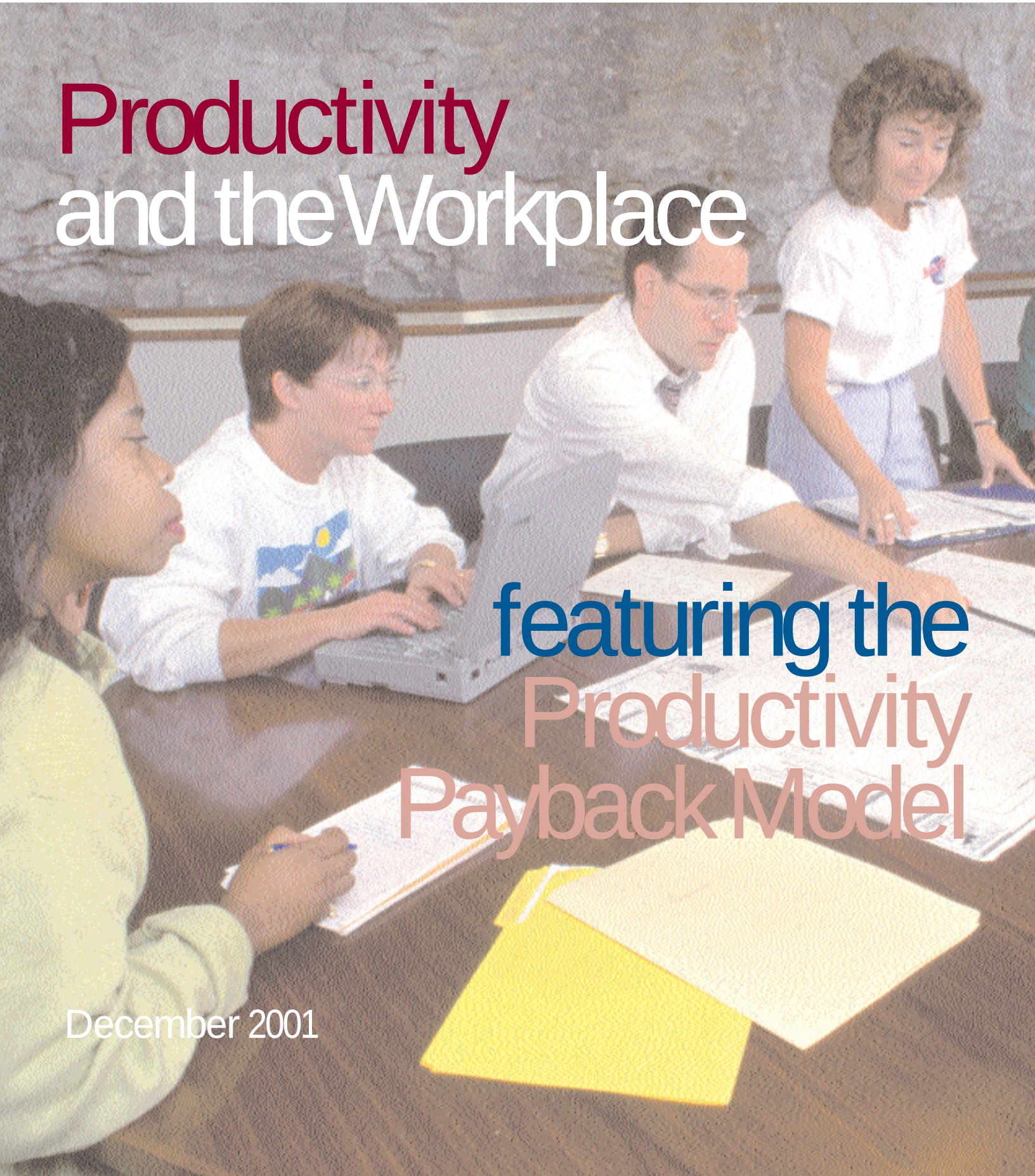
GSA

GSA Office of Governmentwide Policy

Productivity and the Workplace



featuring the Productivity Payback Model

December 2001

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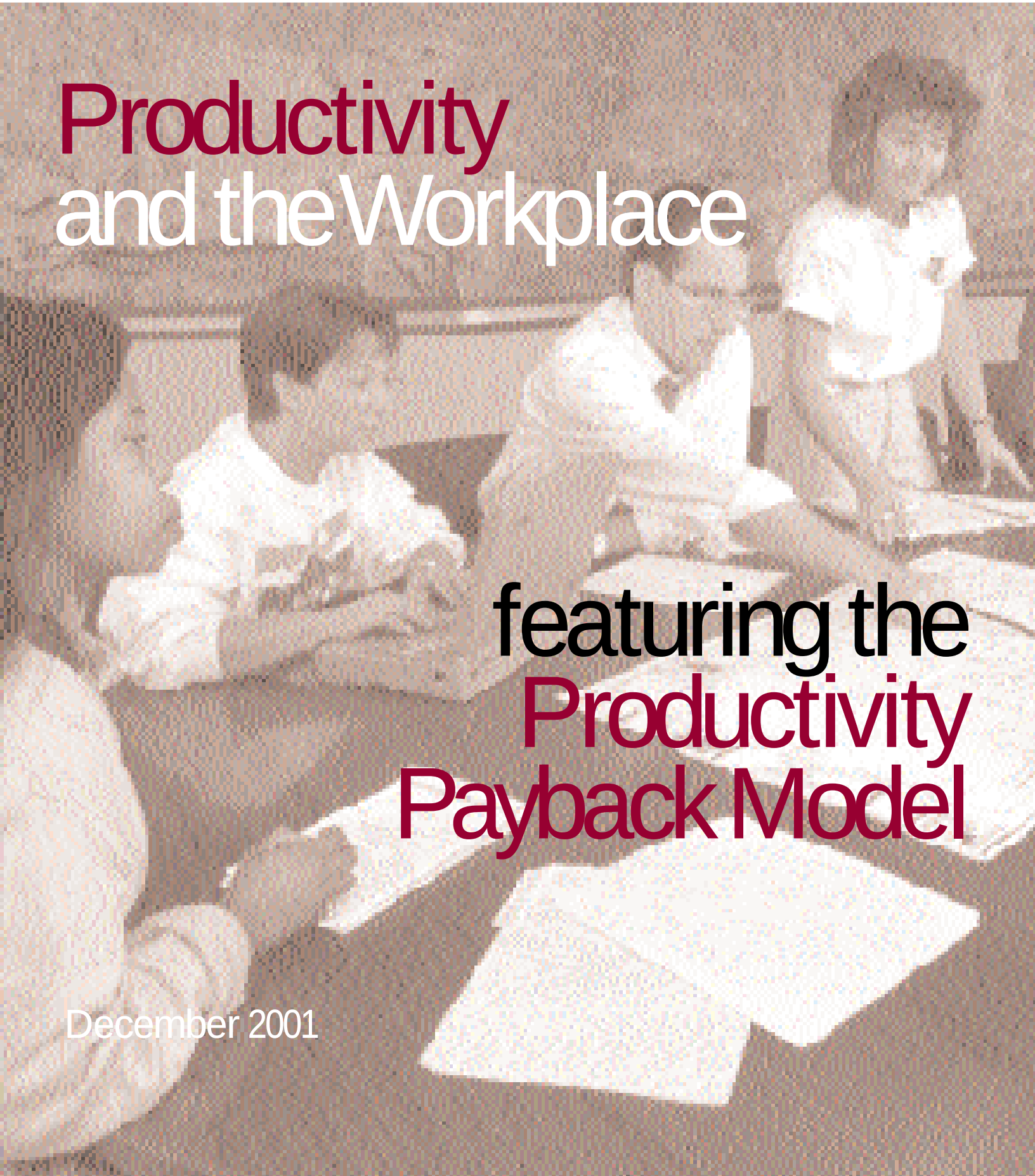

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Foreword

The Office of Governmentwide Policy is pleased to issue Productivity and the Workplace. The emerging concept of the workplace represents an integration of the disciplines of facilities management, information technology and human resources management. Today's workplace requires new measurement paradigms, new performance models and new ways of thinking about what we in Government do and how we can get it accomplished most effectively and efficiently. This study pulls together the work of some innovative thinkers in the private and academic sectors, along with a few thoughts of our own. Also included is the GSA Productivity Payback Model, which will challenge the way you analyze your workplace investments and help you plan more effectively for the modern workplace transformations that have the greatest impact on your organizational effectiveness. We believe that this study focuses the attention of decision-makers squarely on any organization's most valuable assets – the people who serve your customers.

I would like to recognize David Bibb whose Office of Real Property undertook this initiative. With leadership from Stan Kaczmarczyk of the Innovative Workplaces Division, the project team of Ray Wynter and Joanne Shore produced this original publication and its companion "People and the Workplace." Additionally, we would like to recognize the contributors from the Federal government, the private sector, the academic community, the not-for-profit research sector, and the governments of Canada, Ireland and the City of Austin, Texas. Without their dedication and participation, this publication would not have been possible.

The Office of Governmentwide Policy presents this information to the Federal real property community to facilitate more informed decision-making leading to improved asset management. Organizations throughout the world in both the private and public sectors have made performance measurement, benchmarking and strategic planning part of their cultures. We want to lead the Federal real property community in this important effort, consistent with the expectations of the Government Performance and Results Act of 1993.

G. Martin Wagner
Associate Administrator
Office of Governmentwide Policy
U.S. General Services
Administration

Table of Contents

Executive Summary

In recent years, real property professionals have broadened their focus. Instead of providing merely space, we now talk about providing "workplaces." The concept of the "workplace" is the result of the merging of the disciplines of facilities management, information technology, and human resources. The Office of Real Property has advocated a process called The Integrated Workplace to address the planning and design of innovative workplaces. We have also begun to shift our performance measurement paradigm from measuring buildings to measuring workplaces, using new innovative measures such as Cost per Person.

In this publication, we expand on the Integrated Workplace concept with new perspectives on workplace measurement and alternative work environments. Using the conceptual Workplace Performance Model, we piloted a survey that assessed employee satisfaction with three key components of the workplace: People (human resources), Places (facilities) and Tools (information technology). We have included some of the results from this original research. Future research may determine the relationships of employee satisfaction with each workplace component to employee productivity.

We have also developed a new spreadsheet tool along the lines of the popular GSA Cost per Person Model. The GSA Productivity Payback Model will enable users to relate measures of productivity increase and employee turnover decrease to the evaluation of investment in People, Places and Tools improvements in the workplace. At a minimum, our customers will find that the model contains much in the way of useful benchmark data that will provide quantitative support for decision-makers who realize that investing in the workplace is an investment in an agency's people, by far the Government's most valuable assets.

Productivity and the Workplace doesn't tell the entire story. In our companion publication, *People and the Workplace*, we have included additional original research papers by noted professionals in the private, academic and research sectors. The papers address the three major components of the workplace: People (demographic trends and organizational culture), Places (environmental research) and Tools (technology creates the virtual workplace).

Finally, we make some observations from the research leading to recommendations that the Federal Government look to workplace improvements as one way to address the imminent human capital crisis, by providing a 21st century workplace that attracts and retains productive and satisfied employees.

Acknowledgments

The publication that follows is the result of the cooperation and effort of many individuals and organizations in the public, private and academic sectors. We deeply appreciate everyone's assistance over the past 18 months as we explored the impact of the workplace on every organization's most important assets – the people who make it happen. We would like to specifically acknowledge the following individuals and organizations who not only made this study happen but were brave enough and flexible enough to join us in what was, at times, uncharted research territory:

Judi Murtough	Public Works & Government Services Canada
Chris Wilson	Public Works & Government Services Canada
Alain Trepanier	Public Works & Government Services Canada
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Kristie Bissell	Logistics Management Institute
Chris Campbell	Logistics Management Institute

The following GSA associates provided invaluable assistance in data collection, conceptual development, or other support of the initiative that resulted in Productivity and the Workplace:

Ron Whitley	Bob Harding
Rob Obenreder	Jonathan Herz
Margie Lomax	Chris Coneeney
Kevin Kampschroer	Michael Atkinson
Michael McNew	Peter Ford
Thomas James	Billy Michael
Dennis Goldstein	

We hope that Productivity and the Workplace is a valuable addition to the field and a catalyst for further research efforts in this important subject. If nothing else, it represents an outstanding example of cooperation and good will among professional colleagues in academia, the private sector, and governments at the local, Federal and international levels.

Stan Kaczmarczyk
Director,
Innovative Workplaces Division
GSA Office of Real Property
Washington, DC

December 2001

Introduction

GSA's Office of Real Property has conducted a performance measurement initiative since 1997. Although GSA manages a significant portion of the Federal government's office building inventory, many Federal agencies control their own facilities. GSA controls 41 percent of the Federal office space inventory, and only 10 percent of the overall space inventory. While GSA's Public Buildings Service compiled comprehensive data on the GSA buildings, we knew almost nothing about the performance of other Federal buildings.

Our Office formed an interagency working group that derived seven key measures of real property performance (Cost per square foot (owned); Vacancy rate; Cost per square foot (leased); Cost per person; Customer satisfaction; Employees housed; Total square feet). We collect and analyze data each year from participating Federal agencies using a voluntary benchmarking system. The data are rolled up into overall averages and individual anonymity is preserved. We track the annual changes, publish summaries of publicly available comparable data from the private sector, and benchmark with selected non-Federal organizations. The basic performance measurement program (the "7 measures") has been very successful and has drawn considerable interest in the Federal, private, academic and international government sectors.

In the next section, we will discuss the movement in our field from a facilities management framework to the emerging concept of the workplace. We have mirrored this trend in the performance measurement initiative. We will continue to track some very basic measures of facilities performance. At the same time, we want to move from measuring buildings to measuring workplaces. This is tricky in two respects: the workplace concept is more complex, and measures are rudimentary or non-existent. The situation calls for innovative thought and shifting our analytic perspectives.

We took a giant first step along the road to a new measurement paradigm when we developed and introduced the GSA Cost per Person Model. This simple concept – because people are working in different ways and alternative environments, you should broaden the definition of cost beyond real estate to include information technology and telecommunications – turned out to be revolutionary. The concept and the associated spreadsheet model have drawn considerable interest from a broad cross-section of real estate and workplace professionals. The work that you will read about in this publication, covering employee satisfaction and its relationship to

Introduction

productivity, recruitment and retention, represents the next step in the journey.

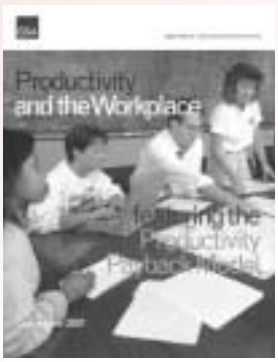
We have published a series of studies that serve as analytical milestones in the Governmentwide real property performance measurement initiative. This publication is the latest edition and, like the others, can be downloaded from our web site www.gsa.gov, in PDF format. Hard copies of the studies may be obtained by request at no charge. Contact us by electronic mail or telephone with your request (see Appendix E for contact information).

The series of performance measurement studies to date:

- **Office Space Use Review** (September 1997) – This publication benchmarked office space utilization rates and expanded the traditional square foot per person outlook to suggest the importance of strategic planning for real estate, as well as the need to look at a group of diverse measures – including cost per person measures.
- **Governmentwide Real Property Performance Measurement Study** (June 1998) – This study captures the work of the interagency group that derived the 7 measures of real property performance, and called for the annual voluntary benchmarking system to track the measures. This study has been recognized as a case study in public administration, and provides real world guidance on measuring a crosscutting administrative function across a decentralized organization. The publication also features case studies in real estate performance measurement from the public, private and academic sectors.
- **Governmentwide Real Property Performance Results** (December 1998) – This publication established the baseline for the 7 Governmentwide measures of real property performance, and includes a

series of profiles of representative Government buildings.

- **Workplace Evaluation Study** (November 1999) – This landmark publication shifted the measurement paradigm from facilities to workplace and introduced the GSA Cost per Person Model. The study also discussed other innovative performance measures and featured case studies of organizations that had undergone – and measured – workplace transformations.
- **Real Property Performance Results 1999** (December 1999) – This publication repeated the voluntary benchmarking effort for the 7 measures, expanded the benchmarking effort beyond the Federal government, and featured an extensive discussion on data collection problems, issues and systems.
- **Real Property Performance Results 2000** (December 2000) – This publication features the results of the third annual voluntary benchmarking of the 7 measures, and expands the analysis by presenting two additional measures. The study continues the data collection issues discussion with a comprehensive paper on Computer Aided Facilities Management systems.
- **Productivity and the Workplace** (December 2001) – The current study pushes the measurement paradigm firmly in the workplace direction. The publication presents the conceptual Workplace Performance Model, introduces the GSA Productivity Payback Model (spreadsheet) and reviews productivity research literature.
- **People and the Workplace** (December 2001) – The companion publication to *Productivity and the Workplace* features discussions on employee satisfaction, demographic trends, virtual management and productivity measurement along with practical guidance on conducting a telework pilot in your office.



The Workplace Performance Model

Photo courtesy Owens Corning

The Workplace Performance Model

In early 2000, our Office conducted a series of internal brainstorming sessions around one of the 7 key indicators of Governmentwide real property performance – customer satisfaction. In the annual benchmarking initiative summarized in the publication *Real Property Performance Results*, we publish the results of the annual Customer Satisfaction Survey administered by GSA's Public Buildings Service (PBS) to assess tenant satisfaction with our building services. This is at best a proxy for a Governmentwide estimate, but the only reliable and consistently collected data we have for this measure.

As we considered customer satisfaction from a Governmentwide perspective, which is broader than the PBS role as service provider to a subset of Federal office buildings, we started to think of this measure more generally as employee satisfaction. The discussion naturally led into the area of productivity, since it is widely believed that employees who are satisfied with their workplaces and their jobs are more productive.

We researched the area of office productivity concerning so-called "knowledge" workers, and found that considerable work was being done on this subject. We also found that in at least 20 years of research, no one had any exact "answers" as to what the key factors influencing productivity were, because no one had determined how to measure it consistently. If you think about it, organizations have different missions and cultures, and a "true" measure of productivity of a knowledge worker in a specific organization must be developed specifically suited to that organization's business or mission. We could not expect to solve the dilemma of consistent measurement across organizations, but we felt that we could still use some of the basic concepts to generate helpful research and business models.

We did not have to look far for our starting point, since our Office has been exploring the emerging concept of the workplace for a while, particularly in our Integrated Workplace initiative. The Integrated Workplace is the result of a collaborative, multidisciplinary approach to developing and providing workspace, uniting your organization's strategic real property plan with its strategic business goals. It responds to the people and work practices of each individual and group, and provides them with the physical space and tools needed for their success. We also found precedent for the multidisciplinary framework in our research dating back almost 20 years.

We developed a model, then a survey to test assumptions of the model. We pilot tested the survey, then began discussing the results and implications with professional colleagues. We consulted, benchmarked, gathered more data, traded ideas, formed partnerships, shared research and explored new horizons. The "productivity" project evolved and continues to evolve to this date.

The Workplace Performance Model

Broadly, there are four phases to this research project:

1. Conceptual . . . . . . In this phase, we developed the Workplace Performance Model described below. The model, derived from the emerging workplace concept, can be described in terms of our Office's initiatives as "The Integrated Workplace meets Performance Measurement."

2. Data Collection . . . . . . We developed a Workplace Analysis Survey to test the assumptions of the Workplace Performance Model and to gather baseline employee satisfaction data in support of the Productivity Payback Model. We collected various samples of survey data, and some of the results are summarized below.

3. Analytical . . . . . . We wanted to provide our Federal agency customers (and others) with a tool that would facilitate informed decision-making in the brave new world of the 21st century workplace. This tool was also designed to change the way you think about investments in your facilities. We developed a spreadsheet that analyzes the trade-off between investments in the workplace and the possible effects on employee satisfaction and retention. This tool, called the GSA Productivity Payback Model, will be presented in the next section. The spreadsheet will enable you to consider productivity impacts in your decision framework even if you cannot easily measure them.

4. Statistical . . . . . . The Workplace Analysis Survey data we collected has more to offer, despite the fact that the surveys are brief and can be completed in five to ten minutes. Final results of a statistical analysis of the survey data are pending, and will be published in a future GSA Office of Real Property publication.

The Conceptual Model

We developed a conceptual model, which we called the Workplace Performance Model. We developed a survey to test its assumptions, and collected several data samples using the survey. Our goal is to eventually identify key factors and promising avenues for experimental research by organizations with the expertise and resources to perform valid research (academia, PBS research program, professional consortia).

The Workplace Performance Model postulates that the workplace consists of three major components:

People

We use this term to refer not just to the people in our organization, but to people or organizational factors.

Places

We use the plural to include alternative work environments as well as the primary home office space.

Tools

We traditionally emphasize tools such as information technology as the main determinants of productivity, but we argue that there is more involved.

Some additional points about ...

People

- Organizational culture is a critical "people" factor.
- An organization's business processes impact employee performance.
- Another important people factor is the extent to which the organization provides alternative work environments and flexible work schedules.
- As many writers on leadership and management have noted, the "soft stuff" is often the critical determinant of performance.
- The costs of People factors are not included in our definition of Cost per Person (but ideally should be).

Places

- This refers to the physical work environment, not only in the main office, but also in alternative work environments such as telecenters and home offices.
- The actual office layout (design) has an impact.
- The type of furniture in the work environment matters.
- Amenities (gym, retail establishments, childcare) are important considerations.
- Building systems can critically impact performance.
- Expenditures on places can comprise 50 to 65 percent of Cost per Person as defined in Real Property Performance Results 2000.

Tools

- Information technology refers to both hardware and software.
- Telecommunications also includes connectivity for remote access.
- The Internet is an important factor in knowledge worker productivity.
- The Tools component includes all typical office equipment.
- Expenditures on tools can comprise 35 to 50 percent of Cost per Person as defined in Real Property Performance Results 2000.

The Workplace Performance Model

When the three components of People, Places, and Tools come together effectively (and the Integrated Workplace process walks you through how to do this), we achieve a "high performing workplace."

A "high performing workplace" can be measured in terms of:

1. Employee satisfaction

2. High productivity

3. Employee retention

Some notes on...

...the employee satisfaction measure:

- We designed the GSA Workplace Analysis Survey (Appendix B) to assess separate employee satisfaction ratings with People, Places and Tools factors.
- We will report some of the employee satisfaction data gathered with the survey in Real Property Performance Results 2001 later this year, but we will still continue to report the results of the annual PBS customer satisfaction survey for the sake of continuity.
- There is some evidence that employee satisfaction is highly correlated with employee productivity. See Christine Barber's paper entitled "The 21st Century Workplace" in our companion publication *People and the Workplace*.

...the high productivity measure:

- The state-of-the-art in measuring productivity of knowledge workers remains self-assessment questionnaires.
- While more quantitative measures of productivity are desirable, we should avoid applying the "scientific management" approach (time-motion studies, keystroke monitoring) to measuring productivity of knowledge workers. What worked in the Industrial age is inappropriate for use in the Information age.
- Uniform measures may be impossible to achieve since what defines a productive employee will always be agency and mission-specific. Put another way, "all productivity is local."
- One idea for future research is to identify organizations that demonstrate high productivity measured in their own terms, then "walk the space."

...the employee retention measure:

- Employee retention is an indirect measure of workplace performance.
- This method is also known as a Human Resources records review.
- Other Human Resources data such as absenteeism can also be helpful.
- The GSA Workplace Analysis Survey (Appendix B) is available for Federal agency use in electronic form. Combined with agency mission-specific productivity measures (if in place), and the Human Resources records review, a customer agency can use the survey results to assess its workplace performance.
- The graph on the opposite page illustrates the conceptual phase of the research project, the Workplace Performance Model.

The Workplace Performance Model

Workplace investments should be measured in terms of:

- **Satisfaction**
- **Productivity**
- **Retention**

Results from Employee Satisfaction Pilot Study

We administered the GSA Workplace Analysis Survey to over 200 people in a variety of organizations and settings. In this section, we summarize some of the data and draw some tentative conclusions. The sample size is relatively small (think of how many "workplaces" there are) and the sampling method was driven more by practicality than statistics. We consider this to be a pilot study. The data are real, however; as real as the comments which many people took time to write on their surveys. People really care about their workplaces.

Our objectives for collecting the survey data were:

- To reinforce the workplace concept through measurement. Instead of asking people about satisfaction with the workplace as a whole, we measured separate satisfaction scores for the People, Places and Tools components. We compiled different answers – there is value in the classification scheme.
- To look for clues for future research directions. We obtained some information of this kind, and hope to get more when we complete the detailed statistical analysis.
- To enable us to secure needed data to provide a context for the GSA Productivity Payback Model. With limited funds to upgrade your workplace, should you invest in People, Places or Tools? The answer depends on where you are along these three employee satisfaction curves.
- To provide an opportunity for the major participants in the survey data collection to benchmark with each other. Detailed information has been shared privately among our partners in this effort.

Refer to Appendix B for the actual survey. The data summarized in this section were derived from answers to questions 5A, 5B and 5C. Satisfaction scores represent the total percentage of respondents who answered either "satisfied" or "very satisfied."

The first table presents a comparison of employee satisfaction scores between the Government sector as a whole and the Private sector:

Sector	People	Places	Tools
Government	68 percent	69 percent	85 percent
Private	70 percent	77 percent	87 percent

From the pilot data, there doesn't appear to be much difference in employee satisfaction between the overall government and private sectors. However, the private sector may have a small edge in Places (facilities).

Naturally, our primary interest is to see how the Federal government compares to other organizations and sectors in general. The following chart ranks employee satisfaction with the People component of the workplace in comparison to others:

Organization/Sector	Employee Satisfaction w/People
Organization similar to GSA	74 percent
Overall private sector	70 percent
Overall government sector	68 percent
U.S. Federal Government	65 percent

The following chart ranks our employee satisfaction with the Places component in comparison to others:

Organization/Sector	Employee Satisfaction w/Places
Organization similar to GSA	86 percent
Overall private sector	77 percent
Overall government sector	69 percent
U.S. Federal Government	58 percent

The next chart ranks our employee satisfaction with the Tools component in comparison to others:

Organization/Sector	Employee Satisfaction w/Tools
Overall private sector	87 percent
Organization similar to GSA	86 percent
Overall government sector	85 percent
U.S. Federal Government	81 percent

Based on an examination of the pilot data, there are a few points worth noting:

- Employee satisfaction with the Tools component seems to be the highest result across the board. Most organizations have kept up with technology investments in the workplace.
- The U.S. Government employee satisfaction scores are the lowest across the board.
- The measured U.S. Government employee satisfaction score with the Places (facilities) component (58 percent) is the lowest of any Places score in our samples or sectors. The U.S. Federal Government employee satisfaction with Places (or facilities), based on this sample, is 19 percent lower than the U.S. private sector (77 percent) with whom we must compete to recruit and retain talented employees. This score (58 percent) is also an astounding 28 percent lower than the organization that is a comparable benchmarking partner for the U.S. Government (86 percent).

During our data collection, we were extremely fortunate to obtain sub-samples from the same organization of “traditional” versus “innovative” space. The data indicate lower employee satisfaction with traditional space (open concept with similar configuration and cubicle for most workstations) than with innovative space (more individualized solutions for each work unit):

Type of Space	People	Places	Tools
Innovative	85 percent	93 percent	82 percent
Traditional	61 percent	79 percent	92 percent

The 93 percent employee satisfaction score for Places in the innovative space was the highest facilities score we tallied, matched only by a small sample of surveys given to employees of "high-powered" U.S. private sector firms.

Finally, those with expertise in developing and administering surveys (although we are not in that category, as mentioned earlier) usually pay particular attention to the "extreme" responses.

The highest scores we found in the "very satisfied" category were:

- Traditional sub-sample — 35 percent very satisfied with Tools
- Overall private sector — 32 percent very satisfied with Tools
- "High-powered" private sector — 29 percent very satisfied with Places
- Innovative sub-sample — 25 percent very satisfied with Places
- Organization similar to GSA — 25 percent very satisfied with Tools
- Small government organization — 25 percent very satisfied with Tools

The highest scores we found in the "very dissatisfied" category were:

- "High-powered" private sector — 7 percent very dissatisfied with People
- Private sector sub-sample — 4 percent very dissatisfied with Tools
- Innovative sub-sample — 4 percent very dissatisfied with Tools
- Traditional sub-sample — 4 percent very dissatisfied with Places
- U.S. Government — 3 percent very dissatisfied with Places

We note the following (without drawing conclusions):

- At the extremes, there are many more people who are very satisfied as opposed to very dissatisfied.
- The "high-powered" private sector sample ranks high in extreme satisfaction with the Places component (29 percent) but also ranks highest in extreme dissatisfaction with the People component (7 percent).

GSA Productivity Payback Model

GSA Productivity Payback Model

The Purpose of the Model

Research consistently demonstrates that the quality of the work-place matters to the most important people – the people who work there. The quality of the workplace is a factor in where we choose to work, how satisfied we are with our jobs, how productive we can be, and ultimately whether we decide to stay at our jobs or look elsewhere. Everyone who has ever worked anywhere knows that the quality of the workplace matters. What the research can do is to assess the factors that matter most and the degree to which they matter.

Most people would agree with the previous statements, including decision-makers in most organizations. Yet, when workplace professionals try to sell decision-makers on projects to upgrade the workplace, a common response is that the project must demonstrate that it will provide a sufficient return on investment to justify expenditure of resources. This, of course makes, perfect sense from an opportunity cost standpoint. Money spent on improving the workplace could be alternatively invested in the business enterprise or agency mission, with a resulting return to the owners or stakeholders.

What doesn't make sense is that the same "Return on Investment" type of analysis applied to the core business or mission should be used to evaluate the "return" on investing in the workplace. The latter is an investment in the people who perform the work, not an investment in facilities, technology and processes. Facilities, technology and processes alone don't get things done – people do.

Keeping in mind the Workplace Performance Model's categories of People, Places and Tools, how often do we encounter the following reactions or attitudes about investing in these areas of the workplace?

We created the GSA Productivity Payback Model to help workplace professionals and organizational decision-makers think differently about investments in the workplace. We argue that workplace improvements in what we call People, Places and Tools components are not investments in process improvement, facilities and technology, but investments in the people who do the work. The payback will come in the forms of increased employee satisfaction, productivity and retention, and these workplace investments should be measured in those terms.

To put our argument in very simple terms: you can't make the right decision if you're looking at the wrong measures.

People

- Reorganizations are only effected as a response to downsizing or mergers, and not to improve business processes or to make better use of existing human capital.
- Telework programs that would improve work/life balance and help employees to be more productive overall are frowned upon because managers distrust workers they cannot see.
- Space standards are reduced to cut real estate costs, adversely affecting the needs of the organization's associates for individual privacy and common meeting areas to work in teams.

Places

- When asked to approve the expenditure of funds for facilities improvements, decision-makers become performance measurement experts and demand to know how much productivity will increase and how will it be measured. Since, particularly in the case of knowledge workers, this is not a question that has been or can be answered with absolute certainty, facilities remain unimproved.
- A standard Return on Investment analysis is applied to a facility improvement project, although the purpose of the upgrade is not to increase the market value of the facility, but to improve the working conditions of the organization's most important asset – the people who work there.
- A new facility is built for the lowest first cost, ignoring the fact that up-front expenditures on features such as raised flooring would increase flexibility and lead to lower life cycle costs by reducing churn costs in the long run.

Tools

- The organization regards computer technology as the major – in some cases the only – determinant of worker productivity and spends indiscriminately to upgrade and improve hardware and software. Often, organizations are not even aware of how much they spend in this area.
- Information technology is updated constantly while the people who have to use the technology to get their jobs done are often not asked if they need the upgrades, or what upgrades they need, or they are not properly trained to make maximum use of the new or updated information technology.
- The same organization that will update its electronic mail software package in a heartbeat will frown if someone asks for a new printer in his or her work area. Meanwhile, the person wastes time every day going down the hall to pick up printouts at the network printer (which, by the way, is an older model that jams constantly).

How to Use the Model

The concepts, data and spreadsheet model discussed in Productivity and the Workplace may be useful in the evaluation of investments in the 21st century workplace:

- As stated earlier, workplace improvements in what we call People, Places and Tools components are not investments in process improvement, facilities and technology but investments in the people who do the work. The payback will come in the forms of increased employee satisfaction, productivity and retention, and these workplace investments should be measured in those terms.
- You may be interested in improving employee satisfaction. Take a look at the employee satisfaction data from our pilot study reported earlier in this publication. How do you think your organization would rate in employee satisfaction with the People, Places and Tools components of your workplace? You can pilot test by measuring baseline employee satisfaction, effecting a change or improvement in the workplace, then reassessing employee satisfaction after the change. Our Workplace Analysis Survey is available for use, but it is simple and designed for research. There are commercially available customer satisfaction survey instruments or you can develop your own with the help of a qualified consultant.
- If you have high employee turnover, you may be surprised to learn that replacing a quality associate can cost as much as one and a half times the value of that person's compensation. You can use the GSA Productivity Payback Model to gauge the extent to which improvements in the workplace can be offset by a reasonable reduction in your high turnover rate.
- You should also consider that workplace investments may be paid back by reasonable increases in employee productivity, especially if you have a highly-skilled professional workforce. If your organization has process-specific productivity measures in place, you can use the same measure/implement/re-measure methodology we discussed above in reference to employee satisfaction. If you do not have such measures, or find it difficult to measure the outputs of knowledge-based work, you can use the GSA Productivity Payback Model to gauge whether the required productivity increase (the one that offsets the workplace investment) is reasonable to expect.
- Use the GSA Productivity Payback Model to think about workplace investments in a more relevant context. Select the productivity option. Describe your workplace investment project. We have provided a few default items with benchmark data. Use these, change the unit costs to your own costs, add other work items, or simply input an overall budget number. Plug in your average compensation for the productivity payback calculation.
- Look at the result. Is it reasonable to expect a productivity increase of this magnitude? Look at the data provided in the Productivity Research Matrix for context. If the required productivity increase is relatively modest, you can be more confident that the investment is a good risk. Of course, you will also look at many other factors before you make your decision, as you would do with any other business decision, but don't forget to consider the human capital piece of the equation.
- Keep in mind that the dollar amount of your workplace investment will only produce the desired improvements in employee satisfaction, productivity and retention if the dollars are invested in the areas of critical need. Invest in the component that needs attention most – People, Places or Tools. A good way to find out what needs to be done is to ask your associates, using a good employee satisfaction survey.

The spreadsheet version (reproduced above) of the GSA Productivity Payback Model is an Excel workbook consisting of five work sheets:

Instructions

This sheet contains an overview of the workbook, general instructions for using the model, and contact information.

Home

This sheet is the basic model. The model supplies default values for most variables. These values are not "absolute" benchmarks, but are all based on real world data. The work items under People, Places and Tools are meant to be examples, and do not capture the entire universe of workplace improvements. The "other" categories are provided for you to capture other work items, or to simply input a total budget number for your workplace project. The model generates two results: the increase in employee productivity required to pay back the cost of your workplace project or, alternatively, the new (lower) employee turnover rate needed to generate savings in turnover costs that will offset the cost of your workplace project.

Productivity Payback Model

Model

Name: _____

Date: 08/09/2001

Project Description:

_____

_____

_____

_____

Number of employees/FTEs: ____

Average salary per employee: ____

Salary multiplier: 1.26

Avg. compensation per employee: $ _ 0 _

Annual turnover rate (%): ____

Employee turnover cost

as percent of salary (%): ____

People

Proposed project(s)	Suggested unit cost	Unit cost		Total cost	Unit cost	# of units	Total cost
___ work at home		___	X ___	_____	_____	_____	_____
___ work at telecenter		___	X ___	_____	_____	_____	_____
___ mass transit subsidies		___	X ___	_____	_____	_____	_____
___ teambuilding training		___	X ___	_____	_____	_____	_____
___ other (optional description)		___	X ___	_____	_____	_____	_____

_____

_____

Estimated cost: $ __ 0 __

Places

Proposed project(s)	Suggested unit cost	Unit cost		Total cost	Unit cost	# of units	Total cost
___ lighting upgrades		___	X ___	_____	_____	_____	_____
___ raised flooring		___	X ___	_____	_____	_____	_____
___ workplace redesign		___	X ___	_____	_____	_____	_____
___ workplace renovation		___	X ___	_____	_____	_____	_____
___ other (optional description)		___	X ___	_____	_____	_____	_____

_____
_____

Estimated cost: $ __ 0 __

Tools

Proposed project(s)	Suggested unit cost	Unit cost		Total cost	Unit cost	# of units	Total cost
___ laptop		___	X ___	_____	_____	_____	_____
___ cell phone		___	X ___	_____	_____	_____	_____
___ internet access		___	X ___	_____	_____	_____	_____
___ IT upgrade		___	X ___	_____	_____	_____	_____
___ other (optional description)		___	X ___	_____	_____	_____	_____

_____
_____

Estimated cost: $ __ 0 __

Results

Total cost of project(s): _____

Increase in productivity required: _____
OR
New turnover rate required $ __ 0 __

Note: A turnover rate less than 5% is considered unlikely.

Details

This sheet provides detailed calculation information supporting the two results described above.

Prod Matrix

This sheet contains the Productivity Research Matrix reproduced above. If, for example, the Productivity Payback Model calculates that a five percent increase in employee productivity is necessary to pay back the cost of your workplace project, you may wish to consult the matrix to judge if the five percent expectation is reasonable given similar types of projects. Please note that the payback time in the model for all scenarios is one year.

Help

This sheet describes the input variables and provides sources for the default values.

For an electronic copy of the Productivity Payback Model, contact Ray Wynter at (202) 501-3802 or ray.wynter@gsa.gov

Research Matrix: Productivity Increases Reported as Consequence of Office Environment Changes

No.	Category of improvement (people, tools, places)	Change/ improvement made	Impacts resulting from change/improvement: Increase in productivity	Other findings	Organization/study	Source (see Appendix D)
1	People	Sick leave incentive	2.2%	A reduction of 5.48 sick leave days taken by incentive program participants. (2.2% derived by dividing 5.48 by 250 working days per year.) Overall annual gain of 15.37 person-years for all county employees	DeKalb County, GA	19
2	Places	Effective reorganization of the physical work space	3%	3% of the total annual salaries of the company's employees	Buffalo Organization for Social and Technological Information (BOSTI)	1
3	Places	High-benefit lighting	5%	$1,911,140 per year ($1.5 million in increased productivity, $200,000 savings due to reduced reject rate, $3,000 savings in maintenance costs, and $3,000 reduction in insurance premiums	Metal Industries	9
4	Places	Thermal comfort, lighting, acoustics, indoor air quality	6%	Absenteeism reductions of 8% to 45%	Rocky Mountain Institute, Snowmass, CO	1, 10
5	Places	High-benefit lighting	6%	$235,290 per year ($28,000 productivity savings, $200,000 saving due to reduced errors, and $7,290 savings in maintenance costs)	Pacific Gas and Electric, Control Data Corp.	9

Research Matrix (continued)

No.	Category of improvement (people, tools, places)	Change/ improvement made	Impacts resulting from change/improvement: Increase in productivity	Other findings	Organization/study	Source (see Appendix D)
6	Places	Noise reduction	7%		Reno Nevada Main Post Office	2, 8
7	Tools	Change of system platform and organizational restructuring	8%	Number of transactions processed increased 7% per year from 1982 to 1993 and errors reduced by a factor of 5	Multinational Bank Funds Transfer Network	6
8	Places	New team structures, ergonomic furniture, improved privacy, environmental systems	9%	Achieved a 9% drop in errors and defective claims and a 1.6% to 4.4% drop in absenteeism	Detroit-based insurance company	1
9	Places	High-benefit lighting	9%	$39,240 in cost savings per year and decreased theft in parking areas (resulted in cost savings)	San Diego Federal Building and Courthouse	9
10	Places	Indoor environments	10%		Johnson Controls (Wyon, 1996, p. 5)	10
11	Places	Lighting upgrade	11.3%	$1,750 annual reduction in energy and maintenance cost	Superior Die Set Corporation, Oak Creek, WI	17
12	Places	Noise reduction	13%		Armstrong research	2

Research Matrix (continued)

No.	Category of improvement (people, tools, places)	Change/ improvement made	Impacts resulting from change/improvement: Increase in productivity	Other findings	Organization/study	Source (see Appendix D)
13	Places	Renovated lighting	13.2%	Decreases in sick leave (25%), lighting energy (69%), and annual operating costs (73%) $44,275 annual cost savings from reduced energy and maintenance costs and increased productivity	Pennsylvania Power and Light	4, 3, 9, 17
14	Places	High-quality office environments	15%		Survey during 1996 national Summit on Building Performance	1
15	Places	New “green” facility	15%	15% decrease in absenteeism	Lockheed-Martin	18
16	Places	Individual workstation environmental controls (temperature)	16%		Carnegie Mellon University (Loftness et al., 1995a, pp. 106-110)	10
17	Places	New 150,000-square-foot insurance company headquarters incorporating Environmentally Responsive Workstations (ERWs)	16%	$0.84 per square foot savings in annual electricity cost	West Bend Mutual Insurance Company, West Bend, WI	17

Research Matrix (continued)

No.	Category of improvement (people, tools, places)	Change/ improvement made	Impacts resulting from change/improvement: Increase in productivity	Other findings	Organization/study	Source (see Appendix D)
18	Tools	Implemented voice response system	20%		Connecticut Mutual Life Insurance	5
19	Places	Ergonomically designed furniture	20.6%		U.S. Army Corps of Engineers	1
20	Places	Ergonomically designed furniture	21%		Miami University (Oxford, OH)	1
21	People	Telecommuting	22%	63% savings in cost of absenteeism and increased employee retention (self-reported)	Telework America 1999	11, 14
22	People	Telecommuting	22.5%	Self-reported	Telework America 2000	12, 13
23	Places	Ergonomically designed furniture	23%	50% decrease in health complaints	National Institute of Safety and Health (NIOSH)	1
24	People	New office design to facilitate teamwork	25%	Reductions in formal meeting time (75%), duplicated files (80%), and cost of floor space per employee (44%)	Amoco Corp., Denver, CO	1
25	Places	Extensive renovation of new leased building	25%	Able to perform the same amount of work in 30% less space	Bank of Boston	1

Research Matrix (continued)

No.	Category of improvement (people, tools, places)	Change/ improvement made	Impacts resulting from change/improvement: Increase in productivity	Other findings	Organization/study	Source (see Appendix D)
26	Tools	Combined information systems	30%		NYNEX	7
27	People	Paid time-off program	36%	36% decrease in unscheduled absences, and $2.5 million per year overall savings	Memorial Hospital, Rockford, IL	19
28	Tools	Use of Internet technologies	54%	Increases in productivity appear to be a result of technology advances (one key finding of this paper is that the nation's 4% economic growth between 1997 and 1998 was significantly attributed to information technology industries)	Center for Energy and Climate Solutions	16
29	People	Telecommuting	58%		Texas Workforce Commission, Commission of Appeals Department	15
30	Tools	Use of Internet technologies	75%	A pilot program testing an integrated electronic data system for automobile manufacturers and their suppliers resulted in a 58% reduction in lead times, 75% reduction in error rates, and a 24% improvement in inventory levels	Center for Energy and Climate Solutions	16

Real World Example

The following example of the Productivity Payback Model is based on an actual case of a Government organization that redesigned its workplace using the Integrated Workplace process. The project included modest space alterations, improved access to natural light, collocation of functions, flexible furniture, and other improvements. According to the analysis, a ten percent increase in productivity will pay back the entire project cost in one year. The analyst believes that the ten percent increase is achievable, if not in the first year, over two years at an annual productivity increase of five percent.

Some of the expected sources of improved productivity in this project are:

- ***Increased access to natural light.*** Many studies have shown a relationship between this factor and productivity. Another benefit would be hard cost savings due to decreased need for electric lighting.
- ***Better circulation.*** Less time will be spent walking to the workstations of associates who are on the same team, but who formerly may have been located on different floors of the facility.
- ***Café and break room.*** This will increase interaction as well as provide a convenient place to eat, cutting back on time spent traveling to and from the facility.
- ***Overall better space.*** An improved environment should make for more satisfied – and more productive – associates in the organization.
- ***Reduced noise and improved ventilation.*** Many studies have linked these improvements to increased productivity.
- ***Reduced downtime due to churn.*** Flexible furniture arrangements will enable organizational changes to be carried out more quickly and less expensively.
- ***Recapture of circulation space.*** The redesign provided the required circulation while recapturing part of the space formerly used for circulation in an inefficient layout.
- ***Serendipity.*** The new layout encourages more corridor traffic and associate interaction.

In addition to the above considerations, the completed project will be showcased as a high-impact Integrated Workplace demonstration project of modest scope.

Productivity Payback Model
Real World Example

Model

Name:	U.S. Government	Number of employees/FTEs:	42.0
Date:	08/09/2001	Average salary per employee:	$75,000
		Salary multiplier:	1.26
		Avg. compensation per employee:	$94,500
Project Description:			
Redesign and reconfigure the workplace using the Integrated Workplace process. Project includes modest space alterations, improved access to natural light, collocation of functions, flexible furniture.		Annual turnover rate (%):	10.0%
		Employee turnover cost as percent of salary (%):	100.0%

People

Proposed project(s)	Suggested unit cost	Unit cost	Total cost	Unit cost	# of units	Total cost
___ work at home		___ X ___	_____	_____	_____	_____
___ work at telecenter		___ X ___	_____	_____	_____	_____
___ mass transit subsidies		___ X ___	_____	_____	_____	_____
___ teambuilding training		___ X ___	_____	_____	_____	_____
___ other (optional description) _____ _____		___ X ___	_____	_____	_____	_____

Estimated cost: $____ 0

Places

Proposed project(s)	Suggested unit cost	Unit cost		Total cost	Unit cost	# of units	Total cost
___ lighting upgrades		___	X ___	_____	_____	_____	_____
___ raised flooring		___	X ___	_____	_____	_____	_____
_X_workplace redesign		_____		___ X ___	_____	_____	$395,000
___ workplace renovation		___	X ___	_____	_____	_____	_____
___ other (optional description)		___	X ___	_____	_____	_____	_____

_____
_____

Estimated cost: $395,000

Tools

Proposed project(s)	Suggested unit cost	Unit cost		Total cost	Unit cost	# of units	Total cost
___ laptop		___	X ___	_____	_____	_____	_____
___ cell phone		___	X ___	_____	_____	_____	_____
___ internet access		___	X ___	_____	_____	_____	_____
___ IT upgrade		___	X ___	_____	_____	_____	_____
___ other (optional description)		___	X ___	_____	_____	_____	_____

_____
_____

Estimated cost: $____ 0

Results

Total cost of project(s):	$395,000
Increase in productivity required:	9.95%
OR	
New turnover rate required	N/A

Note: A turnover rate less than 5% is considered unlikely.

Observations and Recommendations

Observations and Recommendations

Observations from the Research

Our research into the areas of knowledge worker productivity and employee satisfaction was comprehensive, but it was necessarily at a high level analytically. As a policy office, we are responsible for identifying key trends and issues and making recommendations; we are not in the business of developing and proving academic hypotheses. Therefore, the following observations and recommendations are made in the spirit of helping our customers focus on the importance and impact of the workplace on agency mission and employee retention and productivity. A Federal agency's mission, culture, budget and environmental factors will continue to be major determinants of its business decisions.

- The workplace has an impact on employee recruitment, productivity, satisfaction and retention.
- Many organizations have invested heavily in Tools (mainly information technology) and possibly overlooked the importance of Places (the physical workplace environment) and People (organizational culture, work processes, work/life enhancements, amenities).
- People can enjoy themselves at work and still be productive; in fact, they may be more productive.
- Researchers may have overlooked Tools and People, in their zeal to uncover cause and effect relationships between the physical workplace and employee productivity.
- The Federal Government is in some ways on the cutting edge of the new workplace developments (information technology, universal Internet access) and in other ways painfully behind the times (slow to implement telework programs, less attractive office space environment).

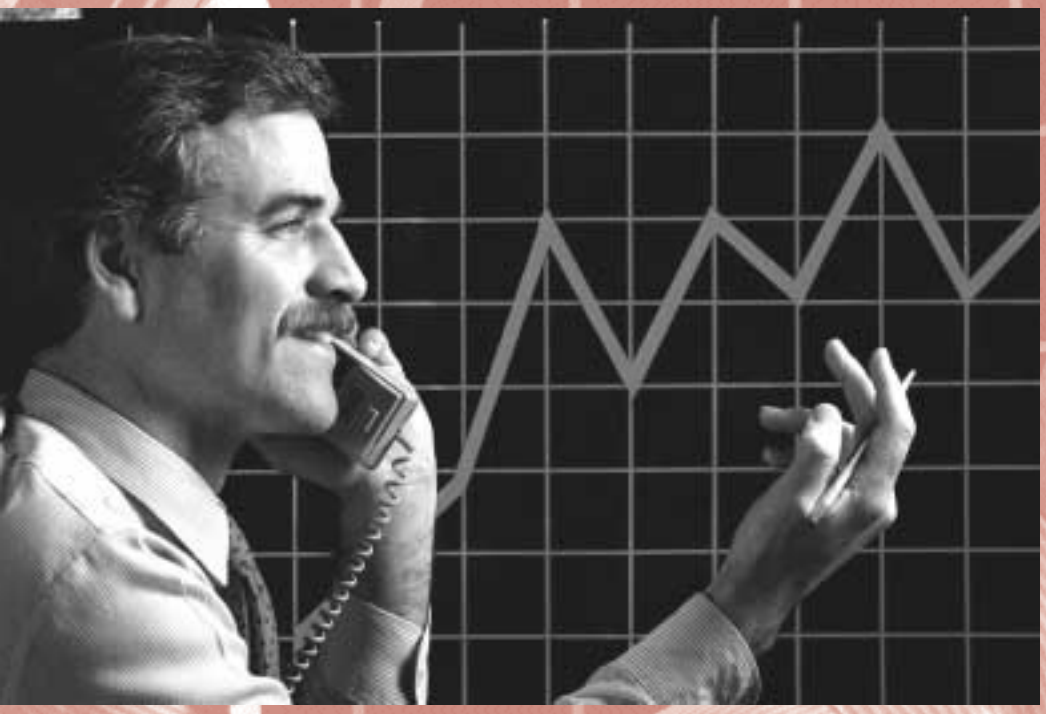
Recommendations for the Federal Government

- Regard your associates (employees) as your most important asset.
- Realize that the workplace has an impact on employee recruitment, productivity, satisfaction and retention, and that an investment in the workplace is really an investment in the people who work there.
- Measure accordingly. Reducing space standards and slashing rental costs are great budget decisions on paper, but may have disproportionately offsetting costs to your human capital. The effects of these decisions are played out in the workplace, not on a budget spreadsheet. Tools such as the GSA Cost per Person Model and the GSA Productivity Payback Model can help you get started in thinking about workplace measurement in 21st century terms.
- Upgrade your main office environment to maximize employee productivity and satisfaction. Use the Integrated Workplace process to maximize your investment.
- Make your workplaces green (sustainable). It's the right business decision, it's the desired direction for the Federal Government, and it's the right thing to do.
- Make full use of alternative work environments, especially telework programs. Keep in mind that alternative work environments are not necessarily linear replacements for main office environments, but an expansion of the workplace concept. Accordingly, the appropriate measure may not be cost but employee productivity and satisfaction. Use the GSA Cost per Person Model to get your analysis started.

Next Steps

- We will continue to collect data using the Workplace Analysis Survey. Please contact us to join this important data collection effort. Our research partners receive the benefit of more detailed results than those published in our studies.
- Upon completion of data collection, we will conduct a detailed statistical analysis of the survey data, and publish some of the results.
- Real Property Performance Results 2001 (December 2001) will be the next publication in our performance measurement series.
- We will collect more data in support of the GSA Cost per Person Model and plan to issue a new version of this popular spreadsheet tool in 2002.

Appendix A: Another Perspective on Productivity



Appendix A:
Another Perspective on Productivity

There are many researchers, consortia, professional organizations and academic institutions interested in the impact of the workplace on employee satisfaction and productivity. We are fortunate to present an original paper that examines the productivity effects of physical changes in the workplace environment.

Dr. James Woods is the Founding Director and President of HP-Woods Research Institute in Herndon, VA. The Institute is a not-for profit corporation dedicated to the advancement of healthy environments.

What is Productivity and How is it Measured?

by James Woods, Ph.D., PE

A Method to Measure Productivity and Building Performance

Introduction

Professionals who design, build and operate buildings, health experts, and building occupants agree that occupant well-being, performance, and productivity are linked to the quality of the indoor environment. However, in current literature, evidence that links human response and occupant performance to indoor exposures is not consistent. Moreover, the literature fails to consistently distinguish between occupant performance and productivity. The fundamental objectives of indoor environmental control are to prevent adverse health effects and to provide environmental conditions that are conducive to the well-being and performance of the occupants and to the productivity of the facility. To achieve these objectives, simultaneous control of thermal, indoor air quality, lighting, and acoustic exposures is required. These four primary environmental stressors affect human response collectively, as each is associated with physiological receptors in the body that integrate the perception of total exposure. Unfortunately, measurable and controllable values for this set of exposure parameters are not generally available as codes, standards, or guidelines. Rather, prescriptive and disaggregated criteria are promulgated such as ventilation rates, pressure differences, air flow rates, background noise levels, illuminance levels, and room air temperatures and relative humidities. As a result, indoor environments often fail to meet their expectations and, not infrequently, degrade to discomforting or deleterious conditions because the parameters

that are measured and controlled only indirectly relate to those that are perceived by the occupants.

In this article, the concepts of "Healthy Buildings," "Continuous Degradation," "Continuous Accountability," and "Building Diagnostics" are described; a model that distinguishes between measures of human response, performance and productivity is discussed; and methods for evaluating and classifying the performance of buildings are presented. The article concludes with an example of how these methods can be used to track and manage the quality of the indoor environment.

Healthy Buildings

The concept of "healthy buildings" is not new. When fire was first brought into caves for heat, light, security, and cooking, it was soon realized that exhaust ventilation was required. Glazing was first used ~1500 BC to enlarge usable indoor spaces by providing daylighting and reducing heat loss in occupied spaces. Operable windows were used extensively during the Renaissance Period, King Charles I may have promulgated the "first building code" in 1629 to minimize risk of incurring the plague in London, and carbon dioxide was first used ~1824 in Welch coal mines as an indicator of adequate ventilation. In the late 1800s, ventilation rates of 30 to 60 cubic feet per minute/person were promulgated in the U.S. to minimize the risk of disease (e.g., tuberculosis) in public assembly buildings. After World War II and until the energy shortages of the 1970s, architects and engineers designed systems to "maximize" comfort, as energy became plentiful and cheap in the U.S.

In the 1920s, an important bifurcation occurred in the methods by which indoor environments were evaluated. Two researchers at Harvard School of Public Health, Constantin Yaglou and Alice Hamilton, independently published works that established the bases for general ventilation (i.e., engineering) and exposure control (i.e., industrial hygiene). In the late 1970s, these concepts were again integrated through research published by the National Research Council and through promulgation of the ASHRAE Standard 62-1981: "Ventilation for Acceptable Indoor Air Quality." These documents provided information with which ventilation rates and exposure values could be rationalized. However, after twenty years, these criteria continue to be used separately:

- Outdoor air ventilation rates, which are easier to calculate than to measure, are typically used for design purposes;
- Exposure values, which are easier to measure than to calculate, are typically used for assessing indoor environments during operations.

During the last thirteen years, two basic definitions for healthy buildings have been proposed. At the first Healthy Buildings Conference, in Stockholm in 1988, Brigetta Berglund, et al. stated that, ideally, "healthy buildings are free from Building Related Illness and discomfort, promote well being and

health, and provide for: non-hazardous conditions, thermal comfort, pleasant air quality, illumination and acoustic satisfaction, social needs and productivity, and distinguished aesthetic qualities." In 1993, Woods, et al. proposed a pragmatic definition of healthy buildings in measurable and controllable terms. This definition states that "a healthy building minimizes occupant complaints and complies with 'acceptable criteria' for exposures, system performance and economic performance."

Continuous Degradation

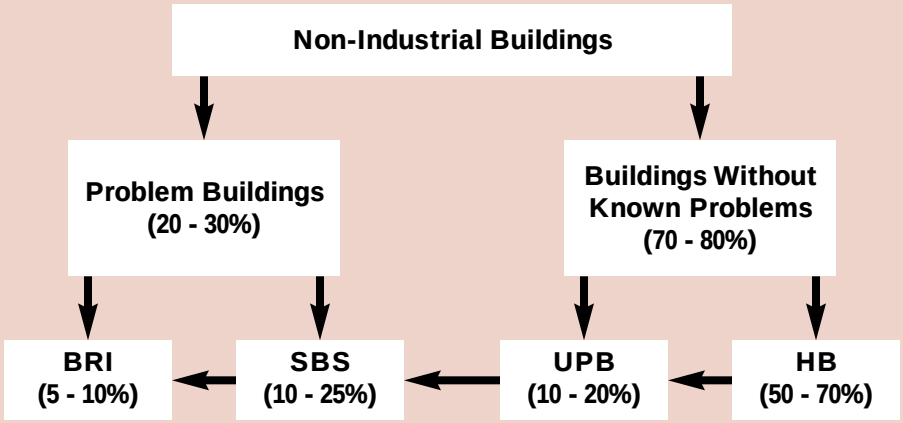
Today, approximately 100 million residential and nearly 5 million non-residential/ non-industrial buildings exist in the U.S. With an annual replacement rate of approximately 2 to 4 percent, it is anticipated that 80 to 90 percent of the buildings that will be in use in 2020 already exist. Current data also indicate that allergic rhinitis is the most common chronic disease in the U.S., asthma is the leading cause of school absences, and tuberculosis is the most lethal infection that occurs in health care facilities worldwide.

From studies that have been reported over the last 15 years (see Fig. 1), it is estimated that approximately 20-30% of the existing building stock has degraded to conditions that cause excessive rates of occupant symptoms (i.e., Sick Building Syndrome, SBS) or illness (i.e., Building Related Illness, BRI). It is also estimated that 10-20% of the building stock has undetected problems (UPB), leaving a residual population of 50-70% of potentially "healthy buildings" (HB).

The consequences of not detecting or intervening in the continuous degradation process can be significant. Results of research and litigation indicate that when a building has degraded to the Problem Building classification the following can be expected:

- More than 20% of the occupants will have acute discomfort complaints (i.e., symptoms).
- More than 20% of the occupants will report hampered performance.
- More than 50% of the occupants will report loss of confidence in management.

Figure 1. Concept of Continuous Degradation



Sick Building Syndrome has been defined by the Building Research Board and by the U.S. EPA as a building or area within it in which a substantial percentage of occupants (i.e., more than 20%) are affected by a set of symptoms that persist for at least two weeks, the symptoms dissipate soon after exiting the building, and the cause or causes are unknown.

Building Related Illness has been defined by the Building Research Board and by the U.S. EPA as a building or area within it in which clinical signs of illness exist in more than one occupant and the illness has been diagnosed as building related.

- The cost of recovering "good will" of the facility from SBS may exceed the cost of mitigation.
- The cost of recovering "good will" of the facility from BRI, including insurance and litigation costs, may exceed the original cost of the facility.

Continuous Accountability

Degradation of building performance can be intercepted and healthy building performance can be assured through a process involving building diagnostics, intervention, and quality assurance measurements. This process may be considered as "Continuous Accountability," a concept that was introduced in 1990 at the Fifth International Conference in Indoor Air Quality and Climate. The Continuous Accountability cycle begins at the planning and conceptual design phase of a building when the Accountable Person (i.e., owner, financier, or planner) sets the measurable and controllable building performance criteria. During the design process, the Accountable Person (i.e., designer or builder) translates the performance criteria to prescriptive criteria, drawings and specifications. During the commissioning and substantial completion period, the Accountable Person (i.e., owner) evaluates the delivered building for compliance with the performance criteria. During the occupancy period, the Accountable Person (i.e., owner, tenant, or occupant) assures continued compliance with the performance criteria. When the function of the space requires change, the cycle repeats.

For the Continuous Accountability cycle to be effective, three commitments are required:

- An Accountable Person must be identified for each phase in the building's life.
- Each Accountable Person must be empowered with authority to assure building performance.
- Each Accountable Person must be educated and trained to assure adequate building performance and occupant protection.

Building Diagnostics

The concept of building diagnostics was introduced in 1985 by the Building Research Board of the National Research Council as a means by which the performance of a building can be evaluated. This concept, which was derived from the principles of medical diagnostics, was defined as "a process in which a skilled expert draws on available knowledge, techniques, and instrumentation in order to predict a building's likely performance over time." This process consists of four essential elements:

1. A knowledge of what to measure.
2. Availability of appropriate instrumentation.
3. Expertise in interpreting the measurements.
4. Capability of predicting likely performance over time.

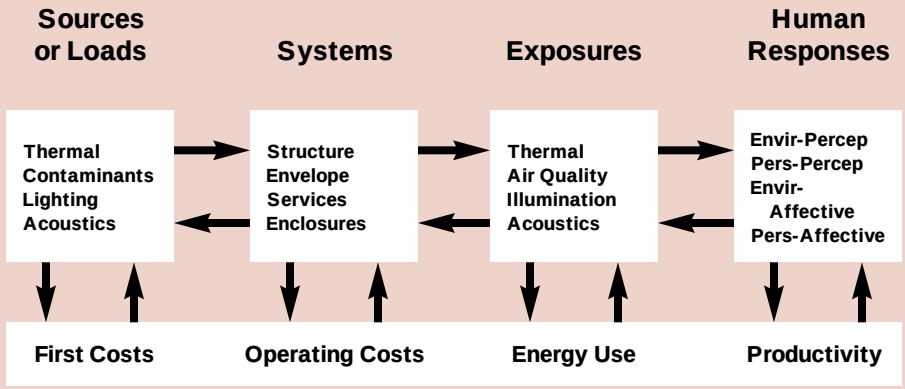
The evolving concepts of building diagnostics now incorporate three phases of investigation:

1. Observation from which preliminary hypotheses are formed.
2. System Analysis through which the preliminary hypotheses are tested.

3. Exposure Analysis through which the hypotheses are validated or refuted with quantitative data.

These procedures may be used to diagnose the performance of a building and its systems at any stage of its life cycle, from planning, design, and construction (i.e., "virtual building") through commissioning, occupancy, and renovation (i.e., "actual building"). During the building diagnostic process, hypotheses should be written in terms of "three related S's": Sources, Systems, and Symptoms. As in medical diagnostics, the focus of the building diagnostic procedure should be to evaluate and classify.

Figure 2. Rational Model



Evaluation and Classification Criteria

In order to achieve this focus and to effectively use the four essential elements through the three phases of building diagnostics for virtual and actual buildings, a set of evaluation and classification criteria is required that is valid and reliable at each phase of the building's life (i.e., planning, design, construction, and operations).

Evaluation Criteria. As a basis for defining the evaluation criteria, a rational model was introduced in 1993 at the Sixth International Conference on Indoor Air Quality and Climate. An extension of this model was introduced in 1997 at the Fifth International Conference on Healthy Buildings to distinguish between measures of human response, occupant performance, and productivity. A third model for defining building energy efficiency was first presented in 1984 and reintroduced at the Seventeenth International Conference on Passive and Low Energy Architecture in 1998.

As shown in Fig. 2, the rational model relates aspects of human responses to the four primary environmental stressors (i.e., exposures). These, in turn, are linked to four types of systems that control the loads or sources related to the exposures. This classic epidemiological model rests on an economic platform that interacts with each of the other elements in the model.

The model recognizes that the primary control objective is to achieve desired human response. In this rational model, four domains of human response have been defined, consisting of two objects of response (i.e., the environment and the person) and two aspects of response (i.e., perception, and affect or judgment). The environmental-affective domain, which includes responses such as "acceptability" or "preference," is often the basis for design criteria (e.g., codes and standards) and for assuring healthy building performance as it tends to minimize

the probability of incurring false-positive errors. Conversely, the personal-perceptual domain, which includes responses such as complaints (e.g., I'm hot) or symptoms (e.g., I have a headache), should be the focus for investigations of occupant complaints as it tends to minimize the probability of incurring false-negative errors in building diagnostics.

This rational model also recognizes that direct control of human response is not feasible from a building perspective, and that control of exposure parameters that closely correlate to desired human responses is required.

For healthy building performance, two economic criteria are also recommended:

- The building energy efficiency should be maintained at 80 percent. (Building energy efficiency has been defined as the ratio of energy required to provide the specified exposure criteria to the energy consumed for this purpose. Thus, energy efficiency focuses on minimizing energy waste rather than minimizing energy consumption.)
- The building's life-cycle costs should be minimized wherein comparison of alternatives includes weighting for productivity improvements in the environment (e.g., cost of salaries).

As shown in Fig. 3, the extended rational model provides an improved framework with which to define and measure the economic performance of the building. This extended model incorporates the five components of the rational model: human responses, exposures, building systems, sources, and economic factors. However, four changes have been made. First, two sets of human factors that influence human response have been added: personal factors and social factors. Second, "occupant performance" has been distinguished from "human responses." Third, another set of human factors, referred to as "motivating factors" that can be expected to influence occupant performance, has been introduced. Fourth, cost factors have been identified which, together with occupant performance, define productivity.

Thus, in accordance with the extended model, occupant performance is defined as the outcome of the interaction of human responses and motivating factors, which include economic motivators (e.g., salary) and other motivators (e.g., professional development). Occupant performance should be distinguished and measured for short-term occupants (e.g., clients being served within an office, attendees in a conference room) and for long-term occupants (e.g., professionals serving clients, staff). Measures of occupant performance are usually site-specific for the tenants of the facility. Examples of evaluation criteria for occupant performance include percent change in achievement of clients, self-reported hampered performance of staff, medical visits/year, and percentage of absences.

Also, in accordance with the extended model, productivity related to the indoor environment is a transformed measure of occupant performance, expressed in economic terms. Thus "productivity" is defined as "the value of the change in

occupant performance compared to the costs of achieving that change." It is this quantitative expression that can be used to evaluate the cost of improving indoor environmental quality by quantifying the expected cost reductions associated with measurable improvements in occupant performance. An example of a measurable productivity parameter is the reduction in the cost of salaries and wages for substitute workers due to reduction in sick leave of permanent staff, compared to costs of improved maintenance of exposure and system performance.

At the Fourth International Conference on Healthy Buildings in 1995, a set of classification criteria was introduced:

Healthy Category

H2: Compliance with all evaluation criteria (enhanced performance and productivity).

H1: Compliance with all evaluation criteria (transparent performance).

Marginal Category

M3: Non-compliance with economic criteria.

M2: Non-compliance with system performance criteria.

M1: Non-compliance with exposure criteria.

Problematic Category

P3: Non-compliance with discomfort criteria

P2: Non-compliance with symptom criteria.

P1: Non-compliance with illness criteria.

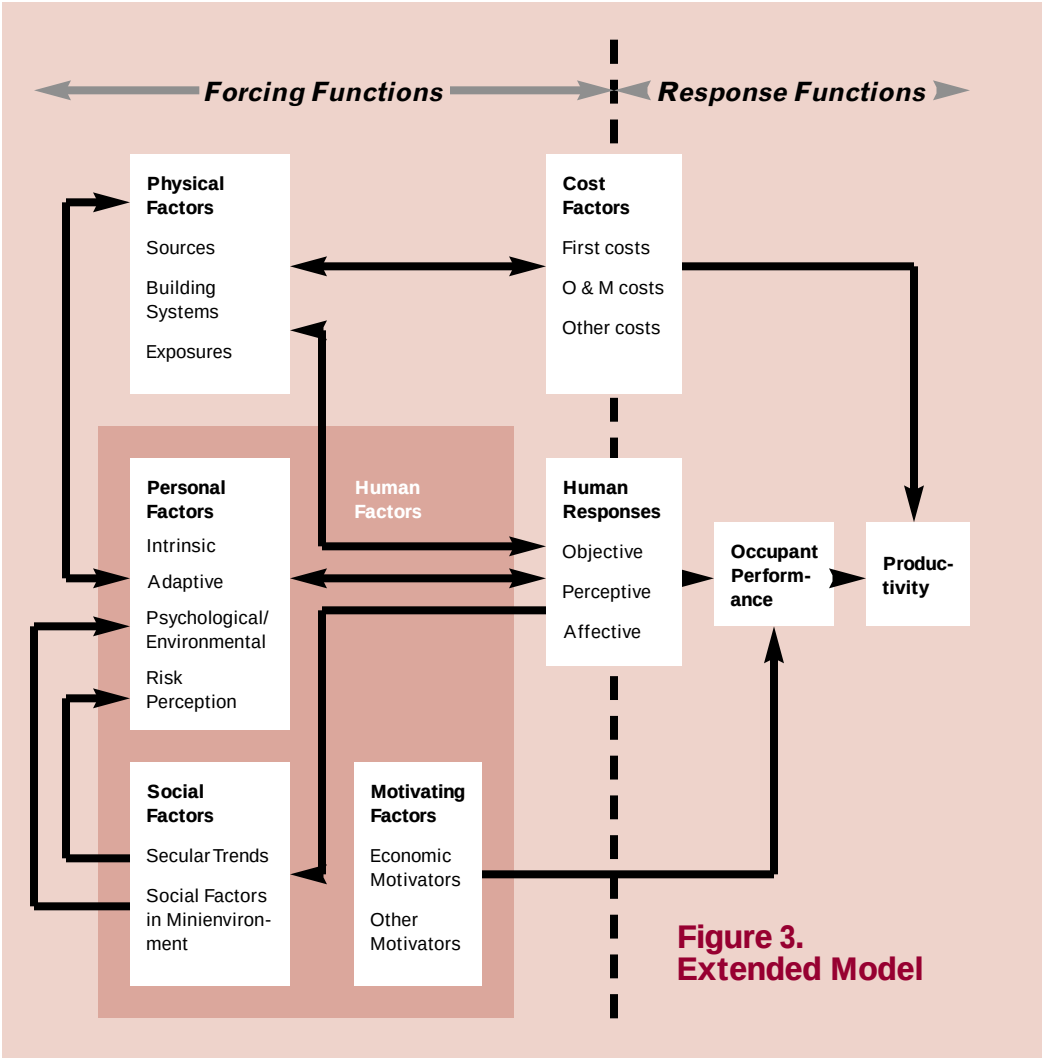


Figure 3. Extended Model

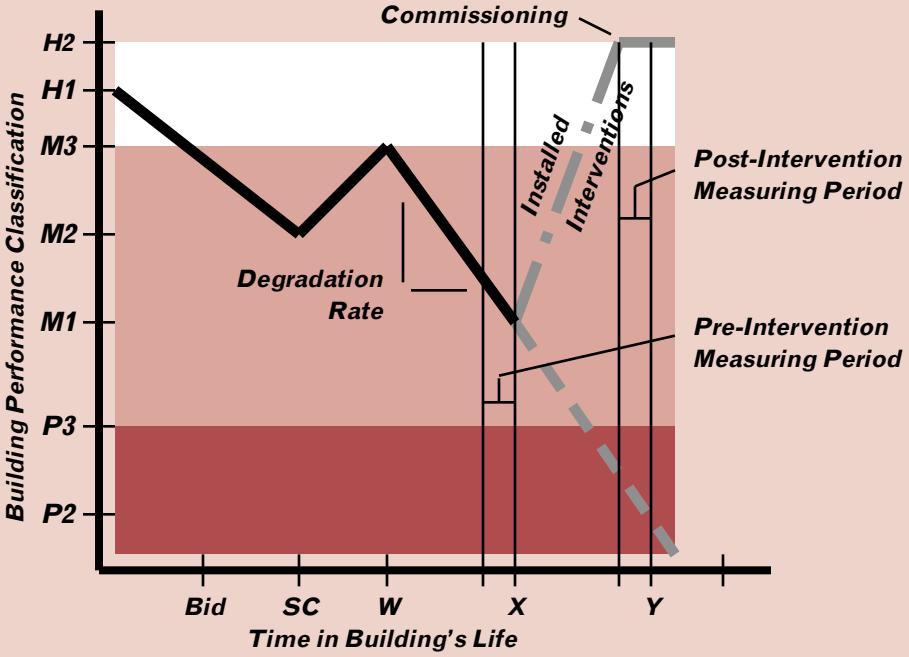
Managing Indoor Environmental Quality

Application of building diagnostic principles, including the use of evaluation and classification criteria, is useful in assuring the performance of a building in its design phases (i.e., virtual building) as well as its operational phases (i.e., actual building). One application is the use of a Building Performance Chronology Chart, which was introduced at the Fifth International

Conference on Healthy Buildings in 1997. An example of its use shown in Fig. 4:

- During the design period, degradation occurred from H1 to M3 at bid date.
- During construction degradation continued to M2 at the time of substantial completion (SC).
- During the warranty period, performance was improved to M3 at time (W).
- After warranty, degradation during operations recurred to M1 at time (X).
- System intervention occurred a X and performance to H2 was achieved, commissioned and sustained.

Figure 4. Chronology of Building Performance



Conclusions

The concepts and models presented here have been used to define evaluation and classification criteria in practice and in on-going research projects. The key to success in the approach described in this article is to define a set of objective criteria with which to evaluate and classify building performance according to compliance with these criteria. This approach also allows a clear distinction between measures of human responses (P1 to P3) and occupant performance (H1 and H2) in the overall assessment of building performance. Finally, this approach allows for a clear distinction between occupant performance and productivity. As the results of using the set of evaluation and classification criteria in the management of building performance become available, it is anticipated that a credible and quantitative database will evolve.

This database will be useful in making future design and operations decisions, which can, in turn, improve the health and well-being of building occupants while increasing the productivity of owning and operating these facilities.

Appendix B: GSA Workplace Analysis Study

Appendix B:
GSA Workplace Analysis Survey

GSA's Office of Real Property developed the Workplace Performance Model to help us focus our research on high performing 21st century workplaces.

Please take a few minutes to support our research by completing this workplace analysis.

1. Background Information

Name (optional) _____

Company/Agency: _____

Department or Business Line: _____

Sector (circle one): Private Gov't Academic Non-profit

2. Which of the following People factors are characteristic of your workplace?

____Work at home options
____Telecenter options
____Hotelling options
____Satellite office options
____Mass transit subsidies
____Flexible work schedule
____Supports work/life balance
____High customer contact
____Organized into work teams
____Mostly independent work
____Competitive pay
____Competitive benefits
____Personal job security
____Right training provided

____Centralized management
____Decentralized management
____Strong Union presence
____Employees are empowered
____Open communication
____High turnover
____Frequent moves
____Recent downsizing
____Expected downsizing
____Diverse workforce
____Expanding workforce
____Aging workforce
____Space standards enforced
____Space allocated fairly

3. Which of the following Tools factors are characteristic of your workplace?

____Desktop computer
____Docking station
____Laptop computer
____LAN connection (wired)
____LAN connection (modem)
____Microsoft Windows operating system
____Non-Microsoft operating system
____Internet access
____E-mail
____Personal digital assistant

____Desk phone
____Cell phone
____Pager
____Voice mail
____Phone card
____Fax
____Copier
____Printer
____Corporate charge card
____Company car available

4. Which of the following Places factors are characteristic of your workplace?

____Private office
____Cubicle
____Bullpen/open space
____Shared or team space
____Desk sharing
____Near a window
____Away from a window
____No natural light
____Movable systems furniture
____Fixed systems furniture
____Executive furniture
____Plug/play connections in floor
____Personal control of temp./airflow
____Overhead lighting
____Task lighting
____Raised flooring
____Sound masking
____Carpeted floor
____Tile floor
____Plaster ceiling
____Acoustic ceiling

____New or renovated space
____Located in historic building
____Suburban location
____Downtown or CBD location
____Other urban location
____General office setting
____Research & Dev. setting
____Secure environment
____Open public access
____Cafeteria
____Lounges/cafes
____Exercise facility
____Shower facilities
____Bicycle racks
____Bank/Credit Union/ATM
____Vending machines
____Retail services
____Travel services
____Child care on site
____Environment-friendly
____Recycling capability

5. Please answer the following questions based on your understanding of the People, Places and Tools factors as listed in the previous three sections:

A) Please rate your personal satisfaction with how well your workplace addresses the **People** factors:

____Very dissatisfied
____Dissatisfied
____Neither satisfied nor dissatisfied
____Satisfied
____Very satisfied

B) Please rate your personal satisfaction with how well your workplace addresses the **Places** factors:

____Very dissatisfied
____Dissatisfied
____Neither satisfied nor dissatisfied
____Satisfied
____Very satisfied

C) Please rate your personal satisfaction with how well your workplace addresses the **Tools** factors:

____Very dissatisfied
____Dissatisfied
____Neither satisfied nor dissatisfied
____Satisfied
____Very satisfied

D) If you could change jobs tomorrow, to what extent would the People, Places and Tools factors listed in this survey impact your decision?

People	**Places**	**Tools**
____To no extent	____To no extent	____To no extent
____To a small extent	____To a small extent	____To a small extent
____To a moderate extent	____To a moderate extent	____To a moderate extent
____To a great extent	____To a great extent	____To a great extent
____To a very great extent	____To a very great extent	____To a very great extent

E) Suppose your organization decided to invest in a multi-million dollar effort to improve employee job satisfaction. Please allocate by percentage where the money should be spent on improvements (the 3 percentages should add to 100):

____ **People** component ____ **Places** component ____ **Tools** component

F) Suppose your organization decided to invest in a multi-million dollar effort to improve productivity. Please allocate by percentage where the money should be spent on improvements (the 3 percentages should add to 100):

____ **People** component ____ **Places** component ____ **Tools** component

6. Your comments? (please use a separate sheet if needed)

_____

_____

_____

_____

Please fax your finished workplace analysis back to the GSA Office of Real Property at (202) 219-0104. Thank you for participating in the development of GSA's Workplace Performance Model! Questions? Contact Ron Whitley at (202) 501-1505.

Appendix C:
Summaries of Projects in Research Matrix

Appendix C: Summaries of Projects in Research Matrix

In support of Productivity and the Workplace, we asked the Logistics Management Institute (LMI) to conduct a search of existing studies and publications that cite increases in employee productivity and other effects that can be attributed to improvements in the workplace environment and to provide summaries of those articles. This information is summarized in the Productivity Research Matrix reproduced earlier in this publication and included in the spreadsheet version of the Productivity Payback Model. This appendix provides more detailed information on the studies summarized in the matrix.

Readers should bear in mind that the claimed increases in productivity, ranging from 2 to 75 percent, are organization-specific and not directly comparable between studies. Each organization chooses to measure productivity in a way that makes sense for the business or mission of the specific organizational unit. For example, in the matrix studies themselves we find a wide range of productivity measures including:

- Reduction in absenteeism
- Dollar value of increased output
- More output per same FTE
- Same output from less FTE
- Reduction in error rate
- Reduction in claims
- Self-reported (subjective) productivity improvement
- Decreased project cycle or case work time
- Reduction in formal meeting time
- Reduction in duplicated files
- Reduction in overtime costs
- Reduced turnover rate

Note: Referenced websites were valid as this publication went to press.

Item: No. 1

Source: Volinski, Joel, Synthesis of Transit Practice 33: Practices in Assuring Employee Availability, National Academy of Sciences, Transportation Research Board (TRB) (Washington DC: National Academy Press, 1999) [online document cited November 2000], p. 23. Available from http://www.nationalacademies.org/trb/publications/tcrp/tsyn33.pdf.

Category: People

Key findings: Reduction in sick leave by 5.48 sick days per employee per year, translated into a productivity improvement of 15.37 person-years of work.

Exec. summary: The TRB was established to assist the transit industry with developing innovative solutions to meet industry demands. Research conducted by TRB is the primary vehicle for providing assistance to the transportation industry. The TRB has conducted much research directed at improving employee availability assurance for the transit industry. Much of this research pertains to workplace enhancements and their specific impact on productivity and related items.

This source consolidates some of the vast amount of knowledge, best practices, and research pertaining to employee absenteeism. One example is a program instituted by Dekalb County in Georgia to encourage employees to reduce their use of sick leave. The program rewarded employees who accrued a minimum of 30 days of sick leave with a monetary award of 25 percent of the accrued days, leaving the other 75 percent of the days to be accrued for the next year. From 1983 to 1987, Dekalb experienced a reduction of 5.48 days of sick leave used per employee, which amounts to a productivity improvement of an estimated 15.37 person-years of work for the organization.

The 2.2 percent increase in productivity reflected in the matrix is calculated by dividing 5.48 sick days by 250 workdays per year.

Item: No. 2

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 7. Available from http://www.asid.org.

Category: Places

Key findings: Increase in productivity equal to 3 percent of total annual salaries of a company's employees.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. ASID and its partners published Impact of Interior Design on the Bottom Line to summarize their findings.

The ASID paper references an article published by INSITE magazine in which the president of the Buffalo Organization for Social and Technological Innovations (BOSTI) estimated that increased productivity resulting from a reorganization of the physical workspace had a dollar value of 3 percent of the total annual salaries of the company's employees.

Item: No. 3

Source: Facilitiesnet.com, "Case Studies: A Special Report from the National Lighting Bureau" [online document], cited December 26, 2000, p.8. Available from http://www.facilitiesnet.com/fn/NS/NS2i0db.html/ticket=123456789012345678911345813 9 or by accessing www.facilitiesnet.com/fn, newsstand, industry reports, lighting/case studies.

Category: Places

Key findings: Productivity increase of 5 percent and more than $1.9 million in annual cost savings.

Exec. summary: Facilities.net is a web site providing industry news and links to industry information for facilities professionals.

This source cited a case in which, 18 months after installing an $8,000 high-benefit lighting system, Metal Industries, Inc., of Elizabeth, PA, achieved annual cost savings of $1,911,140. Of the total savings, $1.5 million is due to a minimum of 5 percent increase in productivity, $200,000 is due to a reduced reject rate, $3,000 is due to a reduction in accidents, and $3,000 is due to a reduction in the cost of insurance premiums.

Item: No. 4

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, 1997, p. 12. Also available from http://www.asid.org.

General Services Administration (GSA), An Overview: The Integrated Workplace: A Comprehensive Approach to Developing Workspace. May 1999, p. 30. Also available from http://gsa.gov/.

Category: Places

Key findings: Up to 6 percent increase in worker productivity and 8 to 45 percent reduction in absenteeism due to improved thermal comfort, lighting, acoustics, and indoor air.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. ASID and its partners published Impact of Interior Design on the Bottom Line to summarize their findings. The ASID paper states that Rocky Mountain Institute in Snowmass, CO, reported employee gains of 6 to 16 percent, with reduced absenteeism, by improving lighting as part of an overall energy management program.

The GSA report cites a Rocky Mountain Institute study that found that worker productivity could be increased up to 6 percent and absenteeism reduced by 8 to 45 percent by improving thermal comfort, lighting, acoustics, and indoor air. GSA sites an ABSIC paper, "The Greening of DEP" (Kulp Boeker Architects, 1998) as the original source of this information.

Item: No. 5

Source: Facilitiesnet.com, "Case Studies: A Special Report from the National Lighting Bureau," [online document cited December 26, 2000], pp. 1–2. Available from http://www.facilitiesnet.com/fn/NS/NS2i0db.html/ticket=12345678901234567891134581 39 or by accessing www.facilitiesnet.com/fn, newsstand, industry reports, lighting/case studies.

Category: Places

Key findings: Productivity increase of 6 percent and first year total savings of $235,290.

Exec. summary: Facilities.net is a web site providing industry news and links to industry information for facilities professionals.

This source cited a case in which Pacific Gas and Electric, Control Data Corp, of Sunnyvale, CA, recognized a 6 percent productivity improvement after installing a new

lighting system that reduced screen glare. By spending $14,890, the organization saved $235,290 in 1 year: $28,000 due to productivity improvements, $200,000 due to reduced errors, and $7,290 due to reduced maintenance costs.

Item: No. 6

Source: American Society of Interior Designers (ASID), Increasing Office Productivity Through Integrated Acoustic Planning and Noise Reduction Strategies, p. 8. Also available from http://www.asid.org.

"Bottom-line Contributions of a High Performance Building" Corporate Real Estate Executive, October 1996, pp. 38–41.

Romm, Joseph, Lean and Clean Management, 1994, pp. xv–xviii.

Category: Places

Key findings: Productivity increase of 6 to 8 percent due to improvements in lighting and annual cost savings totaling between $450,000 and $550,000.

Exec. summary: ASID and four industry partners—Armstrong, Dynasound, Milliken, and Steelcase—are working together to develop methods for reducing workplace noise and distractions and to improve acoustics to boost employee productivity. They published Increasing Office Productivity Through Integrated Acoustic Planning and Noise Reduction Strategies to summarize key findings from research studies correlating worker productivity and workplace noise.

The ASID paper cited an Armstrong-led study involving five major companies. That study found that "more than 80 percent of workers believed they would be more productive if their workspace provided more acoustical privacy."

The ASID paper also cited a renovation project at the Reno, NV, Post Office in which the lighting system was improved and a lowered, acoustical ceiling was installed. Twenty weeks after the project was completed, the Post Office reported an 8 percent increase in mail sorting productivity.

Two other sources—"Bottom-line Contribution of a High Performance Building" and Lean and Clean Management—also cited the Reno, NV, Post Office project. The former stated that the renovation resulted in a 6 percent increase in productivity equating to a $400,000 cost savings and generated an annual cost savings of $50,000 in energy and

maintenance costs. The latter noted that the improvements resulted in an 8 percent increase in productivity 20 weeks after making the improvements. The Post Office estimates that $400,000 to $500,000 a year in cost savings can be attributed to the increased productivity, which leveled off to 6 percent. Lean and Clean Management also noted that the Post Office recognized approximately $50,000 a year in energy and maintenance cost savings.

Item: No. 7

Source: Columbia Business School, Studies in Technology and Productivity in the Service Sector, Multinational Bank Funds Transfer Network [online document, cited December 2000]. Available from http://www.cs.columbia.edu/~michael/cases.html.

Category: Tools

Key findings: Productivity increase of 8 percent attributed to change in mainframes.

Exec. summary: The Columbia Business School established Studies in Technology and Productivity in the Service Sector in 1992 to use case studies for evaluating productivity within service-sector organizations.

This source is a case study of the Global Funds Transfer Network (GFTN). In 1988, in an effort to control costs, the organization shifted from a Digital Equipment Corporation PDP/11 and IBM mainframe to a VAX. By converting platforms, the organization reduced costs per transaction from $5.83 to $2.91. In addition, GFTN restructured, reducing staffing 7 percent between 1988 and 1993 for an estimated savings of $8.2 million.

Despite a 7 percent annual increase in transactions, GFTN was able to reduce the FTEs by 4 percent a year while reducing the number of errors by a factor of 5. The total effect is an estimated 8 percent increase in productivity.

Item: No. 8

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 7. Also available from http://www.asid.org.

Category: Places

Key findings: Decrease of 137 percent in time required to process paperwork, 9 percent drop in errors and defective claims, and drop in absenteeism to 1.6 percent from 4.4 percent.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. ASID and its partners published Impact of Interior Design on the Bottom Line to summarize their findings.

The ASID paper references a case study about a Detroit-based insurance company that "designed its new office to incorporate team structures, ergonomic furniture, improved privacy and new, state-of-the-art environmental systems. Pre- and post-occupancy evaluations showed a 137 percent decrease in time required to process client paperwork, a 9 percent drop in errors and defective claims, and a drop in absenteeism to 1.6 percent from 4.4 percent."

Item: No. 9

Source: Facilitiesnet.com, "Case Studies: A Special Report from the National Lighting Bureau" [online document, cited December 26, 2000], p.1. Available from http://www.facilitiesnet.com/fn/NS/NS2i0db.html/ticket=12345678901234567891134581 39 or by accessing www.facilitiesnet.com/fn, newsstand, industry reports, lighting/case studies.

Category: Places

Key findings: Productivity increase of 3 to 15 percent and annual cost savings of $24,000.

Exec. summary: Facilities.net is a web site providing industry news and links to industry information for facilities professionals.

This source cited a case in which the federal government and employees of the San Diego Federal Building and Courthouse improved productivity, safety, security, and energy efficiency, after investing $1.3 million in new high-benefit lighting. Productivity improved 3 percent in office areas and 15 percent in the courthouse, prison, and post office spaces. The productivity improvements resulted in an estimated cost savings of $24,000 per year. In addition, new lighting in the parking areas resulted in a reduction in thefts, saving $7,500 per year plus an additional $7,740 per year by reducing the investigation costs of the thefts.

Item: No. 10

Source: General Services Administration (GSA), An Overview: The Integrated Workplace: A Comprehensive Approach to Developing Workspace, May 1999, p. 30. Also available from http://gsa.gov/.

Category: Places

Key findings: Indoor environments can affect human performance from 5 to 15 percent.

Exec. summary: This GSA report highlights the benefits of creating an integrated workplace, defined as a "workplace that:

- is designed to support the office mission and the strategic plan of the organization,
- serves the needs and work practices of the employees,
- can be quickly and inexpensively adjusted by the user to maximize his or her productivity and satisfaction,
- is comfortable, efficient, and technologically advanced and allows people to accomplish their work in the most efficient way,
- meets the office's need and justifies its cost through benefits gained."

One of the benefits of an integrated workplace is improved worker productivity. The report states that the workplace environment affects performance. To support this statement, the report cites the findings of several research studies pertaining to the workplace environment and worker productivity.

One supporting finding by Johnson Controls revealed that "indoor environments can affect human performance 5 to 15 percent." The report did not provide any additional details about this statement. The Johnson Controls information was originally cited in Indoor Environmental Effects on Productivity, done in 1996 by David P. Wyon.

Item: No. 11

Source: Romm, Joseph, Lean and Clean Management, 1994, p. 93.

Category: Places

Key findings: Productivity increase of 11.3 percent due to lighting upgrade to indirect, low-energy lighting and natural light.

Exec. summary: Lean and Clean Management demonstrates how promoting energy efficiency can impact an organization's bottom line by increasing both productivity and profits. The book uses case studies to show the process and building improvements and the associated benefits.

The book cites results from lighting system upgrades conducted by Superior Die Set Corporation in Oak Creek,

WI. The upgrade cost just under $3,000 and included an improved lighting system along with occupancy sensors. The company recognized energy and maintenance savings of $1,750 per year. It also recognized an increase in productivity of more than 11.3 percent, resulting in total annual cost savings of more than $45,000.

Item: No. 12

Source: American Society of Interior Designers (ASID), Increasing Office Productivity Through Integrated Acoustic Planning and Noise Reduction Strategies, pp. 9–10. Also available from http://www.asid.org.

Category: Places

Key findings: Productivity increase of 13 percent resulting from acoustical improvements.

Exec. summary: ASID and four industry partners—Armstrong, Dynasound, Milliken, and Steelcase—are working together to develop methods for reducing workplace noise and distractions and improving acoustics to boost employee productivity. They published Increasing Office Productivity Through Integrated Acoustic Planning and Noise Reduction Strategies to summarize key findings from research studies correlating worker productivity and workplace noise.

In research conducted by Armstrong, 73 percent of workers identified background conversations as the primary acoustic distraction. Such distractions were attributed to decreasing worker productivity.

According to industry research, changing the office design can reduce the problem associated with acoustic distractions. Increased privacy, resulting in increased productivity, can be achieved through design changes such as the improving ceiling systems, rearranging office furniture, installing sound systems, and carpeting floors. The Armstrong research also revealed a self-reported 13 percent increase in productivity as a result of changing the workplace design to reduce normal background noise.

Item: No. 13

Source: Bachner, John Phillip, “Heaven’s ABOVE: How Better Lighting Can Benefit Office Productivity,” National Lighting Bureau (NLB) [online document, cited December 26, 2000]. Available from http://www.nlb.org/publications/art_heaven.html.

Co-op America, "Success Stories about Smart Green Offices" [online document, cited December 6, 2000]. Available from http://www.coopamerica.org/business/sgo_stories.htm.

Facilitiesnet.com, "Case Studies: A Special Report from the National Lighting Bureau" [online document, cited December 26, 2000], p.2. Available from http://www.facilitiesnet.com/fn/NS/NS2i0db.html/ticket=123456789012345678911345813 9 or by accessing www.facilitiesnet.com/fn, newsstand, industry reports, lighting/case studies.

Romm, Joseph, Lean and Clean Management, 1994, pp. 90–92.

Category: Places

Key findings: Productivity increase of 13.2 percent, 25 percent decline in sick leave, 69 percent decrease in lighting energy, and 73 percent reduction in annual operating costs.

Exec. summary: The NLB article cites a Pennsylvania Power and Light (PP&L) project in which it installed new lighting in the general office complex. The new lighting, high-benefit lighting, was originally designed to conserve energy. However, after installing the lighting, PP&L recognized a 13.2 percent increase in productivity, a significant decrease in the number of errors, and a reduction in sick leave taken. These changes resulted in total company savings of almost $245,000 per year, of which only $7,300 is attributed to energy consumption savings.

` The NLB article also noted the benefits recognized by the Operations Group of Control Data in Sunnyvale, CA. This company installed an upgraded lighting system and realized savings of $7,300 due to reduced energy consumption, $28,000 due to increased productivity, and $200,000 due to fewer input errors.

The NLB is a nonprofit organization founded in 1976 to educate lighting decision-makers about the bottom-line benefits they can derive for their organizations—whether industrial, commercial, retail, or institutional—by specifying high-benefit lighting.

The article on the Co-op America web site also cited PP&L's findings. The article notes the benefits PP&L recognized after installing high-efficiency lamps and ballasts, rearranging the lighting, installing glare-reducing louvers, and installing local controls that allow employees

working after hours or on weekends to use lights only in their area to conserve energy. The total cost of the improvement was $8,362.

PP&L recognized many benefits by altering the workspace lighting. The benefits included a 25 percent decrease in sick leave due to the reduction in eye strain caused by the old lighting system, as well as a 13 percent increase in productivity due to a decrease in errors and in the time spent per task. PP&L also experienced a 69 percent decrease in lighting energy consumption and a 73 percent decrease in total annual operating costs, resulting in a payback period of 69 days.

Co-op America is a membership organization dedicated to promoting "green" practices in private and business life.

An article from the facilitiesnet.com web site cited the cost anticipated by PP&L after updating the lighting system of one workspace area. According to that article, PP&L's new lighting system for its drafting room in Allentown, PA, cost $49,000 to install. PP&L projected a productivity cost savings of $235,000 each year as well as a reduction in operation and maintenance cost of more than $9,000 annually. Facilities.net is a web site providing industry news and links to industry information for facilities professionals.

Lean and Clean Management stated that PP&L recognized a 69 percent decrease in energy use attributed to the new lighting system. PP&L's operating costs fell 73 percent, productivity increased 13.2 percent, and absenteeism decreased by 25 percent. Total annual cost savings attributed to the new lighting system was $44,275.

Item: No. 14

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 5. Also available from http://www.asid.org.

Category: Places

Key findings: Increase in productivity of 10 to 20 percent as a result of a high quality office environment.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. Impact of Interior Design on the Bottom Line summarizes their findings.

During the first annual National Summit for Building Performance, held in November 1996, ASID conducted a survey of more than 300 summit attendees on their opinions about the impact of the work environment. These attendees included corporate and government executives, design professionals, and product manufacturers. The survey results showed that "summit attendees overwhelmingly agreed that high-quality office environments can increase employee productivity by 10 to 20 percent."

These results prompted ASID and its industry partners to further investigate the relationship between improved office design and employee productivity. In late 1996 and early 1997, an independent firm administered the "ASID 200" telephone survey to 100 "fast growing small and mid-sized firms" and 100 companies from the 1,000 largest corporations. This survey found the following:

Of the "ASID 200" respondents, 90 percent said that improving interior design can boost productivity.

Business decision-makers ranked improving office design and incorporating new technology at the top of their lists of ways to boost productivity.

Of the "ASID 200" respondents, 42 percent stated they increased employee productivity and employee comfort by changing office design including furniture and desk configurations, lighting, and aesthetics.

Item: No. 15

Source: Townsend, Amy, "What Is a Green Office?" [online document, cited November 2000]. Available from http://www.coopamerica.org/business/sgo_whatis.htm.

Category: Places

Key findings: Productivity increase of 15 percent, 15 percent decrease in absenteeism, and $300,000 to $400,000 in energy savings.

Exec. summary: Co-op America is a membership organization dedicated to promoting "green" practices in private and business life. The web site promotes the use of low-energy lighting, noise reduction, recycling, and other green strategies for the workplace.

"What Is a Green Office?" offers some anecdotal evidence (no bibliographical or source information is provided) of productivity increases resulting from environmentally friendly strategies. According to the article, a business may

become more efficient and may improve the work environment for employees if it converts to a green or environmentally friendly workplace. Environmental strategies include using energy-efficient lighting, recycling products, reducing paper copies, and promoting the use of recycled materials.

The article reports several examples of corporations that have recognized the benefits of implementing an environmentally friendly workplace. One example is Lockheed Martin's new design and development facility. According to the article, "Lockheed-Martin built a new design and development facility that resulted in a $300,000–400,000 savings on energy bills every year. In addition, employee productivity went up 15 percent and absenteeism dropped by the same amount. In one year, the drop in absenteeism alone covered the extra $2 million the company paid for the new energy system."

The article also cites Boeing's 90 percent reduction in lighting energy resulting in a 2-year payback with a 53 percent return on investment. A third example cited is the National Wildlife Federation's use of a baler to recycle cardboard and efforts to reduce photocopying. Those efforts resulted in savings of $28,700 in disposal costs, $5,000 profits from selling the recyclable cardboard, and a 40 percent per year reduction in photocopies.

Item: No. 16

Source: General Services Administration (GSA), The Integrated Workplace: A Comprehensive Approach to Developing Workspace. May 1999, p. 31. Also available from http://www.gsa.gov/.

Category: Places

Key findings: Productivity increase of 16 percent, reduced absenteeism, improved performance.

Exec. summary: This GSA report highlights the benefits of creating an integrated workplace, defined as a "workplace that"

- is designed to support the office mission and the strategic plan of the organization,
- serves the needs and work practices of the employees,
- can be quickly and inexpensively adjusted by the user to maximize his or her productivity and satisfaction,

- is comfortable, efficient, and technologically advanced and allows people to accomplish their work in the most efficient way,
- meets the office's need and justifies its cost through benefits gained."

One of the benefits of the integrated workplace is improved worker productivity. The report states that the workplace environment affects performance. To support this statement, the report cites the findings of several research studies pertaining to the workplace environment and worker productivity.

Carnegie Mellon University compiled the findings from several studies. A study by DeMaro and Lister found that the "top quarter [of subjects] performed 2.6 times better in larger workspace with less acoustic and visual disruptions." Another study found that subjects were able to type more efficiently in offices at 68 degrees F, than at 75 degrees F. Another study in the compilation revealed a 16 percent increase in productivity attributed to a new building with individual workstation environmental controls. This study also noted a 1.5 percent decrease in worker productivity when the controls were disabled. Another study found in Carnegie Mellon's research noted an increase in absenteeism and a decrease in satisfaction as a result of moving from a building with operable windows to a sealed building.

Item: No. 17

Source: Romm, Joseph, Lean and Clean Management, 1994, pp. 100–102.

Category: Places

Key findings: Productivity improvement of 16 percent.

Exec. summary: Lean and Clean Management demonstrates how promoting energy efficiency can impact an organization's bottom line by increasing both productivity and profits. The book uses case studies to show the process and building improvements and the associated benefits.

In 1992, upon building a new 150,000-square-foot headquarters facility, West Bend Mutual Insurance Company in West Bend, WI, recognized a 16 percent increase in worker productivity. This increase was attributed to the installation of environmentally responsive workstations (ERWs). The ERWs allowed workers to directly control the temperature and airflow in their

individual workspace. Motion sensors were used to conserve energy when the employee was away from the desk. The result was an $0.84 per square foot annual savings in electricity costs.

The results from the West Bend Mutual Insurance Company were originally cited by the Center for Architectural Research, Rensselaer Polytechnic Institute.

Item: No. 18

Source: Columbia Business School, Studies in Technology and Productivity in the Service Sector, Connecticut Mutual Life Insurance Company [online document, cited December 2000]. Available from http://www.cs.columbia.edu/~michael/cases.html.

Category: Tools

Key findings: Productivity increase of 20 percent resulting from implementation of a voice response and tracking system.

Exec. summary: The Columbia Business School established Studies in Technology and Productivity in the Service Sector in 1992 to use case studies for evaluating productivity within service-sector organizations.

This source is a case study of Connecticut Mutual Life Insurance Company. The company implemented several process improvements for various divisions throughout the organization by unifying separate company databases and creating a universal front-end access to the data. The system allowed for one-time data entry, ability to query reports quickly, and automated routing of documents. As a result, the company recognized a 20 percent increase in productivity.

The Client Services division realized a 13 percent reduction in staffing requirements with the implementation of the new system. In addition, an improvement to workflow resulted in a 32 percent reduction in full time equivalents (FTEs).

The Medical Services division recognized a 44 percent reduction in FTEs with the implementation of an electronic invoicing system.

The Individual Life division recognized a 20 percent increase in a productivity by implementing a voice response system.

Finally, the company merged the Franchise and the Billings and Collections divisions, along with the database system employed. Those actions resulted in a 26 percent reduction in FTEs.

Item: No. 19

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 11. Also available from http://www.asid.org.

Category: Places

Key findings: Productivity increase of 20.6 percent attributed to installing ergonomic furniture.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. Impact of Interior Design on the Bottom Line summarizes their findings.

The ASID paper cites a study by the U.S. Army Corps of Engineers, which reported a 20.6 percent increase in employee productivity 1 year after installing ergonomic furniture.

Item: No. 20

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 11. Also available from http://www.asid.org.

Category: Places

Key findings: Productivity gains of 15 to 27 percent following ergonomic adjustments to office design and equipment.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. Impact of Interior Design on the Bottom Line summarizes their findings.

The ASID paper highlights research findings indicating cost savings and productivity improvements attributed to workspace improvements. A study at Miami University in Oxford, OH, cited 15 to 27 percent gains in productivity following ergonomic adjustments to office design and equipment.

Item: No. 21

Study Title: International Telework Association and Council (ITAC), "Telework America 1999," October 27, 1999 [online

document, cited November 1, 2000]. Available from http://www.telecommute.org/twa/1999_research_results.shtm.

Pratt, Joanne, Cost/Benefits of Teleworking to Manage Work/Life Responsibilities, October 1999 [online document, cited March 2001]. Available from http://www.telecommute.org/twa/twa_research_exec_summary.doc

Category: People

Key findings: Productivity increase of 22 percent and cost savings equaling 63 percent of the cost of absenteeism.

Exec. summary: ITAC is a nonprofit organization dedicated to promoting the economic, social, and environmental benefits of telework. Members share information about the design and implementation of telework programs, the development of the worldwide telework sector, and research.

ITAC, in conjunction with AT&T, the General Services Administration, and the Metropolitan Washington Council of Governments, has undertaken the Telework America project to encourage acceptance and growth of telework arrangements through a nationwide program of public awareness, education, and active public-private participation focused on employee, employer, community, and environmental benefits. The results of the survey were summarized in Cost/Benefits of Teleworking to Manage Work/Life Responsibilities.

Telework America 1999 synopsizes the results of ITAC's 1999 nationwide research survey on telework practices across the nation. The survey respondents reported a 22 percent increase in productivity as a result of telecommuting. Cost/Benefits of Teleworking to Manage Work/Life Responsibilities estimated that, assuming a daily salary of $169, a 22 percent increase equaled "$37 gain in value per teleworker per day."

The web site also states that telework programs save companies in reduced absenteeism and retention costs. Survey results indicate that decreased absenteeism of teleworkers save employers 63 percent in absenteeism costs. In addition, 54 percent of respondents indicated that working from home was an "important" or "extremely important" factor in looking for a new job.

The Telework Facts section of the ITAC web site provides

additional evidence of the benefits of telecommuting. American Express found that their teleworkers produced 43 percent more business than office workers. Compaq also saw a 15 to 45 percent increase in productivity due to the use of telework. IBM was able to reduce real estate cost by 40 to 60 percent using teleworkers. (These examples are unrelated to the 1999 AT&T survey.)

Item: No. 22

Source: International Telework Association and Council (ITAC), Telework America 2000 [online document, cited November 1, 2000]. Available from http://www.telecommute.org/twa2000/newsrelease.shtm.

International Telework Association and Council (ITAC), Telework America 2000: Research Results, Key Findings [online document, cited November 1, 2000]. Available from http://www.telecommute.org/twa2000/research_results_key.shtm.

Category: People

Key findings: Productivity improvement of 15 to 30 percent and annual cost savings of $9,712 per teleworker.

Exec. summary: ITAC is a nonprofit organization dedicated to promoting the economic, social, and environmental benefits of telework. Members share information about the design and implementation of telework programs, the development of the worldwide telework sector, and research.

ITAC, in conjunction with AT&T, the General Services Administration, and the Metropolitan Washington Council of Governments, has undertaken the Telework America project to encourage acceptance and growth of telework arrangements through a nationwide program of public awareness, education, and active public-private participation focused on employee, employer, community, and environmental benefits.

As part of this program, AT&T conducted a survey on the financial benefits of telecommuting. The results of the 2000 AT&T survey revealed that self-reported productivity improvement of home-based teleworkers averages 15 percent. Telework-center-based teleworkers report a 30 percent improvement in productivity. According to the article, “this translates to an average annual bottom line impact of $9,712 per teleworker. With 16.5 million teleworkers in the US that works out to an annual national impact exceeding $160 billion.”

Item: No. 23

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 11. Also available from http://www.asid.org.

Category: Places

Key findings: Productivity increase of 23 percent and 50 percent reduction in health complaints as a result of installing ergonomic office furniture.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. Impact of Interior Design on the Bottom Line summarizes their findings.

The ASID paper highlights research findings indicating cost savings and productivity improvements attributed to workspace improvements. A 23 percent increase in productivity and 50 percent reduction in health complaints was reported National Institute of Safety and Health (NIOSH) as a result of installing ergonomic office furniture.

Item: No. 24

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 7. Also available from http://www.asid.org.

Category: People

Key findings: Decrease of 25 percent in project cycle time, 75 percent decrease in formal meeting time, 80 percent reduction in duplicated files, and 44 percent reductions in both square footage per employee and overall space costs by converting to a new office environment designed to facilitate teamwork.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. ASID and its partners published Impact of Interior Design on the Bottom Line to summarize their findings.

The paper references a case study in which "Amoco Corporation in Denver reported a 25 percent decrease in project cycle time, a 75 percent decrease in formal meeting time, an 80 percent reduction in duplicated files, and 44 percent reductions in both square footage per employee and overall space costs by converting to a new office environment designed to facilitate teamwork."

Item: No. 25

Source: American Society of Interior Designers (ASID), Impact of the Interior Design on the Bottom Line, p. 7. Also available from http://www.asid.org.

Category: Places

Key findings: Decrease of 30 percent in space and 25 percent decrease in staff due to renovations.

Exec. summary: ASID and five industry partners—3M Company, Cooper Lighting, DuPont, Haworth, and Maslund—collaborated to gather research data and evaluate the relationship between office design and employee productivity. ASID and its partners published Impact of Interior Design on the Bottom Line to summarize their findings.

The ASID paper references a case study about the Bank of Boston, which "improved work performance, allowing the company to perform the same amount of work in 30 percent less space with 25 percent less staff by extensively renovating it's leased building. The project paid for itself in less than two years and created a showpiece to attract new clients and further improve the business unit's profitability."

Item: No. 26

Source: Columbia Business School, Studies in Technology and Productivity in the Service Sector, NYNEX: The UNISON and CCVRS Systems [online document, cited December 2000], p. 25. Available from http://www.cs.columbia.edu/~michael/cases.html.

Category: Tools

Key findings: Productivity increase of 30 percent resulting from development of a common service order system (in place of two separate systems).

Exec. summary: The Columbia Business School established Studies in Technology and Productivity in the Service Sector in 1992 to use case studies for evaluating productivity within service-sector organizations.

This source is a case study of NYNEX Corporation, a Regional Bell Operating Company created as part of the AT&T antitrust settlement by merging New York Telephone and New England Telephone. To reduce costs and improve operating efficiency, NYNEX implemented a common service order system known at UNISON (Universal Service

Order NYNEX). NYNEX established UNISON to reduce duplication of maintenance and development services of two service order systems being used by the organization after the merger. An assessment of productivity improvements over the first 5 years of the project indicated a 30 percent increase in productivity (approximately 6 percent per year).

Item: No. 27

Source: Volinski, Joel, Synthesis of Transit Practice 33: Practices in Assuring Employee Availability, National Academy of Sciences, Transportation Research Board (TRB) (Washington DC: National Academy Press, 1999 [online document, cited November 2000], p. 30. Available from http://www.nationalacademies.org/trb/publications/tcrp/tsyn33.pdf.

Category: People

Key findings: Cost savings of $2.5 million attributed to a paid time-off program.

Exec. summary: The TRB was established to assist the transit industry with developing innovative solutions to meet industry demands. Research conducted by TRB is the primary vehicle for providing assistance to the transportation industry. The TRB has conducted much research directed at improving employee availability assurance for the transit industry. Much of this research pertains to workplace enhancements and their specific impact on productivity and related items.

TRB's research indicates that paid time off (PTO) programs can help an organization reduce costs, improve productivity, increase morale, and reduce turnover. PTO programs combine an employee's leave (sick, leave, personal) into one lump sum and trust the employee to use leave as he or she deems appropriate (subject to a few company policies). One objective of this type of program is to reduce unscheduled absences that occur when employees use sick leave. By allowing the employee to use leave at their discretion, employees and managers can plan for absences.

The PTO program initiated at Memorial Hospital in Rockford, IL, in 1980 resulted in reduced overtime costs, reduced temporary help costs, and increased productivity due to a 36 percent reduction in unscheduled absences. The program has resulted in a savings of more than $2.5 million per year.

Item: No. 28

Source: Romm, Joseph, The Internet Economy and Global Warming (Center for Energy and Climate Solutions, December 1999), p. 5 and p. 27.

Category: Tools

Key findings: Annual productivity growth of 54 percent attributed to the use of Internet services.

Exec. summary: This source evaluates the relationship between Internet economic practices and energy consumption. One key finding is that the nation's 4 percent economic growth between 1997 and 1998 was due largely to information technology industries. Increases in productivity also appear to be a result of technological advances.

This source also notes that Finland's banks recognized a 54 percent annual growth in productivity (transaction per employee) from 1984 to 1996. It attributes this increase in productivity to the use of electronic payments systems via the Internet.

Item: No. 29

Source: Texas Comptroller of Public Accounts, "Chapter 4: Human Resource Management, Encourage Telework Among State Agencies," Recommendations of the Texas Comptroller, December 2000 [online document, cited May 4, 2001]. Available from www.e-texas.org/recommend/ch04/hrm05.html.

Category: People

Key findings: Reduced turnover and increased timeliness of processing caseloads by 58 percent attributed to telecommuting.

Exec. summary: "Encourage Telework Among State Agencies" provides background information supporting successful implementation of telework. One of the organizations that recognized increased productivity and cost savings attributed to a telework program is the Texas Workforce Commission (TWC). The TWC began the telework program in August 1991. By June 1999, participation included 68 percent of the agency's legal staff. By allowing employees to telework, the agency was able to reduce office space by 31 percent and increase timely processing of caseloads by from 48 percent to 76 percent (a growth of 58 percent). Teleworkers' sick leave was 38 percent less than staff members not participating in the program. In addition, the agency reported a 31 percent reduction in overhead costs and a reduction in the turnover rate.

Item: No. 30

Source: Romm, Joseph, The Internet Economy and Global Warming, (Center for Energy and Climate Solutions, December 1999), p. 32.

Category: Tools

Key findings: Reduction in lead times of 58 percent, 75 percent reduction in error rates, and 24 percent improvement in inventory levels attributed to the use of an integrated electronic data system.

Exec. summary: This source evaluates the relationship between Internet economic practices and energy consumption. One finding concerns a pilot program to test an integrated electronic data system for automobile manufacturers and their suppliers. The program resulted in a 58 percent reduction in lead times, 75 percent reduction in error rates, and 24 percent improvement in inventory levels.

Appendix D: Bibliography for Research Mix

Appendix D:
Bibliography for Research Matrix

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Appendix E:
Contact Information

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For information regarding any part of the content of this study, or for information about the programs of the GSA Office of Real Property, contact Stan Kaczmarczyk at stan.kaczmarczyk@gsa.gov

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For technical information about the GSA Productivity Payback Model, contact Marguerite Morrell at mmorrell@lmi.org

For information about the Productivity Research Matrix, contact Kristie Bissell at kbissell@lmi.org

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