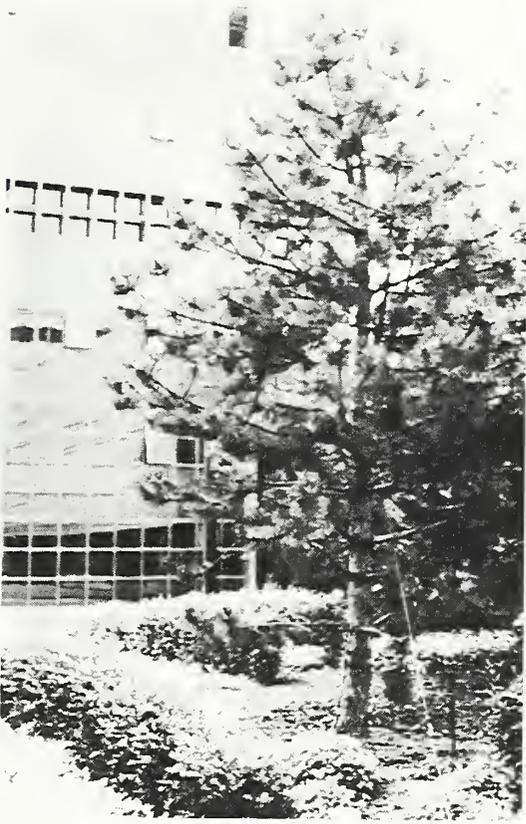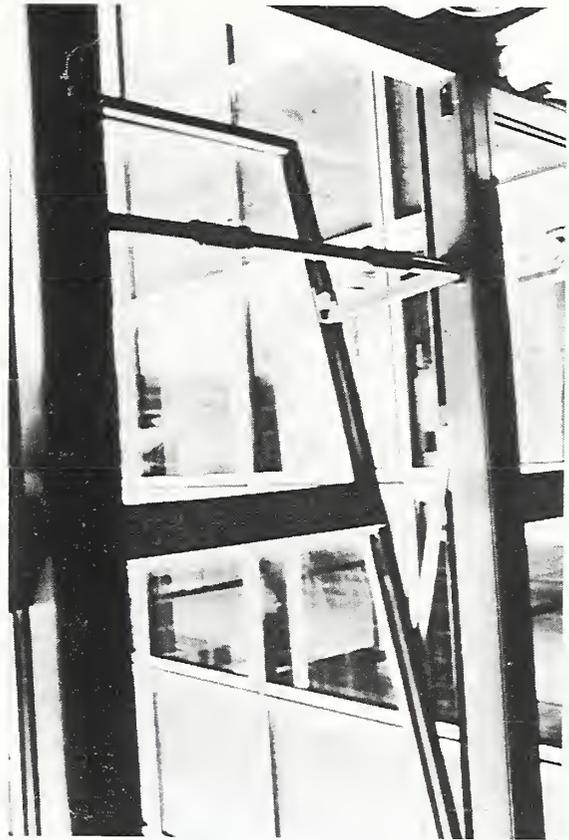
Figure 77. Openable windows

Figure 78. Connection to fancoil units

**Figure 79. Thermal control by fancoil**

For interior layout planning and environmental control, this complex has employed a module - 90 centimeters or a multiple of 90 centimeters. (Figure 80)  A typical office is two meters 70 centimeters - roughly 9 feet by 9 feet.  The module is defined by a ceiling grid that feeds HVAC, lighting, and data distribution.  Power poles bring voice, data, and power, down to the worksurface. (Figure 81)  The power pole has a modular set of presets that can be expanded and changed.  It can have four telephone, two power, and six data presets, or any combination desired. (Figure 82) The ceiling grid also accommodates variations in lighting technology that are quite extensive.  You select up-lighting or down-lighting.  Since it is completely modular, the number of fixtures can be tripled if needed. (Figure 83)  Task lights are provided for everybody, and a long catalogue of choices are available for individual preference.

**Figure 80. Office interior (Ministry of Finance)**
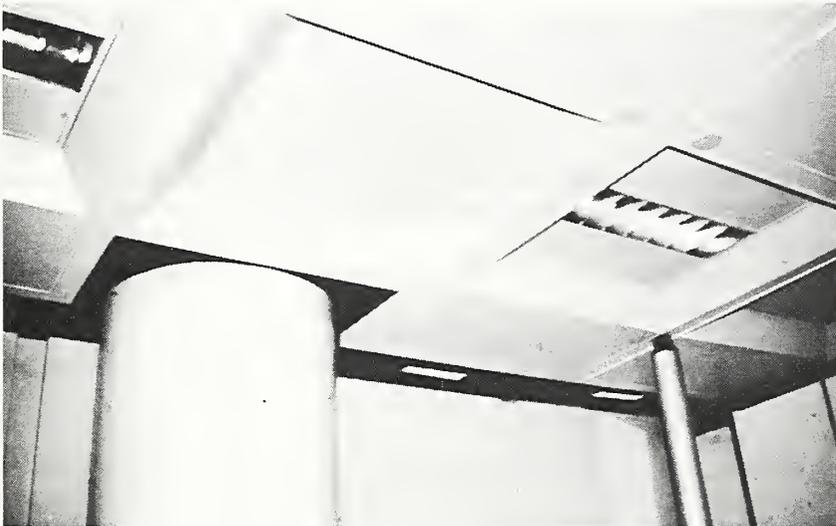


**Figure 81. Power poles**
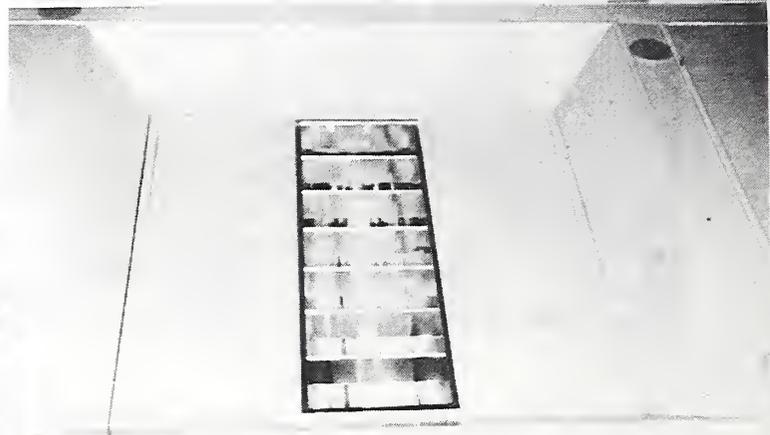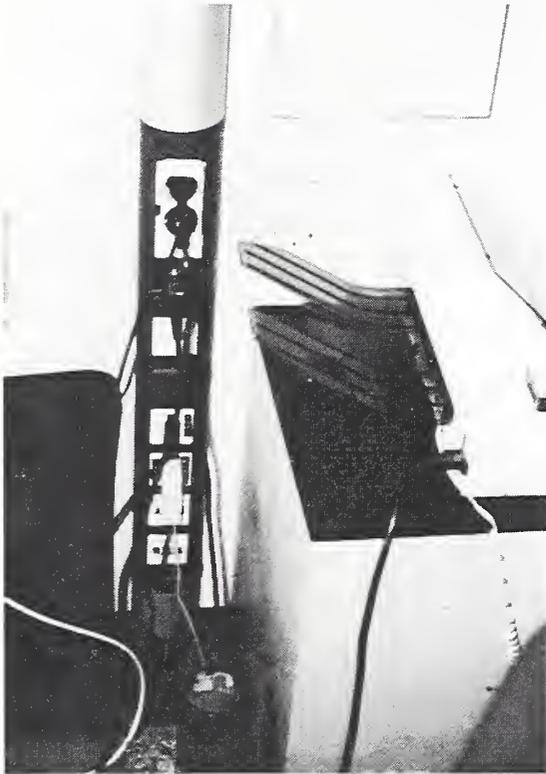
**Figure 82. Power pole connections    Figure 83. Lighting fixture**

The furniture is from any of four different companies.  Steelcase furniture is represented, Knoll, and two French companies.  A range of choices exist, with each department choosing its own.  Since the system is modular and power is fed from the ceiling, considerable flexibility exists.

The central issue of operable windows is a desire for view and fresh air. (Figure 84)  So the designers have attempted to create quite an animated view and introduce a lot of greenery - even on the rooftops.  (Figure 85)
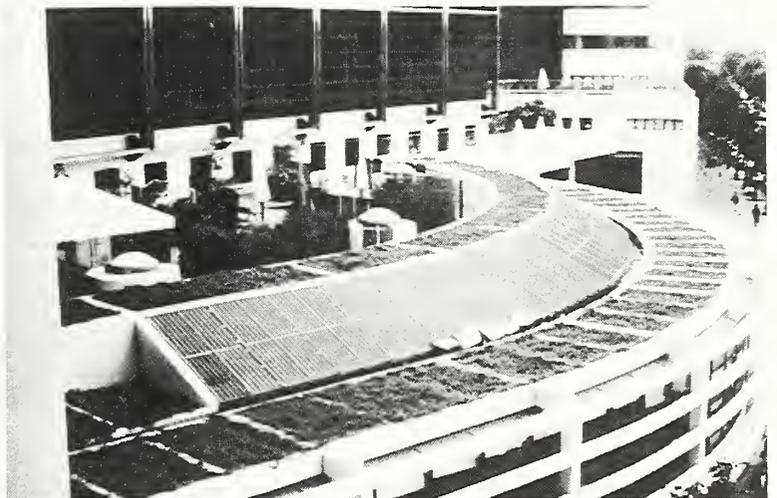
**Figure 84. Openable windows    Figure 85. Rooftop greenery**

In summary, we would like to emphasize that the effort to establish a workstation module is excellent.  This module, however, must be a whole building module, integrating structure, enclosure, ceiling systems, floor systems and telecommunications systems with the furniture systems.  For this reason, the workstation module must be developed by a full multi-disciplinary design team, including the structural, mechanical and telecommunications designers.  Specifically, the workstation module must have corresponding decisions about the heating and cooling module (zone) and control, the lighting module and control, as well as the ducted outside air module and control.  Our recommendation would be to size the zone for each system to the workstation (rather than to multiples of workstations) to allow for maximum flexibility in organizational and technological change - clearly at some initial cost (but great down-the-line savings).  We also recommend that the module be generous (e.g. 12 feet by 12 feet) rather than stingy - since physical space is one of America's great assets in the world market.

A second recommendation focuses on the overall massing of the building complex.  Our national and international studies lead us to believe that access to view (with content), daylight, and operable windows are essential features of a quality and healthy workplace.  This would clearly suggest developing building blocks with thinner footprints, with cutouts, and open air courts (a Washington tradition).  This approach would also generate more manageable workgroups (thermally, acoustically, spatially, and visually) of 30 to 50 people, rather than 200 to 300 people on a floorplate.  We would also encourage direct access to landscaped outdoor spaces to enhance the daily routine, communication, and the quality of life in tomorrow's workplace.

**MR. CYROS**: At this point we would like to address the subject of environmental technologies from an engineering practices viewpoint. The speaker is Valentine Lehr. As a founder and partner of Lehr Associates, Mr. Lehr plays a major role in conceptual engineering phases and contacts with clients and initiated the prime directions for the engineering efforts of the firm's diversified projects in the private, commercial and government sectors. Lehr Associates has provided services for projects on six continents, and Mr. Lehr is knowledgable about construction practices and design standards throughout the world. For many years he served on industry committees that defined construction technology standards and practices in areas such as energy cogeneration, consumer safety and professional education.

# ENVIRONMENTAL TECHNOLOGIES FROM AN ENGINEERING PRACTICES VIEWPOINT

**MR. LEHR:** I hope some of my comments will be useful in the process you are going through here today.

A good bit of the HVAC design community has been spending a lot of its effort and time recently talking about new directions for HVAC in the upcoming years. It is interesting because the buildings being designed now, and those going through the retrofit cycle, will have to last 40 and 50 years. They will go through a tremendous amount of change between the time they are constructed and when somebody decides they are good candidates for replacement. If we look at the HVAC industry itself, we find that it also has gone through tremendous changes in the last 40 or 50 years in terms of defining its objectives and determining how to achieve them.

This process is continuing. For example, there is an upcoming conference in Washington next spring dealing with the new directions of the HVAC industry. In preparation for it, I have been doing some research. If you go back into the literature, to the late 1950s and early 1960s, there was a tremendous amount of literature and research on the benefits of air conditioning, because in that era it was not a given that buildings would include air conditioning. Of course, today if you are building a major building, it is automatically air conditioned. But we have taken that for granted only for a few short years.

One thing that becomes very apparent as we look at what is driving the HVAC industry is that the user, the consumer - the occupant of the building in my mind, as well as the owner, operator or developer of the building - is becoming far more sophisticated, and that sophistication is imposing a series of demands which have to be realized if we are to develop a successful building.

Now, what is the consumer, the user, demanding? He or she is demanding increased levels of comfort. What is comfort?

The first problem is that comfort is at best, a movable target. What is comfortable for me is not necessarily comfortable for everyone else in this room, and what is comfortable for one person may be not satisfactory to the person next to him. I am comfortable now sitting here. A little bit earlier, I was sitting at the back of the room, and the climate there is terrible. I was certainly not comfortable in that location.

So, even within a fixed space, the question is, "What is comfort and how do we achieve the level of comfort which enables people to be productive and maintain their productivity throughout a day, a week, a month, or throughout an entire career?" A lot of research has to be done on that, and even when it is completed, I believe with certainty, that there is no simple or complete answer to the issue of comfort.

If we are to deal with the issue that different conditions are comfortable for different people, we will have to deal with a system which can respond to the specific requirements of an individual. To achieve that, we have to look at the problem from the perspective of three time frames: the short term, the intermediate term, and the long term.

If we look at short-term strategies - those which we will see and be implementing in the foreseeable future - in the next five to eight years - if we are going to make more people comfortable, more control zones are needed. The old approach of having a few zones throughout an entire building on a particular floor may have been acceptable once, but it is certainly not an acceptable solution now. So, the implementation of an ever greater number of zones, more VAV (variable air volume) zones for example, is a good strategy for dealing with existing buildings.

But if we are dealing with a new work environment - the type of project being considered here, we have to go beyond that. We want to be able to generate an individual environmental area which is responsive to the particular user's requirements.

We begin by thinking of the traditional terms of comfort and the classical concerns of a user, and those are, "What is the temperature  What is the humidity," and perhaps, What is the air velocity  Am I getting drafts?" But clearly we have already gone well beyond that.

Take, for example, the issue of smoking. That has been dealt with in many areas by legislation, but it is indicative that people are concerned with indoor air quality, which is a hot topic right now. More important than that, for example, the nature of allergic reactions in different environments is another area of great concern. All those things have to be dealt with.

So, in the short term, we are looking at strategies which can give us more zones which will enable more people to achieve an environment acceptable to them.

As we move to the intermediate term, the situation gets to be even more interesting, because we can look at the impact of control systems on what we are doing.

For example, what do we do today to define a comfort condition within a zone? Well, someplace in this room there is probably a control thermostat on the back wall; that device sets the temperature level in the room. Certainly it is sensing temperature in this room. Very few HVAC systems have sophisticated controls which will also monitor things such as humidity. Certainly, nothing monitors parameters such as draftiness. As I said earlier , if you sit in the back of the room, a cold draft comes in on top of you, and that is not monitored. So, one basic concept is how are we controlling things.

A very interesting series of technologies are emerging. I don't know if anybody here is familiar with making TV commercials. One project we have been working on for a long time deals with a media company that makes a lot of commercials. It is an interesting process. When a commercial is finished, they screen it for a reaction, and invite people in to look at the results. They then ask them for their opinions. That is what they do on the surface.

However, in addition, there is a sophisticated series of devices which, for example, can monitor exactly where a person's eyes focus on a screen. So if, for example, a screen delivers some message, like, "Buy Carter's Little Liver Pills," and also appearing on the screen is a picture of a young lady wearing a skimpy bathing suit, the question is, "What are you looking at?" and "What is the message you are getting?" These findings are used in the decision making process of how a commercial is rated, marketed and used.

Well, that same type of monitoring technology is rapidly evolving in other areas. So, the question really is, "Is a thermostat on the wall an appropriate means of determining what is comfortable in the room and the answer clearly is that it is not.

What type of new technology is emerging? It is possible, for example, for scanners in a room to monitor skin temperature and skin moisture content? An appropriate algorithm can be employed in a computer program which averages the comfort levels of people in a room and then drives the controls of the HVAC system to optimize comfort levels.

That type of technology is emerging and is something which we will begin to see perhaps in 10 to 15 years.

The third level, the long range plan, is something even beyond that. If we can monitor and average skin temperatures and skin moisture content in a room, why not go one step further, and monitor an individual. For example, as you enter the room, you are identified, and as you move from space to space, your individual requirements and reactions are monitored, and as you move from space to space, your individual climate and zone is changed.

We have to stop thinking of HVAC systems in terms of ducts and air diffuser outlets, and begin to think of scenarios which will enable us to conceive of developing multiple individual zones. Perhaps my space is my body plus one or two feet on each side, and my space can be different from the space of the gentlemen on either side of me. That type of a system is coming.

The building we looked at a while ago - the Colonia Insurance Company - is one I am quite familiar with. The type of technology they have in the floor outlet system is not very often seen anywhere in the world, certainly not in this country. But it begins to offer the type of system which could respond to individuals and move personal zones around.

Those are the types of things and strategies which I believe the industry is beginning to examine.

I was rather surprised by an occurrence recently. I thought some of the technologies we were talking about in terms of sensing skin temperature and skin moisture content were quite advanced. I happened to be in Japan in September and went to a research laboratory north of Tokyo.

One thing of interest was the research work being done in monitoring comfort levels and brain alpha waves, correlating alpha wave activity with comfort conditions during sleep. This was in an attempt to look at control strategies for indoor climatic conditions - in this case, for hotel rooms. They began to think of it as a control strategy.

We are a long way in this country from thinking about monitoring alpha waves. When I think of that technology, I think that "Big Brother" may be upon us in the not too distant future. But that is happening in research laboratories in Japan at the moment. They already have developed some advanced concepts of how to remotely monitor a person's alpha waves. A little far-fetched, but it indicates that there are alternate ways of defining what comfort levels ought to be, and how we control systems.

Now, obviously, all of these things cost money. If we are to respond to the sophisticated user, we must respond not only to the needs of the people who use a particular space, but to those who own, build, develop, and maintain these spaces. Clearly, when we look at some of these alternate strategies, there are cost implications.

Not all of the technologies result in increased costs. For example, if we develop a series of control zones, and as we develop more zones, the cost theoretically should rise. But the individual cost of a control zone will in fact asymptotically peak at some point and then decline, due to an economy of scale. Using the same devices often reduces the unit costs.

If we provide more control zones, again we have a curve that drops. As we make more people comfortable in their individual environment, and more importantly, as we are able to shut off control zones for unoccupied areas, an operational economy can be achieved. This also does not go down indefinitely, but asymptotically approaches some minimum value.

These things are quite important because cost is going to be a function of demand. When we talk about these things in a recessionary period, we wonder what the demands will be, but history tells us that the building industry is going to revive. If we look at the retrofit market as well, the potential for having cost effective things happen is going to be quite good.

What other concepts can result in cost savings? We heard earlier from Mike Hooker about ambient task lighting systems. In the future we might think of ambient task HVAC systems. Certainly the criteria for a transient zone is quite different than for a work zone, where a person is going to spend a considerable amount of time. As we become more sophisticated in creating control zones, we have an opportunity of dealing with HVAC systems which are more responsive, and less expensive to operate.

Ultimately, what will drive the requirement for improved and more sophisticated systems is the user. Today we do not ask whether a building should be air conditioned, because the user demands it. In the future, we will not ask whether we need a sophisticated HVAC system. It will be a given, because the user demands it.

But most people are not prepared to spend a lot of extra money. What is a lot of extra money?

Well, it might cost 15 or 20 cents a square foot, per year. That is not a lot of money. I think that things are going to develop in a different vein; the sophisticated user is going to demand a more sophisticated product. That is the history of what has been happening to date.

How does all of this relate to the project at hand? What is the correlation between what people are talking about and what people foresee in the future against the reality of doing a 1.7 million square foot building and all of the things associated with it?

If people want to be more comfortable in a space and, that is in the short term, a function of the number of control zones that we have, then developing control zones on a workstation basis is an imperative. I think that is going to happen in the HVAC area. It is going to happen in lighting. It is going to happen in many other environments.

That is not without precedent. For example, in the large financial trading rooms, we have had situations where we must deal with extremely high equipment heat loads. Our solution was to install fan coil units directly at the workstation, which picks up the heat load from that equipment. That has proven to be immensely successful.

Two years ago it was an innovation - it was winning awards in design competitions for engineering systems. Today it is commonplace. It is only a slight extension in the use of technology - to meet the requirement for improved user satisfaction - on a workstation which includes individual climatic control.

What about a workstation with climatic control? Is this going to be an air-based system?

I think not. It is more likely to be a water system. Water has many advantages. First, it is easier to route around. It is far more flexible. It is a far more efficient means of transmitting energy. In addition to dealing with the climatic condition in the environment that the user occupies, it has tremendous potential to deal directly with the cooling requirements of the equipment to be installed.

Years ago mixing electricity and water was considered an absolute taboo. Today it is not. In the future we will increasingly have integrated systems which, for efficiency, will have the heat removed through water. We will have to use distributed water systems both for workstation and equipment needs.

As a result, there will be a tremendous impact in terms of building design because now we have another utility to be distributed. We are also going to have to consider it in terms of the modular arrangements necessary for the workstation detail.

What other types of things are we talking about?

We have to improve the controls situation. We now deal with control situations which are quite simple. What we need is the capability to load into the controls, presets for different conditions. Preset lighting is old technology. Preset air conditioning? Is it useful? Yes. Does it give us a great deal of flexibility? Absolutely.

The response of a control system to an actual environment is very primitive today. We need better algorithms. We need better control strategies, which anticipate changes that occur, rather than reacting to them. I think this will markedly improve the comfort levels as well.

Another important issue is off-hours operation. I am not sure how much of that will exist in the proposed DOT building, but more and more we find that the traditional work period - 8:00 AM. to 6:00 PM, five days a week, and perhaps some Saturday time, is not the way buildings are being used. When we look at HVAC systems operations, we have to design our systems to accommodate non-traditional work periods. This is best handled on a micro level, because the amount of space occupied during those off-peak periods, or off normal hour periods, is quite small.

In summarizing, we are dealing with a very sophisticated user who is becoming more sophisticated and more demanding. I do not think we can quantify, in many of these areas, an economic advantage for spending extra money. I think it is going to be something that must be demanded.

I thought we were going to hear in the lighting discussion, a story you might have heard. Some bright industrial engineers were doing some time-and-motion studies and decided to study the effects of lighting in a particular production department which was remarkably stable. Its production had remained the same year in and year out. (The Hawthorne Studies - "Management and the Worker", F.J. Roethlisberger and William J. Dickson, Harvard University Press, Cambridge, MA, 1941 - ed)

They increased the lighting levels, and production went up. They thought this was quite marvelous. They increased the lighting levels again, and the production went up again. They did it a third time, and thought they had discovered this tremendous correlation between lighting levels and productivity. As a control, they went back in and they reduced the lighting to the initial level, and the production went up again.

Obviously, the result was not that the productivity of a person was correlated directly to lighting levels, it was correlated to the fact that the system, not the HVAC or lighting, but the management system, suddenly cared about people - about their comfort and was interested in them - the employees responded to that.

As we look into the future, I think we are going to find the same thing happening. If you provide individual control zones, productivity is likely to improve.

**MR. CYROS**: In the building design issue area, we are going to talk about effects of workstation concepts on building design. Robert Cioppa is a partner in Kohn Pederson Fox. Has had over 20 years of experience as an architect and administrator. He has been the managing principal for the design and construction of corporate and investment office buildings, totalling more than $800 million for such clients as the Urban Investment and Development Company, INA Corporation, and many, many more.

## BUILDING DESIGN ISSUES - EFFECT OF WORKSTATION CONCEPTS ON BUILDING DESIGN

**MR. CIOPPA:** At some risk, I would like to deviate somewhat from my paper because a few ideas were not discussed. Much of what I was going to say has been covered. Maybe that is the advantage and disadvantage of being last to speak today.

The process which DOT is undergoing is unique. This singularity has been mentioned, but you must have a strong realization of its unique composition at this point. While single user buildings of 1.7 million square feet housing 8,000 people have been built in Washington - the concept of designing, based upon the thorough investigation of what might constitute the office environment for the next few decades, relating such concepts to your program needs, planning on such a scale and designing the building over a railroad, truly makes your process unique.

Also, in Washington there are constraints which might be manipulated to your advantage. You are not allowed to have the proper floor-to-floor dimension, for instance, because of the height limitations in the Capitol; the amount that you are reducing the floor-to-floor dimension of the building to achieve the area for your program demands within a particular volume will influence the degree and kind of flexibility achievable in your project. The concepts discussed earlier are predicated on having the correct floor-to-floor dimension. Since you cannot sacrifice square footage for height, you have to seek unique solutions.

I am impressed that a client has brought together this degree of expertise to investigate problems and potential solutions.

I also am impressed that you have so much time. It is rare to have the opportunity of working on a building to be completed in nine years. The typical time frame has been two to four years at best.

This duration of time, while frustrating from your standpoint, gives you an opportunity to achieve a number of things:

It is important to bring together the expertise represented at this conference. It is also essential to weigh the various ideas put forth against what is achievable in the construction environment of Washington in the mid 1990's.

However the opinions of these experts must be weighed in relation to the cost/benefits they generate. Many solutions mentioned will impact the square foot building cost, and the cost/benefit is something only you, as a client, can evaluate.

I would encourage you, if you try out new technologies, that it be done with caution. While there is some benefit in pushing technology, it can be harmful if new approaches are not thoroughly tested before being built into buildings. You have this wonderful luxury of time. Through the use of mockups, and the installation of new technology in a limited way, in your current buildings, such notions of modular workstations, HVAC distribution, a different approach to data control and data distribution can be tested.

I suggest that mockups not be used in a sterile environment such as a warehouse, since these installations only replicate a workspace and are never used. Rather, use a portion of your current workspace and perform work in the mockup. There is no substitution for this type of testing. It is something that we encourage clients to do, and they have a difficult time appreciating its worth until they do it.

There are a lot of notions currently being investigated in corporate life, in terms of planning standards and new technologies. You have heard a little bit about it today and will no doubt hear more tomorrow.

A number of our clients have "uncoupled" space requirements from grade levels. I think the comments about particular workspaces being more than required is very cogent. A number of our clients are trying to establish the size of the workstation based upon the job to be done within the space, and not by the job title of the occupant. This is an important thing to look at, particularly if your current standards would force the segmentation of the DOT staff into different buildings. The fact that you are not putting your entire workforce within the same building is something that should be thought through very carefully.

We are currently working on the Foley Square Courthouse for District One, and they are going through considerable soul-searching to ensure that their entire operation is housed within the same building. This may be impossible for you, but the Courts would sacrifice standard individual workstations sizes to ensure that "Probation" is in the same building as "Pretrial," etc. They use a system based neither on grade or title to make decisions regarding workspace standards.

It might be more important to have a collegial community where everybody suffers a little bit, but perhaps can be more productive.

The remainder of my comments are intended to provide some perspective on office design.

Architects always look backwards in order to look forward. I want to examine the history of the office building and office space, to reestablish how the form evolved.

It is no great revelation that early office buildings were small, but were able to house the entire operations of a company within a building, consistent with the scale of its surrounds. Sometimes, they resembled Ducal Palaces. (Figure 86)

**Figure 86.** An early office building

If one considers these buildings today - and many are still extant - it is clear where they are deficient and differ from a modern office building. For instance, if you were to renovate these buildings, it would become clear that these buildings were built to the standard of their day. Whether they were built decades ago or only 10 years ago, they contained the latest available technology. (Figure 87)
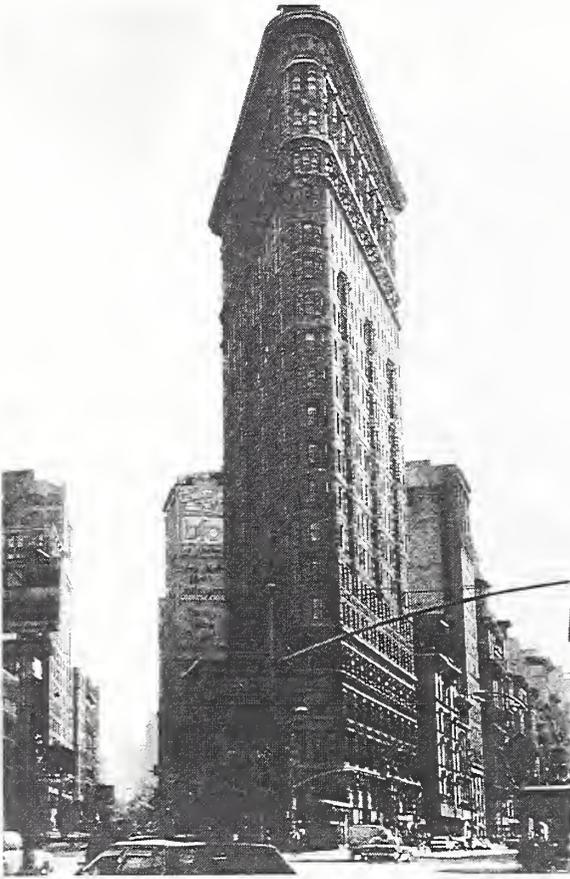
**Figure 87 - An Early High Rise Office Building**

One only has to consider the consequences of renovating a building built prior to 1930 to understand the progress the workplace of today has undergone. Such a renovation would entail the introduction of modern systems for HVAC, lighting, fire protection and electronic communication and upgrading of elevator controls. However, there would remain an architectural legacy which could not be changed. Its structure may be of steel with close column spacing, its fenestration - its windows - might correspond to some decorative stylistic preference but have little to do with a modern office module. (Figures 88, 89)

Likewise, its floor-to-floor dimension probably never anticipated room for such elements as raised floors, HVAC systems and recessed lighting. After World War II, all building systems that so dominate the architectural approach to the office building of today were introduced.
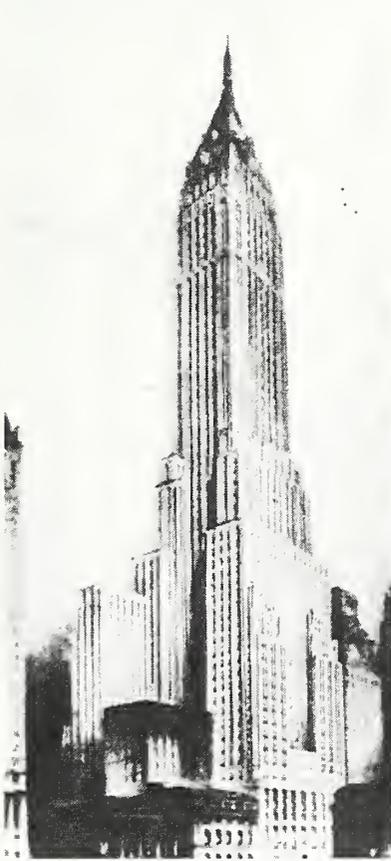
**Figure 88. 1930's building    Figure 89.  Post WWII building**

In addition to these systems - HVAC, long-span steel and concrete, lighting, communication, raised floors - the growth of corporations called for larger floor plate sizes to accommodate large functional groups.  Floor sizes grew from an average of 10,000 to 15,000 sq. ft. in the 1930's to 20,000 to 25,000 square feet by the 1970's.  In the 1980's, 35,000 to 40,000 square feet plates were demanded. (Figure 90)

The architectural problem that this increase in volume creates is that architects have to somehow bring the bricks and mortar together to enclose this expanded workspace, give it identity, relate it to its surround, create an image for the occupants, and produce a pleasant and productive interior environment.

**Figure 90. Modern building (1980's)**

The development of the workstation or workplace was a more straightforward process than is generally perceived. The worker at the turn of the century was basically warehoused. In that environment, there were two types of work - the boss had an office, and everyone else was in an open bullpen. (Figure 91)



**Figure 91. An early office**

Technologically, these open spaces were productive. Quite frankly, they were able to do their work. They had no HVAC and primitive lighting. (Figure 92)
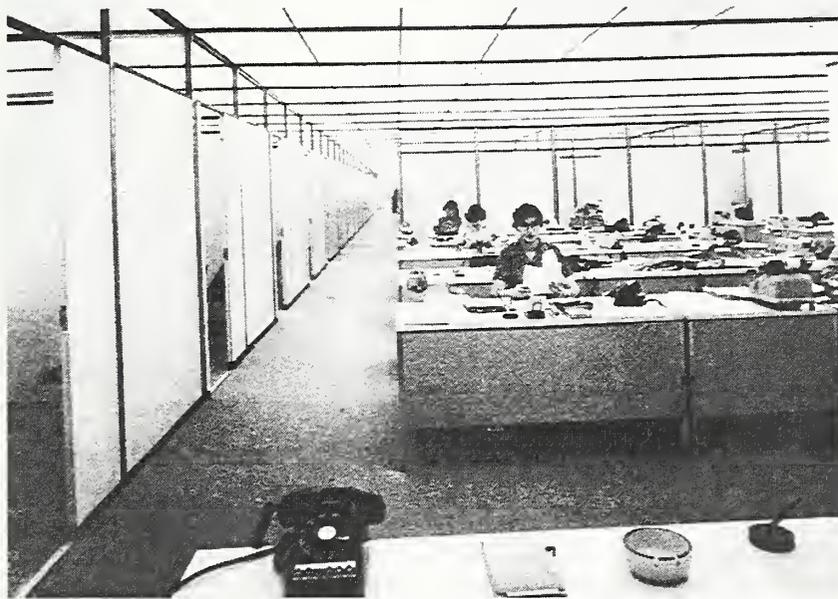


**Figure 92. A later version of an open space office.**

All modern technological systems may be viewed as a response to the needs of this type of office worker's environment. Until the 1970's, the environment consisted of enclosed offices and a majority of open office "pool" areas. When one considers the open office landscaping systems of today, it is difficult to imagine that they were developed as alternative solutions to the open office pool areas, but that is the case.

The notion that modern planning introduced to the workspace was the module. Theoretically, it was felt that there exists a "platonic ideal" notion of some dimension that universally fits all kinds and types of workspace. In the late 1950's, early 1960's, it was applied ruthlessly to everything, where the person became the anomaly - the only non-modular component of the office.

The workstation as a concept is very successful in terms of defining a person's privacy, his or her work environment, and giving a sense of individuality within a very large corporate or departmental environment. (Figure 93)

**Figure 93. Workstation in open office**

Into this environment of modular open workspace, the workstation was introduced to provide a better environment and more privacy than a desk in an open space. As a replacement for the bullpen, it has proven to be very successful. (Figure 94) The average workstation was able to adapt to the tremendous electronic equipment demands. And, coupled with a raised floor or cellular deck system, it introduced a high level of flexibility.
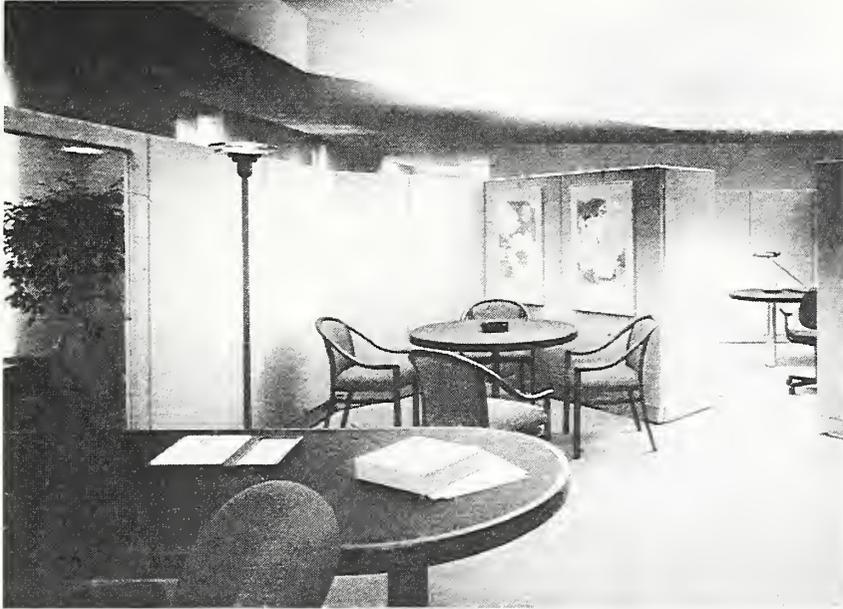
**Figure 94. Workstation with panel systems**

As with most successes, the workstation concept was applied universally in some corporations, both to open pool areas and as a substitute for private offices. The problems of such an application became quickly apparent. Open workstations could not provide a high level of privacy; hierarchical problems developed; workstations consumed more space and became more elaborate - all in an effort to substitute for a private executive office. The primary advantage of this application was the elimination of light and view blocking walls along the building perimeter. It was a very egalitarian solution, offering the highest quality environment for all workers. It also allowed architects an unusual freedom of expression with regard to the building exterior massing, and a varied treatment of window areas. As long as one stayed within a core to wall depth of 40 to 50 feet, every imagined exterior expression could be used. (Figure 95)
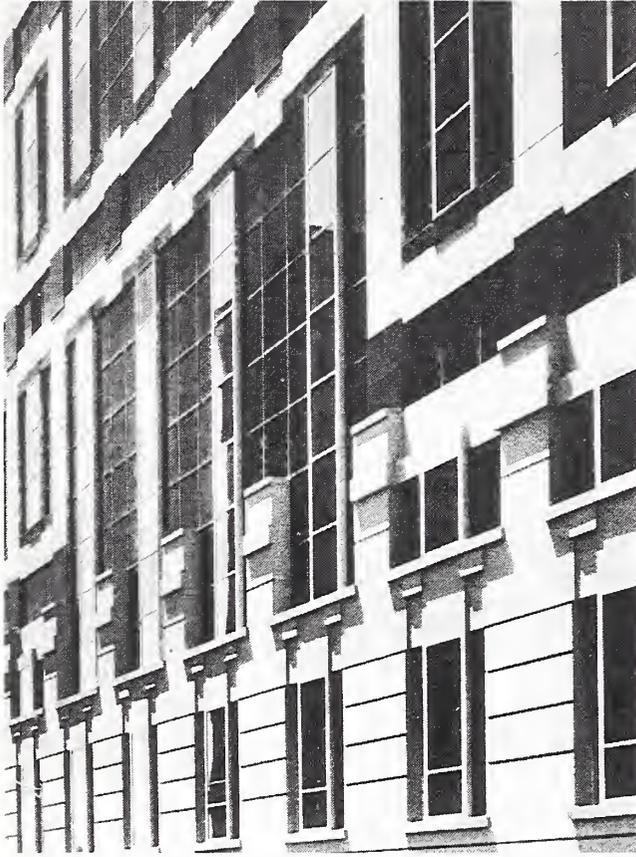
**Figure 95. Building exterior design creativity**

The architectural design process is often viewed as designing from the outside in. The ground rules were clear - a five foot module along the wall; 30 foot column centers or better still, no columns at all; 40 to 45 feet from the core to the outside wall; 13 feet to 14 feet floor-to-floor dimensions; no floor plates less than 25,000 sq ft, except at the top - the "crown" of the building.

The reality is very different.

However, such an approach is really a simplification. A building which truly responds to its interior program must develop many elements - module, structural span and column positions, working floor depths, utility spaces, and finally, community spaces.

The module - the rigorous grid which binds all of the elements of an office building together has been the most studied unit of planning in modern architecture. The module has been expanded to order floors, structure ceilings, design lighting, and furniture - we even speak of 'modular' houses. In effect, it is an attempt to regularize planning, organize growth, and otherwise provide order to our "human acts."

The proper size and spacing of modules has been tinkered with for decades. Because of the proliferation of speculative office buildings, a kind of 'gentlemen's agreement' has established the size at five feet. The five foot size relates to nothing in particular other than an office width of 10 or 15 feet, and a nominal desk width of the same dimension.

Besides the office space along the building's perimeter, not one thing relates to it. Ceilings and lighting were regularized at two feet by four feet, or two feet by two feet; workstations do not conform to any standard size.

The important characteristic of a module is its convenience for planning purposes. The reduction of a module to its smallest reasonable component is the key to flexibility; for example, a two foot six inch module offers double the possible combinations of office planning, than one of five feet. (Figure 96) The logic can be extended to achieve a type of syncopation of uneven divisions within a larger module of ten feet for even more layout combinations. (Figure 97)
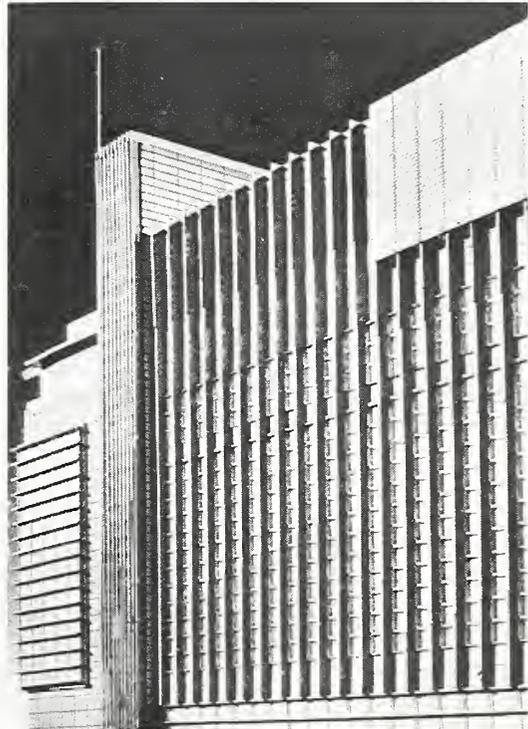


**Figures 96 and 97. Two types of building modules**

The placement of the core is perhaps the next most important element of building planning. In our work in Europe, Germany in particular, the core to the outside wall dimension is limited by a very human concern - that of natural light. No one may work more than 25 feet from a window.

That's hardly the case here in the United States, the core to the outside world is strictly a matter of adding up dimensions - office depth + corridor + three workstations + corridor to equal 45 feet (+/-), aligned on both sides of a core. The large bulk office building quickly became unmanageable in the aesthetic of the modulated box. (Figure 98)
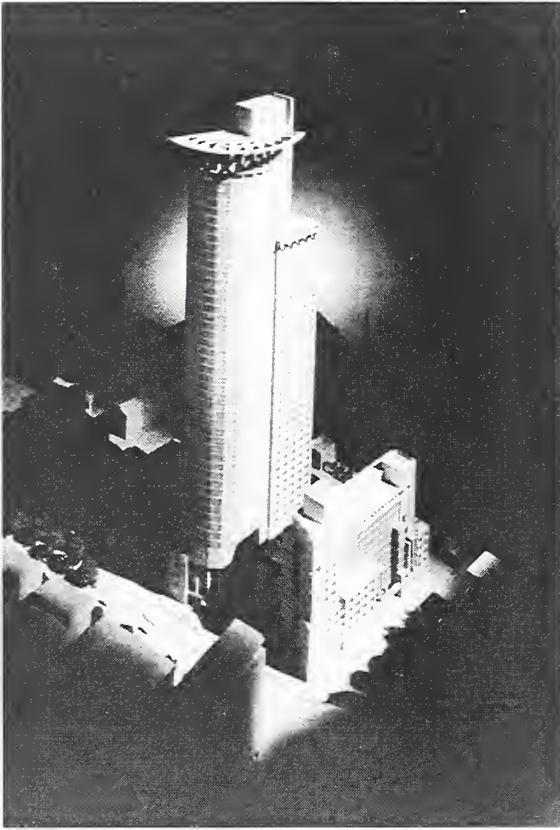
**Figure 98. Large bulk office building**

The careful placement of core to the outside wall is the key. But we can look at this dimension in another way, as a kind of super module, with extensions dividing a large floor plate, into bars of flexible space. The resultant spaces offer light on both sides and can achieve the same result as bulk spaces.
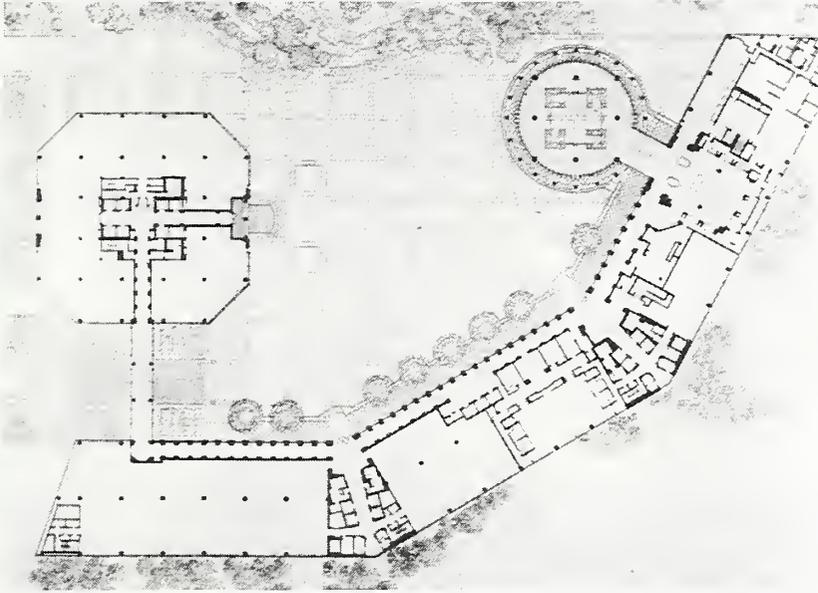
**Figure 99. Flexible space design - illustration**



**Figure 100. Flexible space design - photograph**

In an attempt to allow office space to accomodate change, interior designers and architects have applied technology from laboratories, computer rooms and hospital planning. Raised floor systems, interstitial spaces and multiple utility closets were used as a type of overlay technology for the office space. A combination of these approaches can be used to lessen story height, supply air, and provide flexibility. (Figures 101-104) Finally, the office environment is not complete without a developed sense of community or corporation. (Figure 105) Over the years, owners and architects have employed a number of devices to instill or symbolize this unity of organization. Atria or central courtyards were prevalent at one point. (Figure 106) The theory behind the approach is that if people could see one another, they are united by "stares." Community activity spaces were offered - cafeterias, exercise facilities, etc. (Figure 107) By themselves, such spaces constitute important benefits to any work environment. But, it was not until the most basic of human organizing elements was applied to them that they became integral to the sense of corporate community that element - the notion of street, or linear circulation, and a gathering place where interaction can take place. (Figures 108, 109)
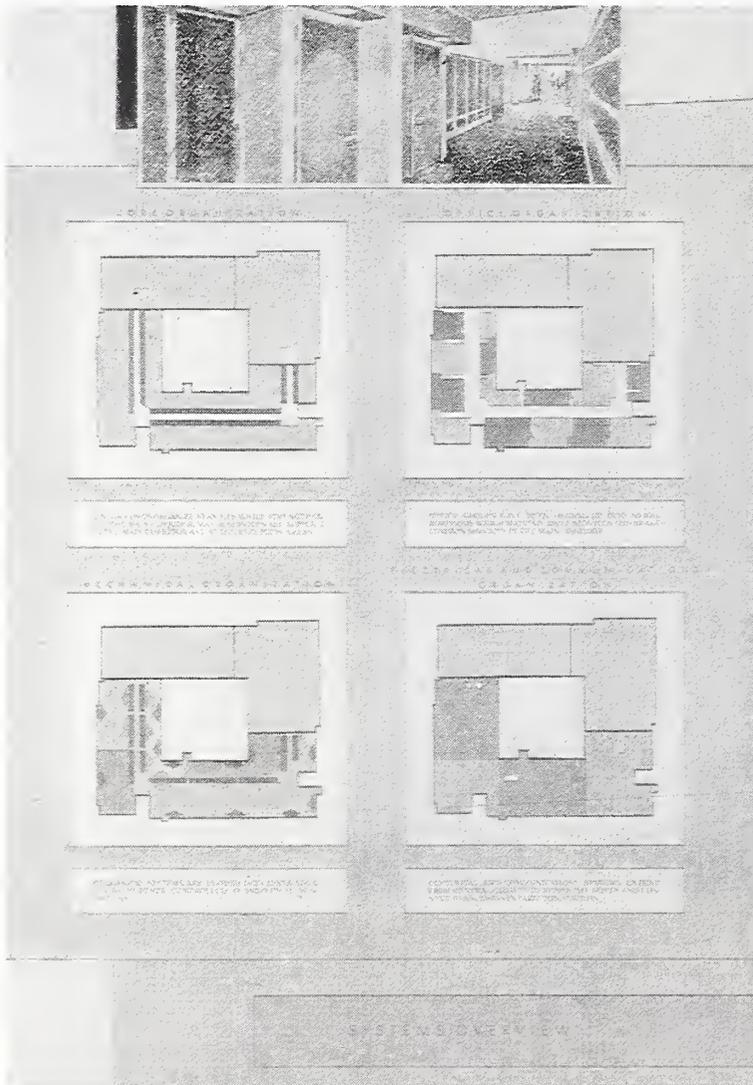


Figure 101. Application of new technologies (a)

MECHANICAL

PRESSURIZED RAISED FLOOR SUPPLIES
AIR TO INDIVIDUALLY THERMOSTATICALLY
CONTROLLED DIFFUSERS.
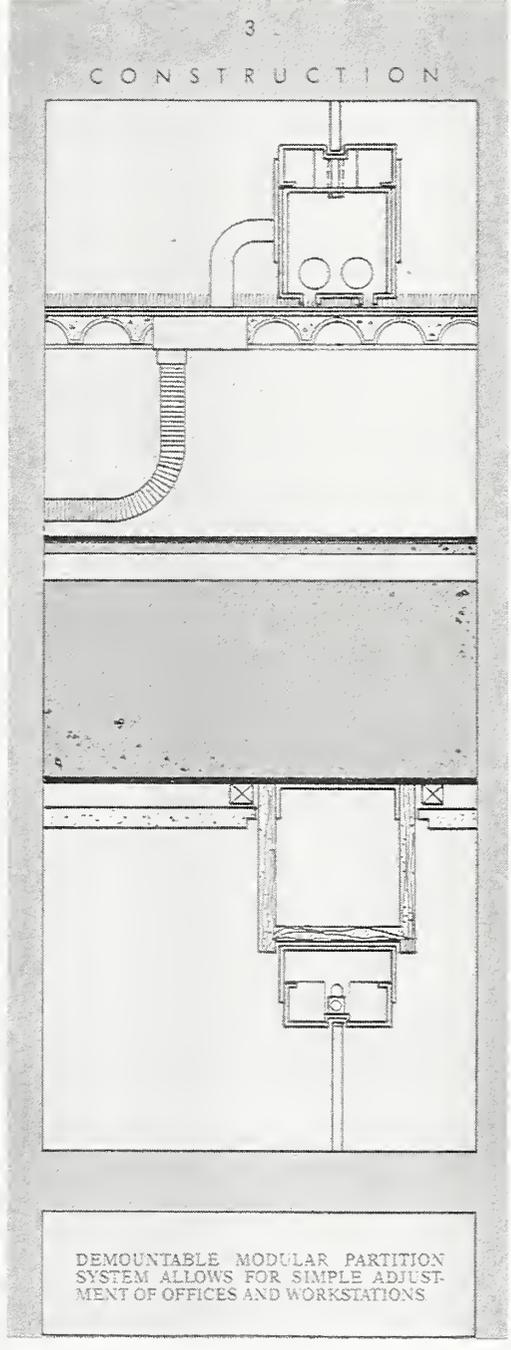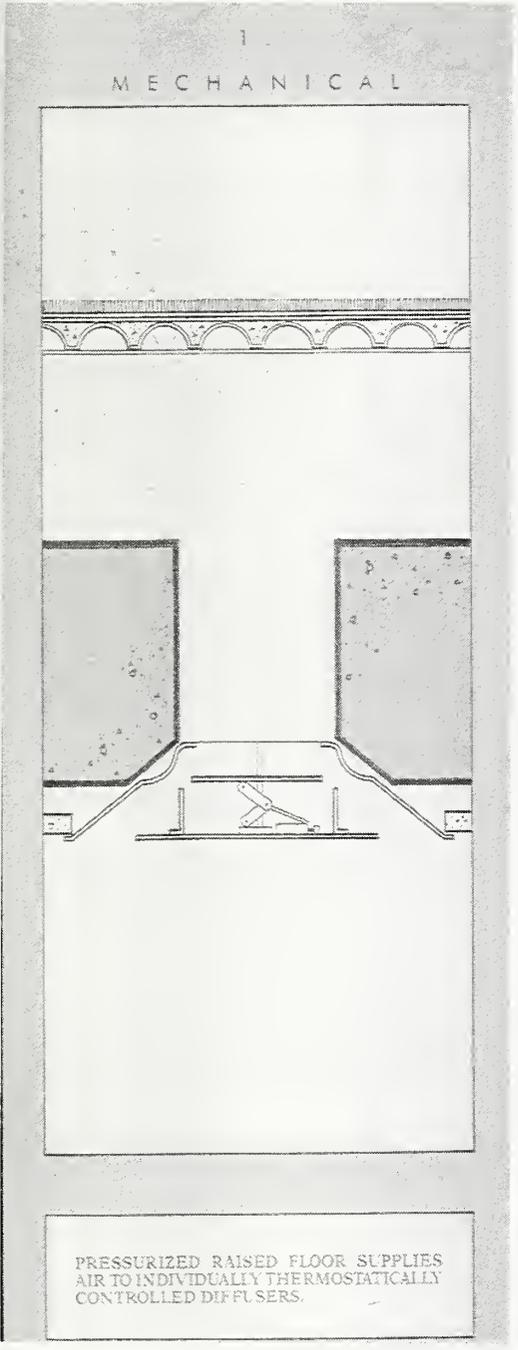
**Figure 102. Application of new technologies (b)**

CONSTRUCTION

DEMOUNTABLE MODULAR PARTITION
SYSTEM ALLOWS FOR SIMPLE ADJUST-
MENT OF OFFICES AND WORKSTATIONS.

**Figure 103. Application of new technologies (c**
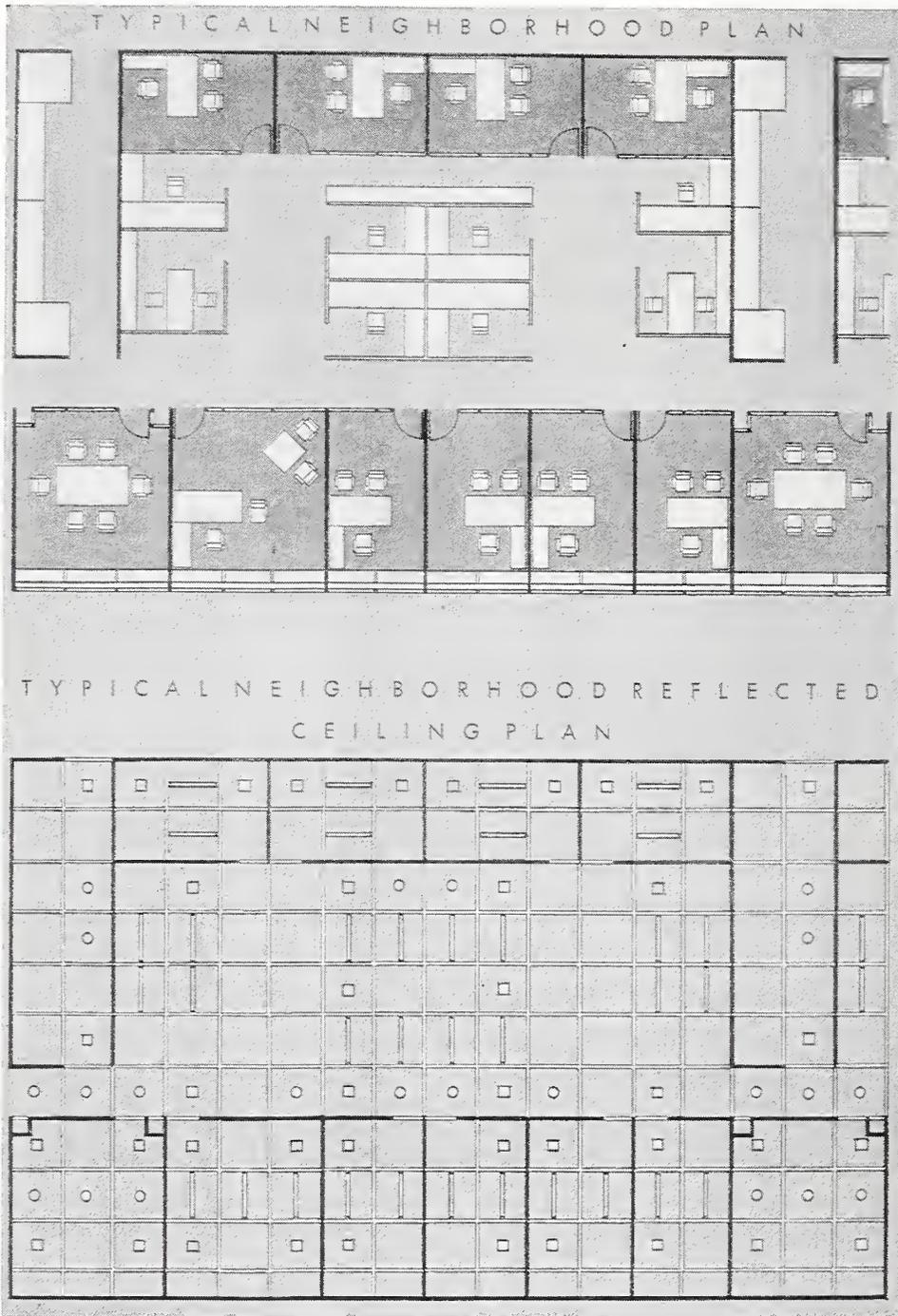
Figure 104. Application of new technologies (d)
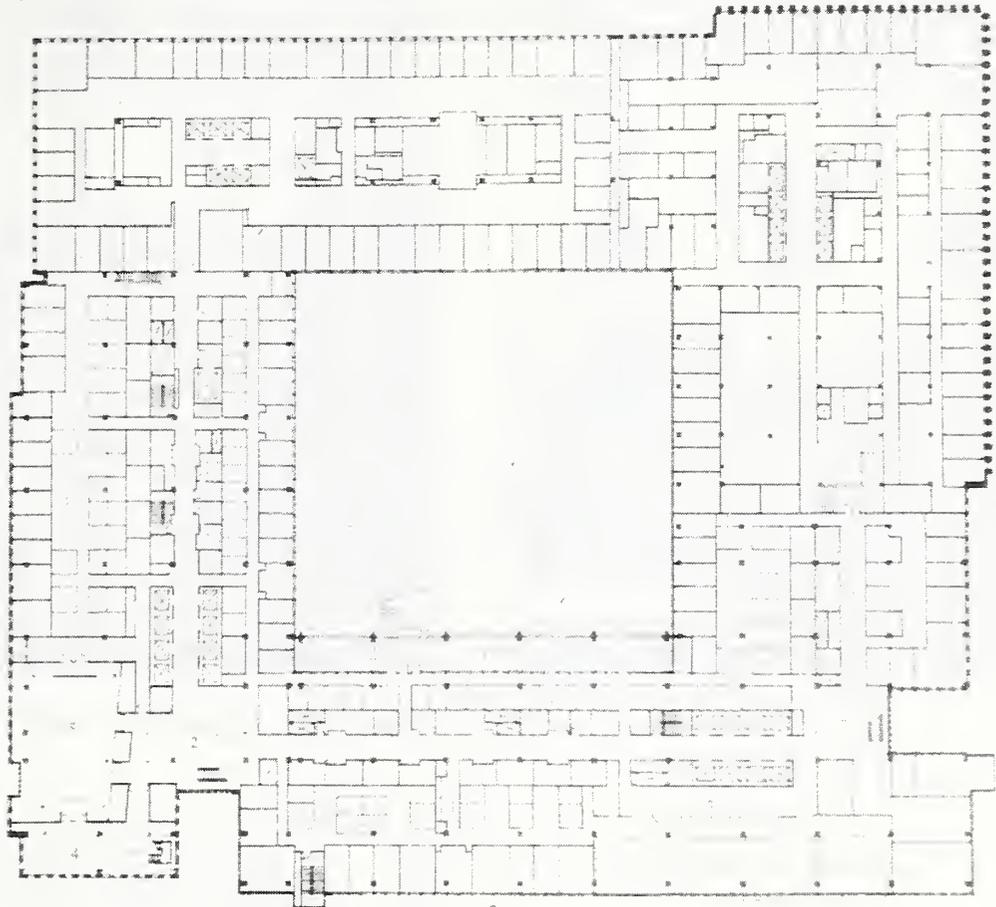
D BUILDING

PHASE I

PHASE I   PHASE II

1 OFFICES
2 RECEPTION (OPEN TO ABOVE)
3 TERRACE
4 EXECUTIVE DIRECTORS RECEPTION
5 EXECUTIVE DIRECTORS BOARD ROOM
6 EXECUTIVE CONFERENCE RECEPTION
7 EXECUTIVE CONFERENCE ROOM

Figure 105.  Building as a community

**Figure 106. Atria and community space (a)**
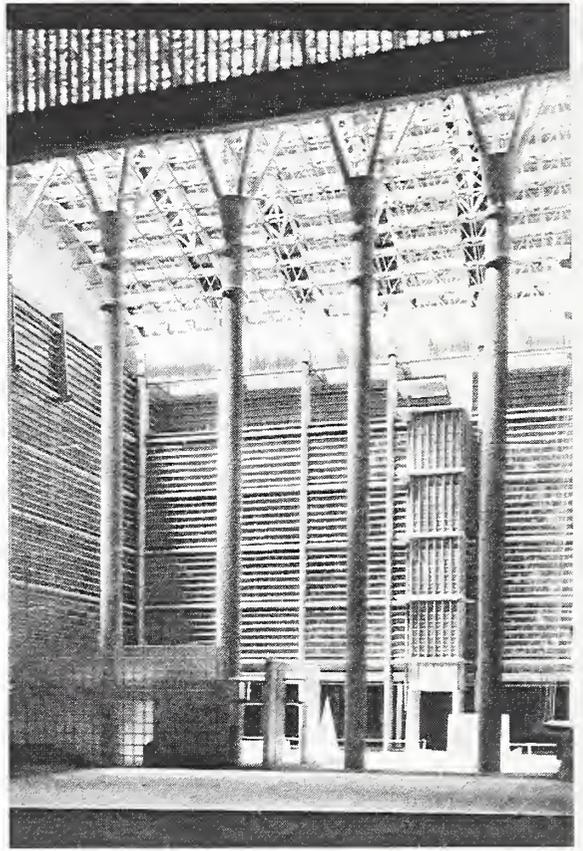


**Figure 107. Atria and community space (b)**
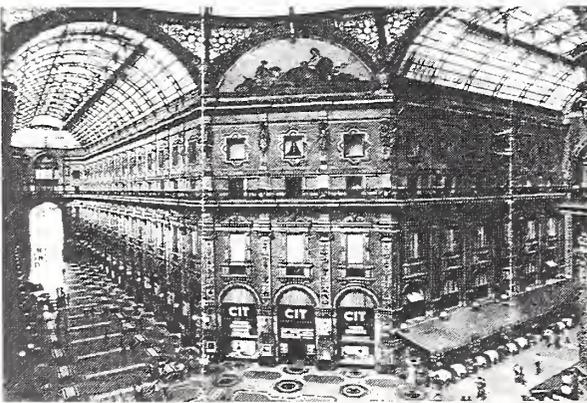


**Figure 108. Linear circulation area (a)**



**Figure 109. Linear circulation area (b)**

These amenities need to be grouped and used in a way that adds to the expression of the building - gathering amenities, unifying them with central spaces, allowing people to circulate through them, developing streets. People congregate there. They communicate. (Figure 110)
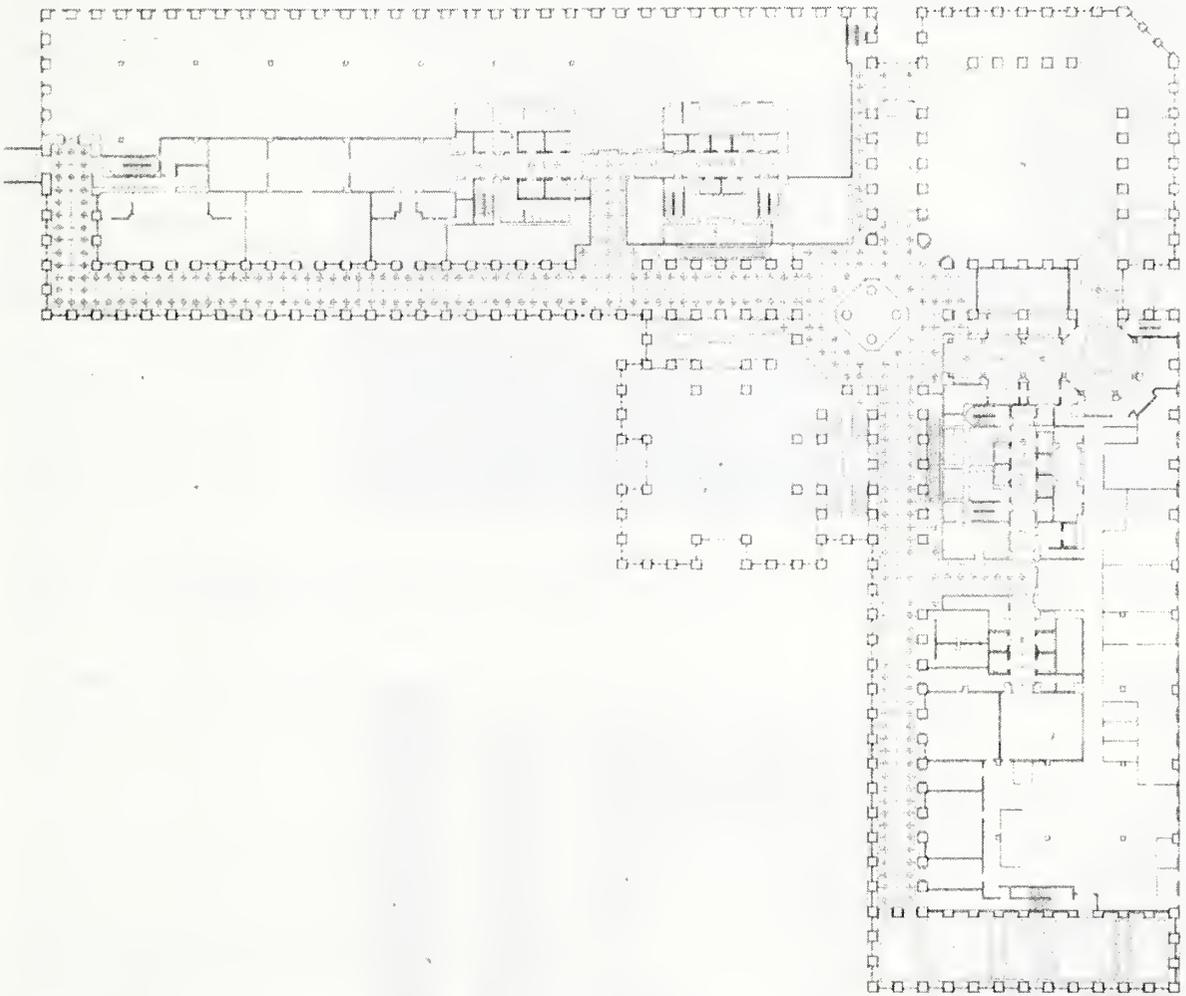


SECOND FLOOR PLAN
PROCTER & GAMBLE GENERAL OFFICES EAST

KOHN PEDERSEN FOX ARCHITECTS

**Figure 110. Central circulation space**

Also the expression of the family within a building can be used to develop internal gardens and child care facilities. Many corporations are instituting these innovations. (Figures 111, 112)

Finally, there is the aspect of team membership. It should comprise the resources around this table. The architect cannot supply all the answers. This has been driven home to many clients who have gone through the process. There is a vast amount of information needed and should be weighed expertly, with consultation, so that the client can make the proper decisions.



**Figure 111.  Garden area**
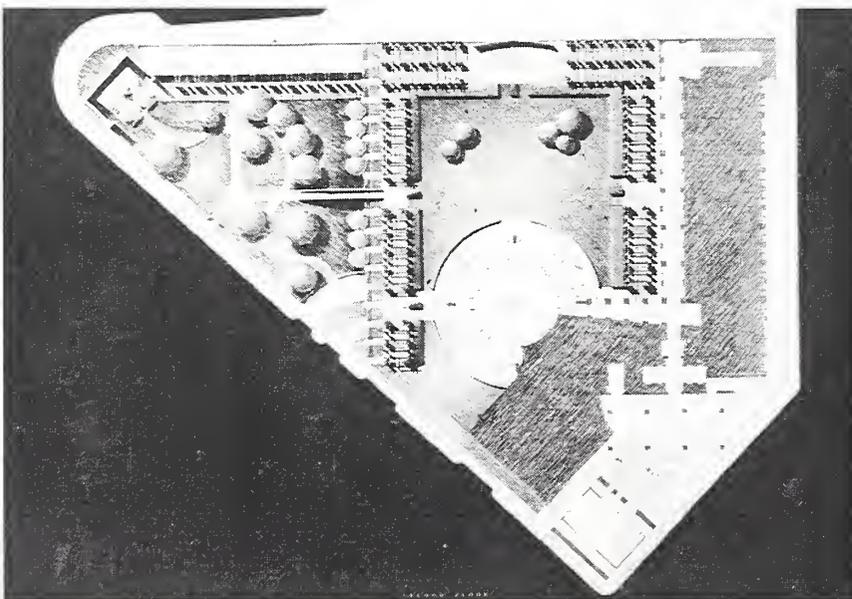


**Figure 112.  Plaza and garden area**

**MR. CYROS**: We started by examining the workstation design process, programming tradeoffs, forecasting and computer modeling of tradeoffs. We then got heavily involved in workstation standards, criteria, ergonomic considerations. We looked specifically at workstation environmental factors, human resource issues, leading edge workstation design, the impact of new technologies on office and workstation design. That was further broken into voice communication, security and safety systems, video conferencing and the like. We also dealt with information on data systems, networking, present and future, lighting issues for open-plan offices, new environmental design and control approaches both here and abroad, environmental technologies from an engineering practices viewpoint, and the last topic, building design issues. We looked at the effect of workstation concepts on building design. A lot of material and a lot of different approaches to these issues.

## OPEN DISCUSSION

**MS. KANDER**: *I have a question about ergonomic issues at the workstation - specifically ergonomic chairs, split adjustable work surfaces, and how they relate to the San Francisco legislation and the proposed New Jersey legislation.*

**DR. HEDGE**: *That is a great question. Since I am the ergonomist at Cornell, it is right up my street. The San Francisco legislation is great, but it is out of date. The information that the legislation was based on is nearly 10 years old.*

*More up-to-date legislation is going to be enacted in Los Angeles soon. They are following San Francisco, but taking a different approach. The key thing is that a lot of the ergonomic considerations being examined fall into a couple of categories. They look at environmental conditions, and postural factors, such as seating, repetitive motion injuries caused by keyboarding, electromagnetic fields, etc.*

*The Human Factors Society published a standard, now known as the ASME standard in 1988. That standard was, first of all, never intended to have the weight it is now being given. This year the Human Factors Society is starting to revise it.*

*I suggest that you delay consideration of these issues until at least 1993, when the revised standard appears. One problem is that they only started to look at keyboarding and did so in a crude way. They ignored the variety of computer input devices.*

*I think we are going to see a change in how organizations think about the quality of worklife for individual employees and what is needed to ensure healthy working conditions for them.*

*You have an ideal opportunity. You do not have to rush to implement things. You can examine what is happening in these different parts of the U.S. to see how organizations react to this, to see what the ergonomic evidence is in favor of one or another approach.*

*This has thankfully raised ergonomics to the forefront. It will allow us ergonomists to clear a lot of misconceptions about what does and does not work in an environment.*

**MR. VALENTINE**: *In the San Francisco legislation there is about a two-year window before they decide on the issues. So, it is not as if San Francisco has already decided all the key issues because they have given us a two-year escape hatch.*

DR. HEDGE: *What I meant by the issues was that they have identified certain things to be addressed. In the first draft of the San Francisco legislation, for example, they prescribe lighting standards for VDTs that were ridiculous. They would suit manufacturers of certain kinds of lighting systems extremely well, but would not benefit computer users. Now they have taken a more moderate approach.*

*I think we are likely see a more sensible approach, "If we are going to try and set standards, what is the evidence that these standards work?"*

*The same thing is true with ventilation. ASHRAE has been quite ludicrous in how it has treated ventilation. In 1973 it, for example, set a standard for ventilation based on no hard empirical evidence, and it has revised the standard, based on no hard empirical evidence about that ventilation revision. Now, people are beginning to seriously ask, "If we are going to build buildings and environments to do this, we want some evidence that it works, or if it doesn't work, we want to know what to do."*

*I think you have a window of opportunity. You are going to see in the next few years a lot of work testing out some of these assumptions, and some of them are flawed.*

MR. GRAHAM: *Alan was talking specifically about the DOT building. The question came from Debbie Kander who is from Bellcore. They are trying to make decisions now. So, 1993 is a little late.*

VOICE: *The word or the term "module" or "modularity" or "building module" has been used all day. Working with massive plans and programs with GSA, it is something we have tried to get agencies to adapt. Now I hear pros and cons from the panel, but I have no clear feeling whether you are pro or con to the building module.*

MS. LOFTNESS: *The issue of modularity is a tough one, because you do not know exactly to which module you are referring. If it is the size of the workstation footprint, and whether it should be 8 by 8 or 10 by 10 or some variation, there are some answers. If you are trying to define the mechanical zone, which might be called a module, or the lighting grid, which might also be called a module, and the structural grid, you get different answers.*

*You are defining all of those at once. That does not mean that you have something that looked like a 1950's office where everything is rectilinear and boxy. In fact, the workstation may be the loosest of the modules if the other modules are well defined.*

*The problem is when everything else is too tight a fit - HVAC, lighting and structural modules, you have to make the furniture tight to fit into it. So, you have to solve those simultaneously.*

*Just to address workstation furniture, one building I was going to show in a slide is Pacific Bell - a large new facility for 6,000 people. They have gone to 8 by 8's with Knoll open office systems furniture, and are bursting at the seams. They are in terrible shape.*

VOICE: *Are they bursting at the seams because there was no growth room; what was the reason?*

MS. LOFTNESS: *Work surface and storage is a big issue. They have too much equipment on their desks. They have passed the 2 to 1 ratio of peripherals to workers. So, they are in deep water.*

*What makes it worse is that the other modules, the lighting and the HVAC modules, are so coarse - there are large areas which are controlled by one HVAC zone and one lighting zone. It is a very elegant building. Its just that they decided on a specific footprint and that has been a problem for them.*

VOICE: *Isn't that the building where they are going from open to closed because they are not happy with the open landscape?*

MS. LOFTNESS: *Not that I know of. I think they are still committed to an open plan. They did not start with a fixed single box. They had multiple workstations, but they are moving to a fixed universal footprint.*

MS. WOHL: *Do you think it is a transitory problem that, by the time these folks at DOT get to their building, will be solved?*

*We are in the stage in the evolution of the office in which we use all the features of the paper-based office, and all of those of the electronic office, simultaneously. It is a very messy stage and will probably be around for most of the next 10 years. I am not talking about a paperless office because I think that is fantasy. But if you want to look at space requirements in terms of the electronic hardware, the placement of components, the storage of paper, and how much paper is going to be where, that it might be different in 10 years than it is now. You should take that into consideration.*

MS. LOFTNESS: *Let me rephrase it. I think there is the issue of buying one screen and having maybe two or three stacked processors so you can run Apple and IBMNET and DECNET and stuff like that.*

*But, we are a gadget nation. We are developing, and so is the rest of the industrialized world. You are going to replace what you can miniaturize or merge with new elements. It is just like your stereo set. It is not getting smaller. It just keeps piling another new technology on top of the old.*

MR. VALENTINE: *There are alternatives to putting the equipment on the desktop. We hang stuff off attenuated arms and put it below surfaces. Part of the problem may be that they are trying to put too much of the common equipment ...*

MS. WOHL: *Poor use of vertical space.*

MR. VALENTINE: *Poor use of vertical space may be a part of the problem.*

MR. HOOKER: *No matter what you do, you will want a modular building. The building is too big to try to do every square inch uniquely.*

*The most modular building I have worked on was one designed in 1928 by Albert Kahn. There are three stone cuts in the building. It is a totally modular building, and is the only building I have ever worked on where the module did not break anywhere. It was as if the designer was trying to build, using a computer and a CAD system. It was the easiest building I have ever put on a CAD system. Yet, it was done a long, long time ago.*

*The challenge is to somehow in our design team, rekindle that spirit that I think Albert Kahn's office had on that project - where the whole team talks to one other and develops a singular approach.*

*All too often we communicate from a distance - each person located in a different building - in fact, unfortunately, in different states. Oftentimes we may have a heating expert in Oklahoma and a lighting consultant in New York and an architect from Massachusetts - all working on the same project - this makes it difficult for these people to talk enough, or work effectively as a team.*

*Perhaps a return to the old concept of the master builder, which was the reason, I think, that Albert Kahn was successful, because there was a lot more control in the modularity and what was going on in that building.*

*Interestingly, the building I described does not succeed in the modern workplace. It was successful for work in the 1930s and 1940s and 1950s, but now with the computer systems, it has fallen apart because they can't raise the floors, and things like that.*

*If you apply all the disciplines together as a team, you will end up with a module, and probably with a modular building.*

MR. BLOOMQUIST: *The question in both parts of the phrase has the term "workstation" in it. Let me cite Michael Shrage, referenced in my paper. The primitive unit of design in these systems should no longer be the individual. It should be the relationship, the collaboration, the working in teams. That may well be what produces productivity and allows us to compete in a global marketplace with other nations for wealth from knowledge.*

*So, I dissent from both sides. The real question is how much collaborative space do those knowledge working teams have. And what kind of tools do we have to do to design a building today? Given what I have said, zero.*

MS. OVERLIN: *I would like the panel to gaze into the crystal ball and provide some thoughts on what the office environment or what offices will be like in the future. Do it in the context of a building of 8,000 people, a governmental building, which is to be a first class building to last many years, and to anticipate new technologies.*

*For example, if there are 8,000 people, do you think that in the future all 8,000 will have an office in that building or will 2,000 work someplace else? Will 8,000 have an assigned office, or will there be assigned offices for some people, and the others will have roving spaces?*

MR. CYROS: *I would like to ask each panelist for a 45 second response to that?*

DR. WILSON: *A lot of things are happening. F International in England has 20 percent of the workforce working outside of their office. In the United States, the estimate is 11, 12, or maybe 15 percent, in Japan about 20 percent of the workforce work outside the office, using computer connections. They all say this trend is continuing and intensifying. I don't know whether you are in a situation that you can predict or not, but that is what is happening.*

MR. ROSENHECK: *I think the office of the future is going to be an extension of what it is today. The cultures will change. Middle management will be eliminated. That may not reduce the numbers of people, but it will shorten the communication link. People will act not only as individuals the way they do today, but will also work in groups and teams. That will require some increase in equipped rooms that will allow them to operate as teams. But they will also have the ability to walk away, go to their private inner sanctum to do their thinking and creative work.*

MR. GRAHAM: *I think that the office of the future is going to have several kinds of changes. First, I agree with Forrest Wilson's statement. There will probably be selective groups of employees working outside of the office or in an alternate mode.*

*The equipment used will be different. We may not be using keyboards. Keyboarding may be replaced by voice activated computers and pens, which are already being used quite a bit.*

*The kind of workspace may change because there will be more of a team approach - the matrix organization. The kinds of spaces that the groups will work in, and their private spaces may not be completely assigned. It may be more free access space within the building.*

DR. HEDGE: *The answer is quite simple. It depends entirely on what you want to achieve, because it is your policy. If you say that everybody who works for DOT has to work five days a week, 9:00 till 5:00, then you will have to build for 8,000 people, if that is your planning figure. If you expect them to work at home two days a week, then they will do so.*

*One trend I see in buildings, is when you have invested in a building, why only run it for one shift? A number of organizations are moving to two and three-shift office work in the way in which factories use shift systems. The government may think it is beneficial to get 24,000 people in this building by going to a three-shift system.*

*Let me give you an example of the key role of management. It concerns the infamous socio-technical workgroup studies and the studies done with Volvo, where they decided to change how cars were being produced, so that small teams of nine people could work on producing Volvos.*

*They gave their people production targets, and found that the teams were hitting their production targets and leaving work by about 2:00 in the afternoon. Then after a while, management said they are supposed to work till 4:30. So, they changed, and shifted their production targets, so the teams slowed down and production started going down.*

DR. WILLIAMS: *I think there is going to be enormous diversity in the workplace. You will see more flex schedules so people will start late and leave late. There will be more part-time work and job-sharing. People from different cultures will require different kinds of holidays, and that kind of diversity will have to be accommodated.*

*One of the things that Alan mentioned we see already in my organization. Our central business system operation is a 24-hour operation. There is workstation sharing, those kinds of things. As we move to accommodate that kind of diversity, you will see some things that are very different from what we are seeing now.*

*But I also agree that the management of the DOT will play a huge role in what they allow to happen. As long as we insist upon 9:00 to 5:00 or 8:00 to 4:00, or whatever, we will continue to have a lot of offices like we have now. We have all mentioned the move toward pushing more decisions downward, working toward teams, etc. We are going to create a lot of those differences as we go along.*

MR. BLOOMQUIST: *To reiterate, the concept of workstation, according to the dictionary, implies one person. That may turn into a secondary design issue. The primary design issue should only be prescriptive, not descriptive. It should turn into collaborative space. We need a new management practice. We need a practice that changes from an organization chart based layout to what I will term a knowledge map layout.*

*There will be new management practices in the future. There are three things that managers will have to manage concurrently - projects relating to products or service, re-engineering, and the general learning of the team - and they are going to have to manage those over time.*

*Also, three types of environments: information environments, social environments, and physical environments. That has to happen with a user reconfigurable system.*

MR. VALENTINE: *I agree with the comments that predict a traffic congestion impact, job sharing, managed flexible time - I mean managed flexible time as they have in Europe. Tasking and free-addressing are all issues that are going to change the population movement into and out of any building in any major city in the United States.*

MS. LOFTNESS: *I would like to return to the issue of user reconfigurable systems. We have done some work with the Canadians years ago on a rolling workstation where, when you went home at night, you folded it up. Some of the peripherals were removed from "your space" when you are gone for several weeks, and the space is made available to your neighbor. Another feature was that you can move to a window when you wanted window access, or have privacy when needed.*

*I think that is something of a dream. For DOT I think the best thing I could wish for you - as an academic on a college campus - is a campus with outdoor fresh air, houses that communicate. It is a delightful place to work.*

MR. HOOKER: *I am going to exchange my designer hat for my business owner hat because it is a very different picture when you own the building and you are paying for it. Suddenly, square feet means something like, "I have to spend that much for so many square feet for my mechanical system."*

*I would hope the office of the future would be smaller, modular, and centrally located, because people should be able to interact on a large scale. But I like this concept mentioned earlier, of the European villages, where you group things into small manageably sized workgroups, that can allow for lots of creature comforts within a workgroup, and yet allow for a central location, so the director of one department can visit with the director of another one.*

*What I would be most concerned about in a project like this is that we do not know what happens with the politics. Our job may change in eight years. The fear I would have in building an office complex this size would be that the same thing can happen to you as happened in health care with the 800 bed hospital that is now a white elephant. You might end up with 1.7 million square feet and 4,000 employees. If so, what do you do with the space? I would want that space to be flexible so I could do something else when everything changes.*

MR. LEHR: *We certainly are in a global marketplace and one thing that is happening is we are learning from our neighbors. Some things we are learning are not consistent with our work ethic.*

*If you look at Europe, the worker values free time. That is true in Germany, France, Holland and England. Four week vacations are the norm. Six week vacations are not unheard of. Lots of holidays. If you go even further into the Pacific Rim and to Australia, people really enjoy time off.*

*What does that mean? That means we are building bigger buildings that are being less used. On the other hand, you have this real problem of economics - it is going to cost us more per worker hour to build buildings in the future.*

*We have a lot of issues to confront, but in the future, I see more free time in the offing, and that has a big impact. As a matter of fact, we are back to our every two year debate on the nine-day/fortnight, working nine longer days in two weeks instead of ten shorter days in a two week period. I think that is going to have a marked impact on the office of the future.*

MR. CIOPPA: *The office of the future that I would like to see is one based not on a planning or a workspace module, but a module required to perform a function, to achieve a goal, to produce a product. I like to think about advertising offices and to a certain extent design offices, where people are reconfigured at intervals to perform a specific function that is management given. That is the kind of modularity I think that the office of the future needs.*

MR SUTHERLAND: *The office of the future is here. We are practicing it every day. We just don't recognize it. In reality people work all over. They work in their cars and at home. What is wrong is the management systems, the infrastructure hasn't really recognized that this is going on. We are trying to force fit what I consider to be an obsolete management system and office structure on what is really happening.*

MR. BINDER: *It depends on where the government is. If it is 10 years behind in management technology, the office of the future is today.*

*You have to decide how you are going to manage your staff. That is the key. If you are going to do it exactly the way you are doing it now, then build 8,252 workstations and good luck. But if not, send people home and let them work on the plane or on the road. It is strictly a management decision.*

DR. TORAN: *I am not going to speculate about the office of the future because what is the future? How far ahead are we talking about? I am pragmatic. I am a facilities manager. You have to make a decision next month. You have to make a decision next spring, and so on. That's when you start to plan. I would use the best knowledge we have today. What is the best knowledge?*

*We are running, or opening, six buildings for a changing organization. We have to force our architects to find holes in the floor and our users do not know how they will be working because the organization changes. That can be pretty much your case in 10 years in the government when administrations change.*

*From that point of view, if many things are decided, it will be a shell built in Washington between those streets on top of something else. So, economy would be my first point of interest because I'm forced into economy. I do not know how much you are forced into economy, but I would expect that you are.*

*I would try to create an open shell. I will use the word "modular." What does modular mean? People are modular. We reach so far, we are so high and so on. We have repetitive components, be it desks, be it chairs, be it whatever. Nobody will produce as in the Middle Ages - you have to make the best decision today, open space, modular, let's find the best modules and let's do it.*

DR. DeCOUVREUR: *In many cases, despite our preference for the current situation, we will be forced into making changes. My only question is whether we will continue our former habits of making changes too late, or will we try to evolve smoothly.*

VOICE: *Much was said earlier about wireless technologies. I wonder if we can return to that discussion, particularly if we are going to legislate against radio frequency (RF) radiation from VDTs. Will we have to contend with legislation governing wireless network systems?*

*For example, the Russians thought it was a good idea to use RF flooding our Moscow embassy. We put up screens and nobody got cancer. Not much is known about lots of RF density. We are talking about designing a building to be built over railroad tracks, and you have all that electricity arcing and creating all kinds of RF fields. What is that going to do?*

VOICE: *Where does this take us? Is infrared a better technology, or is wireless something you only use in shared areas like conference rooms?*

MR. HOOKER: *We mentioned RF and electromagnetic forces (EMF). It was mentioned this morning, but nobody has really addressed it.*

*I am convinced that we are going to run into some legislation on it. There are serious issues involved with RF and EMF from our building systems, and when you start talking about gigahertz you are going to have some shielding problems. It will be very difficult to shield those kinds of signals from the user.*

MR. BLOOMQUIST: *The solution is a new wiring and cabling architecture. The equipment room on every floor of the building has to be addressed in a more economic fashion. The concept of distributing things out into the floor space is indicated.*

*Then we run into organizational problems such as the MIS department cannot find the wiring. How is it kept secure? That requires an associated management practice, but it is a hybrid technology between RF and fiber.*

MS. WOHL: *The problem is not the need for different wiring technology so much, although we could use some help there.*

*Once you have people walking around inside the building with all kinds of portable devices which are talking to one another, and sending information back and forth to update things, you cannot have people dragging wires behind them.*

*You want to start addressing the various wireless technologies that you can use and identify which ones at various times are practical, technologically, economically, and in terms of weight. Sometimes the technology does not weigh much, but you need an 11 pound battery to operate it. So, it is not practical to use it in a portable device. Now we are choosing between cellular technologies, which are great in terms of the modems, but the batteries needed to operate them are not terrific.*

*We are choosing infrared, but it is not very effective, except for very short distances. Also, you cannot use many infrared devices in one room because it is very hard to separate the signals.*

*There are some very interesting things going on with radio frequencies. For example, Ericcson has set up a new company to buy up all the 900 unused radio frequencies in the United States to be used to distribute office information between and within office buildings. They will have a new way to distribute information.*

MR. CYROS: *You address it well in terms of doing an inventory, but I do not hear an answer to RFI as an issue.*

MS. WOHL: *As far as I know, only the radio frequency is questionable. The cellular telephone seems to be, as far as anyone can tell, immune to that problem.*

MR. CYROS: *You're aware that cellular technology requires only six-tenths of a watt of output because the antenna is so close to your head that federal regulators are fairly certain that can present a problem.*

MS. WOHL: *You are talking about a telephone; when you talk into a phone. When you use a device based on cellular technology to transfer information from a device that you are not using as a telephone, but rather a cellular modem built into a device, you are talking about something different -*

MR. CYROS: *I am also combining it with something that Marshall said, that we see that voice input - in the computing world - may be a way to go, if not pen input. So, it may be easier to speak and have that data transmitted.*

*I would like to ask the panelists in the audience the same question about crystal balling the office of the future.*

VOICE: *We do research on it and it is interesting. We have radio waves all around us now. The real issue is a question of field intensity. That determines the health hazard. It is also somewhat frequency dependent.*

*I have a funny story to tell you about a computer company that tried to occupy an office building in Chicago. They unfortunately located on the first floor and found out that none of their CRT's worked correctly. They could not determine what the problem was. They hired a consultant who said the transformers were in the basement below. The building had 60 hertz power lines, which are the major current bus bars running across your office space to the vertical riser, and the field intensity was destroying all the CRT's. It also might be unhealthy.*

*There is also a theory about the danger of living near high tension lines. Why aren't we doing more research in the country regarding health hazards in offices. You cannot make simplistic statements like the health risk is frequency dependent. It is really field intensity dependent. Therefore, your greatest health hazard might be a 60 hertz AC power line.*

MR. HOOKER: *But you can shield 60 hertz signals pretty easily. Reynolds Wrap is one of the best shields going for 60 hertz.*

VOICE: *With electric fields, correct, but not with magnetic fields.*

DR. HEDGE: *There is a project I am working on in Sweden, a national project, looking at electromagnetic fields. We are making comparisons across a large number of different office environments and also looking at domestic environments - looking at very low frequencies (VLF) and EMF. We are looking at the magnetic and electrical components.*

*Some of the early evidence suggests that some health hazards, the odds ratios, are associated with exposure to the magnetic component to the fields and not to the electrical components.*

*You are absolutely right about the power outlets. We have been doing some measurements at Cornell, and you are getting far more from your surge protector and your laptop that you place right on your groin - than from the screen. There are a lot of misconceptions. Larger monitors actually give lower field strengths because of the distance between the coils. So, I think this whole area is really going to take off.*

*Why hasn't there been research in this country? If you can find a computer company willing to support findings that you may have 70 million or 80 million devices that are a health hazard, I would welcome the name of that company. I think that is the simple reason. The power companies likewise have not been that keen to look at the effects of power lines.*

VOICE: *We are talking about 8,000 people. That is an awful lot of frequency assignments even if you use spread spectrum techniques.*

*All of my professional life I have heard spectrum people say, let's get things off the spectrum and into wires. For example, Clay Whitehead, when he was head of the White House Office of Telecommunications Policy, proposed getting the broadcasters out of spectrum into cables, so we could use the spectrum for other things.*

*I have a hard time understanding the logic behind this wireless stuff in an office where most people are going to be tethered to desks.*

MR. ROSENHECK: *The key to a product is how it is marketed. Is somebody going to buy that equipment? I think you are going to find the volume of wireless technology in the office will be limited. The people who will succeed are those involved in nationwide radio transmission, because of the thousands of units already in the marketplace.*

*I have one client, as an example, that has 10,000 people who do nothing but take inventory and then feed it back on scanners. They are in areas where there are very little telecommunications where they can plug in.*

*I think we are going to find that Motorola is going to buy satellites. They are going to have wireless transmission from the laptop, and it is going to come in to some central point. That is where the wireless is going to become big, I think.*

MS. WOHL: *If you want to know how companies are going to behave in the future, a good way to find out is to look at what the most forward thinking companies are doing at any point in time. Already we have had a division of organizations between what we call "new wave" companies or "old wave" companies.*

*New wave companies use computing quite differently than traditional companies. If you examine them you will find they are highly penetrated with computers. They generally have on average of two computers per employee. They use collaborative computing at a fairly high level already, while it is only being used at about the 20 percent level in ordinary organizations.*

*When you look at the history of the new wave companies and say, "Well, it took them about seven years to get to that point from where they started," you can then forecast where ordinary companies are likely to be in 7 to 10 years. I think that is a helpful analogy to use.*

DR. TORAN: *Among the problems mentioned today, we didn't mention carpal tunnel syndrome, which comes from using the keyboard. With more and more keyboards being used, the question is what developments can we expect for non-keyboard users?*

MR. CYROS: *Voice input, arm rests, frequent breaks. What else would we add to the list?*

MR. ROSENHECK: *Pen. It seems to be the latest one this week.*

DR. HEDGE: *Regarding carpal tunnel syndrome, we have been doing a lot of work, testing alternative devices at Cornell and we use a video motion analysis system to do that.*

*The problem is not so much keyboarding, but how the keyboard is used. It is possible to use keyboards and not significantly increase the risk factors for carpal tunnel syndrome. It depends on whether you are prepared to consider redesigns, not just of the keyboard, but the entire work environment. There is just as much risk using a pen or a mouse. We will probably have repetitive voice injuries if we use voice input.*

*The key is to understand from the research literature the major risk factors, and those you can influence, by the design of the workspace.*

*Unfortunately, the ASME standard that the Human Factors Society produced paid no attention to carpal tunnel syndrome. It is not mentioned in the standard - because at the time, they were not concerned about it. Rather, they concentrated on screen visibility issues. Now I think you will find a major change.*

*We can learn from what has happened in other countries - for example, in Australia, where carpal tunnel syndrome reached epidemic proportions, we can now learn how they resolved a lot of those issues.*

MS. LOFTNESS: *I would like to bring up the issue to the workstation manufacturers, since we have two of them here. One thing that surprised me about carpal tunnel syndrome is that although the workstation manufacturers attempted to address it very early on by having adjustable height work surfaces and keyboard supports, they seem to have retreated partially, because the market was not buying it as much as they had anticipated.*

*There probably needs to be pressure on the computer manufacturers also, to look at computer work stands, as part of the hardware that they market, instead of leaving the problem to furniture designers with other agendas - workstation height and adjustability. In Europe I have seen some lovely and workable computer work stands that are vertically adjustable and tiltable. They can accommodate different people's sizes and stress conditions.*

MR. CYROS: *Are you suggesting that the computer industry ought to get into the furniture industry?*

MS. LOFTNESS: *Possibly, since I don't see the furniture industry making much progress.*

DR. WILLIAMS: *I do not think we, as a company, have backed off from looking at this issue. Even though there is a lot of adjustability built into chairs and furniture, we still find people unwilling or not knowledgeable about how to use that flexibility. One thing our research is pointing to is that we need more intelligence built into desks, computer stands, etc., to make it easy to accommodate different individual preferences and needs.*

*We continue to be very concerned about it as an issue, and we will continue to see more of that. I mentioned this morning the aging of the workforce. We will continue to see the cumulative trauma disorder as something we need to keep looking at.*

*I do not think the problem will go away, or that we in the furniture industry can avoid it. We have done some projects in which we have tried to work with computer manufacturers, as you suggest. I think it is a great idea, but it is hard to get that collaboration going, because of the cost involved.*

DR. HEDGE: *There are a number of products available now, that I think will have significant effects on things like carpal tunnel syndrome.*

*The key problem is not just the adjustability of the height of work surfaces. The key risk factor that you can do something about is the wrist deviation in the vertical plane, the degree of wrist extension. Industrial studies have shown that it is the acceleration movement, going from extension to flexion, that poses the major risk. It is not so much in the deviation which we originally thought was a major problem and believed was the reason that the QWERTY keyboard layout was bad.*

*What we see is that computer keyboards tend to be angled at around 14, 15 degrees - the angle which triggers increases in pressure in the carpal tunnel. As you begin to "clank down" on your keyboard and make lots of keystrokes per hour, that is the risk. The height does not matter, unless it is very high, where your wrist is in a neutral position. Of course, we do not do that.*

*One of the things the Australians did was to say, "Well, this is crazy. Let's take the keyboard and tilt it. Let's work so that the hands are straight in line with the keyboard." I think Steelcase has a new product called "Details," that does that.*

*In Tasmania they use the tilted keyboard and eliminated carpal tunnel syndrome from the public service. They conducted studies, looking at problems of operations. That was the original idea. Let's increase the size of the carpal tunnel. They found that 52 percent of people developed the syndrome again within 18 months when they went back to doing the old job.*

*So, you can reorient the keyboard, but then you have to go beyond that. It is not just keyboard input. Many companies use mouse and pen input, and then you have to consider where the documents will go.*

*You have to start thinking in terms of an ergonomic envelope, which has been around for ages in industrial ergonomics but has not "taken off" in the office, because we have horizontal writing surfaces. I only know of one system that has been marketed recently - called "Protex" - which combines the different requirements of pen, mouse, paper, keyboard input, and document holder, into a system that retrofits onto anything. I think that is where we will see a lot of changes. I also think the ideas of industrial ergonomics will finally be applied to the office.*

MR. CYROS: *I would like to ask our hostess, Melissa Allen, if she has any last minute comments.*

MS. ALLEN: *I have a thought for the panel. We are talking about a building to be delivered in the year 2000. But we are also talking about a planning module coming out now, based on joint work amongst all these organizations represented here today. The day that we move into that building the centralized control of the module will disappear*

*because those organizations, although we talk as a department, are independent entities. The Federal Aviation Administration will inevitably have control of what it does within its assigned space.*

*The challenge for you to think about and discuss is how to address the inevitable changes of organizational responsibility for the space in terms of planning this building. Do you simply create a generic space and let people do with it as they will? It is like housing in a building a bunch of separate corporations. It is almost like a speculative office building with 11 corporations in it, only we are headed by one person.*

(Whereupon, at 6:05 p.m., the conference was recessed, to reconvene at 8:40 a.m., Thursday, November 14, 1991.)

# THURSDAY, NOVEMBER 14, 1991

**MR. CYROS:** We come together for our second day of this workshop. Our first topic is facilities management and end user experiences. Like these panelists, I am an end user, and I think that you have three outstanding end users here today.

We will begin by hearing from Stephen Binder from Citicorp, where he is the Vice President and Director of Space Planning. His responsibilities are for real estate in the United States and Canada. He has had 25 years at Citibank.

## FACILITY MANAGEMENT (END USER) EXPERIENCES - CITICORP

**MR. BINDER:** Let me tell you what I do for a living now because it has nothing to do with what I am going to talk about. My new job is Director of Space Planning. I am responsible for $114.15 per minute. That is the value of our real estate portfolio in the United States. Who has a calculator to figure that out? Six hundred million dollars.

I am responsible for tax assessment and valuation; all the real estate. Anybody who wants to move has to see me. What is so unusual about that is in the past there was no space czar of Citibank. I cut across corporate culture. People at Citibank hate my guts because I can say, Melissa, your lease expires and you are moving to Peter's building. The fact that his building is in Santa Monica and yours is in Washington, D.C. - that's life. I am doing that with a smile, and everyone loves me at Citibank.

But my real goal is to save money for the corporation. I would like to get the $114.15 a minute that I control, down by a couple of pennies each year. This year we will have brought it down by $100 million. That is a lot of money. Tax assessment evaluation; we send someone out to contest the government in any municipality. What does he do? He says, "I don't agree with your assessment." Last year he reduced our tax assessments by $6 million. This year he already saved $5.3 million. He has $700,000 to go to reach last year's figure by the end of the year.

That is what I do today. That has nothing to do with my past experience. For the last 15 years, I was Director of Project Management, and my last building was this tall green building in Queens, which is still standing the last time I checked, and it is theoretically built for the 21st century.

If I took eight years to do a building, I would probably be looking for a job. If I hired a consultant and gave him nine years to do a job, forget it. They would be milking me for money. It would never happen in 100 years, 1,000 years. Let's see eight years ago was 1983. That's the year I opened Arrowwood Conference Center, 300,000 square feet, 300 bedrooms. In 1984, we opened a 165,000 square foot facility in Tampa. In 1985, we opened One Sansome Street, 700,000 square feet. In 1986, Citicorp Center in L.A. was completed; it is was 1.1 million square feet. In 1986 also, a building was completed in Rochester - 165,000 square feet. In 1989, 1.4 million square feet in Queens. So, if I took eight years to do one building, I would not be here. I would probably be working for Met Life. Ed Toran is going to tell you in a few minutes he is doing six buildings concurrently, not one building.

Now, let me describe what I do now. One Court Square is a 50 story building, four story low rise atrium, which has all amenities in it. It has a 100 foot high glass rotunda, and 1,436,950 rentable square feet, very similar to yours, but much fewer people. There is about room for 4200 people.

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The FAA protested our original design, that called for a building 715 feet high. What do they think about that? They said we were in the flight path for La Guardia Airport, and they were right. So, their choice, as far as we are concerned, was to move La Guardia Airport.

VOICE: *They could have moved New York.*

MR. BINDER: They could have moved New York. FAA had a suggestion, which is to have the building half the height. Our building is down a little bit, 655 feet. They changed the flight patterns.

The problem is if you set parameters, you've got to stay within them. This is the approach that we took. In-house staff managed outside consultants. Why do we hire consultants? Does anybody know?

VOICE: *For their expertise.*

MR. BINDER: For their expertise. Anything else?

MS. ALLEN: *To tell us what we want to know.*

MR. BINDER: To tell us what we want to know. Anything else? Because you cannot make a decision internally. Indecision. We do the same thing; we do not want to hire that many people in-house. So, we out-source it. So, inside out.

Variety package designer. You can have one big box of cereal - or buy a variety pack and have your choice of different cereals every day for the next 9 or 16 days. We did the same thing. Citibank is no different than the government.

We have different agencies as well. We have different groups that do not talk to each other. They all report to the same CEO. In your case it is the White House; in our case it is the "second floor." But they don't care about design, we do. We didn't put all our eggs in one basket. We hired 11 different design firms to manage the interiors and one firm for the building, a different firm.

Third, communication. Do you have a communication plan to your employees to tell them where they are going?

MS. ALLEN: *Yes.*

MR. BINDER: Good. That's what we did. We did it three ways: see, hear and touch. We showed them a video we had made. We had a newsletter. We had an audio tape. We had conferences, presentations. I made a presention to about 6,000 employees in the auditorium describing the new building, and then took them to see the building. They could see the area, their floor, the neighborhood, and how to get there.

Pre-occupancy evaluation. We asked employees their opinions. Not a single one wanted to move. None. Nobody wanted to go to Queens. That was a foreign land. If you know Manhattan, Queens is only a mile away from midtown Manhattan, one subway stop from our headquarters building. So, our answer was, if you want to stay employed, you move.

Why did I do a pre-occupancy evaluation? I also did things about furniture. Why do you pre instead of post? Who does post-occupancy? Anybody?

Vivian, why do you do post occupancy evaluations?

MS. LOFTNESS: *To see how well the space is working for its program.*

MR. BINDER: Right. So, why is that not good?

VOICE: *It's too late to change it.*

MR. BINDER: It's too late to change it. Here you just spent a lot of money to find out you made a mistake. It's a big problem. Do it up front. Ask people early so you can learn, and if you do a post-occupancy evaluation, you better have money in your budget to change the building because if not, you will disappoint the employees. So, we ask them first. Do we ask them later? Not in the same way. We ask privately.

Everybody goes - all levels, from top to bottom. So, he or she is in Manhattan. They move with the staff. At Citibank, who wants to go to Queens? Nobody. Politics start. Everybody goes, including the President and the Chairman. "I'm not moving to Queens." "We need customer contact." "It's not my property." Does that sound familiar?

Guess what happened when the building was completed. We worked our way through it. Somebody took ownership and we managed to get through it. Yes, there is in-fighting and political fights. So what? Keep working at it. But if you give up, you will never get it done.

Who's afraid of the administration? The next administration is in eight years, and I don't want to get this building done because the new administration may cancel it.

If you are afraid of changes with the CEO, you will never get anything done. Your job is facilities, space planning - not worrying about who is in charge; the government in this case.

Our last approach is flexibility. Some people were for this yesterday. Some were against it. I have not decided where I am, but I build for flexibility anyway. The reason is that I don't know what the office of the future is going to be like. But I build enough vertical and horizontal space in the building to take care of any contingency.

VOICE: *How do you know you put enough space in the building?*

MR. BINDER: In the building? I have no idea. We have 18 million square feet of office space. This is only 1 million square feet. But I have flexibility for any technology. This is the infrastructure. That's why we have facilities to help us out.

VOICE: *If you don't know what the future technology is going to be, how do you know you have enough space in the building?*

MR. BINDER: I have enough vertical space. I have far more than I will ever need, but maybe not. That was our approach.

Those are the construction numbers for our building. We have 12 corners. Why do we have 12 corners?

VOICE: *So that people can have corner offices and have double windows and feel like executives.*

MR. BINDER: Absolutely. So, even if it is open plan or closed, it doesn't make a difference. We split the core. Why did we do that? Every item that goes in the core is accessible through a service corridor. Nothing penetrates the core on the outside. Why did we do that?

VOICE: *To maximize the leasable area.*

MR. BINDER: Right. I want to maximize my space. When you have telephone closets and --

VOICE: *You have to have corridors for them.*

MR. BINDER: Now I can build offices. We went to a 5 foot module in the building - 15 feet works well with our module. I don't know what your space standard will be. It worked well for us. Somebody yesterday said it should be 2 foot 6 inches. Whatever. The point is this works well for Citibank.

The clear span between the core and the outside wall is 45 feet. There are no columns. It works well with our standards. We have a 6 inch raised floor. We depressed the slab 6 inches so that with a raised floor everything is level with the core. There are no ramps in the building. All the elevators are flush. We also put in concrete raised floor panels. Why did we do that?

VOICE: *To kill the drumming effect. So, it will sound like a real building instead of like a phony building.*

MR. BINDER: Absolutely. Employee comfort. They do not think they are on a raised floor. It also makes it easier to rewire. Speaking of wiring, we have a 10 foot wire grid. We have a 10 foot by 10 foot wire grid laying on top of the slab, so we can access electricity anywhere we want as well as a local area network (LAN).

All the air is in the ceiling. So, half the staff who likes to be blown on their head are happy. I don't know what the right answer is, but that is what we did.

VOICE: *Did you say that your core was a raised floor and the rest was depressed slab?*

MR. BINDER: Yes, or you could say that the core was normal and this is depressed. However, you want to look at it.

VOICE: *So, your telecommunications is going up.*

MR. BINDER: Telecommunications is also delivered in this space.

VOICE: *He's talking about access to the wire closet.*

MR. BINDER: The wire closet comes out into the raised floor. The closets are on opposite sides of the core. We have two closets to make our life easier because the user could care less. So, by having it here, it is immediately accessible.

We have all the air circuits and mechanical circulation in the ceiling brushing against the windows so the circulation doesn't fall directly on someone's head. That was our solution, which allows us more floor space. We have no convectors or radiators. We have full height windows that have just started 6 inches above the raised floor.

The building cost was $175 per square foot. I don't know how that compares with your budget.

Interiors. Modified open plan was our standard. If you want private offices I don't care, but it is going to be in places that we tell you. So, if you build them in a corner, that is it. We built for the function, not the title. So, if you are an assistant vice president, that job is assistant vice president. The office is built for that job. If you are vice president, the job is more important, and we will build accordingly. It doesn't matter to us because I'm not going to change it, and we built it where it needs to be. That's what I mean by zone.

Leveraged procurement. I am sure the government operates like we do. You negotiate, negotiate, and negotiate again.

We used universal planning. There was mixed feelings about it, but it worked for us. We used 75 usable square feet as our module. This is an administrative building, and our operations modules are much smaller. We have four modules - 75, 150, 225, and 300 square feet.

And 95 percent of our offices meet these three standards, but the senior most person gets 300 square feet. So, rank must still be accommodated, but all the other grades are collapsed. Almost all managers in our corporation are in the same sized module. Four levels of officers are collapsed into one, because 80 percent of our promotions fall within this space standard. So, we do not have to change anything. We spent $80 to $120 for the interior build-out - LANs, new furniture, etc.

Generic stacking. The street level is public. The basement houses the building support facilities, and businesses are above.

VOICE: *Do you think that is an expensive building, Steve?*

MR. BINDER: Yes, too expensive.

Lessons learned. Advanced planning is essential. Universal planning is the solution to true flexibility in our case. It probably will be in yours. I don't care what the office of the future is because I am ready for it. I have to live nine years before the office of the future is here. The building becomes our test case for workstation standards, and now we are going worldwide with the standard.

We bought too many lines of furniture. Most of the building has two lines of furniture, but a couple of the floors are exceptions. Next time they won't be.

Our goals are your goals. Build in the most modern, flexible technology. Increase building and staff efficiency and productivity. Reduce ongoing facility administrative costs. Provide staff with a 21st century work environment.

Good planning, carefully executed, is often mistaken by others, including their supervisors and staff, as dumb luck. So, even with all this planning, in the end somebody is going to be unhappy with your work.

Melissa Allen is concerned about the building deteriorating after completion. The answer is to start planning now. In our building we had the same problem, 11 different companies, groups. Nobody talks to one another. We have a post-occupancy group. We have a tenant committee. They are all responsible for maintaining the building. Yes, we lead, but they share in managing the building. I run it, but they have something to say; they are part of the team. You start it now, and when you are finished, they continue the work.

**MR. CYROS**: Our next speaker is Dr. Edward Toran. He is the Director of Space Administration in Metropolitan Life in New York. His education is architectural, specializing in interior architecture. He has a doctorate in the theory and history of architecture and art. His work experience has been in the interior, architectural and industrial product design, human engineering, office space planning, and computer programming.

## METROPOLITAN LIFE INSURANCE COMPANY

**DR. TORAN**: Melissa Allen said yesterday - and we all are quoting her constantly since her needs are the center point of our meeting - that this is basically a brainstorming session. That allows us to ventilate different thoughts and conclusions.

We heard yesterday that our hosts could be confused because they hear different opinions. That should not create a problem since all those opinions can be weighted. You brought in different specialists. They are talking from their points of view, and some of them from visionary perspectives. I have worked in research for many years; the task was to look forward and to write about future possibilities. Therefore, being today in -what one calls- the real world, I view such perspectives with understanding and caution. But here we all work towards a better realization of how to deal with the whole project.

My contribution will not be to continue listing technical options. As a user myself, I will try to comment on some of the ideas mentioned yesterday and take a look at design attitutes.

My daily work forces me to be a pragmatist. Steve Binder mentioned that I have five new buildings, and approximately 200 other projects. They range from adjusting one workstation to moving 700 people at a time. Our headquarters complex housed 20,000 people at one time. After constant zig-zagging through reductions and additions, it may remain with only several thousand occupants, in a technologically very different kind of workplace. So, we are going through different practical experiences.

What can we learn from the diverse statements made yesterday? How do we draw usable conclusions out of all of this? The background of this project was not discussed, and I don't know how far it has been developed. In any conceptual work, I would ask myself some very basic questions - in this case, "What is the Department of Transportation doing?" "What is transportation?" "How does it have to be administered?" "What kind of a work environment would people need who administer transportation?"

There is nothing wrong in starting with a clarification of basic definitions. Years ago in London, at a dinner given after a conference of the British Council of Industrial Design, the main speaker - the top British transportation official - said that since he was invited to talk, and was responsible for the British transportation, before coming to the dinner he consulted a dictionary to be sure of the definition of the word "transportation." It was so impressive. If he could ask himself such questions, we can also do so.

While talking about transportation, what will this country's transportation of the future be like? How should a government's building for a transportation agency be organized? Will it be a purely administrative building with people talking to computers, with lots of paper? Do they need laboratories? Somebody mentioned blueprinting rooms and an extensive library. What about testing areas? For example, the FBI has various testing and display rooms that influence the composition of a building.

Many circumstances in a project may not be clearly established because of difficult conditions in changing organizational or political situations, with unclear budgetary and approval procedures.

But is project management not accustomed to aim at moving targets? As they say, to shoot at a running rabbit, from a spinning merry-go-round, attached to a fast-going train, at midnight, in a dense fog. One has to work out a reliable approach for these planning conditions.

It was said that the consultants will come up with technical answers. But you have to use some flexible logistics to accomplish the whole thing, whatever the circumstances. Very often it means to ignore classic textbook approaches.

We all learned in school, or read in books, how to approach a project, do proper planning, testing: first look at this, then don't forget that, explain it to others, get it approved and build it. But what if your users are in a state of reorganization, when they don't know how they will be organized, or who will be heading them. They do not know which groups will be sitting with whom. They do not know whether they will be, as somebody mentioned yesterday, a matrix organization. Will they be organized by departments, or get together by projects, and so on?

This indicates that a most flexible building shell is needed. You cannot wait for the "proper" moment when everything will become clear. You have to make your decisions in the next days and months. Specifications are expected next spring, someone mentioned. There is nothing else to do now but to quickly assemble the best flexible concepts known today.

There is nothing wrong if you cannot apply visionary elements in today's specifications. Your building is not a display in a Worlds Fair. It was good to listen to what may be available in the future. But I would not buy something for a new building that was just brought out of a test lab, with the salesman assuring us it will work beautifully even if all the bugs are not ironed out, just "trust him." One can buy last year's model, not being afraid of missing a lot. Because it may be better understood and superior to the products of previous years. This risk management approach combines progress with reliability. For a facility manager there is always a danger in trying to combine too many new technologies in a large new project.

Therefore, if you use the best proven technology and a flexible interior space, it should perform well in the coming years.

The immediate problem is how to recognize good design around us. Which tendencies are progressive; which attitudes are wasteful? The question is what kind of measuring criteria should one apply to assess what is being offered.

One eternal criterion is the economical view in its widest application. Not just in "money." It can be also economy - or efficiency - in style, expression, usage, culture, psychology, maintenance, etc.

About economy of space - yesterday Vivian Loftness said something like, "Let's not be afraid of using more space, this country is big, there is a lot of space." As an aside, that is what a Swiss painter once told me. He said, this is a big country. I asked him how he knew it. He said, "I see that painters here use huge canvasses and brushes, and make large strokes to express what they feel. Painters in Switzerland use smaller frames to solve their artistic problems, because the walls and rooms are small."

There is an interesting point in the relation between perceived needs and the cultural environment or status symbols. I know that this country is big, there was a movie with such a title. But I am sorry to say, "a pity that New York City is not a part of this Big Country". In my corporate space planning I cannot afford to waste space. We would be good at designing submarine interiors.

Economy - in its different aspects - will always provide a usable measuring point for design issues about how to put to best use what is given, allowed, available, affordable.

As a practical example of efficiency in using design elements, let's look around this conference room. I want to illustrate a widespread acceptance of components that may result in questionable design conglomerations. It shall not be a critique of these rooms, or the hotel, the architect, or those responsible for selections - it could be someone sitting here.

In any complex project, excellent planning will be broken down to many sub-parts, interpreted and implemented by others. For example, in the best of buildings, because one dimension was not shown on a master blueprint, the electrician in the field might install an outlet in a bad place, causing a strong visible feature on a wall that is an unnecessary aesthetic horror.

There is a sculptured molding at the ceiling on three sides of this conference room, but none on the fourth side. Why? Because this fourth side is a moving wall. Since this wall is removable, the molding on the ceiling would make no sense in a wide open ballroom. That brings up the question, does one actually need a sculptured molding on the ceiling at all? If one can exist without a design component in one place, why does one need it in a similar place? These are not only matters of design philosophy, but they have important impacts on function, appearance, budgets, and maintenance. We know that moldings are used not for their 'decorative' value but to cover unsightly borders between the work of different trades, or different materials, where joint lines are unresolved, wide, or unfinished. So, a molding gets slapped on to cover unresolved design work or expected bad workmanship.

Architecture and interiors play a role in people's status symbols, fashion, conspicuous consumption, and so on. These moldings above our heads are wood products which could be bought in any local lumberyard. But the shapes are copied from ancient Greek architecture where they were carved in stone on temples. Without being aware of it, our contemporary society accepts it as fashionable to copy older design forms, instead of looking for the best contemporary solutions to a problem. The more people become aware of these thoughtless design approaches, the better results we can obtain with existing opportunities.

In the world of functional and visible things that we use and see, we can ask simply, "What do we really need, or want, to see?"

Look at the doors in this room - they have heavy exposed hardware, attached as if it were a typical design afterthought, which it is not. Afterthoughts in design often end with something visibly strange, added on top of finished surfaces, something that appears to be isolated and does not match with adjacent materials, shapes or colors. You have all seen wiring on walls or across floors, attached with tapes on carpets, signage boards, unsightly brackets, outlets, cameras, security devices, or furniture placed in the middle of traffic areas.

Could these door closers here be recessed into the door? Yes, they could. But the question is, how much energy is someone willing to put into design, price, scheduling, and manufacturing? And "better" does not mean "more expensive" - energy invested in design work pays off later.

Another question is what is visually acceptable to whom. Germany, as a country of design awareness, was mentioned several times yesterday. In Germany they pay a lot of attention to the little mechanical details, such as bathroom plumbing, cabinet hardware, and try to make some components, that one does not have to see, disappear. By the way, while talking about functional design and bathroom plumbing - also in this hotel - they have nicely shaped shower handles that turn around a full 360 degrees but the water temperature is hard to adjust. That crucial difference between adjustments - where you get either burned by hot steam or frozen by ice-cold water - is one uncontrollably small fraction of a turn of the knob.

Again, the level of the outside decorative design is not followed by the function of the whole assembly. And, as in all design, we are not talking about unknown human needs, or unknown engineering principles. Good operational, manufacturing and construction principles are well known, it's just difficult sometimes to get them together.

Then, what about complex design resulting from purchasing practices? The walls of this room have a wood strip called a chair rail. It is a very thoughtful element designed to prevent the banging of chairs against the wall and damaging it. But if you look at the chairs purchased for this room, they are lower than the rail. As in that corner, they hit the wall and we see scratched wallcovering all over.

There are five different kinds of lights in these rooms. Yet the space is lit unevenly. Yesterday the speakers sat in a long row on the raised platform in the front of the room. Not two of them seemed to be lit in the same way. Some faces were in the dark, with bright light fixtures behind them, and it was a problem to see them. Lighting design can provide intriguing fixtures that are unpleasant sources of light, mainly if specified and installed incorrectly. People may use catalogues to select light fixtures - or any other design components - on the basis of their appearance in the catalog instead of functional quality.

Again, good things exist but can be selected or applied, in the wrong way. Perhaps we, the users of this conference room, should throw the switches differently. On a larger scale, after all planning was done and interiors installed, users may not understand how to best use features that were built-in, and make their own reconstructions. That is a tendency that can lower the planned efficiency of the environment.

Speaking here allows me now to stand up for a while, which is good because I do not have to sit. Sitting for so many hours on these chairs is somewhat painful. Why? The chairs have a padding that, perhaps if worn out, is not comfortable for long meetings. They may be perfect for a dinner party.

These are small observations about how to look at design-at-work, and they apply also to organizing large-sized projects. The message is - we can use existing principles and products. But the trick is to create an appropriate framework that will follow through from understanding the users' requirements to provide the most "honest" design solutions. By "honest" I mean doing away with pretentious status symbols, false decoration, and so on.

Such phenomena as status symbols and conspicuous consumption have not been mentioned yesterday. However, they play an important role in many users' minds. I have a page from the newest issue of a magazine called "Insights." In a paragraph called the "Hall of Shame," they discuss the FDIC building, cited for extravagant expenses. There is a picture showing big arches, and other parts considered to be excesses in interior architecture, such as the type of classrooms and conference rooms used. You will have to carefully specify what treatment of support and public areas you need. If configurations, dimensions, or materials become too "grandiose," your building may be justifiably criticized.

Who is the true end user who will judge and approve the many features of the new building? Is it Melissa Allen and the people she works with? The Department of Transportation? Layers of committees? The government? The people of this nation? The taxpayer?

In addition to building an office building at the Union Station, you have a responsible task to create something that should become a new landmark. It should have those simple logical qualities that will help it to survive architectural fashions and make it a noticeable architectural achievement.

There are always two directions in good design that have to work together: from inside out and from outside in. Yesterday we were considering the relation of the building shell to the workstation, going from the outside towards the inside. This process alone may neglect the needs of the real user of architectural interiors.

As a space planner I prefer to start by organizing the building shell based on the needs of the workplace, from workstations to the framework that will envelop them. But to wait until all users express their wishes in detail - that may be an arduous task, taking more time than is available. Marshall Graham made a good point with the method of determining space requirements through a simplified outline of what may be expected, and then fitting into it.

So far we talked only about the interrelation between the workplace and a building. What about going a step further and look at the larger urban environment in which the new building will exist?

This is Washington, not New York. You can find quotations here, etched in stone on a street, to the effect that Washington should represent - I believe the word was the "finest" - the finest experience that the nation can have in creating an environment.

It is a regulated urban area. Streets should be 130 feet wide. The street going from the White House to the Congress should be 160 feet wide because of sections allowed for walking, trees and horse carriages. Since the end of the 18th century, Washington was based on such rules, and it is one of the most beautiful cities in the world. The wide open sky can be enjoyed by people walking in broad streets lined with low building facades.

From a historian's point of view, how long can such 18th century rules be preserved in a modern and important city? That depends on whether the function of the city changes in history. Washington, as a center of the nation's administration and representation, will probably not become a port or a smoke stack district. Buildings and work places will continue in their existing functions and symbolic shapes.

Yet, other developments are not impossible.  For example, the Louvre in Paris got a glass pyramid addition.  It is turned on an angle to demonstrate it was not intended to be part of the existing Louvre complex.  The idea is that the new and old can create a powerful unity which keeps the old objects even more alive.

French architecture was mentioned here earlier.  The French approach architecture with a great sense of fun.  They somehow seem to say, we'll try it out, we'll do it.  If it doesn't work, the next time we'll do something else anyhow.  If you look at the new architecture of Paris, you will see there is a lot of experimenting and playfulness going on.

A good example of combining function, status symbols, decoration and fun, is outside of Paris in a suburban bedroom community. They have this long main street, leading from one end of the community to the railway station.  The station building is the center point of the commuters' morning interests.  The main facade is one enormous clock face, visible from far away, with the entrance doors beneath.  As a building facade it makes sense.  Anybody walking that long main street to catch a train will appreciate this building facade's time information.  That is meaningful architectural design, a good transportation facility.

Now about status symbols.  At the other end of this long main road stands an obelisk, but it is slightly tilted.  In a world where people are accustomed to seeing obelisks and pay little attention to them, in this small French suburb I received an artistic jolt.  It is an instructive humorous statement, that makes you contemplate why people build obelisks at all - or any other architectural symbolic manifests. What, or whom, do they represent?  What better ways are there of doing many things that we accept thoughtlessly.  Poetically said, the existence of the tilted obelisk shakes up sleepy morning commuters and invites them to reassess their routine attitudes.  It inspires provocative food for creative design thoughts.

Whether in the suburbs of Paris, or in Washington, buildings are a part of a city, and we have to deal also with political, cultural, and other messages.  From that perspective, your building solution will be at the center between the conflicting interests of the city of Washington and the functional individual workstations requirements in the office area.  I hope it will end in a creative balancing act.

You have a building lot limited by zoning, streets and height restrictions.  It appears that the building volume allowed may not be completely utilized.  Economically speaking, would it not make sense to see how best to fill out the maximum of allowed space, rather than to plan for 8,000 people.

What if other governmental agencies share this building with DOT?  Again, with a flexible shell it could make more sense.  If closer contacts and better communications is one goal for this undertaking, there could be even more government groups talking to each other under one roof.

To conclude - one can always bring specialists together to resolve large problem issues.  But, on the long road to completion, different things may surprisingly happen.  To achieve good results, it is important to create a system of communication and cooperation which allows for initial concepts to be carried through to a fully successful end.  As I tried to show, energy invested into planning and awareness about what is, or is not, necessary, can influence the final outcome of a complex endeavor, primarily in a world where people are accustomed to accept 'fashionable' solutions.

**MR. CYROS:** Thank you on behalf of the panelists. They had a couple of final comments to share with you.

First, we appreciate the opportunity to share our feelings, mixed as they may be, certainly from the heart and very sincere.

Secondly, I would like to thank the individuals on this panel who had to put up with the likes of Kreon Cyros.

On behalf of all of us, we would like to thank you for your hospitality and for having us here.

(Whereupon, at 3:26 p.m., the conference was concluded.)

# APPENDIX A WORKSHOP ATTENDEES

## 1. Participants and Affiliations:

**Mr. Don Avedon** - Principal, Avedon Associates; former executive director, International Micrographics Congress; consultant (Avedon Associates, 14 Accord Court, Potomac, MD 20854)

**Mr. Stephen Binder** - Vice President, Real Property Services (Citibank, N.A., One Court Square, 8th Floor, Long Island City, NY 11120)

**Mr. Lee Bloomquist** - Principal Engineer, Steelcase R&D (Steelcase, Inc, P.O. Box 1967, Grand Rapids, MI 49501-1967)

**Mr. Robert Cioppa** - Architect, Kohn Pederson Fox Associates (Kohn Pederson Fox Associates PC, 111 West 57th Street, New York, NY 10019-2272)

**Mr. Kreon Cyros** - Director, MIT Office of Facilities Management Systems (Director, MIT Office of Facilities Mgmt Systems, 77 Massachusetts Ave, Room E19-451, Cambridge, MA 02139)

**Dr. Gilbert G. De Couvreur** - Director, Canadian Workplace Automation Research Center; Director, R & D Integrated Systems (Canadian Workplace Automation Research Center, 1575 Chomedey Blvd, Laval, Quebec H7V 2X2, Canada)

**Mr. Martin Duby** - Program manager, U.S. General Accounting Office (GAO); building retrofit manager (USGAO, GS&C Facilities Management, 441 G St. N.W., Rm. 1800, Washington, D.C. 20548)

**Mr. Marshall Graham** - Principal, Graham Associates; developed earliest computer systems for space allocation; facility management consultant (Graham Consulting, 303 East 57th St. New York, NY 10022)

**Dr. Alan Hedge** - Professor, Cornell University, Deptarment of Facility Management; ergonomic researcher (Cornell University NY State College of Human Ecology, Department of Design & Environmental Analysis, Van Rensselaer Hall, Ithaca, NY 14853-4401)

**Mr. Michael Hooker** - Professor, University of Michigan; Principal, Michael Hooker Associates, lighting consultants, (Michael Hooker Assoc.,111 North First St, Ann Arbor, MI 48104)

**Mr. Valentine Lehr** - President, Lehr Associates, Mechanical Engineering firm (Lehr Associates, 130 West 30th Street, New York, NY 10001-4092)

**Ms. Vivian Loftness** - Professor, Carnegie Mellon University; Architect; Member of Advanced Building Systems Integration Project (Department of Architecture, Carnegie Mellon University, 1325 Doherty Hall, Pittsburgh, PA 15213)

**Mr. William Miller**, Director, Steelcase R & D, (Steelcase, Inc P.O. Box 1967, Grand Rapids, MI 49501-1967)

**Mr. Herbert Rosenheck** - President, Technical Planning Associates; Systems integration specialist (Technical Planning Associates, 18830 Los Alimos St., Northridge, CA 91326)

**Dr. Arthur Rubin** - Research Psychologist, National Institute of Standards and Technology (NIST), Building 226, Room A-309, Gaithersburg, MD 20899.

**Mr. Duncan Sutherland,** - Architect, Fitch RichardsonSmith; "office futurist;" office consultant to Japanese organizations (Fitch RichardsonSmith, P.O. Box 360, Worthington, OH 43085)

**Dr. Edward Toran** - Director, Space Administration, Metropolitan Life Insurance Company (Metropolitan Life Insurance Company, One Madison Ave., Area 12-Z, New York, NY 10010-3690)

**Mr. Peter Valentine** - President, COMSUL; telecommunications specialist. (COMSUL, 475 Gate #5 Road, Suite 212, Sausalito, CA 94965)

**Dr. Cecil Williams** - Human resource specialist, Herman Miller, Inc.(Herman Miller, Inc, Director, Health & Wellness Program, 8500 Byron Road, Zeeland, MI 49464)

**Dr. Forrest Wilson** - Professor of Architecture, Catholic University; former editor-in-chief "Progressive Architecture," former senior editor "Architecture" (5815 Bryn Mawr Road, College Park, MD 20740)

**Mr. Tim White** - Professor, Florida A&M; Director, Architecture Programming curriculum (Department of Architecture, Florida A & M, Tallahassee, FL 32307)

**Ms. Amy Wohl** - Principal, Amy Wohl Associates; Office Automation consultant (Wohl Associates, 146 Montgomery Ave, Baly Cynwyd, PA 19004)

## 2. Workshop Guests and Affiliations

**Ms. Melissa Allen** - DOT/OST (Office of the Secretary of Transportation), Deputy Assistant Secretary for Administration, (400 7th St SW, Washington, D.C. 20590)

**Ms. Kathy Baxter** - DOT/OST (Office of the Secretary of Transportation), headquarters planning team member; space planning specialist (400 7th St SW, M-41, Washington, D.C. 20590)

**Mr. Don Burns** - GSA/NCR (General Services Administration, National Capital Region); space planner and interior designer - assigned to the DOT consolidation project (7th & D Sts SW, Room 7660, Washington, D.C. 20407)

**Mr. Joe de Buzna,** DOT/OST (Office of the Secretary of Transportation), Telecommunications Division (400 7th St SW, M-33, Washington, D.C. 20590)

**Ms. Marguerite Christensen** - DOT/OIG (Office of the Inspector General), Administrative Officer; technical planner (400 7th St SW, Room 9202 JP-20, Washington, D.C. 20590)

**Ms. Maria Cooke** - DOT/OST (Office of the Secretary of Transportation); contract specialist working in the procurement area for the new building (400 7th St SW, Room 941, M-64, Washington, D.C. 20590)

**Mr. Clay Deaton** - DOT/FAA (Federal Aviation Administration); Special Assistant to the Director of Logistics Service; responsible for property management and facilities management (800 Independence Ave SW, Room 400 West, Washington, D.C. 20591)

**Ms. Deborah Derivas** - DOD (Department of Defense), Pentagon Strategic Management; interior designer (Pentagon, 3C 345, Arlington, VA 20301-1145)

**Mr. Michael Dillingham** - COMSUL Ltd.; telecommunications engineer (7500 San Felipe, Suite 900, Houston, TX 77063)

**Mr. Paul Ducharme** - GSA/NCR (General Services Administration, National Capital Region); space planner (7th & D Sts SW, Room 7660, Washington, D.C. 20407)

**Ms. Lee Foster-Crowder** - designer (Foster-Crowder Design, 1333 H St. NW, Suite 600, Washington, D.C. 20003)

**Mr. John Gardner** - 3D/International, DOT project; lead space programmer (66 Canal Centre Plaza, Alexandria, VA 22314)

**Mr. Tom Glenn** - DOT/NHTSA (National Highway Traffic Safety Administration); Chief, General Services Division (400 7th St SW, NAD-51, Washington, D.C. 20590)

**Mr. Crawford Grigg** - DOT/OST (Office of the Secretary of Transportation); Chief, Real Property Division (400 7th St SW, M-47, Washington, D.C. 20590)

**Mr. Lyle Hayhurst** - DOT/FHA (Federal Highway Administration); Chief, Property and Services Branch (400 7th St SW, HMS-21, Washington, D.C. 20590)

**Mr. Lon Henrichsen** - DOT/OST (Office of the Secretary of Transportation); Chief, Telecommunications Division (400 7th St SW, Room M-33, Washington, D.C. 20590)

Mr. Wayne Hirst - DOT/UMTA (Urban Mass Transportation Administration); Chief, Administrative Services Division (400 7th St SW, HMS-21, Washington, D.C. 20590)

Ms. Deborah Kander - Architect (Bellcore; 6 Corporate Place, IM254, Piscataway, NJ 08855-1320)

Mr. Richard Kreutz - 3D/International; Project Manager for the DOT headquarters building project (66 Canal Center Plaza, Alexandria, VA 22314)

Ms. Mary Kay Langan-Feirson - DOT/OST (Office of the Secretary of Transportation); attourney providing legal counsel for the new building project (400 7th St SW, Room M-33, Washington, D.C. 20590)

Mr. Rich Lieber - DOT/OST (Office of the Secretary of Transportation) - Chief, Procurement Operations Division (400 7th St SW, M-64, Washington, D.C. 20590)

Ms. Kim Lydon - DOT/SLSDC (St. Lawrence Seaway Development Corporation); technical and management planning (400 7th St SW, Washington, D.C. 20590)

Mr. Ronald Martin - DOT/RSPA (Research and Special Programs Administration (400 7th St SW, DMA-11, Washington, D.C. 20590)

Ms. Jewel McKee - GSA/NCR (General Services Administration, National Capital Region); space planner; GSA Space Planning (WPEP) (7th & D Sts SW, Room 7660, Washington, D.C. 20407)

Mr. William Miller - Director, Steelcase R&D (Steelcase, P.O. Box 1967, Grand Rapids, MI 49501-1967)

Ms. Anne Overlin - 3D/International, Director of Interior Design, Washington Office (66 Canal Centre Plaza, Alexandria, VA 22314)

Mr. Edward Pearson - DOT/MARAD (Maritime Administration); Chief, Supply and Space Management (400 7th St SW, Room 7313, Washington, D.C. 20590)

Mr. Angelo Picillo - DOT/OST (Office of the Secretary of Transportation); Project Director for the Headquarters Building project (400 7th St SW, M-41, Washington, D.C. 20590)

Ms. Eileen Powell - DOT/OST (Office of the Secretary of Transportation); Deputy Director, Office of Financial Management (400 7th St SW, M-80, Washington, D.C. 20590)

Ms. Becky Prendiville - DOT/OST (Office of the Secretary of Transportation); space management specialist (400 7th St SW, M-47, Washington, D.C. 20590)

Mr. Arnold Prima - DOD (Department of Defense); Chief, Design and Construction; responsible for about 160 buildings besides the Pentagon (The Pentagon, 3C364, Washington, D.C. 20301)

Ms. Marjorie Laine Prince - DOD (Department of Defense) interior designer (The Pentagon, 3C 364, Washington, D.C., 20301-1155)

**Ms. Linda Rhoades** - DOT/OST (Office of the Secretary of Transportation) Deputy Director, Office of Personnel (400 7th St SW, Room 9101, M-11, Washington, D.C. 20590)

**Mr. Philip Rockmaker** - DOT/OST (Office of the Secretary of Transportation); assistant project manager for the Headquarters Building project (400 7th St SW, Room 10317, M-41, Washington, D.C. 20590)

**Mr. Larry Schadt** - DOT/NHTSA (National Highway Traffic Safety Administration) General Services Division (400 7th St SW, NAD-51, Washington, D.C. 20590)

**Lt. Ken Soler** - DOT/USCG (Coast Guard); Assistant Project Officer; involved in project planning and coordination (US Coast Guard, 2100 2d St SW, Washington, D.C. 20593)

**Mr. Roy Spillenkothen** - DOT/OST (Office of the Secretary of Transportation); Project Manager for Headquarters Building project (400 7th St SW, M-41, Washington, D.C. 20590)

**Mr. Thomas Taylor** - US Fish & Wildlife Service (1849 C St NW, Arl Square 322, Washington, D.C. 20240)

**Mr. John Trouton** - 3D/International; architect; manager of design (66 Canal Centre Plaza, Suite 310, Alexandria, VA 22314)

**Ms. Tracey Vanness** - GSA (General Services Administration), (18th & F Sts NW, Washington, D.C. 20405)

**Ms. Dorothy Walker** - DOT/OST (Office of the Secretary of Transportation) Workforce Diversity, Office of Personnel (400 7th St SW, Room 10312, M-14, Washington, D.C. 20590)

**Mr. Anthony Waller** - GSA (General Services Administration); space planner (18th & F Sts NW, Washington, D.C. 20405)

**Ms. Betty Ward** - DOT/FRA (Federal Railroad Administration); Chief, Administrative Services (400 7th St SW, RAD-30, Washington, D.C. 20590)

**Ms. Marilyn Zelinsky** - Project editor (Interiors Magazine, 1515 Broadway, New York, NY 10036)

MR. CYROS: Our next speaker is Martin Duby. He is the Project Manager for Facilities Modernization at the U.S. General Accounting Office in Washington, D.C. He has managed modernization of the GAO building which has a gross area of 2 million square feet and 4,000 occupants. He spent time as Director of Office of Budget and Management in the Office of Conservation and Renewable Energy, Department of Energy. Then he moved on to be the Director of the Bureau of Support Services, Health Care Financing Administration in the Department of HHS, Director of Administration, National Academy of Sciences.

## GENERAL ACCOUNTING OFFICE

MR. DUBY: About two months ago, my daughter called me from school. She is in her last year at Yale Law School, and is likely to finish in about the top 10 of her class. She has been recruited by most of the major law firms in the country. When she called me she asked, "Guess who's coming tomorrow?" I said, "GAO." She said, "You're right." GAO has an incredible recruiting program, probably more so than almost any organization in government and in the private sector.

The reason is that the boss, Chuck Bowsher, has his priorities straight when it comes to people. He wants to hire the best, train them and give them challenging work. He wants to give them the best tools to do their job, and reward them for good work.

He recognizes the value of a facility to his organization from a couple of perspectives. First, it presents the organization to the federal employee, the private sector, and to the customer using the services of that organization. And two, it provides a workplace for, in this case, 4,000 people who perform the services of the organization. So, I think I am working for someone who has his head on straight.

That phone call got me thinking. I wondered what would happen if my daughter came to the building for an interview. We started this modernization program several years ago. We have two floors completed, out of seven. But even after two years, I felt I would be proud to show her the work we have completed. The first floor houses commercial activities and the recruitment area. The seventh floor is what I call the law firm, and the Controller General's area and so forth.

We have amenities not mentioned earlier, such as a fitness center. We also have a day care center and a cafeteria we have just remodeled.

What we have is a building that represents a city within a city. From the outside, it is unimpressive. On the inside, it is going to be dynamite.

When I read the transportation brochure describing DOT's new building, I thought, from the outside it is going to be dynamite, but I am concerned about what it might be like inside. That is what I would like to talk about.

When looking at the prospectus, I learned little about where you folks are heading. I then examined the assumptions made by GAO for our building when I got there about three years ago; they are very similar. We had a facility that was large in scope, large floor plates. You are talking about housing 8,000. Our building houses 4,000. In both cases we are dealing with sizable populations.

I looked at the 125 square foot per person yardstick that you have specified. Our planning assumptions were based on 128 square feet per person. So, over the last three or four years, they have not been reduced much.

It is a high technology building. It is going to support a knowledge based staff. I think the constraint that you folks have to work with - the air rights - is going to make the inside of your building a little more complicated than mine.

When I started to work at GAO, they said, "Take a look at this - what do you think?" I said, "I don't like it. I want to look at it for a while and think about it." We went through a process.

Let me define a user. I am a user of all the services represented by the speakers yesterday and today. I am trying to pull these disciplines together so to come out with a successful project. That is going to be within the next three or four years, three years hopefully, because my task is to work myself out of a job.

We first looked at the front end - we talked yesterday about this relationship between the user requirements and the mission. We talked about that in relation to the workstation, and then to the building shell. Now, let's look at that model, because yesterday morning should have given you a feel for the disciplines involved and how to use them. When I explain my process, I hope it will come together.

The first thing we did was to make sure we knew what the organization was all about. What is the mission? Some speakers do not know what DOT does. I do not know exactly what you do. I know you have a navy (the Coast Guard) and airports, and many other things. But you are basically a knowledge based program management organization. GAO is similar to that. It is a huge consulting company. We provide advice to the Congress of the United States.

We deal with high powered folks who receive substantial salaries. Our salary and expense budget annually is about $450 million. We do not have any big capital projects except for our computer operation and our building. So, it is all salaries. That is why having a good facility is so significant.

What did we do? My paper (NISTIR 4801) describes our approach. You will see we have revalidated overall organizational objectives and converted those to design objectives, just to compare them with the GSA initiated program.

While I was doing this, GAO did a very smart thing. They divorced themselves from GSA through legislation, bought custody of the building, and all of the artificial constraints went out the window. I didn't have to be constrained by factors such as the 128 square feet space limitation.

Then we examined who we are, what we do, and what kind of workstation is needed for this building. Keep in mind the building exists. It is a huge facility between 4th and 5th and G and H. The only other building on that city block is a Catholic church which we had to build around.

I brought in some folks with experience, including Mike Brill from BOSTI in Buffalo. If you are not familiar with him, you ought to read about his work.

They met with our staff in focus groups throughout the building, and collected data. Mike brought a psychologist with him. When they conducted their meetings, they dealt with what people really wanted. The philosophy was, "Let's build this thing from the inside out, the office, the workstation first." I had some ideas, but kept an open mind.

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They developed a paper (included in my workshop paper NISTIR 4801). It was a recommendation that the ideal workstation for our business is a private office, 130 square feet, furnished with systems furniture, wall-mounted, and basically "one-size-fits-all." I used that expression yesterday and someone took offense. It accommodated the worst and the best case. In other words, the worst offenders with storage and all their stuff, our lawyers and economists; then our auditors, who don't need quite as much space. He looked at the work surface requirements, storage requirements and adjacency needs.

We found that these people really need privacy. We are talking about auditors and lawyers. All the work represented in this room is knowledge based, so I won't use that expression.

In effect, we finally decided to assume that we are going to go for private offices. How far can I go?

Then we went to the second aspect covered yesterday - programming. We developed occupancy objectives. How many people can I fit in this building if we have private offices? The question was asked yesterday whether a limit can be set first, and then have people to fit into it. Well, that is what we finally did. So, 750 people can fit on a floor.

We started out with a 90 percent open/10 percent closed ratio. You have 85/15. We now have 40 percent open, 60 percent closed. Incidentally, Mike Brill indicated our floor plate is the biggest one he has worked on, except for the one in the Chicago Merchandise Mart.

We decided on having 750 people per floor, and with the architect, we laid out different working scenarios. We did not think we could fit any more people on a floor with the constraints imposed - the lack of any natural light source except the exterior window wall.

Next, we prepared a stacking plan, who goes where. We know the limits on each floor. Now, who is going to be there? The objective was to move people, not walls.

We discussed flexibility. We have been talking about moving people all around buildings. They have to go to meetings. They work in teams. I think that is a lot of nonsense. Each person in our building may belong to 10 different teams and as many different projects. We have 1,000 projects ongoing and maybe 2,000 senior professional staff. Each person has a major project responsibility but also supports other teams.

Fix the person at the workstation and give him or her some other places to go when required. It is almost like living in a neighborhood and inviting company over to your house. Let the person have his or her own space.

We developed a stacking plan, which called for a large division and a little division on each floor. DOT has eleven organizations in its loosely knit confederation. You'd better make sure there is enough contiguous space to accommodate entire organizations to preclude spillover onto other floors.

Our concept is to have no party walls. For people who have not lived in Boston in a tenement area, party walls separate apartments into perhaps four or six pieces. So, it is all open. I cannot see having the Coast Guard on one side of the building and then a line down the hall and then the railroad people on the other side of the building.

You are probably going to have to segregate your facility into various components. Politically, it's probably the only way you can succeed, because each one will want to "do their own thing." Thus, you need a well thought out stacking plan.

We also have a theme for our building. It is allegedly an historical building. I don't know why. They call it depression modern. I call it depressing at times. It will not be though, once we finish it. But we have a theme for the building, based on its existing architectural characteristics, which we see replicated on each floor.

Somebody mentioned yesterday, "You have enough private workstations." With 200,000 square foot floor plates with windows only on the exterior, the challenge is dealing with your interior design standards and concepts to make this thing more habitable. But our private office concept makes it a lot easier for us to set up our space.

The last thing was to develop a management and an implementation plan. I used a commercial facility manager who replaced GSA when the legislation passed, giving us responsibility for the building. He helped with construction management and design. I also utilize consultants. I have a minimum size staff and want to keep it that way. My philosophy is like Steve's (Binder), "Get this job done and then adjust."

We have a single contract for furniture for 4,000 workstations. It happens to be with Herman Miller. The furniture system is used like a "tinker toy" set. I can adjust components any way desired, but we will probably have about 20 or 30 standard workstations in the building. These offices are very elegant. I have reduced many 225 square foot areas for our GS 15's, down to 150 square feet, and they look huge. We have a relatively small number of 275 square foot offices, which are for our SES's (Senior Executive Service). Also, the seventh floor contains some of the historical offices, that are about 400 to 600 square feet.

I am trying to present a process and a framework to make decisions to accommodate people with different needs. Without some type of framework, you will be running on an intellectual treadmill for the next eight or nine years, and nothing will ever happen.

I advise you to organize your program along those lines. Your building will have to be very flexible whether open or closed. You ought to assume that once you build it, that you won't change it. I think systems furniture workstations are harder to move in a lot of ways than drywall.

Your biggest problem will be the politics of your eleven separate organizations. I think you have to focus on the stacking plan and make sure you can segregate these organizations. When you complete your plan, it should reflect an overall theme for the building. But you know that the various agencies will want to follow their own priorities. Don't try to micromanage them, or the nine years is going to extend out to 30.

In my paper (NISTIR 4801) I described some lessons learned. I don't know if the wire plan was successful, but I couldn't get everybody to agree on a single plan. What we did was work with the physical facility - wire closets, vertical risers, etc., to accommodate virtually anything.

Watch the systems furniture issues because there may be a mismatch of the wiring schemes that are commercially available now, and the electrical design for your building. I know that when you start tying things together, it is often not as simple as it might appear in the literature from some vendors.

One other observation on culture. Historically, GAO back in the 1920's, audited vouchers. That was their job - all those green eyeshade people. The building was originally designed to handle large amounts of paper. It has one foot thick reinforced concrete floors to accommodate paper storage.

However, the organization is contiuously changing. For example, the number of secretaties and support staff has dropped considerably. As a result of computerization, instead of a 1 to 3 or 1 to 4 secretary/professional ratio common some 20 years ago - it is 18 to 1 in GAO's legal division. That is incredible. So, our salary budget is rising accordingly; 60 percent of our people are in the GS-13 and above level. I guess that is a knowledge based staff.

You do not have the same requirements you had a few years ago. You have to plan for that kind of staff evolution. The ratio is going to get even higher. I don't know if I am going to get by with a 60 percent factor for closed offices.

## OPEN DISCUSSION

**MR. CYROS:** We are going into the open discussion period to take questions for any of our two previous speakers and our last speaker: Steve Binder from Citicorp, Edward Toran from Metropolitan Life, and Martin Duby.

**VOICE:** *What is the basis for determining open versus closed office space for any given population.*

**MR. DUBY:** *It is a function of what you do for a living. We have 3,000 in the building now. We will have 4,000 in a couple of years. The question posed to our people was what aspects of their jobs require privacy. That is a loaded question.*

**VOICE:** *I was going to say I need more privacy and more space. So, how do you really determine that?*

**MR. DUBY:** *You've got to look at risks and the realities of what is going on in the workspace. For example, we know how many interactions an individual has with other people during the day. So, the way the workstation is set up, you have a private office, say, 150 to 140 square feet, designed to have two chairs for small meetings. They go in, close the door, meet and then leave when the meeting is over.*

*I don't need as many conference rooms with that kind of a setup. When I first looked at the plan, they had a great many team rooms. Nobody has a meeting in an open landscape system. They go to conference rooms. Suddenly you have a ratio of 1 to 10, 1 to 7, whatever. When you look at the arithmetic, a 124 square foot standard, or 128, or my final number, it comes pretty close. In order to support open systems workstations you need a lot of meeting space.*

MR. BINDER: *Also you set some ground rules. In addition to what Martin said, the most you would ever want is 50/50. If you are going to ring the outside with offices, they will never change in size. You set the rules. They will not have any more interior, and go to the client and you say that's it, 50 percent outside. You can fill them up as you want. This is the square feet.*

VOICE: *I'm the client. I can't do that.*

MR. BINDER: *Okay, but Melissa will do it, but you can do it. You have to set some ground rules. In addition, you have to set some parameters.*

VOICE: *But that is not really based on what the person is doing. It is based on the architecture of the building.*

MR. DUBY: *It depends on where you are. You are in a different business than I am. Your raison d'etre is clerical support, and open is probably a more efficient, more effective solution than for the kinds of things I do with a workforce that is 60 percent GS-13 and above. I do not know what GS-13's make anymore, but you are talking $100,000 for each staff member here. It is a different ball game.*

DR. TORAN: *There are no rules etched in stone. In our organization, I see changes, changes in both directions. The company is 123 years old, and I have not been there from the beginning. But at Metropolitan one can find anything that existed in the last 123 years. One sees some remnants.*

*There was the open box space.. Then there was a time when much of this penetrated into offices. So, everybody had an office room. Now we see a strong trend back into this open area, open meaning cubicles.*

*For a while our Chairman, who has been chairman for the last three years or so, was trying to get vice presidents to sit in a workstation, surrounded by something like 4 foot high panels. Of course everybody revolted, and finally they proved to him that it would not work.*

*But his idea is that at the top of a modern organization, ours or a similar kind, people get together because of physical contact. He does not want separation amongst them. It has to be a team that works together.*

*In some of our new buildings we are moving to this new culture. People who used to sit in offices are going to be in an open area, in cubicles with 80" high panels. For them it is perhaps a shock, but one expects that is a new way of communicating. The company is different. The tools they are working with are different. So, it is a matter of perception, of politics; what somebody wants to do with it.*

VOICE: *In Martin's (Duby) case, the person who sets the rules is Chuck Bowsher, and he says, "I want the people who work here to feel like they work at Arthur Andersen." There is a traditional style of working, as well as the support, that you need a private office, and they can justify it. At GSA, it is not a person, but a mentality that says we want to have open space so we have the appearance of not wasting space and of having the best efficient space. It was difficult to marry these two requirements, and to have any agreement.*

MR. DUBY: *That is one of the reasons we divorced them.*

VOICE: *It's not simple, it depends on who sets the rules. If DOT has someone in charge who says, "This is how we work it; this is how our people like it," then that will be the ruling factor.*

MR. GRAHAM: *I agree with that comment. There are many organizations with the same kind of people housed in different kinds of space, and it is a management decision and management mentality that will establish the rules.*

*There is one organization that many of you know. You have probably eaten many of their products - M&M Mars. The two Mars brothers have made the ruling for all of their offices that everyone will sit in open space, from the president on down. So, in New Jersey in the M&M Mars operating offices, the lawyers, personnel people, the president, the vice presidents, all sit in open space office areas with various amenities around them.*

*In other organizations, the operating style is to go to closed space, and the same kind of people, as in the M&M example, would be in closed offices. I know of no research that says that functional needs will determine the people who should be in open or closed spaces.*

VOICE: *Marshall (Graham), what is the utilization rate per occupant in the M&M case with all that open space?*

MR. GRAHAM: *Almost identical to staff members who are in more traditional types of offices. It calculated out to be about the same kind of space that you would have for a mixture of closed and open office areas, and even for the use of systems furniture.*

VOICE: *What's the number itself?*

MR. GRAHAM: *I don't remember the number right now. (After checking past records, the average office sizes were 120 square feet for middle managers, 80 square feet for clerical staff, and 150 square feet for top management, However, the area for the top management staff was designed with added conference seating nearby and with larger circulation spaces for access and passage of staff members).*

MR. CYROS: *Privacy is a matter of definition. Can you see me when I adjust my necktie or heft up my pants? That is privacy, visual privacy. Can you overhear my conversation with one of my staff or when I am on the telephone? That is an auditory privacy. In an office with 80" high walls, if you can assure me of auditory privacy, for me that is a private office.*

DR. TORAN: *I would like to mention a building you might be familiar with. Union Carbide in Danbury - 15 years ago or so created an experiment where everybody had a private office. The rooms were modular, and I think only the chairman and president had two modules. They shaped the building in a zig-zag fashion so everybody had an office at the window. I think they had bad luck in their business, and when I saw them and asked whether they would do this again, they said never again. I don't know what we can learn from something like that.*

VOICE: *The technical literature contains information about modern computers requiring power in a way that causes problems with the standard electrical 'rules of thumb' around which pre-wired systems furniture is built. Has anyone in your use of systems furniture run into this problem? Is it as serious at least as some technical journals indicate?*

MS. WOHL: *Worse.*

VOICE: *I'd like you to expand on that.*

MS. WOHL: *It depends entirely on the vintage of the furniture. The newer the furniture, depending on the brand, what you are trying to do, and the combination of cabling you are trying to pull through, it can be better or worse. Pre-wired furniture is the worst case because the chances that it will be what you need, is becoming smaller and smaller.*

*I don't usually make wiring recommendations because that is not my specialty. But somebody who does that kind of consulting, like a LAN specialist, will probably make several recommendations - possibly fiber optic backbone cables, and several different kinds of local area network cable. Other recommendations might include peripheral cables that have to come through and various other cables that have to be pulled, as well as the electrical and telephone systems.*

*The chances that, by coincidence, all of these cables have been pre-wired into whatever you happened to buy three years ago - good luck. We just say to customers, "What you really want is space so that you can pull what you need to pull."*

DR. TORAN: *I would like to mention an experience before coming to Metropolitan Life - a huge project for a major corporation. We planned a panel system and specified an electrified base. After we went through the details, they found that the many components of an electrified base would limit the possibilities of further development. It also would make the whole panel system inflexible. They switched to so-called wire management, which means to tidy up loose wires because one can add them, pull them in different directions, and keeps them somewhat neat. But from that day, my experience with a so-called electrified base, which at the time of design tries to account for all contingencies possible in the channel - that's a no-no.*

MR. VALENTINE: *I would like to add to Amy's (Wohl) comment. As we move in the technology business toward structured wiring systems, it will be important to have the furniture companies understand what that means. One of the best examples of that problem exists because if you try to take IBM type 2 cable and put it into a structured wiring system - it is an absolute disaster.*

MS. WOHL: *Sure. You cannot do it. You end up with this gorgeous, beautiful, wood-veneered furniture, and you try to figure out how to fasten the wiring on top of it. I have had a lot of fun standing there with the carpentry crew of some Fortune 500 company trying to figure out a suitable way of fastening it on top of the oriental rug.*

MR. CYROS: *Is it any easier in offices with fixed walls?*

MS. WOHL: *No. My favorite job was when we went into a building in St. Louis, and thought it was going to be "a piece of cake." We were going through the building. It is modern, two-story, slab construction, typical office park building. Anything we have to do is going to be possible in here.*

*We get to the executive suite, for which we were making the recommendations, and the president's wife of this very large company had been the interior decorator for the executive suite. The whole executive suite had been done in antiques, insides of English castles had been transported here. They had oriental rugs on hardwood floors. There was no place to conceal a wire anywhere. The president's office had no desk. It had a coffee table in the middle of the room. I tipped it up to see whether we could cut a hole in the middle of it and sink a CRT in the middle of it to use as his workstation, and the secretary screamed to tell me how much it was worth. You can't get there from here.*

MS. LOFTNESS: *I want to get back to the issue of open versus closed office space, because I understand that it has been decided that 85 percent of DOT's office space will be open, and we have to figure out how to electrify the panels now.*

*I think there is a problem with the reason for the open planning in the Department of Transportation. It is to essentially cheat the occupant out of space and access to windows, to try to squeeze every financial benefit out of that. If you have 200 people with 20 feet of window wall, you have a serious problem.*

*If you want to stay with the open plan, your investment in the base building must be higher, not lower. Even though you manage to get some square footage back, the square foot cost is going to go up. You cannot assume that it is a way to save resources.*

**MR. CYROS:** The next session has to do with looking ahead toward the electronic office. What will the office of the future be like? Our speaker is Duncan Sutherland, Vice President and Chief Technology Officer of Fitch, Richardson, Smith. Over the years Duncan has split his professional career between the high technology and architectural design industries, and he is also a founder of Wang Laboratories Advanced Systems Laboratory in the early 1980s. He is the principal author of a book that I recommend sincerely that you should become familiar with. It is called "Officing, Bringing Amenity and Intelligence to Knowledge Work."

# LOOKING AHEAD TOWARD THE ELECTRONIC OFFICE; WHAT WILL THE OFFICE OF THE FUTURE BE LIKE? - OFFICING

**MR. SUTHERLAND:** I will talk about the future of the office, but probably not as any of you might expect it to be presented.

I want to talk about what I see going on in the world. I am not a consultant. So, I am not selling anything. I am an end user and I live in offices. I spend a lot of time thinking about offices, worrying about what the office might be like in the future. But I will caution you that I am not looking at the office from a purely physical point of view.

I have heard more answers today than at any conference I have ever attended. The problem is that I am not sure we know what the questions are.

A lot of what I am going to say in a compressed time frame probably has no utility to DOT. I say that because it sounds to me that you already know what you are going to do. The kinds of questions I think are important to ask, probably would have been asked years before you have gotten as far as you are. Nonetheless, I think it is important to ask some of these questions, even if they are now rhetorical, because as you go through the planning process, it may cause you to rethink some basic assumptions about the relationship between time, space, and work.

Officing in the 21st century was the subject that I was asked to address. I would like to take a minute and talk about our itinerary. Itinerary, as you know, is when you take a trip, you want to have a plan. You want to know where you are going. We have three stops on this very, very rapid trip.

I want to look at the office in terms of three questions. What is happening? Why is it happening? What does it all mean? I am going to do this in the context of the work that I have been doing with the Japanese, and in the context of my general inquisitiveness, running around talking to people at lots of companies about what they think about offices, and people who live in offices, and reading and studying topics having nothing to do with offices.

I don't read literature about offices. I read about everything else and try and synthesize all of that diverse material into an idea of the office. I read fairly eclectically in the cognitive sciences, social sciences, history, philosophy, and other areas that apparently have little to do with offices. But interestingly enough, when you read about what is happening in the world today, it all starts to gel into some important implications for the office as we know it.

So, our first step is to determine what is happening. That is very simple. The office is dead. The problem is that we do not know it. The invention of the office took a long time. Nobody had a book to reference, which said step one; you create a bureaucracy; step two, you create a hierarchy; step three, you create offices. The office, as we know it as a modern entity, was created out of "whole cloth."

The same thing is happening now, but it is a long process. However, it is hard to distance oneself far enough from the process to understand where it may lead. As we have heard from many people, the idea of an office of the future is a mythical entity. There is no such thing. It is whatever the office will be in the future, and as Alan Hedge so aptly pointed out yesterday, it is our responsibility to create that. We are in control.

So, to ask what it might be, and expect someone else to define it for us, is nonsense. We should create it in whatever form we think appropriate.

I am not going to guess as to which direction the spirit of the office may go. Depending on the quality of your own office, you may think it is going in one direction. Some of the ones I have worked in may be going the other way.

But having said that the office is dead, what is happening to replace it? I am talking about a time frame of possibly 50 years or more. It depends on many factors that are out of control. What is happening that may reshape the office in a form that none of us would recognize, were we looking back from that future position?

There are a couple of things. The primary factor driving this change is a realization that for the last decade we have been running down a track on a railroad that is dead-ending at a cliff. That has to do with this idea of information.

My thesis is that the idea of information has gotten us into a lot of trouble. We have been pursuing many ideas for managing information. We talk about an information society. As far as I am concerned, that is mostly bunk.

We have lost sight of the fact that information is a behavioral phenomenon. It is an experience which one dictionary definition says justifies a change in plan. Well, it is pretty hard to manage that because it is not tangible.

Now, we do manage all the artifacts of human information processing; papers, books, articles, newspapers, and so on, but those are only artifacts. They are only useful when you reinterpret them as new information. I am not going to go into all the details, but that is basically the way cognitive scientists think it is working.

Information, like beauty, lies in the eyes of the beholder. This happens to us all the time. You and I read the same planning document, we go away, we come back a week later, and it is as if we were not at the same meeting. I thought you agreed with me. I did, but the problem was that we created totally different information from the same so-called objective data.

This phenomenon causes one to question what an organization is in the first place. We all have to admit, whether we want to or not, that an office is a response to something. It is not created because we like offices. An office is a tool created to fulfill an organizational mission. It sounds trite, but sometimes we lose sight of that fact. The office reflects a belief about how an organization processes information, not in the physical sense by moving paper around, but as a conceptual model that management has about the world. So, the office, in essence, is an extension of the human mind.

Another way to think about the office is as an information processing metasystem. That is a twenty-five cent word. Metasystem simply means system of systems. I argue that the basic system is in the office - the individual as a human information processing system. Therefore, the organization becomes a metasystem in effect.

What causes this metasystem to be functional - to allow survival of an organization, are three things - I am going to concentrate on two of them. One is the quality of interpretation of the external world by the individual. In other words, the belief systems that one carries around in ones head, impact how the outside world is perceived. If you

are "in sync" with the demands of that world and process information effectively, you survive. If not, you don't survive. It is pretty simple. Some rules are built in, others, we learn.

That is why you can walk down a street in Washington, if you live here, and never see people sleeping in the doorways and on subway grates. If I come in from Columbus, Ohio, that is all I see. The mind is good at adapting.

If your individual processing systems are out of whack, the organization cannot survive. There is nothing you can do about it, and no facility is going to fix it.

There is another level of importance to consider. It is called shared meaning, because as an organization, we do not operate as individuals. We operate as collectives of individuals. Not only must we ensure that each individual functions effectively as an information processing system, but the whole system, the metasystem, has to function as well. It has to be responsive to the demands of the environment. If this sounds a little Darwinian, I guess you could say it is.

But how that shared meaning occurs is the critical thing I want to focus on here, because that is where facilities largely come into play. Facilities can impact individuals, but they can make a big difference in the creation of shared meaning. How does that happen? By shared meaning.

Shared meaning can be enhanced or impeded by a facility. We have heard many examples of how facilities get in the way of creating shared meaning in an organization.

My contention is that we should be rethinking facilities in the context of a new metaphor. We need to create environments that enhance information processing at the individual and organizational levels, where we have shared meaning. Because no matter how nice a facility you live in, if those processes are not 'in sync' with the demands of the environment, you will fail.

What has happened since the office as we know it was created, is that the environment has changed radically. The office today is a product of the industrialization of western society. As a result of a confluence of events, this thing called the office was created. There were no corporate jets. There were no telephones. There was no highway system or railroads. The telegraph was there. Sailing wasn't reliable, so your mail might not get to England. If you think about the environment when the office was created, when the structure of the office was laid down, that is what existed in the world.

Today, you know what has happened. We have corporate jets. We have telecommunications, globalization, new humanism, greening issues, enabling technologies that we could not even imagine, like video conferencing, and cognitive psychology, which is a major driver. Why? Because we are now starting to understand for the first time how the human mind works.

I don't know if you read a recent article in the New York Times. For the first time scientists have made movies of the memory working - an amazing breakthrough, because we are getting to the point where we will be able to model environments, understand and see the implications of how environments effect human information processing and by extension, organizational information processing.

So what? Who cares? It makes a difference because the uncertainty in the world has increased dramatically. How do you deal with uncertainty? By creating more information, which reduces uncertainty. How do you create more information? By creating more knowledge. Knowledge is the driver, but we do not know how to manage knowledge. We are not good at it. We are good at managing things.

One thing was stressed yesterday and today - economics. It is the primary driver, not learning how to extend the endurance and creativity of individual office workers. We try to create generic workstations for economic reasons. You cannot afford to design an office individually for each of 8,000 people in your organization, or so you believe. I submit that may not be true. It is certainly true in traditional economics, but it may not be true in the future, for a simple reason.

We know there is no generic human mind. Human information processing, or call it creativity or something else, is idiosyncratic. We are all different. We work better at different times. We work better under different conditions. Some of us work well in cars with cellular telephones, some work well in an office or at the beach watching the sailboats, and others work well on decks in nice weather.

No facility works all the time for all kinds of information processing, for all people. So, we need an incredible diversity of workplaces to support different kinds of intellectual work, performed individually, and as teams. Facilities should be flexible and respond to this incredible dynamic, and reflect the idiosyncratic nature of human information processing. But that idea flies in the face of conventional wisdom about the design of facilities and the economics of facility management.

Nonetheless, we need to respond to this individual diversity because that is how we will get the knowledge and the leverage to enable us to be competitive in the 21st century.

Second, we need to deal with the issue of time. This nonsense of an 8:00 to 5:00 workday is an artifact of the industrialization of the western world. Sure, we need to come together to coordinate. Sure, we like to come together because we are social animals, but that does not mean that we need to come together from 8:00 to 5:00 every day - this mass inflow and exodus to and from our cities.

Japan recognizes that. They are trying to reduce the populations of Tokyo and Osaka. They know the current situation is crazy. It doesn't work for a lot of reasons, but that is one of them. We do not have to do it any more.

Technology allows us to extend the office work day to 24 hours. This is what we do anyway because we do not quit work at 5:00. We are knowledge workers. We work in different places - while driving, or in the shower. I woke up at 4:00 this morning and changed my slides. I had a new idea. So, I put them together differently. That is reality. The 8:00 to 5:00 workplace does not cut it.

Moreover, as Ackoff suggests, the idea of breaking up learning and work is an artifact. It is something that we just carry with us. We need to extend information processing as individuals and organizations across 24 hours a day, 365 days a year, because that is how we work.

Finally, the implications for facilities. I don't have all of the data that Steve Binder presented this morning. I have one number, and that is 40 or 50. It is a range of weight that the smallest person in an organization can pick up and move. The individuals in our organization build their own offices, and it creates havoc. I don't know where to

find things. It is probably not ergonomically sound. The facilities change all the time. I have to make sure people aren't putting extension cords in and overloading the circuits. I am a toolmaker and a traffic cop. But it works.

We build the environment daily, based upon what we are trying to do. Individually we create our little places. Teams get together, and they rebuild their space. It does not fit into today's paradigms at all. But, it is an alternative that examines how individuals can express themselves and their communication needs in physical space without the constraints of a traditional bureaucratic process. Good idea? I don't know. It works for us. It probably would not work for you.

Think about this. How do kids communicate in kindergarten? What do they do? They sit around the floor. Is it because they can't afford chairs? No. They sit on floors and play, and they do that through life. In your home you sit on the floor and on stairs. In offices we don't do that. It is not professional.

In our office, meetings are often held on the stairs - with clients ranging from large to small organizations. Participants sit on the floor in their shirtsleeves with computers; terrible ergonomics, but it works. That is what happens when you enable a facility to be totally responsive to the needs of the users. Does it work in all organizations? Of course not.

What is the bottom line? As you think about this building, I leave you with one challenge. I do not expect you to create crazy places like I have suggested. But question the assumptions that people give you about why you have to do things. Are they real or contrived? Are they artifacts or things you should consider?

Question. Because there is so much conventional wisdom about the office today that leads down a wrong path. It is no wonder we have to have conferences like this, where experts are brought together to identify problems we know we will have, before we even build the building. Isn't that a heck of a statement?

We put ourselves in boxes. You have seen the nine dots problem. Connect the nine dots, four straight lines, don't lift your pencil. You know how hard it is to solve because we create boxes for ourselves all the time. Once we create boxes, we cannot step back far enough to create innovative solutions. You have to get outside the box. I challenge you on this building to continually try and force yourselves outside the box.

There are experiments going on today which are very interesting, and I encourage you to look at them. The Steelcase headquarters building - their research and development center in Grand Rapids - is shaped like a pyramid. It is not a pyramid because they had Egyptian designers, I don't think. It was an effort in re-engineering. The facility was considered as part of the process of changing how a company works. Has it worked or not? Ask the people at Steelcase. Probably not, because it is part of a long-term process, but it is an interesting and exciting endeavor.

Chrysler built a billion dollar Technology Center. Did Iacocca build a monument? Yes, he did. But if you examine the planning that went into the building - eight years - it was designed to change the way the company functions. The facility is an integral part of the work process. I suggest that this goal could be employed in the design of the DOT building.

So, in closing, I have one question. Given what is known about the mission of DOT and the realities of government, if we did not have buildings as we know them, what should be invented for the new DOT headquarters, if anything?

**MR. CYROS:** The next area, new information technologies. Our speaker is Don Avedon. He is a well-known consultant in the document management systems sphere where he specializes in micrographic electronic imaging and office automation systems. He is also editor in chief of the International Journal of Micrographics and Optical Technology and on the faculty of the Institute of Records Management. Mr. Avedon was for many years the Executive Director of the International Information Management Congress (IMC), and the publisher of the IMC Journal. In addition he is an author of over 200 papers in the area of office automation, electronic imaging and micrographics standards.

Micrographics has been around for a while and is one possible solution to the volume of paper.

A newer technology is the optical disk. More than 10,000 pages of information can be stored on a small disk. But more important than the compactness of the information is that we could retrieve any one of those 10,000 pages in two or three seconds and transmit it to anybody's workstation, whether it be on another floor, in another building, or 1,000 miles away. So, putting the information that traditionally has been on paper in an electronic form gives us a lot of advantages.

Perhaps the future workstation, at least for many people, might have a display that can interface with the mainframe or a microcomputer and at the same time bring up documents from an optical disk.

We are looking at an approach to having a single display on a knowledge worker's desk so that they can, (1) retrieve data from a computer; (2) retrieve documents that they need; (3) use that display or workstation in a word processing or spreadsheet mode, or whatever - all from a single workstation.

As for the central file, 250,000 square feet just for file cabinets, it is terrible. There are better ways. That small box in the foreground on this picture has a footprint of about 3 square feet and can store on optical disks 1.2 million pages or the equivalent of 120, four-drawer file cabinets, and we can find any one of those pages in less than five seconds, and then it can be transmitted to the appropriate workstation.

Another unit, which is perhaps in size the equivalent of three or four file cabinets, can hold 20 million pages of information and be the equivalent of 2,000 file cabinets and again retrieve any document in less than 10 seconds.

So, there are some techniques, and this equipment is commercially available today and can reduce that amount of file space that you talk about for four-drawer or five-drawer file cabinets.

The cost of paper based systems continuously rises. The cost of space is going up. The cost of people to do the filing and retrieval is continuously going up, but the cost of technology is going down. Therefore, economically looking at these new approaches to handling information makes a lot of sense.

Very important in the future scheme of things is communications. I talked about getting a document from one of those jukeboxes to a person's workstation regardless of where it is. That will be done by communication. Therefore, we must, in our new building provide for local area networks.

We must also provide for wide area networks so that people who are interacting with those in the headquarters building but perhaps are hundreds or thousands of miles away, can also interrogate the data and documents that they need in seconds, not wait for the mail and not wait for a courier. That too is possible.

We also know - and many speakers have mentioned this in the last day and a half - that there will be more people working at home or perhaps at the beach. The technology is here today to deliver data and documents to a knowledge worker regardless of where they are working. If in the year 2000 a large number of DOT's employees work at home, from the information technology point of view, they will have just as good access

to both data and documents there as they would if they were at the headquarters building. When I say just as good, I mean access to all of the material and at the same speed.

Electronic imaging offers many advantages, but you should not think of it as just a way to reduce filing space or reduce clerical staff. You have to think of it as an entire new way of doing business. Once you automate to this extent, there are many extensions to the process that allow us to do our professional jobs better and faster.

For example, a letter comes into the mail room from a taxpayer about some issue. Instead of putting it on the interoffice wagon and routing it from one person to another over the next two weeks because each person sees it in sequence, we scan it, we index it, and we distribute it simultaneously to everybody who needs to see it, for information or action . Think about electronic systems as being integrated into the entire process of doing business.

Depending on which end of the telescope you are looking through, the year 2000 is either very far away or very near. I am very anxious to hear Amy Wohl's presentation on the future of information technology because it is my opinion that it will be very difficult to predict where we will be in eight years.

As an example, eight years ago we did not have electronic imaging for documents at all. It has gone from conception and invention to reality and to being used by more than 2,000 companies in the United States today. It is an everyday, commercially available technology that has come about in less than eight years.

What will the next eight years bring? Let's hear what Amy has to tell us.

People talk about the problem of connecting various information products from various manufacturers. I predict that by the year 2000, that problem will be solved through standards, open architecture, and by innovations in our communications systems. As information is transmitted from one place to another and goes through a switching center, with the appropriate software, we can convert the format and make it compatible with another device by another manufacturer.

The Association for Information and Image Management (AIIM) did a study with regard to media allocation. They talked about the next decade having less paper, less microfilm, more information in electronic form. See figure 111.

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MEDIA ALLOCATION

Type of Media              Year

                        1989      1999

Electronic               1%       5%
(Magnetic & Optical)

Microfilm                4%       3%

Paper                    95%      92%
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**Figure 111. Media allocation**

Although those numbers appear to be realistic, don't be fooled. They are percentages. The volume of paper will increase, and so we will have more paper in spite of the fact that the percentage may be less.

Technology will continue to fall on us. Every day there are several press releases about new systems, new products, new technology, and advances. You need to be flexible in designing the building and the workstations because the information technology used within those workstations, in my opinion, will change substantially in the next eight years.

Between now and the opening of your new building, more information and more knowledge will be created on a single day by many fold than is created today. There will be more paper, not less paper, created eight years from now, but we will also have more use of multimedia, magnetic media, optical media, film, of perhaps holograms, in addition to paper. I do not think any of those media will be replaced. I think we will just see more of all of them.

As for the individual work areas, many of these items have been touched on by other speakers. Nobody pointed out, however, that there will need to be more common spaces for such things as printers. Each individual does not need their own printer in an electronic imaging system, but they need access to a printer, just as they need access to fax machines and copiers. So, in planning for the future and planning for electronic imaging, don't forget the printer for that purpose.

Regarding the central services areas, I believe you will need less space and that 250,000 square feet for file cabinets will not be necessary in spite of the fact that we will have more knowledge and more information being created. I believe we can use such things as the optical disk to reduce that requirement. I see the need for less cabinets, less shelving, and more automated equipment. That will mean more power, more air conditioning and things of that sort, in the central services area.

# OPEN DISCUSSION

Mr. Miller: *We did a study at Steelcase on the impact of multimedia, and produced movies from our CAD system which we think is a more effective way to communicate. We assumed that teams would produce movies and other forms of multimedia, but would throw 90 percent of it away on a weekly basis. When they stored it, they would use at least a 100 to 1 compression algorithms, and every month they would throw 90 percent away of everything that was left. So they were archiving only about one percent of the data annually and using something better than 100 to 1 compression ratio.*

*The 600 people in that pyramid, produced 30,000 gigabytes of data per year. I just did a little calculation. That is 300 file cabinets storing optical disks. For the DOT, that will be 15,000 square feet of additional filing space created every year just to store optical disks.*

*Have you ever heard of revenge theory?*

MR. AVEDON: *No.*

Mr. Miller: *Basically, Murphy's Law and Parkinson's Law are subsets of the revenge theory. Every time you think you have the problem solved, someone comes up with a new requirement.*

MR. AVEDON: *I agree with that, and that is part of the challenge of trying to plan a building eight years in advance without knowing what will be created in terms of information, what media will be used, and what workspaces and central file areas will be needed. That is a challenge.*

VOICE: *Does multimedia take more space than paper?*

MR. AVEDON: *Multimedia of certain types. Motion pictures, as you described, yes. Other forms of information, perhaps no.*

*Also, we do not know what compression ratios we will have in eight years. You talked about 100 to 1. In paper documents we talk about 20 to 1. Technology is certainly advancing, and we hope that those ratios are substantially improved.*

DR. HEDGE: *One thing you didn't touch on and that I see happening is that people are moving away from shared facilities like laser printers to individual workstations. It ties in with what Duncan (Sutherland) was saying - the idea of working anywhere. What people do is use the most convenient technology available to do the job. If I can bring something to my desktop, I do not have to walk to a library, to a photocopier, or a printer, I will do that, because it will enable me to process that task quicker and get on to the next one.*

*Rather than have more things moved to centralized shared facilities, as was the case with the mainframe dominated world, things are going the other way. We now see situations where laser printers are on everybody's desk - not because of the volume of printing, but for the convenience of being able to get hard copy in seconds, not minutes.*

*You see that with the laptop. You don't need to have that power. If you wanted to reorganize your job, it is very convenient. Even if you only type two lines a day while lugging this thing around, the convenience is something you want.*

MR. CYROS: This next topic is human resources issues in the office of the future. Our speaker is Gilbert DeCouvreur. He graduated from the University of Laval in electro-mechanical engineering with a NASA research fellowship. He completed his Ph.D. in electrical engineering with a minor in mathematics. After a career in teaching and research in telecommunications systems in Quebec, he joined the Quebec Industrial Research Center where he established the Systems Engineering Division. He then spent 13 years as the Manager of Systems Engineering in the Canadian Department of Communications, and since 1984, he has been Director of Integrated Systems at the Canadian Workplace Automation Research Center in Laval, Quebec.

## HUMAN RESOURCES ISSUES AND THE OFFICE OF THE FUTURE

DR. DeCOUVREUR: I am not a philosopher or a sociologist, but I intend to speak about people, because as a systems engineer, I like to consider the office as a global system, whose key element is the people.

In general, I agree with Duncan Sutherland when he says that the office concept of the past is dead, at least in the sense that significant changes have already been made in some organizations, and that more and more people have become sensitive to the need for changes.

However, I believe that more drastic changes will be needed, and that people's aspirations will be a major driving force. This will not be easy becaue people evolve faster than huge organizations. Maybe I am speaking like this because I am a public servant.

In this presentation I intend to cover the following subjects. First, where we come from, with some examples of the recent past. I will then look at the pressures for change that will, in my opinion, result from people's evolving expectations. Finally, I will discuss some elements of the global office system.

Of course, everybody knows about the old ways, based on work fragmentation into tasks performed by specialists and management control, in order to achieve the corporate objectives of growth and profits. There is no need to discuss that issue, except that I have one question: Is it really true that these old ways are gone? I think we have a long way to go, and I will give you some examples.

Let's start with the example of a ministerial mail control system. You certainly know that ministers are flooded with all sorts of letters that must be answered fast and carefully. The ministerial mail is handled by a special unit. They log the information and send the letters with a special form, down the administrative ladder, with due respect for the hierarchical structure, four to five levels below, where a draft response and a briefing note are prepared.

While the material is being staffed, changes are usually requested at every level; this is a long and tedious process. In one instance, which I presume is somewhat typical, the turnaround time was four to six weeks, and the Minister became rather annoyed. Something had to be done - and it was. The initial log-in process was computerized, but nothing else was changed. Needless to say, the turnaround time did not improve, and the Minister was still unhappy.

In comparison, the two examples documented in Michael Hammer's paper the July-August 1990 issue of the Harvard Business Review, are good illustrations of "process reengineering". These are the examples of the accounts payable process at Ford Motor Company, and of the insurance applications process at Mutual Benefit Life. This paper was discussed yesterday, and I recommend it highly. If you think that improvements are needed in your organization, this paper describes an excellent approach. The key is very simple; if you are not prepared to make fundamental changes, you are not going to improve anything significantly.

If we now look at changes, I think we can summarize what has usually happened in the past as follows:

- Most of the time it is competitiveness, productivity, better quality and service, that have been the major considerations. These are all very legitimate issues, but I am convinced that other pressures for change are emerging.

- In general, changes have not been sufficiently fundamental to result in significant improvements. This is the primary reason why the office technology dream did not materialize. The solution is given in the paper by Michael Hammer, noted earlier.

- To a large extent, changes have been implemented in reaction to pressures, after the situation had clearly deteriorated. Doesn't that indicate that we have a tendency not to ask ourselves whether we could do better when things appear to be going well? This attitute will have to change. We will have to be more critical in the future, and learn to be more proactive.

Let's look into the future - at the emerging "people driven" pressures for change.

Let's look at skills first. We all know that the workforce of the future - and I mean those kids who are still in primary school or maybe still in diapers. When they enter the workforce in 20 years or so, they will have more advanced skills, especially in terms of computer literacy. We also know that the attitudes of youngsters toward authority and control has significantly changed, and these changes are likely to continue. They expect to be given opportunities to have more interesting, more challenging work after two or three years of experience, not having to wait five or ten years. We can also anticipate that people will want significant changes in management styles and much more participation in the decision making process. If your organization doesn't meet these expectations, another one will, and you will lose your best employees.

At this point I would like to go back to the subject of skills from a different perspective. We have blamed the educational system for not being able to cope with technology revolution. We have blamed governments for not providing adequate funds for the educational system. But, education should not stop at graduation.

From what I read and hear, it seems that you have the same problem in the United States as we have in Canada. Apparently, we (collectively) spend half as much on training, on an employee per year basis, as our Japanese and German counterparts. If that is the case, I know of no better way to plan for decreasing competitiveness in the future. We are digging our own graves.

I find the subject of training courses to be especially interesting. One, two and three day courses are given, where the instructor zooms through the material in Olympic record time. An employee is sent to the course and comes back absolutely submerged

in material. The employee is unavailable for the duration of the course and has learned little. This approach is inefficient and expensive. We should train our employees in the art of training themselves. That works.

So much on skills and training. Let's return to people's expectations, again with the persepective of the workforce of the future. We know that people are exposed to concerns and issues at a very young age, on TV, and in the classrooms. In my opinion, this has already had, and will continue to have, a significant impact on values, in particular with regard to the quality of life.

I was very interested to listen yesterday to an exchange of views on the subject of commuters. Somebody asked, "Are you going to have 8,000 people in that building in 10 years?" The answer was: "Well, you just tell them they better get there and this is it. You are in control." Well, that example shows you that you are not. If that is what you really think, you have a problem. Here is an example of that issue.

The regional office of the Department of Communications in downtown Toronto had a major turnover problem. People living in the suburbs preferred to work for suburban companies, and save the money, have less stress, and save the time required for commuting to downtown Toronto.

Even if the public service is often accused of being too conservative, Dave Lyon, the Regional Executive Director, decided that the only way to solve the problem was to establish suburban satellite offices, where employees would be allowed to relocate on request, regardless of whether his or her manager would relocate to the same regional office. He also decided not to modify the organizational structure; in particular, no local satellite office managers would be appointed.

Obviously, additional equipment would need to be deployed, using the most advanced available office technologies. Although some people were skeptical at the outset, the general response has been very enthusiastic. The first satellite office is scheduled to open in the fall of 1992, and one or two others will follow. When the process is complete, less than half the staff will remain in the central office in Toronto.

I would now like to turn to another subject, "the information society;" first from the technical point of view.

Office workers have powerful machines at their desks, linked to other machinery and mass storage through local area networks, wide area networks, etc. There are at least three places I know of where companies are experimenting with 2.5 gigabits per second fiber links. This means that the 10,000 pages contained on the CD mentioned earlier in the meeting, could one day be transmitted in a matter of a few seconds.

We have absolutely phenomenal technologies that will bring huge amounts of data to our fingertips, but isn't there a difference between data and information? It is already bad enough to have to search for a few paragraphs of meaningful information scattered through fifty pages of data. What if the same information is scattered through 10,000 pages of data?

Are we really talking about an information worker, an information society, or about a data submerged office worker, a data submerged society? As far as I am concerned, if we do not make significant progress in information retrieval systems, we are going to have serious problems. And the advent of superb multi-media systems is not the answer

to the "data vs information" question. Useless data is useless data, no matter how beautifully it is displayed! Furthermore, the hardware will cost a lot more.

Now, before I talk about management, my last topic, I would like to make a comment about office design, a subject that has not been very well covered during this workshop. I suggest that we do not go overboard. Let's face it, if I have to choose between an undesirable boss and an undesirable office, I will take the undesirable office (although I like nice offices).

Concerning management, we still have a long way to go. We still have a lot of management by control. We have heard about management by objectives, by tasks, by actions, by delegation, and by negotiation. But we know that there is still a great deal of crisis management around.

I was recently invited to comment on a questionnaire to evaluate managers on the specific point of human resource management, by the consultants who had prepared the questionnaire. I discovered to my amazement that the word 'motivation' had not been mentioned once, and there were more than 40 questions on the form.

As far as I am concerned, management is a service. You have to make difficult decisions and establish control once in a while, but it is essentially a service. Your staff does not work for you. You work with them, and your prime responsibility is to generate a climate in which the natural motivation of your staff will flourish. Motivation combined with excellence is the answer. That, we can do today; we don't have to wait for the year 2000.

**MR. CYROS:** Our next topic is a forecast of information technology developments and possible impacts on workstation design by Amy Wohl, President of Wohl Associates - a consulting firm specializing in office information systems, personal computing and end user computing. Mrs. Wohl is editor and publisher of the monthly newsletter Trends Letter. She is also a frequent contributor to the trade and general business press on office automation, personal computing, computer literacy, and technology. She serves on the program committees of COMDEX, PC Expo, UNIX Solutions, and the Windows Conference. Mrs. Wohl was a member of the National Academy of Sciences panel on the effect of technology on employment.

## A FORECAST OF INFORMATION TECHNOLOGY DEVELOPMENTS AND POSSIBLE IMPACTS ON WORKSTATION DESIGN

**MS. WOHL:** It is a little strange being the last speaker at this kind of conference. I have enjoyed enormously listening to everyone talk, and wanted to jump up and down occasionally and either agree profoundly or disagree immediately with what someone was saying. I hope that I will remember some of those things as I go along and have enough time to mention them to you.

The first thing that I need to mention is that in my paper (NISTIR 4801) I talked about 10 trends, but there are actually 12 in the matrix. As I was working on it, I decided to add two more, but I forgot to correct the number in the text.

So as not to keep you guessing, I should pass on to you the reference that Duncan Sutherland made to the good old days when he and I were inventing office automation in the late 1970s and early 1980s and tell you that I am the author of the infamous remark that the paperless office is as useful as the paperless bathroom. It is a remark that I think holds up remarkably well.

On the other hand, take heart. We are starting to have a lot less paper around in some offices. I do not think it will ever vanish entirely but I think we are making some improvements.

Now, the first trend that I wanted to talk to you about today is one that you could have read about in the New York Times about a month ago. People like me take heart when on the front section of the business page of the New York Times they try to explain to a general business audience something like ubiquitous computing because they think this is mainstream stuff.

This is something that Xerox is working on at their Palo Alto Research Center, which is where Xerox tries to reinvent the future, but never manages to successfully commercialize it. Those of you who have watched Xerox from Washington may have participated in some of their earlier experiments. The White House and the National Institutes of Science and Technology back in the NBS days participated in the Xerox Alpha Bravo workstation days.

In any case, ubiquitous computing has as its idea that we will eventually - and eventually means today for some workers at Xerox Park, but for others of us, in the decade to come - we will work in offices where the information devices we carry around with us will be light and portable so that we always have them with us. They will be varied in size and suited to the task at hand, and will speak to one another and to the home stations where we keep the rest of our information, which is constantly updated.

For instance, if I meet you in the hall and schedule a meeting, I jot it down on the hand-held, pen-based computer that I can carry in my hand, and I write down on the schedule, meeting Melissa (Allen) from 10:00 to 11:00 on Tuesday morning. It will go back, using whatever wireless communication system we use in my office, to the home based system, check to make sure that this does not create a conflict on my system, and probably on your system, too, Melissa, and schedule a meeting. Then if I try to schedule another meeting at the same time later on, it will say no, you can't do that. You have already scheduled something then.

The idea is to create an environment in which you can rely upon the computer system to do all the things computers do well, keeping track of status, turning data into information, connecting you to information resources.

Computers don't think. They just keep track of things for you and help you find things. You have to figure out how to use them for the things they do well and ignore them the rest of the time. That is something we have not learned to do very well yet.

For each topic I cover this morning, I am going to talk about the technology enablers that let me do these things, and then some design implications in terms of how they are likely to change the way an office looks and works, and then some applications.

In the case of ubiquitous computing, some technology enablers deal with miniaturization. Things are getting smaller, so we can build very small devices. You will be able to buy a device before the 1990's are over, that lets you, when on the road, have a credit card sized object in your pocket to communicate with your secretary. You will be able to write a note on it, and it will automatically be an electronic mail message by telephone, cellular modem or whatever back to your office. It will probably vibrate a little bit, or beep if you prefer, to let you know it has a message coming in. All through miniaturization.

Pen interfaces allow us to work in a much more natural mode. Only about 25 percent of the people in offices use computers today. This is primarily because we have not been able to convince people that using keyboards is a natural act.

Even though we have sold 60 million computers, many are sold to people who already have computers. When we go to a pen-based interface, then a lot more people are likely to use computers.

Now, please understand that using a pen-based computer today does not mean, contrary to what you read in the papers, that the computer will understand cursive handwriting or even printing. A few of them will understand printing. None of them understand connected handwriting.

What they will do is understand gestures. You can have a book in front of you with a form on it, and you can check things off on the form, and it will select them for you. You can write something on the page, and select from a tab or a menu where you would like that stored in your computer. So, it becomes - we call it ink - a new form of data. It is essentially a graphic information object which you want stored. When we get better at recognition, you will probably print the name of the thing you would like it stored under, gesture to say this is title, maybe underline it, and it will store it under that recognized object.

So, we are getting at a new form of technology enabler. There are dozens of people working on pen-based computing. None of the products that we are talking about now are very real. In 1992, there will probably be about two dozen real products in the marketplace. They are all in the process of being made real right now, this minute.

One thing that makes ubiquitous computing real is voice recognition. Several speakers yesterday talked about voice recognition. What we have today is not the kind of voice recognition like my talking to you. We have discrete word, voice, recognition, and we have it for a trained system; that is, the system has to be trained to your voice. Or you

have to use a very small vocabulary of a few hundred words, a tradeoff. Or you need a giant machine that costs millions of dollars and would not fit on your desk, or you can't do it in real time. You pick which one you prefer.

Most of us prefer a speaker trained system that understands a lot of words and does not cost much. You can already buy things for less than $1,000 that do that, and which allow you, for instance, to command a personal computer package. One product available today does that already. When you combine that with ubiquitous computing, it means that you can talk to your system and make certain things happen. It does not understand what you are saying. That is natural language voice processing. That will not happen until probably well into the 21st century, somewhere around 2010, 2015, 2020. We are not at that level of natural language processing yet.

Of course, we need wireless connectivity to hook all this stuff up. What will happen then? We will have very small portable workstations in all kinds of designs. Do not assume that everything that you are going to see will look like today's portable computer: seven pounds with a keyboard on the front end and a clam shell design with a screen hanging off at the top. Lots of these are going to look very different than that.

If you are a lineman working for a telephone company or a Coast Guard fellow working on a ship, what you may want is something that can hang on your belt. If you are traveling on an airplane and want a little message pad to write back to your office, you may want something credit card size that slips in your pocket. So, there may be all kinds of portable devices that are enabled by miniaturization that look very different.

If you use any kind of portable device, you are going to need to be able to exchange information with your home-based system. That is what docking is all about.

And you are going to need to be able to be a guest docker when you are not in your office for any extended time. What if you go to a meeting for the day, like we are today? What if this meeting were in your office building? Wouldn't you like to be able to receive your electronic mail and get at your database for the conference, rather than having to take all your data with you for that meeting? You need guest docking to do that. So, we have to figure out how to deliver those services.

All of these will generally allow us to have better access to information and facilitate group decision making and communications.

I was interested to see that Gilbert (DeCouvreur) mentioned one of my favorite topics. As we get these super high transmission speeds and wider bandwidths, we won't have to store everything at our workstation or in the office building. You do not necessarily need 200,000 square feet of filing cabinets or the equivalent of optical disk storage or the additions for multimedia. You are absolutely right. We are going to store a lot more when we start using multimedia, because with a super high bandwidth you can store it someplace else. You get cable TV, don't you? You have all those movie pictures coming down the line. Do you keep them in your house, or do they come down in a cable? Do you watch them and then let them go back and be stored in the cable TV?

When we deliver by fiber optic cable into each city grid and further, into each major building in the city, you will then be able to determine how far out you want to carry that fiber optic delivery system within your office. If you choose to carry it all the way to the workstation, you will be able to deliver at such high speeds that you can

determine where you want to store things because you will be able to deliver large amounts of data at such high speeds that where you keep things will be a matter of convenience, not the speed at which something is delivered.

One trend that has suddenly heated up is something which for old office automation people is highly reminiscent. We listen as the personal computer industry discovers groupware and collaborative computing, and recognize that this is office automation reinvented. What we are really talking about is supporting the activities of people working together in groups.

But it did not happen in the late 1970's and early 1980's, and we talked about it last time. It is happening now. Why? Because we have new technology enablers.

The first technology enabler is that workstations now are much cheaper, secondly, so much more is already connected. The last time around, we had to ask everybody to install electronic mail. Today we go into offices where people are already almost fully penetrated with personal computers and almost fully connected, and suggest adding applications to the investment already made. The incremental cost of doing that is very small, so we can get them to try lots of additional things.

Some of the design implications from this are you need to think about having a totally new interface on top of the workstation, because if multiple users share a workspace - now we are not talking about the physical workspace, but the virtual workspace, the information space, if you will - they have to have ways of understanding what is it that they are working on together.

If five of us are working on a contract together, how are we going to know which part of that work is yours and which part is mine? How are we going to negotiate the changes? Will we do that with color? Will we do that with different parts of the screen? What is the most useful way of using the user interface to help us do that? By the way, we will need bigger screens to sort out all these different kinds of information we are going to want to simultaneously keep around while working our way through that decision process.

If we are going to use technology to allow us to distribute workers over larger geographies and let people work at home or in distributed offices part of the time rather than bringing them all into expensive central buildings and deal with the transportation issues of getting them to those buildings, then they need equipment that facilitates working in groups electronically. Collaborative computing is one of the places where that comes together. So, they need large enough screens and the right software and interfaces to let them do that.

Obviously, those screens have to be colored because color is one thing that helps you differentiate different kinds of and different people's work in that environment. Some of the applications of things like multi-authored documents, group decision making and real time conferencing enable many people to meet and work together as if they were all in one place.

Downsizing is already a trend. It is going to continue and get a lot sharper before it starts to damp down. I was tempted to omit this from my list because I feel that by the time we get to the year 2000, the pendulum may have started to swing the other way. That is, this may be a trend that gets less interesting over time. However, you are going to be dealing with it during the planning phases, and so I felt that you needed to know about it.

People are taking applications that yesterday, as new applications, would have gone on mainframe computers, and are putting them onto personal computers and local area network service. So, there is much more emphasis on placing applications on an appropriately sized system, and the appropriately sized systems have changed considerably.

Why do we do that? Pure economics. Why can we do that? Because the power of the microprocessor is enormously higher now than it was 10 years ago. You are facing different sets of economies and technology enablers. You pay your money and you take your choice, but by the way, it could be one one-hundredth of the cost to do an application in this environment than it can be to do that same application in the new mainframe environment. It is very persuasive when you look at the numbers.

One of the areas that strongly influences what a workspace will look like is the new interfaces which are going to come along because you will have to design the workspace to accommodate the interfaces you are going to use.

For instance, think about the noise pollution if everyone uses a voice interface. You might have to give people directional microphones or use acoustical buffering or something. The first time I ever used a voice input device at UFP, I forgot and answered the phone, and the computer went crazy trying to parse my phone answering. So, you have to figure out how you are going to handle all those things.

We already have the mouse interface. If you are going to continue to use mice, you need more real estate next to your desk. You have to roll it around in a space.

We are moving quickly to devices which use fixed real estate as part of the computer keyboard so that you do not need as much space to point. The pen device works on top of the screen, and when combined with new flat display technology, it is going to cause a reduction in the amount of space you need.

A lot of the new interfaces use gestures. You can point at the screen and tell the system essentially what you want by the kind of gesture you make. It is often combined with pen. So, for instance, two movements might mean I want the next page. A movement in the upper right-hand corner might mean quickly page through these pages and stop when I stop doing this. A tap might mean go to that tab that I just tapped on, little tabs like you would find in a reference binder.

There are also various body movement tracking systems in use now, particularly in the virtual reality field, to check your body position, or to give you things, depending on where you are looking in the room. For instance, if my glance went to one part of the room, the computer might track it and since the calendar is located in that direction, bring the calendar up to the screen. So, it might know certain things. Or maybe it will track the fact that when you sit down in your chair, you weigh an extra pound today and need to plan for your exercise program.

I am just going to mention multimedia. You can read about this in the press. We are starting to accommodate multimedia already in workstations. By the year 2000, it will be a given. You will have multimedia on literally every workstation you install. That means you have to allow for much more bandwidth and color in every workstation.

We are going to have new operating systems delivered by the year 2000. We won't be working in the operating system environment we use today at all. DOS will have gone away by then. This means that we will work in a much more powerful environment, and that you will have new interfaces and new applications.

Together with new operating systems, we are going to move to object orientation. That means that each thing that appears on the computer screen has knowledge about itself encapsulated inside it. So, if you have a document and ask to open it, you won't have to first open a computer program that knows how to work with that document. By opening the document you will call forth all the computer programs associated with that document and all the information required to work with it. It is all there in one place.

The enabling technologies for this are obviously the same three that we keep talking about all along: faster processors, cheaper memory and new software technology. That is a theme song that I will return to over and over again, that enables a whole new class of applications.

By the time we enter the 1995 time frame, we will be looking at whole new classes of software for you to play with. Some will come about because of a new software building software called CASE which makes it easier and faster to build software. It also creates a discipline where we can reuse some software, so that the next generation can be on your desks even faster.

After Don Avendon's fine presentation on imaging, there is not much left for me to say except that I expect this to happen a little faster than he does, but maybe I am overly optimistic. We see so much of it used in such interesting places that we keep thinking someone will take advantage of it.

I am writing a booklet on business re-engineering now. This is often an application that occurs together with a business re-engineering process. That is, people often use the imaging application, together with business re-engineering, to make a substantial difference in how their organization works. You see such big paybacks on some imaging projects because they are really combinations of imaging technology and business re-engineering processes. It is not one thing that is going on, it is two different things.

I want to mention thin screen color because thin screen color is the enabler that will let you build flat displays. Instead of needing a big, thick box for a display, you can have a thin, elegant object that you can hang on the wall, like a picture, lay on top of the desk as a blotter, make any size or shape that you want, or carry it around with you. That is going to completely change your notion of what a computer looks like.

**MR. CYROS**: We will now go into our open discussion. We spoke about facilities management as end user experiences. Then we talked about what will the office of the future be like, new information technologies, human resource issues and the office of the future, a forecast of information technology developments and possible impacts on workstation design.

# OPEN DISCUSSION

MR. BLOOMQUIST: *I am going to build this question on the DOT document we received, about hiring creative individuals. It also relates to something said earlier - the goals of the facilities which we heard about this morning.*

*In the publication by Art Rubin entitled "Intelligent Building Technology in Japan," there were generic goals of facilities and generic benefits expected from facilities. The top three were morale, creativity and productivity.*

*Now, I can see those being generic goals of facilities if we have tools to assess how well we achieve those goals in a facility. I can see the post-occupancy evaluation being used to address the goal of increasing morale.*

*As to the productivity goal, I can see in the work of Jones and DeMarco (mentioned in my paper (NISTIR 4801) used in the function point metrics and the software arena and the reference to McCue we had earlier, about how that type of metric could be used to assess our goal of increasing productivity.*

*I don't see any way of assessing how we could increase creativity. So, that is the question I would like to have Gilbert (DeCouvreur)and Duncan (Sutherland) talk about a little bit.*

DR. DeCOUVREUR: *Forget the word "facility" as commonly used. Facility can be your living room, your bathtub. Some people are just great. They read in the bathtub and they think. Why not?*

MR. SUTHERLAND: *Ben Franklin did it.*

DR. DeCOUVREUR: *There is nothing wrong with that as long as the person is happy and does good work, he is productive, creative, whatever you want from this chap.*

*I have one fellow where I work. He is a really funny character, a genius of a programmer. He has a swivel chair and almost lies down when working. He has both feet on his desk, his keyboard on his lap, and he is in swimming trunks very often because he doesn't like to wear other clothing. But he is fantastic. I would hate to lose him.*

MR. BLOOMQUIST: *I'm not arguing about that. I am wondering about the kind of tools we can use to assess the success in achieving those goals.*

MR. SUTHERLAND: *The problem is the same one we ran into earlier in office automation. There are some things that depend upon judgment. It is meaningless to try and create metrics because, 1) you are never going to be able to do it to anybody's satisfaction, and 2), some things just remain judgmental.*

*I would use performance evaluation as an example. You are a knowledge worker in the purest sense of the word, and at the end of the day if I were measuring your work, I would judge you on things that are not often tangible. I could count the number of research reports you write and the number of speeches you give and this kind of thing, but it is still a judgment call.*

*We are now at the point where we look at each new employee as being a two-computer employee; that is, we have to have a mirror image of technology in the home of what is in the office. Well, we don't have a lot of money.*

*It forces us to make other judgments and tradeoffs because I cannot build a cost model that tells me that is the right thing to do. I feel it. It is a gut feeling, because if I do not give them a mirror image of their work setup, they won't be as productive at home as they are in the office. Now, Amy Wohl has told me I don't have to buy all the big stuff I'm buying now. That is great. In fact, that is purely a judgment call that I make as an executive of the company. And I am not investing in other things.*

*I am not trying to beg the question, but at some point we get too hung up on the metric and forget that the responsibility of management is to make these kinds of judgments. Sometimes they will be right, and sometimes wrong. If you are right more often than not, then hopefully the company will succeed. But in some areas we are going to have to "bite the bullet."*

*Remember, Amy, the productivity measurement work in old days? Everybody wanted to do cost justification and they resulted in convoluted equations.*

DR. TORAN: *We should not leave the subject of creativity - I will compare it with something where one produces something, a factory, a studio, an artist, a computer programmer creating a new program. Creativity is another environment we are talking about here. Of course, we all have to be creative.*

*But here we are talking about upper management of some kind, somebody who will be running something. There will be transportation. There will be many different technical levels. Those people can sit at bus stops and, if you suggest a sauna where seven of them will come and sit in the bathtub and it will help, then I can accept it. But we are talking about an exchange of information and so on.*

MR. CYROS: *I believe that the idea of providing a creative office space per se, is an erroneous concept. I can give you the finest office in the world, and with the rotten boss that Gilbert talked about, you will not be creative in the bathtub, or anywhere else.*

DR. TORAN: *I am not against creativity. But, we are talking about the creativity in a managerial environment where people get together, which is different from the creativity of an artist or a factory worker.*

MS. WOHL: *Two things. First, Duncan (Sutherland), there is some research that says if you give employees computers to take home, they will on average, work one hour more a day than without them. So, it can be justified to do that.*

*But perhaps more important to the point of Lee's question, when we get into a question about facilities with a client, we usually try to look at issues that deal with the auditable financial things that fall out from the quality of the workspace. In other words, can you see differences in terms of the well-being of the organization, reflecting changes in the facilities? Do you have changes in the turnover rate? Do you have changes in the recruiting rate? Do you have changes in absentee rates attributable to the move to the facility, all other things being equal? If you can see that, you may assign them to the facility because that is a reasonable thing to do. We look for that sort of information to use with clients.*

DR. DeCOUVREUR: *I would like to add a comment about trying to create an environment that leads to creativity. When I was a student in the United States 30 years ago, I had the privilege of visiting what used to be called in the past, "Radiation Laboratory 19." I have never, never, seen such a dreadful place - small wooden tables, soldering irons everywhere, equipment piled up, sardine cans. The amount of gorgeous work that was coming out was absolutely amazing. The people were excellent and motivated.*

*Now, maybe they would have liked to have a nice office also, but that would be "gravy." I don't think that making the office fantastic will resolve the other fundamental problems.*

DR. HEDGE: *I want to pursue this issue of creativity, when we are talking about a cognitive process that results in a unique outcome, and the crucial feature of creative work is information. That is what all researchers use. The crucial thing about that information is the convenience of getting it, whether from another person, from a mass storage facility like a library, doing some testing on a computer, or whatever.*

*If you want to facilitate creativity and creative work, you have to identify the key tools needed, and then determine how to supply them to that individual, wherever he/she is, because creative ideas do not come in fixed time frames or fixed places.*

*When we reach the point where each of us who wants to do creative work can carry a simple tool that allows us to access any information database, do any processing or whatever, then we will be more creative.*

*Now, in terms of facilities, I don't believe we can dramatically influence creativity one way or another, apart from their effect on human interaction patterns. If your creative work requires interaction with others, rather than just with technology and static information, then the facility could have a major impact. If not, you can put somebody in a dreadful lab.*

*The Rutherford Lab at Cambridge had six Nobel Prize winners in a room with 16 people in a very small space, in a shed, literally, at the bottom of a garden. You do not need great facilities for great ideas, but you do need access to information.*

MR. CYROS: *Being from an institution strongly oriented toward science and engineering, with countless computers, let us not forget the human being. I like to think of my creativity and that of my staff as having nothing to do with connectivity and coming out of computers. Rather, it is built on the basis of experience and the concepts we formulate as humans. So, let's also think about that human mind.*

*That goes back to Gilbert (DeCouvreur). I need tranquility, the opportunity to think, and whether in a bathtub, gazing at a blank wall, or through bars on my cell - it really does not matter - because I am an individual. But you as a manager have the responsibility for having that style of management to allow me to think. I say the office comes second.*

MR. SUTHERLAND: *Kreon, not only allow you to think, but provide the tools to help you think. Your point is well taken. I would guess a lot of the scientists at MIT do not do their best thinking in the office.*

*The problem we run into is this 8:00 AM to 5:00 PM mentality that we have. It is forcing us to try and create environments in buildings to replicate something that already exists in the natural world and which we use. Why are we doing that? It is stupid.*

*If I were Ben Franklin, I would go to my bathtub. I would not try to put the bathtub in the office. That is nonsense. But, because we have the self-imposed constraint of having to be in this building for these hours and are not allowed to work somewhere else, because we are not really working if we are somewhere else, because I cannot see you - we create this incredible complexity we do not need. It is never as successful as the natural world.*

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MS. OVERLIN: *If we are thinking about years after 2000 and about 8,000 government workers, as an example, do you imagine that in the future workforce everybody will have to be creative or will some people still do repetitive, non-creative work?*

MR. CYROS: *A short answer by every panelist in the room please.*

DR. TORAN: *Not everybody will be equally creative, needing the same kind of tools to produce equal results.*

MR. DUBY: *We are starting to implement total quality management at GAO. I do not see how you can have any process that does not involve creativity. We deal with continuous improvement, and you want input from everyone to contribute ideas in that process.*

MR. SUTHERLAND: *I would echo what Alan (Hedge) said earlier. Creativity is what we describe as a result of something we don't understand very well. Everybody is creative to some extent - it is just a matter of the level. You have to provide an environment that supports creativity when and where it is needed. I do not know of any job in any organization that doesn't require some creativity to deal with issues that arise. I think that is the bottom line.*

*I take great offense at the distinction about knowledge workers and non-knowledge workers. Everyone is a knowledge worker because that is the nature of the beast. We live, breathe, think knowledge. We are knowledge machines, if you want to use a mixed metaphor.*

MR. AVEDON: *We will have both kinds of people, but all will be creative, some more, some less. Some will be held accountable for being creative and others will not.*

DR. DeCOUVREUR: *I agree. The level of creativity will vary extensively, but that is not the fundamental question. Whether a person needs be very creative every time or sometimes, you need to provide the right environment to enable a person to be happy at what he does, and be motivated and productive.*

MS. WOHL: *As we get out into that time frame, there will be less need for repetitive work and more emphasis on training people at every level to do creative work. We are going to have to provide more education to get people, even with more limited skills and educability, to be more creative.*

DR. HEDGE: *I think you need to think of a basic organizational dimension that goes from conformity through to creativity. By definition, highly creative people can be highly disruptive. They are not the sort of people that will conform to 9:00 to 5:00 types of work or particular routines. You have to recognize that individuals vary enormously in their abilities. Unless your organization is like a university, and can cope with the idiosyncracies that we all have, you will not see creativity flourishing. It may or may not be necessary in government. Government may prefer conformity.*

DR. WILLIAMS: *One thing we should be aware of is that some of us are using the word "creative," when we mean participative. I agree with the statements made about being careful how we categorize these various things because all of us can participate by making suggestions and that sort of thing. That does not mean being creative in the sense of the Nobel laureates that you are talking about.*

MR. BLOOMQUIST: *There is a reference in our paper (NISTIR 4801) to the Office of Technology Assessment, which projects trends regarding repetitive work versus what is called knowledge work. Stephen Roach's article defines creativity from an economic sense. Re-engineering. The question is where you want to allocate re-engineering in the hierarchy. It may require all of us to become creative about our own processes.*

MR. HOOKER: *Everybody in an organization needs to be creative, but the individuals we are talking about - the ones making the strong advancements - we could call free thinkers. Free thinkers tend to be rebellious and probably need a boss like Gilbert. He would provide the opportunity to be a free thinker.*

MR. GRAHAM: *Without using the word "creative" but rather the term "knowledge worker" and the "repetitive worker," I find a blending of functions going on. I work out of my home and do many things that ordinarily a repetitive person would do, because the computer and its techniques allow me to do more of them.*

MS. LOFTNESS: *I also think that each individual will do a mix of creative and repetitive work, but I believe you need better environmental quality for repetitive work than for creative work.*

MR. VALENTINE: *I get concerned about the possibility that all people will want to be knowledge workers. Based on our economy, in the final analysis, somebody has to produce something. We have to grow vegetables and build houses. A balance is needed. It is nice to have all these knowledge workers, but somebody has to produce something or we don't have an economy.*

(Whereupon, at 11:45 p.m., the conference was recessed, to reconvene at 1:40 p.m.

QUESTIONS TO THE PANEL

MR. CYROS: *Having received instructions from DOT, we are ready to proceed. The format this afternoon will be to respond to four several thought-provoking questions. They are looking for your opinions, your concepts, your ideas.*

*Question number 1. Remembering that you are taxpayers and you will be paying for this building, how much of the "advanced technologies" and "innovative space" options should be specified for the competing architects; how do you pay for it; how do you sell these?*

MS. WOHL: *If you use advanced technology wisely, the use of advanced technology will allow you to do enough miniaturization and distribution of people that the space needed will be reduced, and you will be able to pay for the bill by those reductions.*

MR. CYROS: *Interesting. How do you measure those reductions.*

MS. WOHL: *They will be in real dollars.*

DR. HEDGE: *What do you mean by advanced technology? Are you talking about engineering systems in buildings or computer technology that comes in and out of the building?*

MS. ALLEN: *Both.*

DR. HEDGE: *Do they all come out of the same budget of DOT?*

MS. ALLEN: *The computer on the desk will not come out of this budget, but the wiring, including fiber optic, will be part of the budget.*

DR. HEDGE: *I do not think you need tremendously advanced technology to create good environments for people to work in from an environmental standpoint. You may want to focus much more on the work content.*

MR. ROSENHECK: *I would like to address the wiring issue - fiber, cable and coaxial cable. You must be able to put in a wire cable system to facilitate not only the new systems that are planned, but also the worst case; that is the real problem. How much of that will be there in eight years? For example, we no longer put coax in for terminals. We learned how to move it to twisted pair.*

*You must decide on your backbone system. You must install that at least when moving, and ensure you don't preclude the next generation of technology.*

*You must then determine what you can afford. A major decision is needed: once you have decided about your closets, how far do you wire out to the workstation, depending upon the kind of workstations you will have? So, there are major questions now as to how much electronics is put in for the building and how much for the user.*

MS. LOFTNESS: *The question is somewhat of an oxymoron; you want technology innovation and competing architects in terms of reducing costs. The key factor is to avoid competing architects. That is likely to be the big cost item, not the technology or innovative space options.*

*I believe that architects cannot manage the breadth of knowledge required for the modern office. There are important roles for architects in the design process - critical issues. But to use architects to explore and resolve cost in relation to technology and innovative space options may result in elegant images and fun ideas, but not a building that will maintain costs, while responding to those critical issues.*

DOT VOICE: *There may be a misunderstanding of the question. It is intended to address the issue of how much would you recommend - technology and the space options, that we would package, and give to architects in a design competition. We are going to run a competition next spring. How much technical detail about the systems and space planning options should we give to the architects in that competition? We were not suggesting we would let them solve the problem for us.*

MR. CYROS: *How much of the advanced technologies and innovative space options should we build into our specifications that are given to the competing architects?*

VOICE: *In a design competition.*

MR. HOOKER: *I like the question. As a taxpayer from Michigan, I demand that you provide your architect with the innovative concepts we have been talking about in terms of space planning. You, as a government organization, must become more efficient and more responsive to people's needs. When you do that, you are not going to build in the old way. You will have an innovative building.*

*On the other hand, as a taxpayer I am concerned about some of the technological advancements described - that somehow this building will be the "first on the block" with new hardware and equipment. I am also concerned about a building of this size using new and untested hardware. I advise you to use tested hardware and perhaps untested, innovative concepts and space planning.*

DR. WILLIAMS: *I would like to build on what Mike Hooker said. As a taxpayer, I agree with efficiency. But one thing is very important to me - and I think it answers the second part of your question - how do you sell it?*

*I would like to better understand your function in the government; why you do what you do? That should be the justification for the innovation you put into the building. Only if your constituency knows what you do will you be able to perform the job analysis needed to determine the specs for the internal parts of the building.*

DR. TORAN: *If I understood the question, what proportions of monies to put where and how to justify the fiber optics and so on, I would think you should aim for the least expensive looking building you can get through the art committees. Rather than putting money into the famous heavy facades, use the money for functional interiors, for good technology.*

MR. VALENTINE: *I will return to the issue of how to sell this. One problem we have in justifying facility planning is that for the most part, those responsible examine what we do in terms of cost, and not as an investment. It would be wise to try to get a buy-in from senior management as to the nature of the investment first. And as part of that process, it is important to describe how you intend to manage this investment over a long term period, to further substantiate the value. By separating the issues of cost from investment philosophically, you can get more buy-in.*

MR. BLOOMQUIST: *I would like to build on what Cecil Williams said on selling this building. Say we have projects requiring integration. We have to integrate fast trains between, say, Chicago and Detroit with some sort of hub airlines and there is some sort of hydrocarbon payoff. Projects can be estimated in terms of value to the country.*

*We do not as yet have tools that can account for how projects perform in terms of those financial goals, but in my paper, Stephen Roach refers to a need for something beyond activity based accounting, which in the future might be applicable.*

*Now, Melissa (Allen) said yesterday that no matter what plans are put in place, they will be changed by the management occupying the space. This makes me think that again the process of management practice - the allocation of space, appropriation and furnishings - will be negotiated among organizational units.*

*You should budget for developing tools, practices, training, or something, that enables business managers to negotiate skillfully with each other, treating facilities, the advanced information technology, etc., as tools in managing their operations. Those practices today are largely acquired by art and craft. Try to put some sense of science or technology in that negotiation process.*

*Finally, you justify the initial building against projects which I suspect are enormous in scope. You supply with the building a process and tools of negotiation and an accounting methodology and budget for that. I think you could develop them within nine years.*

MS. LOFTNESS: *Let me return to the competition. It worries me because I think the competition glorifies an old process, which is that architects have all the good ideas. They are very spatially and visually oriented, and then they accommodate the technologies. You can tell the architects what to do, but it is not inherent in the development process.*

*I think you should design a loose-fit building. It accommodates the best of technology, but does not install it. It is capable of accommodating fiber to the desk, but does not cover installation. It can accommodate the best innovative space concepts, but does not require that they be installed. It allows you to meet the challenge of the future.*

*To do that, you need design teams. If you have a competition, it must be conducted for design teams, not just architects. You may have five design teams, each one with a telecommunications specialist. We have not heard enough about the competitive process to know your intent.*

DOT VOICE: *We recognize that you are not going to select an architect just for his/her architectural abilities. The team will be evaluated, addressing all these other disciplines.*

MS. LOFTNESS: *I agree with Edward Toran in many respects. Much of the cost of buildings today is embedded in the enclosure and some major public spaces. It should be embedded as deeply in the service network as in those elements. It is a question of having a team that can develop a fuller understanding of the cost and user implications of various design and technology system alternatives so appropriate tradeoffs are made. I would hate to see the mechanical system thrown out at the last moment, or the number of elevators in the building reduced, because of budgetary limitations.*

There are some team issues there. If you want to manage cost, it is not by eliminating technology or space options. It is by incorporating them in the early conceptual design.

MS. DERIVAS: *I am participating in the Pentagon renovation effort. As part of this effort, we have senior level DOD people who are specialists in information management and technology. These people are defining the requirements. For example, for the fiber optic backbone we are going to have in our building they write the specifications so that information requirements are going to be driven by them, not the other way around. Speaking as a design person, you would get a white elephant if you didn't have the ADP issue and capacity and so on, addressed by a completely separate group.*

MS. WOHL: *I argue for the maximum amount of flexibility, and would demand that the architects design as much future flexibility into the building as they can accommodate, because technology is going to change rapidly, during design and construction, and after occupancy. If you do not allow for a lot of flexibility, it will be obsolete on the day you move in.*

MR. GRAHAM: *Getting back to how much technology to build in, flexibility is very important, but the most important resource you have in the building is people. The objective should not be to save money on automation or new technologies that may help people do their jobs better, but to deliver to the architectural teams as much of the logical and forward looking technologies you think will help your staff do their work.*

MR. HOOKER: *I want to return to the selling of this building. My budget typically, as the lighting designer for the project, will be the first one cut.*

*I sell my discipline to my customers through education. If you educate your people to understand the reasons for your decisions, you will sell it, because selling is education.*

*When you write specifications, write very tight ones. A loose specification works if with an honorable and knowledgeable contractor. If you give me a specification that asks for a lighting study, I could probably spend five years on it. On the other hand, I could also spend a couple of days on the same study. So, make sure you carefully define the deliverables expected and what you want them to design.*

MR. CYROS: *I think what you said, Michael (Hooker), is what you demanded of them as a taxpayer, they should be demanding of you as a potential participant, meaning you in general.*

MR. HOOKER: *Absolutely.*

DR. DeCOUVREUR: *I have the same comment as Amy Wohl. Go for flexibility. Even if you know the up-front cost will be higher. The last thing you want to do is put yourself in a situation of needing major refurbishing costs year after year.*

DR. HEDGE: *I think you should sell this as a "green" building. One thing that has not been discussed in this workshop is the large movement taking place worldwide, looking at ecological design where you use energy in a very effective way in a building; where you create a building that integrates the environment inside and outside in a very effective way.*

*I would look to what is happening in some European countries, pick up on that process, and jump on that environmental movement. You could be the first truly green building in Washington. Then you might get some additional support.*

DR. WILSON: *Further to what Vivian Loftness was saying, there is a precedent for this. I think that Art Rubin some time ago wrote up the TRW building (NISTIR 4801) in Cleveland where they began with the interior problems, which could be green interior, mechanical, and human factors - the human considerations - and hired the architect as a separate package with a very specific thing for the architect to do. In that way you had a prime designer involved in all the things you are primarily concerned with, to make this building work. But it was a good system and it worked in two different ways.*

MR. CYROS: *The second question is, "What would you recommend as the next step to be taken? Given that we propose to have a design competition next fall, what would you suggest that they, the competitors, respond to?"*

MS. WOHL: *The first thing needed in any project is a goal. You must have a vision of what you want the building to look like, not physically in terms of the architecture of the building, but what purpose it serves, how it is going to support the people who work in it, how it is going to be different than the environments that they work in now. Without a vision, nothing interesting is going to happen and you won't be able to write a good specification.*

MS. ALLEN: *How do you develop that vision? We have ideas.*

MS. WOHL: *Whenever we have worked with a client - I don't usually work on architectural projects, I usually work on technology projects - but whenever we have done that, we have sat down first with management, and then with workers, and the client in groups, and asked them to prioritize the goals of the organization, the impediments to carrying out those goals, and ways to remove the barriers. What is the environment that you would like to work in? What does it look like? How is it different from this environment?*

MR. GRAHAM: *To add to Amy Wohl's point, we have had a session for a day and a half, requested by DOT. One of the first things I would do is to examine the material obtained from this group, the questions and answers, and review them. Then, either scrap them because, "We know everything about this already," or take segments (or all) of them to define some parameters you will be looking for in this building. But I would first take, as a starting point, some of the material covered here.*

*You said that there have been organizational changes on a continuing basis. I would target the period of time that you need the most updated program, so you will be ready to give it to each architectural team. Without an up-to-date program, the architectural competition teams are going to be working in a virtual vacuum.*

DR. HEDGE: *Another dimension you should think about is defining what currently does not work very well. At the moment you have an organization spread among different buildings. There must be a reason for wanting to bring that organization together. Do you expect to have 11 organizations in this building that will not communicate? If so, you have to look within each of them to see what benefits each organization expects to get by bringing employees together. Does this offer opportunities for new patterns of working, for new transmission of information between those organizational units? What is it that is not working well? If everything is fine, why do you want to move? I would start by collecting some of that kind of information, in addition to what has been suggested.*

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MS. LOFTNESS: *I think identifying what is not working for you now is a very critical first step.*

*The next thing is something many people do in designing or selecting their homes - identify which houses, or parts of houses, they like. Visit some advanced and modern offices, not just on the North American continent - and identify what you feel is a good working environment and use that as a basis to establish this goal or vision.*

*I agree with Alan (Hedge) that the vision of a green building is a very interesting one. North America will have to move in this direction; maybe this is the right project for it.*

*The competition statement, which is obviously dear to your hearts, should make it clear that you expect the full team to respond, and not in a linear fashion. It has to be clearly stated what kind of expertise you expect on the design teams, and what kind of output you expect from them, to allow you to judge the competition.*

*Let me add one thing about flexibility - flexibility used to mean redundancy. You had a flexible ceiling. It had hundreds of light fixtures so furniture could be moved anywhere, and the light fixtures would remain in place. That is not flexibility today. Rather, flexibility has three components.*

*One is spatial forgiveness. Don't tight-fit your building.*

*Two is access. If you don't provide access, there is no flexibility. That is something that many older buildings do not have. It usually means you have lots of modular satellite closets and mechanical rooms that are distributed.*

*The third is modifiability, which gets to a plug-in/plug-out capability. That is more possible today than in the past. You have units of HVAC that can pull out if they fail, and be replaced with other units.*

*I think we have to define flexibility if that is one of the major goals. Otherwise, it will be misinterpreted.*

MR. BLOOMQUIST: *I want to continue to brainstorm and build on the concept I elaborated initially. In the design competition, you should issue a request for proposal (RFP) for a post-occupancy evaluation (POE) deliverable, that would assess all of the designs, using three approaches.*

*Let's assume a matrix environment where you have functional silos and the manager in one functional silo is developing capabilities. Across that at a right angle, is a project or product organization. Assuming that, there are three types of POE's. At some time you would administer these POE's.*

*First, there is the project oriented POE, at a large enough scale to makes sense- logically after every project important to Mr. Taxpayer. Then the functional managers should conduct a functional capability POE that relates how we use the building, negotiate for space and facilities, and define the tools and technologies to be used.*

*Thirdly, there should be a POE, to evaluate every major re-engineering effort.*

MR. HOOKER: *You are doing a great job. But it is time to start building your building. I understand these people have been working on a program for two years. You have programmed this thing to death.*

*Unfortunately this group of experts with all the ideas we have been talking about is not designing a building for you. We are just talking. Maybe the next time you assemble a group like this, there should be a real product useful to you - your building. You have done all the right things by spending the time on planning, and I am sure these people have written a good program. But I think it is time to get on.*

VOICE: *Michael, write your Congressman, would you please?*

MR. HOOKER: *I will.*

MS. ALLEN: *We are at the point where the two years of planning is not our idea. It is the taxpayers' idea, which is why I asked the taxpayers' question. There are $600 million that we are asking you as taxpayers to ante up for this building, and until you are willing to do that, all we can do is plan it.*

MR. HOOKER: *How much money are you spending on planning?*

MS. ALLEN: *Not that much.*

DOT VOICE: *You have to realize that at the end of 30 years, we are going to save the government $100 million.*

DOT VOICE: *I am not sure all these folks know we are in three buildings. Two are rented buildings, one of which rolled over on a lease a year ago. It went from $6 to $33 a square foot.*

MS. WOHL: *Wouldn't it have been cheaper to move?*

DOT VOICE: *There is no place to move.*

DR. DeCOUVREUR: *Come to Montreal. It is about $12 a square foot..*

DR. TORAN: *I have to admit sitting on this side, I am somewhat in the dark. I do not know the history of it. Obviously, if you have those programs and they worked, we would not need to discuss it in this fashion.*

*I agree with Michael Hooker that if the programs are clear enough - and I suffer a little because I feel that some of the advice we have given you is not good advice. If you are asking us what to specify and we are telling you to write tight specifications, we did not answer your question. You still do not know where the tightness should be. Perhaps it is time to do something, because I am not sure what more we can advise.*

VOICE: *Perhaps we are using the word "program" in a slightly different context. The program we have is a space program. It deals with a number of people in the building, their functions, and what space we anticipate they are going to require for occupancy. It does not deal with the technology of the building per se. That is the question we are trying to address to you by means of this seminar.*

DR. TORAN: *Perhaps you should have somebody dedicated to prepare a technological program.*

VOICE: *We are now in the process of doing that, and that is why we are trying to get your feedback.*

DR. TORAN: *The next step is to prepare a technological program, marry it with the space program, and turn it over to the architects.*

VOICE: *The most significant answer you have given is that you seem to feel, to a person, that the technology program ought to be highly specific, and I fully agree with that philosophy.*

MS. DERIVAS: *One of the things I wanted to propose as an option would be to hire an architectural firm to work as a client advocate for you, and then that architect would be precluded from bidding.*

DOT VOICE: *That's him (pointing). That is your consortium.*

MR. VALENTINE: *I think that accompanying that technology study, there should also be an economic study that helps describe those payoffs, life cycle costs, etc., all the things we are talking about. This can be used to document what Amy Wohl talks about, in terms understandable by people with limited building design background or experience.*

MR. GRAHAM: *It becomes a very interesting exercise to superimpose technology concepts on the space program so you can examine alternates. It is this gaming process. For example, if you use a given set of technologies, these are the space implications. Or, if you go use certain imaging systems to save paper, this is the effect. The total space required for the file cabinets and for some storage space will be different. With that kind of gaming, you may end up with five or six alternates. Superimpose the technology on your space program, which is the starting point given to your team.*

MR. CYROS: *I want to remind you about the question number two. What would you recommend as the next step to be taken? Given that we propose to have a design competition next fall, what would you suggest that the competitors respond to? Then if you will add this dimension, how specific should they be in those specifications?*

MR. DUBY: *You have three buildings that you are programming for over the next 10 years. Right? You said two were going to be renovated and one you wanted to build. Have you considered starting something now so you can test out design ideas? You can identify something you can do within your budget over the next three, four, five years?*

*The success that we are experiencing at GAO is based on two phases. The first was to build some smaller replicas of what the big division floor is going to be. One organization serves as "the guinea pig," and then apply the approach to the whole building during the next year. It is something you can do within your budget. It is a replacement building for some of the bad space you are probably in right now. Once you get some experience with the designs and systems tested, and learn what works, the other 10 organizations are likely to be supportive of your work.*

*I would start working on a project, hardware, software, building - now.*

MR. PRIMA: *One thing you are going to have to write - and I heard you asking how to set those goals - is the evaluation for analyzing the design competition. Everyone knows that, but that is one way to get started.*

*I love this idea about running a couple of tests. Do a couple options. Try a number of these things and see how they work.*

MR. DUBY: *Get people involved so it won't be a treadmill exercise. If you lose the appropriation window, you have another year to wait. In the meantime, you can get into it and really do some good things.*

MR. HOOKER: *I want to raise a question. We need to write very good, tight, technical specifications. We also need a technical program. We need a technical program for lighting, acoustics, and all the other disciplines.*

*How you are going to judge this competition? Each participant will go out and collect his experts, and you will have teams. You will have five architects competing. You will have five separate teams of experts, and maybe the person you want for telecommunications is on the team of an architect who does not know how to design facades the way you want. How are you going to judge that? You probably want to select team members from all the different groups because the best telecommunication person is not necessarily with the best architect. How do you solve that problem?*

MR. CYROS: *That problem is commonly solved in construction by separating out each team member, have them address their specific area of expertise. Submit it as a team, but keep the option of selecting different components for the competition.*

*I keep going back to the question. What are the next steps, and what do you suggest that the competitors respond to, how specific should you be? It works this way, if I may.*

*The most important thing is that this building is not driving DOT. DOT should be driving the building. As your facilities manager, I want to know the mission of your department and your agencies. I would like to hear about the work and management process you plan on using to meet that mission.*

*We have talked a lot about management process. We heard about people, people, process, process, and then place. But I have not heard a lot about people and management styles. We talked about creativity. What processes do you expect to have to meet that mission? You need that from each agency. That is where you, the negotiator, have to do some team building and negotiating, to get that into a single document.*

*I suggest that you go back to the same groups and determine how well the existing facilities meet the work process and the management process that we want. Out of that you will discover some good things. You will also discover some bad things. That is where you begin to build the specifications for a competition, to be able to say, "in order to meet the management process and the work process we want for our mission in DOT, here are the kinds of things we want." And you can be, in some cases, relatively specific. The more general you are, the greater the possibility for misinterpretation.*

*To sum up some earlier comments, you then need to know:*

*A. How do you judge the competition? You have to develop your own rules.*

*B. How well does it meet the criteria you offer?*

*It has to be in writing, because there will be some very unhappy competitors if you just say, "I like her design better his design."*

*Finally, if you can divide the competitive teams into the specific disciplines of team members, the technical side versus whatever other side, the heating, the ventilating, the lighting, it will give you the option to select the very best ones down the road.*

MR. ROSENHECK: *In every project I have been involved in where I had responsibility for the telecommunications and computing requirements, whether a network control center or the major data centers in a facility, I have never worked for the architect. I have always worked for the owner and acted as a buffer between all those people.*

*I have never worked on a project where I was not required to put down very early, at least the "straw man" requirements that dealt with the technology I was responsible for.*

*In my most recent project I came in late. They had already decided the size of the building, how many people would be in there and the HVAC requirements, in very gross terms. I asked about the location of the data center. They said, "Well, it is going to be in the basement like all other good data centers." I said, "Given that, what size will the computer be and where are your resource requirements?" I didn't see them, so we determined them. It turned out that we used all the HVAC capacity that they conceived they would need in the building. They finally decided not to put the data center in the building. Otherwise, they would have had to double the cost.*

*So, you must decide what you are going to have in the building, and have at least a "straw man" that defines your requirements and the technology you want to apply. Don't leave it for the architect. He probably does not even have a computer on his desk.*

MR. CYROS: *Tim White indicated workstations could be separate from building systems. Other speakers advocated integration. Please comment.*

MS. LOFTNESS: *There has been too long a separation in the design and development of environmental systems and workstations. I do not think they have to be meshed. If you try to mesh your electric and data cables with the workstation, some chaos results when you try to move a workstation or a panel or a partition. But they have to be modular. They have to deal with each other. They have to provide zones that are compatible.*

*The mechanical, electrical and data zones that you establish have to be tightly tied to your concept of workstation evolution and workstation size, not necessarily strapped to the furniture.*

MS. WOHL: *You have to make sure you understand the space requirements for all the strange things that nobody counts on. I have never forgotten the Mobile building in New York where they did not consider how much space cables require. They had to move the data center from the basement to the middle of the building. In that way they only had to run half the cables up and half the cables down, which is all that would fit through the middle of the building. You never want to do that. That is a decision that must be made before any "piece of iron" is put into place. They had to pay an additional $100,000 a year for insurance, because the data center was not underground.*

DR. HEDGE: *I predict that you are going to see in the next decade a variety of systems that will be integrated into the furniture. They will "fine tune" the environment for each individual worker in terms of things like ventilation, air quality and lighting. Those systems do not need to be an integral part of the base building HVAC engineering systems.*

*It is a decision you have to make, but if you are concerned about fine tuning things for people, I would try to put that off for a while and think about conditioning your base building and focusing on where you are going to get the cabling, etc.*

DR. TORAN: *Strangely, I think we all agree. One should divorce the building. While it is absolutely true the modular sizes have to work together, you should divorce the construction of the building and the furniture systems. The building will be built for 50 to 200 years. The furniture system will be changed, based on your needs every 15 to 20 years.*

DR. WILSON: *If you are planning on this building for, say, 40 years, and if you do value engineering and compute the cost of it over 40 years, you will have a pretty good idea about the most important elements in the building for you to concentrate on, cut out, and take care of in your contracts. I think you will find the costs of the things that architecture is concerned with are relatively minor, when considering the lifetime costs of the building. I think that is what these people have been saying.*

MR. CYROS: *Why did you select 40 years? I heard 50 to 200.*

DR. WILSON: *Well, for the first time in history we live a lot longer in our buildings. I would give it about 20.*

MR. CYROS: *Well, you are all welcome to visit me at MIT, and I will take you on a tour through our main campus built in 1916.*

DR. WILSON: *That is one nice exception.*

MR. HOOKER: *Yesterday I heard that you have 11 different agencies that will show up on move-in day and potentially redesign everything being planned, or at least they will have control. If the individual agencies may not be happy with what you are doing or want to change them, perhaps a better solution would be to treat the building as tenant space, shell it out, omit the lighting, heating and furniture, and just build a shell. Then bring in those specialists later, at the appropriate time.*

DOT VOICE: *We are not going to be laying out this building in a vacuum. There are 11 organizations that will be involved in planning the space for their group.*

DOT VOICE: *The changes in administration are not expected to result in changes in the building systems, but floor layouts and modules and/or systems furniture types might be changed because the agency administrators are relatively independent.*

DR. WILLIAMS: *With regard to the occupants of the various parts of the building, perhaps you could provide us with some insight about how much participation you have had from the agencies. I cannot imagine the entire Department of Transportation moving into a building and having parts of that Department then move off and do things that are totally different from the building program. It makes me wonder if your planning has been only at the top level or how far down did this go.*

MS. ALLEN: *Let us not answer that. There are people in the room from those agencies. There is a NHTSA representative here. Is there an FAA person still here? How much involvement have you had in the planning of the building?*

MR. GLENN: *What we were required to do is complete a questionnaire for each organizational entity and then to try to project our increased staff the best we could downstream.*

*We are a relatively small organization - less than 1,000. I was in a position the last 10 years where when the Republicans were in, and then the Democrats; we had a wide swing. When Reagan came in, we lost about 25 percent of our staff because we were a regulatory outfit. I had pockets of space everywhere. I am looking for flexibility. You get a new regime and they could completely have a different agenda. The Administrator's suite, the pockets of space right next to that change, so you end up having to move walls.*

*I think you are talking about having pockets of space, flexibility and interchangeable things in terms of lighting and other systems. I have had problems with the air conditioning in the old building. Having HVAC modules down to the level of the workstation for comfort, and individual environmental control makes sense. How you bring it about I don't know.*

MR. HAYHURST: *I'm another customer and client. We have been involved in planning quite extensively. We have been asked for input from day one at various levels of management.*

MS. ALLEN: *Let me answer from our perspective. We have been trying to involve the agencies in terms of requirements and the issues being dealt with.*

*What I was trying to reflect yesterday was the political reality of the organization. The head of each one of those organizations is appointed by the President of the United States with the consent of the Senate. They report only to the Secretary, not to any of us in the Office of the Secretary.*

*Therefore, the Administrator of NHTSA or the Administrator of the FHWA - each one of them will bring their own character to the organization and want to control their own domain. We can work collaboratively, which we try to do. We can work coercively, which we sometimes do.*

*But the reality is despite our planning, when push comes to shove, perhaps five years after we have moved into the building, the new Administrator of the FHWA, or some other organization, could say, "I need 800 more people in downtown Washington." and I would have to figure out how to fit them into the building.*

DR. WILLIAMS: *That does sound like good involvement, and helps me to understand the participative process as being pretty complicated.*

*Someone this afternoon used the word "vision" about this building. Visions never work unless everybody up and down the line participates in defining the vision. You are likely to get into this tenant thing recommended earlier, unless you have a vision and participation by all of the units. You may have it only for limited periods, until your personnel changes, and then you start over again. But I would encourage you in this process of planning the competition next fall to get that vision as clear as possible from as many units as you can.*

MR. VALENTINE: *To what extent do politically appointed folks get involved with facility standards?*

# APPENDIX A  WORKSHOP ATTENDEES

## 1. Participants and Affiliations:

**Mr. Don Avedon** - Principal, Avedon Associates; former executive director, International Micrographics Congress; consultant (Avedon Associates, 14 Accord Court, Potomac, MD 20854)

**Mr. Stephen Binder** - Vice President, Real Property Services (Citibank, N.A., One Court Square, 8th Floor, Long Island City, NY 11120)

**Mr. Lee Bloomquist** - Principal Engineer, Steelcase R&D (Steelcase, Inc, P.O. Box 1967, Grand Rapids, MI 49501-1967)

**Mr. Robert Cioppa** - Architect, Kohn Pederson Fox Associates (Kohn Pederson Fox Associates PC, 111 West 57th Street, New York, NY 10019-2272)

**Mr. Kreon Cyros** - Director, MIT Office of Facilities Management Systems (Director, MIT Office of Facilities Mgmt Systems, 77 Massachusetts Ave, Room E19-451, Cambridge, MA 02139)

**Dr. Gilbert G. De Couvreur** - Director, Canadian Workplace Automation Research Center; Director, R & D Integrated Systems (Canadian Workplace Automation Research Center, 1575 Chomedey Blvd, Laval, Quebec H7V 2X2, Canada)

**Mr. Martin Duby** - Program manager, U.S. General Accounting Office (GAO); building retrofit manager (USGAO, GS&C Facilities Management, 441 G St. N.W., Rm. 1800, Washington, D.C. 20548)

**Mr. Marshall Graham** - Principal, Graham Associates; developed earliest computer systems for space allocation; facility management consultant (Graham Consulting, 303 East 57th St. New York, NY 10022)

**Dr. Alan Hedge** - Professor, Cornell University, Deptarment of Facility Management; ergonomic researcher (Cornell University NY State College of Human Ecology, Department of Design & Environmental Analysis, Van Rensselaer Hall, Ithaca, NY 14853-4401)

**Mr. Michael Hooker** - Professor, University of Michigan; Principal, Michael Hooker Associates, lighting consultants, (Michael Hooker Assoc.,111 North First St, Ann Arbor, MI 48104)

**Mr. Valentine Lehr** - President, Lehr Associates, Mechanical Engineering firm (Lehr Associates, 130 West 30th Street, New York, NY 10001-4092)

**Ms. Vivian Loftness** - Professor, Carnegie Mellon University; Architect; Member of Advanced Building Systems Integration Project (Department of Architecture, Carnegie Mellon University, 1325 Doherty Hall, Pittsburgh, PA 15213)

**Mr. William Miller**, Director, Steelcase R & D, (Steelcase, Inc P.O. Box 1967, Grand Rapids, MI 49501-1967)

**Mr. Herbert Rosenheck** - President, Technical Planning Associates; Systems integration specialist (Technical Planning Associates, 18830 Los Alimos St., Northridge, CA 91326)

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## 2. Workshop Guests and Affiliations

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**Ms. Kathy Baxter** - DOT/OST (Office of the Secretary of Transportation), headquarters planning team member; space planning specialist (400 7th St SW, M-41, Washington, D.C. 20590)

**Mr. Don Burns** - GSA/NCR (General Services Administration, National Capital Region); space planner and interior designer - assigned to the DOT consolidation project (7th & D Sts SW, Room 7660, Washington, D.C. 20407)

**Mr. Joe de Buzna**, DOT/OST (Office of the Secretary of Transportation), Telecommunications Division (400 7th St SW, M-33, Washington, D.C. 20590)

**Ms. Marguerite Christensen** - DOT/OIG (Office of the Inspector General), Administrative Officer; technical planner (400 7th St SW, Room 9202 JP-20, Washington, D.C. 20590)

**Ms. Maria Cooke** - DOT/OST (Office of the Secretary of Transportation); contract specialist working in the procurement area for the new building (400 7th St SW, Room 941, M-64, Washington, D.C. 20590)

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**Mr. Michael Dillingham** - COMSUL Ltd.; telecommunications engineer (7500 San Felipe, Suite 900, Houston, TX 77063)

**Mr. Paul Ducharme** - GSA/NCR (General Services Administration, National Capital Region); space planner (7th & D Sts SW, Room 7660, Washington, D.C. 20407)

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**Mr. Tom Glenn** - DOT/NHTSA (National Highway Traffic Safety Administration); Chief, General Services Division (400 7th St SW, NAD-51, Washington, D.C. 20590)

**Mr. Crawford Grigg** - DOT/OST (Office of the Secretary of Transportation); Chief, Real Property Division (400 7th St SW, M-47, Washington, D.C. 20590)

**Mr. Lyle Hayhurst** - DOT/FHA (Federal Highway Administration); Chief, Property and Services Branch (400 7th St SW, HMS-21, Washington, D.C. 20590)

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**Mr. Rich Lieber** - DOT/OST (Office of the Secretary of Transportation) - Chief, Procurement Operations Division (400 7th St SW, M-64, Washington, D.C. 20590)

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**4. TITLE AND SUBTITLE**

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Transcript of Proceedings

**5. AUTHOR(S)**

Arthur Rubin

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U.S. DEPARTMENT OF COMMERCE
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**11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)**

This report contains the proceedings of a workshop conducted November 13, and 14, 1991 for the Department of Transportation (DOT). The workshop was held to assist the Department in planning a new Headquarters Building. Eighteen experts, representing various disciplines associated with building design and use participated in a workshop, and prepared papers prior to the meeting. The present report consists of the edited transcript of the meeting - presentations and discussions. An earlier report (NISTIR 4801), contains the prepared papers.

Workshop presentations covered the following topics: workstation design process, programming tradeoffs, workstation standards and criteria, ergonomics, human resource issues, leading edge workstation design, impact of new technologies on office and workstation design, lighting, environmental technologies information and data systems, building design, facility management, forecasts of the office-of-the-future. These issues were discussed by panel members, and with representatives from the Department of Transportation and other federal agencies.

**12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)**

Architectural programming, building design, building environment systems, design module, furniture, information systems, lighting, office-of-the-future, office technologies, telecommunications, workstation design, workstation standards

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