

1-1-1991

Facility management evaluation for Sundstrand Corporation, Aerospace Division

William T. Schuyler

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Facility Management Evaluation for
Sundstrand Corporation,
Aerospace Division

by

William T. Schuyler

An Applied Management
Decision Report
submitted in partial fulfillment
of the requirements for the degree of
Master of Business Administration
Cardinal Stritch College

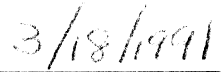
May 1991

APPROVAL PAGE

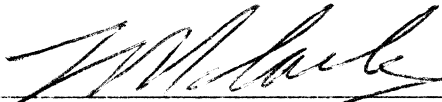
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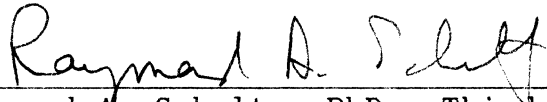
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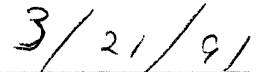
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EXECUTIVE SUMMARY

This Applied Management Decision Report (AMDR) examined the problem of ineffective office designs with the onset of the "Automated Office". The company on which this report focused on was Sundstrand Corporation (Sundstrand). The current office environment is of a "paper flow" type and many business functions within the company have been automated. Therefore, the competitive position of Sundstrand could be affected by its current physical office environment.

The AMDR focused on a facilities management evaluation of the Systems Development department. Seven main areas within the office area were reviewed. These areas were: general design, lighting, acoustics, climate, furniture design, and workstation design issues. Within each of the areas ergonomic industry standards and recommendations were evaluated against the current office facilities along with cost issues for each analysis area.

The AMDR also presented three additional topics which are related to the seven main analysis areas: health and safety aspects, legal issues within the office environment and Sundstrand's financial position. Upon completion of the facilities management evaluation a series of possible alternatives to this problem were presented. A detailed analysis of each of the alternatives was performed and the most viable alternative was chosen for implementation.

Also, a detailed implementation plan was discussed and its impact upon the resources of the company were evaluated.

The chosen alternative from a cost effective view is to renovate and redesign the current physical office environment. This solution will provide long run returns to the company, office personnel, and its stockholders. Ultimately, it will keep the company in a competitive position within its respective industry.

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ACKNOWLEDGEMENTS

I would like to thank Gregory Soule, Barbara Schatkza and Rodney Calacci, who are managers at Sundstrand Corporation, for their assistance in providing me with a multitude of information about the company. Also, their assistance in providing me financial information was very helpful.

I would also like to thank Roberta Middleton in Sundstrand's Office Planning department for providing me with current cost values of the office fixtures and their depreciation values. This helped me to calculate a cost/benefit analysis for this report. Also, for the assistance in providing me with various aspects about the current office environment (i.e., lighting levels, noise levels).

Finally, I would like to thank many of my co-workers for their viewpoints and ideas that helped to formulate and express a large portion of this report. Their input into this topic was quite insightful and I hope that this report will eventually benefit them.

SECTION 1
INTRODUCTION

The management of growth is one of the most critical elements of corporate leadership. Another major factor in corporate success is the management of critical human resources. The combination of growth and human resource management is joined in the area of facility management. This study focuses on the management of office facilities as a part of facilities management.

Sundstrand Corporation (Sundstrand) is an internationally known company which produces many products for aviation, aerospace, and industrial markets. It is listed as a Fortune 500 company and promotes quality products to the customers which it serves. The company is a market leader in many of the products it produces, such as: Constant Speed Drives, Electrical Generating Power Units and Data & Voice Recorder Systems.

The company has gone through a very large and rapid growth period during the years of 1982 through 1988. During these years Sundstrand expanded their operations, physical plant and office areas at an alarming rate. Many departments within the company doubled in the number of personnel but not in work space. This has forced employees to work in a less than optimal work environment and has hampered productivity.

The Systems Development department within Sundstrand is one of the departments which has experienced rapid growth. As the department has grown over the years it has been subjected to limited facilities management. Consequently, the personnel within this department are exposed to a less than optimal and possibly health threatening physical work environment. Also, legal aspects have begun to surface which must be addressed.

As Sundstrand expanded its physical office facilities many areas were overlooked. The concept of ergonomics, which is the synergizing of human beings with the physical work environment, has not been addressed significantly. Office work environments have been designed with standards that are at least 15 years out of date. Also, with the onset of the "automated office" environment many additional factors within the physical office space were ignored or inadequately implemented.

This case study evaluated the facility management concepts applied within the Systems Development department at Sundstrand Corporation, Aerospace Division and used the department as a model for many concepts and ideas for facilities management improvements. The results of this case study could be applied to the entire corporation.

SECTION 2

ORGANIZATIONAL SETTING

History of Sundstrand

To discuss the organizational setting of Sundstrand and how the current case study problem developed a review of historical company growth should be performed. The following sections of the case study will identify various important historical elements pertaining to the origin and growth of Sundstrand.

Beginning Elements of the Company

Sundstrand was born in 1905 by three inventive and ambitious young gentlemen. Levin Faust who was an inventor and machinist originated the concept of the company. While Elmer Lutzhoff and Swan Anderson, who were tool makers, provided the initial financial and creative assistance for the company. The original company name was Rockford Tool Company.

The 1910's and 20's showed great potential for this company and growth occurred in several different areas. As new products were created more employees and physical building space was needed. The company was on the move and relocated to one of its current plantsites at Harrison and 11th Street. By the end of the 20's the company went public through stock offerings.

Through the 1930's the company saw many changes occur. Most of the changes centered around diversification and expansion. Sundstrand also began to increase their research

and development functions during these years. The main emphasis for Sundstrand was on increasing efficiency and productivity from their machines and employees (Sundstrand, 1989a).

Company Formation and Growth Process

Sundstrand continued to grow and prosper during the 1940's and 50's. The company had expanded internationally during these years by forming Sundstrand International Corporation in Dijon, France. New plant and office facilities continued to develop during these years. By the end of the 50's Sundstrand Corporation, which was its new name, had three major divisions: Machine Tools, Hydraulics and Aviation.

The 1960's marked a major growth period for Sundstrand. During this time three major acquisitions occurred. These acquisitions increased the company's product lines and began further market penetration. Growth was abundant as facilities in LaSalle and Rockford, Illinois; Arvada, Colorado and several other locations opened.

The 1970's were not major years of growth for the company. Several divestitures occurred during these years which helped Sundstrand to become more financially sound. No additional office or plant facilities were developed during these years.

Recent Company Developments

Many events and opportunities have occurred for Sundstrand during the past 10 years. There has been a

series of additional acquisitions and product line developments. To review some of the more recent accomplishments that Sundstrand has achieved refer to Table 2.1 (Sundstrand, 1989b).

Along with these growth opportunities came the additional need for office and manufacturing space. Furthermore, increases in the complexity of business and operating functions have caused a change in the office environment. For example, the relationship with the US government is more intense and bureaucratic. Thus, additional personnel were required to complete government contracting functions. During this time the physical office facilities were forced to accommodate these additional personnel.

During the 1960's through the 80's the Systems Development department changed drastically. Computer technology was brought directly into the physical office facility through the use of computer terminals. Also, the department changed from a "paper flow" facility to a "paper sparse" office. During these years the demand for the department's services rose drastically and additional personnel were needed to accommodate the increased demand.

Table 2.1

Recent Growth Opportunities for Sundstrand During the 1980's

-
- 1981 - Acquisition of Accelerex Inc.
York, Nebraska - plant and offices built
 Acquisition of Sundstrand Hydratec
 Acquisition Vandling Corporation
 Acquisition of the Mobile Controls Division
 of Honeywell, Inc.
- 1983 - **Rockford, Illinois - Electronics plant and
 offices built**
- 1984 - Sale of Hydraulics Division
 Acquisition of Wulfsberg Electronics, Inc.
 Acquisition of Sullair Corporation
 Acquisition of Signatron, Inc.
- 1985 - **Selmer, Tennessee - plant built**
**Rockford, Illinois - Repair Center plant and
 Administrative offices built**
 Acquisition of Turbomach Division of Solar
 Turbines, Inc.
**Grand Junction, Colorado - plant and offices
 built**
 Creation of Pneumatic Systems Division
- 1986 - **Rockford, Illinois - Rockford Data Center built**
- 1987 - Hydraulic Power Systems Division merged with
 Sauer Getriebe AG to form Sundstrand-Sauer
 joint venture
Rockford, Illinois - Corporate Headquarters built
 Rockford, Illinois - Advanced Technology Group
 offices expanded 110,000 ft.
**San Diego, California - Advanced Technology Group
 offices expanded 133,000
 ft.**
- 1988 - **Nuevo Laredo, Mexico - plant built**
- 1989 - Divestiture of Sundstrand-Sauer holdings
- 1990 - Acquisition of Maco-Meudon Inc.
-

Sundstrand has taken the position of becoming a market leader in the product lines which it manufactures. The main strategy the company has implemented during these years is to increase earnings and return on investment. It appears that the importance of the company employee has not been highlighted at this time. As plants and offices were built to accommodate the growth of the company, facilities were designed to be somewhat state-of-the-art for the respective time period. Due the lack of management understanding or concern existing facilities have not been brought up to current industry standards where employee productivity can be properly achieved. This case study offers areas where improvements can be made.

Current Company Environment

The corporate history of Sundstrand identifies growth patterns from which the current company environment has evolved. Aspects of strategic items defining the current environment such as; the external environment, company profile issues, company mission, goals and beliefs are presented to provide insight into the philosophy of the company.

Elements of the External Environment

External environment elements effect a company in many different ways. It is important to examine these external and somewhat uncontrollable forces to determine how well a company can adjust to factors outside of their control.

The external elements play an important role on the current and future direction of the company. Many decisions, including plant and office expansion and modernization, have been based upon remote environment factors. The following subsections review some of the external environment issues as they effect Sundstrand.

Economic Issues. Economic issues substantially effect Sundstrand's strategic decisions, operating environments and growth patterns. The company's customers are both military and commercial. Therefore, the national economy plays an important role in determining the current and future growth patterns of the company. Any physical asset modernization efforts that Sundstrand attempts to employ rest heavily upon the forecasted sales of its customer base. If economic outlooks are dismal for future trends then any expansion efforts will probably be postponed.

Social Issues. Social issues are another important area of the remote environment that affect Sundstrand. Many changes have occurred in just the past few years. One major change which has happened is the shift in military defense spending by the Unites States government. This decrease in spending and the social attitudes towards defense spending have caused Sundstrand to realign their customer sales base more towards commercial customers.

Social attitudes towards employee health, well-being and fitness have also changed over the past years. This change has caused Sundstrand to become more responsive to

employee needs. Medical benefit and fitness programs have been instituted within the company to meet this demand. The next area of change which will need to be instituted by Sundstrand is meeting the demands of a better physical work environment.

Technological Issues. This area within the external environment is continuously changing for Sundstrand. The nature of Sundstrand's products necessitates a high level of attention to technological changes. All tools to keep up with industry standards must be considered.

Sundstrand has used the computer in innovative and cost effective ways. The computer and office automation have changed the way the company does business. Many aspects of the work environment must be adjusted to make proper and effective use of these tools.

Company Profile Concepts

The profile of Sundstrand (i.e., products, customer types, markets, etc.) is an important area that needs to be examined. This will shed light upon the current environment of the company and will assist during the problem analysis portion of the case study.

Customer Sales Profile. The sales profile outlines the entire customer base. It is useful for identifying current and future customer trends, new products and potential customers.

According to Sundstrand's 1989 Annual Report (Sundstrand, 1990b) its customer base is composed of 73%

commercial and 27% military. There are two distinct segments that the company serves, they are; aerospace industry - 67% of total sales and the industrial industry - 33% of total sales.

The military customer base is made up of almost every branch of the US armed forces and other governmental agencies as well. The aerospace commercial sector is made up of mostly large scale airline producers, such as: Boeing, McDonnell Douglas, General Dynamics and General Electric. The industrial business sector is composed of several different types of customers as identified in Table 2.2.

Table 2.2

Sundstrand's Industrial Business Segment

Customer Type	Percent of Sales
Construction	16
Energy/Hydrocarbon	14
General Industry/Utilities	12
General Consumer	11
Wood & Paper	10
Mining & Metallurgy	9
Chemicals	9
Transportation	7
Smaller Industries	7
Agribusiness	5

Product and Market Segments. Market segments and the products sold within each area are important elements which should be reviewed. According to Sundstrand's Worldwide document (Sundstrand, 1989b) the aerospace business segment has eight individual market segments: Electrical Power Systems, Engine Accessories, Turbo Power, Actuation systems, Space Systems, Environmental Control Systems, Telecommunications and Avionics. The industrial business segment has four market segments: the Falk Corporation, Fluid Handling, Heat Transfer and Sulliar Corporation.

The products sold within each of the market segments is quite large. A detailed list of all products that Sundstrand currently produces is found in Appendix A (Sundstrand, 1989b). The list of products that the company produces continues to grow on a yearly basis. The Research and Development team is the cause for the yearly growth. Also, acquisitions have helped to increase the product line and depth.

Plant and Office Facilities. Sundstrand has office and plant facilities located throughout the world. Most of these facilities are located in the continental US. The total amount of building space that Sundstrand currently occupies is 7,730,000 square feet. Of the total square footage, the Aerospace business segment occupies 3,598,000 square feet and the Industrial segment occupies 3,836,000 square feet. Also, the Corporate offices occupy 296,000 square feet. Table 2.3 lists the locations of all plant and

offices that Sundstrand owns and maintains (Sundstrand, 1990b). This table attempts to identify the magnitude of the case study problem.

Table 2.3

Sundstrand Office and Plant Facilities

<u>Aerospace Business Segment</u>	<u>Industrial Business Segment</u>
P/O Phoenix, Arizona	P Auburn, Alabama
P Prescott, Arizona	P/O Arvada, Colorado
P/O Brea, California	P Michigan City, Indiana
P Irvine, California	P/O Dowagiac, Michigan
P/O San Diego, California	P/O Camdenton, Missouri
P/O Denver, Colorado	P/O Milwaukee, Wisconsin
P/O Grand Junction, Colorado	P/O Wauwatosa, Wisconsin
P/O Rockford, Illinois	P Sao Paulo, Brazil
P/O York, Nebraska	P/O Rexdale, Ontario, Canada
P Moses Lake, Washington	P/O Dijon, France
P/O Redmond, Washington	P St. Priest, France
P/O Dijon, France	P Mount Brison, France
P/O Republic of Singapore	P/O Mexico City, Mexico
	P/O Neuvo Laredo, Mexico

P = Plant Facilities Only

P/O = Plant and Office Facilities

An important issue relevant to this case study needs to be pointed out. As each facility was built many state-of-the-art architectural designs were used. As time progressed the facilities have fallen behind prevailing industry standards. Thus, with the onset of computers and office automation many office facilities are in need of upgrades in order to increase worker productivity. Many office areas have ineffective and outdated facilities, such as: Technical Publications, Customer Services, Purchasing, Contract

Services, Order Entry and Systems Development. Possible justification for this is because Sundstrand is very conservative and allows the industry to govern the pace and mode of operations.

Elements of Corporate Philosophy

The corporate philosophy governs how a company will react under certain situations. Sundstrand has developed a philosophy that appears to be functioning adequately and can be seen in the review of selected elements within the corporate philosophy which follows.

Mission of the Company. Sundstrand's mission statement is composed of two distinct components which are outlined in the company's Statement of Commitments (Sundstrand, 1990a). The first and foremost item is "To satisfy the needs of selected worldwide aerospace and industrial markets by developing and manufacturing high quality, proprietary, technology-based components and subsystems and by achieving customer satisfaction" (p. 1). The second item is "To serve market segments where we can either be a market leader or have a strategy to become one while achieving returns that reward shareholders and employees and permit the business to grow and prosper" (Sundstrand, 1990a, p. 1).

Part of the mission statement identifies market leadership while satisfying or rewarding employees. One element of employee satisfaction is a pleasant and productive work environment. A physical work environment not up to industry standards may cause loss of market

leadership. Therefore, the mission of the company might not be obtained and undesirable financial results could occur for the company.

Strategic Goals of the Company. Sundstrand has five strategic goals that are to be achieved within the next five to ten years (Sundstrand, 1990a, p. 1). The goals are stated as follows:

1. To provide superior rewards to investors by achieving returns on equity among the top quartile of Fortune 500 manufacturing companies.
2. To anticipate and fully satisfy customer needs by providing superior products utilizing appropriate advanced technology and customer service.
3. To recognize that every member of the Sundstrand team is a valued individual and important contributor.
4. To be a responsible corporate citizen by being an active participant and a positive contributor both in the local community and at the national level.
5. To team with strong business partners with similar philosophies and objectives.

Goal number three (3) has significant importance with respect to this case study. Since Sundstrand realizes that every employee within the company is a valued asset, it should also realize that the physical work environment that each employee is exposed to on a daily basis is also a valuable asset. If careful planning and attention are not provided for this environment serious financial and possibly legal consequences could occur over time.

Corporate-wide Beliefs. Sundstrand has a stated list of Corporate-wide beliefs (see Table 2.4). According to

Sundstrand's Statement of Commitment (Sundstrand, 1990a, p. 1), the most important belief is "superior quality in all things".

Table 2.4

Corporate-wide Beliefs of Sundstrand Corporation

1. Superior quality in all things.
 2. Continuously improving the way we do our jobs, managing our business and serving our customers.
 3. Having a genuine concern for cost while fulfilling all commitments and providing total value to our customers.
 4. Maintaining the highest level of integrity and trust in all our relationships, reflecting respect and fairness in all our actions.
 5. Adhering strictly to our Code of Business Conduct and Ethics.
 6. Managing our business aggressively yet prudently.
 7. Encouraging the personal and professional growth of each member of the Sundstrand team.
 8. Developing a sense of ownership and belonging in each team member through effective two-way communications.
 9. Fostering innovation in all business and technical activity by recognizing and rewarding superior contribution.
 10. Developing and maintaining relationships rather than just executing transactions.
-

Several of the beliefs are centered around the employee and his/her relationship with the company. Sundstrand has

identified the value of the relationship and the importance of discussing problems with employees.

Current Work force Evaluation

A review of the company's most important asset, its personnel, is essential for analyzing the case study problem. Sundstrand is a relatively large corporation. It currently employs around 14,000 people who are located throughout the world at the company's different operating facilities (Sundstrand, 1990b). Table 2.5 presents information pertaining to the levels of employment that Sundstrand has retained over the past ten years.

Table 2.5

Number of Sundstrand Employees for the Past 10 Years

Year ----	Total -----
1979	15,400
1980	15,600
1981	16,100
1982	13,100
1983	13,400
1984	15,200
1985	16,100
1986	16,000
1987	14,200
1988	13,800
1989 ^a	13,700

^a1989 total employees is composed of 8,220 office and 5,480 factory employees

Many of Sundstrand's employees use a computer in their daily work environment (both factory and office personnel) because of extensive automation of the manufacturing cycle and administrative functions. Thus, many of the employees have been thoroughly trained on the use of a computer but their knowledge of the proper environment for its use is extremely limited. This case study has provided information for increasing this knowledge level.

SECTION 3
IDENTIFICATION OF PROBLEM

Conceptual Overview

Every company is plagued with their share of strategic and operating problems and Sundstrand is no exception. Many of the company's problems originated from rapid growth and acquisition.

Company Related Problem

During Sundstrand's rapid growth period decisions about physical office facilities were made and many were based on archaic or minimal standards. The end result from these decisions were poorly designed office work areas.

Most of Sundstrand's office space was designed according to the time period that the office building was built. Thus, the office space was laid out for a "paper-flow" environment for performing daily job tasks. As time and technology advanced the office environments have not kept pace. An example of this would be deteriorated office fixtures and furniture.

This case study examined the inappropriate use of ergonomic factors within the facilities management operations at Sundstrand. Ergonomic factors such as: general office design, office layout and design, lighting, acoustics, climate, furniture and workstation design are discussed. Also, the feasibility of designing efficient physical work space per employee to perform more productive

work are addressed. The Systems Development department has been the focus of this case study.

Other areas related to the above problem have been analyzed. The first was the current legal issues that might face corporations in accordance with facilities management policies and practices. Next, was the health ramifications on company personnel who are exposed to the inadequate work environments. Finally, cost considerations for Sundstrand were discussed.

Impact on Organization

Creating the proper work environment is essential to any company and Sundstrand is no exception. Among several resources which were researched for this case study the most important impact on the company identified is a loss in worker productivity (Paznik, 1987). This loss can be converted into additional overhead costs on product or services provided and losses of net income and company profits will occur. When this happens stockholders become aware of the situation and immediate corrective actions must be taken to stop the spiraling effect of lost profits.

Additional impacts upon the company are: increased employee benefit costs (i.e., increases in health insurance claims, increases in sick time/payments), employee morale problems and higher employee turnover rates. This list is not complete. Additional impact areas are discussed further within the case study.

SECTION 4

ANALYSIS OF PROBLEM

Elements of Analysis

Understanding the scope of the case study problem can be accomplished through detailed analysis. The analysis section covers the following areas: overview of the evaluation process, elements of ergonomics, health and safety with respect to ergonomics, legal topics, and issues of cost for Sundstrand.

Overview of the Evaluation Process

The evaluation process identified several areas for the rest of the analysis section. Three areas reviewed in this subsection are: Sundstrand's position on the office environment, benefits of an ergonomic environment and the process of evaluation.

Sundstrand's Position on Office Environment. The physical office environment at Sundstrand is composed of many different elements. Much of the existing office space was designed for use during the 1960's and the 70's. During this time the main components that were considered for effective and efficient operation of the office were "paperwork" and the "flow of paper". The office facilities were designed for this type of environment.

Sundstrand attempted to keep up with the changing technology by "automating the office". Many types of computerized equipment appeared within the daily work areas for many office employees. The equipment (i.e., terminals,

personal computers, printers, plotters, etc.) was brought in without any attempt to redesign the office environment to adapt the employees to the new equipment.

Sundstrand might not have designed their office environment in an ergonomic fashion for many reasons. One reason might be the conservativeness of the company and its slow rate of change. Also, past executive decision making policies suggest it is possible the company might not perceive the physical office environment as a high impact item on worker productivity.

Benefits of a Ergonomic Environment. The benefits of an ergonomically designed office environment are abundant. The most important is the increase in employee productivity. Table 4.1 shows the levels of increased worker productivity after ergonomic improvements have been implemented.

Table 4.1

Improving Productivity in the Workplace

Study/Site	Change or Element	Percent Improve	Measurement
----- - - - - - FURNITURE - - - - -			
Springer, T.J.	Ergonomic Furniture	10%	Data Entry: Trans per hour
	Ergonomic Furniture	15%	Dialog: trans per hour
	User Adjustable seats	4%-6%	Trans per hour
USA-CERL	New Furniture - Open Office Plan	19.6%	Completed line item Purchases
Wells Fargo Bank	New Furniture - Open Office Plan	28.4%	Operational efficiencies
- - - - - FURNITURE and FACILITY - - - - -			
Seal, D.J.	Facility Redesign, Custom Furniture	30%	Activity Logs & Employee est.
TRW	New Private Work place, new technology	39%	Number of lines of error free code code
- - - - - ENVIRONMENT - - - - -			
Penn. Power & Light	Lighting redesign	13.2%	Drafting drawings/hour
	Lighting redesign	75%	Lighting Oper./ maint. costs
Wisner	Noise reduction - 25dB	50%	Reduced factory rejects
	Noise reduction - 20dB	30%	Reduced typing errors
	Noise reduction - 20dB	30%	Increase in Production

Source: Cited by Paznik, 1987, p. 12.

Based on several areas of study the following list of additional benefits has been developed (Schatz, 1988; Paznik, 1987; Minter, 1989; Joyce, 1989). This list is not complete, but it does include the more important items.

1. Increases in employee morale and job satisfaction.
2. Decreases in employee insurance claims.
3. Decreases in employee sick time.
4. Decreases in "discretionary" employee absences.
5. Decreases in "on-site" employee lost time.
6. Decreases in employee job turnover.
7. Increases in work space efficiencies.
8. Increased working relationships between employees and management.
9. Lower overall product indirect overhead product costs.
10. Increases in hiring talented resources, by using the office environment as a selling point.
11. Increases in net income and ultimately profits for the company and its shareholders.
12. Improved office environment should be considered a "continuous improvement" element for the corporation. This flows with the current philosophy followed by many companies.

Process of Evaluation. A formal facilities management evaluation follows several steps. An extensive review and analysis with respect to pertinent ergonomic issues should be done along with identifying related industry standards. Also, cost factors within each area of the facilities management evaluation have been presented. Finally, an evaluation of Sundstrand's Systems Development department has been performed to compare with the industry standards.

Elements of Ergonomics

According to Joyce, (1989) ergonomics is: "... the challenging task of balancing their employees' needs with the requirements of new technology. This balancing act is

the focus of ergonomics, the science which addresses human performance and well-being in relation to the job, equipment and environment." (p. 38). Ergonomics is an interface mechanism between employees and their exposure towards the physical work environment.

Employees are a company's most important asset. Ninety percent (90%) of a corporation's total operating expenses are "people costs" (Minter, 1989). Accordingly, management should realize the importance of providing an environment for their employees which is conducive to rapidly changing technologies. Also, the overall working population is aging and becoming more "service" oriented (Minter, 1989). Therefore, proper attention to employees and their work environment is very important.

To apply ergonomics effectively within a corporation's office six key elements must be brought into balance. Joyce (1989) states these six key elements as:

... job design, including criteria and strategies for implementing change; software design that refers to system and screen design for greater usability; environment that refers to space-planning, use of color, lighting, acoustics, air quality and thermal factors; workstation design, including chairs, work surfaces and accessories such as document holders and footrests; equipment, including video display terminals (keyboard, CRT, screen), and training, that includes guidelines for technical and skills training to prepare people to deal effectively with technology. (p. 38)

The underlying aspects of ergonomics must also employ human factors. There are five different types of human factors that must be interwoven within the ergonomic

environment. First, motivational needs like privacy, individuality, and status must be incorporated. Second, social needs must be met (i.e., interactions between workers and people, either face-to-face or by telephone). Third, sensory needs must be accommodated. These include worker comfort, sight, hearing and touch. Fourth, anthropometric measures must be incorporated in the office design. This deals with the placement of equipment and materials; size, shape, height of work surfaces and the location of storage facilities. Finally, esthetics must be employed in the design. These include use of colors, different shapes and forms, various textures, quality of light, use of plants and artwork.

Incorporation of ergonomic concepts will assist in completing a well planned and executed office design. This should include an evaluation of the affected employees' job tasks and descriptions. Also, company management must train their employees in the concepts and use of ergonomics in their daily work environment. This shows concern from a management view that employee health and well-being are important to the company. Finally, a post evaluation or survey from the employees should be performed. This allows feedback to management to see if ergonomic office designs are providing the stated benefits to employees.

General Design Issues

The design of the office environment is of paramount importance for the future success of a company. According

to Suskind (1989) "One might consider the analogy that the office is to the service industry as the shop floor is to the manufacturing environment. Proper planning, design, and layout are critical to success." (p. 52).

In 1988, American companies spent around \$70 billion dollars to design and equip offices. This dollar amount is around two times more than 1983 figures (Evans-Correia, 1988). This shows that the executives in American businesses are beginning to realize the importance of properly designed office environments.

Proper office design can only be accomplished if all levels of management within a company are involved. They must completely stand behind the process and its objectives so that the end results are accomplished. Full management backing is necessary to complete an efficient ergonomic office environment.

To successfully design an ergonomic office the proper design team must be created. This design team should consist key people from several areas within and outside of the organization (i.e., department managers, personnel managers, facilities personnel, health professionals, purchasing personnel, and selected operative employees). It is important for this design team to be properly educated in ergonomic concepts and their effects on the office area.

Several considerations must be included when designing the new office environment. First, space evaluations must be properly done so that the "right fit" can be found for

employee productivity. For example, Systems Development personnel need adequate space to work with computer documents and the terminal simultaneously. In turn, the job functions and task descriptions must be thoroughly analyzed during this process. An improper design for Systems Development personnel (i.e., Programmers and Analysts) tasks can lead to repetitive and dysfunctional body movements. Next, the proper use of windows and outdoor views should be taken into consideration. Finally, the office design must be comfortable against current demands and future needs must be incorporated in as well (i.e., expansibility, adaptability, modularity of office design).

Office Layout and Design Issues

Understanding the elements behind space-planning an ergonomically effective office layout is important. According to Stibler (1989) "Space-planning, in its technical vernacular, is the 'development of programmatic information into a realistic floor plan that works for the functions that happen in that space.'" (p. 14). Thus, the design of an office is a systematic process with an end result of productivity for the employees who use it.

An ergonomically designed office must be correctly laid out. Three basic layouts exist. Modular office systems are fully integrated work areas clustered together and enclosed with partitioning within the units. The units are organized throughout the office space in a systematic way. Open space plans are designed with clustered workstations with three to

six workstations per cluster. The clustered workstations are sometimes sectioned off by good quality partitions. Finally, enclosed office space is designed by sectioning work areas with floor-to-ceiling partitions. Many companies develop hybrids of the three office layouts.

Advantages of each type of office layout exist. Modular office systems provide the benefit of being self-contained units that are easy to relocate. Whereas, the open office plan makes the most efficient use of space. More employees can be placed within the office space which lowers square footage costs per employee. The enclosed office layout provides for more privacy for employees. Although, it uses more square footage space per employee.

There are several important factors to consider within the office layout and design process. Future growth of the company is extremely important when developing office layouts. Also, the space must be designed with flexibility in mind. This flexibility must take into account the interactions between people and the flow of work within the office space. Analyzing proximity and work flow between employees should also be done. Finally, it must be emphasized that management involvement during this process is extremely important.

Sufficient work space and adequate workstation storage are additional elements to consider within office layout and design efforts. Each of these assist in providing peak worker performance. Also, wire cabling within the office

layout is a substantial design component. Concealing the cabling will provide safety, as well as, overall esthetics.

Office Layout and Design Cost Issues. The cost for office space is composed of two parts. First, is the actual square footage that the office space consumes. The average cost for American companies is around \$55 per square foot (Evans-Correia, 1988). Whereas, Sundstrand's square footage cost averages around \$59 (Calacci, 1989). Second, is the interior design cost which consists of, interior construction costs and peripheral furnishings. Currently, this cost averages around \$60 per square foot for American companies (Suskind, 1989). Sundstrand's per square footage decorating cost is about \$40 (Calacci, 1989).

Sundstrand's Systems Development Office Layout. A review of the System Development department office layout can be seen through a blueprint copy of the office area (see Appendix B, Middleton, 1990). It provides insight into the major problems currently confronting the employees in the department, such as: work space, workstation design and proximity of workers.

The office layout of the department is a hybrid between an open plan and enclosed design. This provides some functional utility for the overall department. But, the department uses standard office furniture. This furniture was quite adequate during the decades of the 60's and the 70's. It has since become ineffective in the "automated

office" environment. The furniture requires excessive space and does not work effectively with computer equipment.

The partitioning of the open plan office space is done through the use of inadequate partitions. It appears the only purpose for the partitions is to section off work areas. Acoustical qualities are not evident in the partition units. Finally, the landscaping of the office, which is the overall view and flow of the layout, is adequate. The esthetic qualities of the office landscape are lacking.

There are several important observations that deal with the spatial organization of the office layout. Flexibility has been designed into the office but, it is not being used efficiently for an "automated office" environment. The flow of work and proximity of people within the department are not well planned. Also, the privacy levels within the individual work areas is non-existent.

A review of the physical work space within the office layout shows there is an insufficient amount for each employee and storage capacity is limited as well. These deficiencies are aiding in reducing worker productivity by forcing high constraint levels on employees. Also, there are extensive amounts of exposed wiring throughout the department causing hazards.

Lighting Issues

Efficient and ergonomically designed offices rely on many elements such as lighting. Whitehouse (1990) states,

"According to the poll of office workers, executives and design professionals, only 33% said they currently enjoyed proper lighting. Of that group, 71% said lighting can improve production." (p. 32). These statistics identify the levels of employee satisfaction in current working environments. Whitehouse (1989) also states:

The value that lighting brings to the VDT user is noted by the Buffalo Organization for Social & Technical Innovation (BOSTI) group, which claims that a high level of job dissatisfaction is evidenced among employees who spend extensive time at computer terminals. Noting a variety of physical complaints from users, BOSTI says that many of them stem from a user's inability to control glare on VDT screens or to adjust computer components such as keyboards and screens to proper working heights and angles. (p. 70)

Lighting within an office can be emitted from four different types of sources. Direct lighting, which occurs in most offices, is overhead lighting that is generated usually by fluorescent fixtures. Indirect or ambient lighting is reflective lighting that usually comes from wall or ceiling type fixtures. Task lighting is located at the employees' desk and is controlled by the individual. Finally, natural lighting is sunlight that comes in from windows and skylights into the office work area. Natural lighting is an important lighting source for it helps affect and control psychological aspects of workers in the office. The type(s) of lighting chosen are important and should be selected based on the main types of tasks being performed by the employees within the office.

Once the proper type(s) of lighting have been chosen the proper level must also be selected. The optimum level of lighting for an "automated office " is 300 to 600 luxs and is based upon the job tasks performed. In a "non-automated office" the levels of lighting should fall between 500 to 1000 luxs (Owens, 1987). For example, employees who use computer terminals require lower lighting levels while management require higher lighting levels since most of their work is with paper processing and conferences. Most offices, whether automated or not, have lighting levels of 750 to 1650 luxs (Bettendorf, 1990). Also, along with the level of lighting is the need for adjustability by office employees.

The most preferred type of "automated office" lighting is indirect accented by individual task lighting at employee's work areas. This provides the proper levels of lighting with adequate amounts of freedom for the workers. Also, direct lighting if used, should be refitted to disperse light in a different manner. The use of parabolic reflective lighting with softer fluorescent bulbs (i.e., pink or blue) accomplishes this task.

The use of natural lighting should also be controlled in an "automated office" by using adjustable closures (i.e., vertical or horizontal blinds, draperies, curtains) on windows to limit the amount of incoming light. Owens (1987) identifies the relationship between natural lighting and the computer terminal as:

VDT's should be situated at a 90-degree angle to windows and should be placed as far away as possible to eliminate glare. Experts say that VDT screens should never be placed with a window immediately in front of or behind the VDT. The angle of view should be no more than 50 degrees from the operator. (p. 28)

Lighting Cost Issues. The overall cost of lighting an office environment can be quite astounding in today's cost controlled businesses. The average cost of retrofitting a single direct overhead lighting fixture runs around \$50 (Whitehouse, 1988). Benefits which are achieved through upgraded lighting systems can be quite astounding. According to the National Lighting Bureau (1988, p. 1), "... the benefits of lighting is supplemented with a number of case histories which underscore the value of these benefits. In one case, new lighting that cost \$15,000 to install saved more than \$235,000 in its first year of operation. In another, a \$3000 lighting system retrofit earned more than \$44,000 in its first year."

Sundstrand's Systems Development Lighting. The overall design of lighting in the Systems Development department is poor for an "automated office". The lighting is designed for general office work and there appears to be no formal evaluation of the current job tasks performed with respect to lighting sources.

The department uses mostly conventional direct lighting as its source. The overhead fixtures are composed of bright white fluorescent tubes which cause difficulty in working

with computer terminals. Also, the use of task and indirect lighting in the department is non-existent which is a very poor design decision especially when computer terminals are used extensively.

Natural lighting is quite abundant and is difficult to control. The draperies over the windows are very poor mechanisms for controlling the light source. Thus, the amount of glare that is created on the computer terminal screens is quite excessive.

From previous facility management studies the overall level of lighting in the department averages somewhere around 1000 luxs (Middleton, 1990). This level is quite high for the type of work performed (i.e., analysis, designing and programming business application systems). The direct lighting sources produce this level of lighting and there are no adjustable features for it.

Acoustical Issues

Sound levels of noise in the office area are also important elements within the overall office design and should be reviewed to determine the optimum levels. According to "Noise in the Office:" (1988, p. 75), "When designing an office to control noise, designers should look at the total office environment. 'Some areas require a high level of privacy, others a moderate level, and others, little or no privacy,' says Lewis H. Bell an acoustical engineer ...".

Within the design process several elements can be used to reduce and control noise levels and overall distractions in the office. These elements are: acoustical panels and partitions, sound absorbers, carpeting, ceiling tiles, background sound mechanisms and acoustical enclosures. These elements can be used to keep the office noise level at the optimum amount, which is, 50 to 55 decibels (Owens, 1987).

Exterior sounds that occur around the office complex also need to be thoroughly examined. These sounds, such as: street or freeway traffic, air traffic, and construction noises, effect the environment by transmitting through windows and skylights built into the office building. Using the proper types of windows (i.e., triple pane) in the structure can reduce the amount of exterior noise within the office area.

Controlling speech privacy (i.e., traveling sound) can be accomplished through the effective use of the office ceiling. Properly designed acoustical ceilings with the correct amount of lighting fixtures can reduce traveling sound immensely. Also, acoustical panels and partitions will help to reduce this type of noise. Acoustical ceiling tiles of good quality will absorb approximately 80 to 95 percent of all traveling sound in the office area (Noise in the Office, 1988). Floor coverings (i.e., carpeting) will also assist in removing traveling sound if properly installed. Also, background noise mechanisms (i.e., "white

noise") will assist in creating a quiet work environment that is conducive to worker concentration and productivity.

Acoustical Cost Issues. The cost factors associated with the individual elements which control sound and noise (i.e., ceiling tiles, panels and partitions, carpeting, etc.) can vary based on product quality and desired level of noise reduction required. The following cost ranges are based upon average current industry costs. Acoustical ceiling tiles can cost between \$30 to \$120 per tile. While, panels and partitions can range between \$30 to \$200 per square foot and carpeting can range between \$10 to \$40 per square foot. Furthermore, background noise mechanisms can range from \$5000 to \$50,000, depending on the overall office square footage. The above price factors are based on current market trends.

Sundstrand's Systems Development Acoustics. The Systems Development department experiences many noise problems and this appears a major problem affecting the department. Two components which contribute highly to the problem are telephone calls and daily employee conversations.

The levels of exterior sounds that are carried into the office area are quite high. The office building faces a major primary street within the city of Rockford with a lot of truck traffic, the problem of exterior noise is exacerbated by the use of "single pane" windows.

The amount of speech privacy is almost non-existent within the entire office area. This includes enclosed managers offices and the work areas of operative employees. Poor material quality and office construction are the major reasons for this problem. Conversations at a normal tone of voice travel around 20 to 30 feet.

The office ceiling structure is an ineffective mechanism for controlling sound due to non acoustical ceiling tiles. Also, there are many lighting fixtures within the ceiling and this causes excessive traveling sound. In addition, the office area lacks a background noise system to counteract traveling sound.

Finally, office flooring coverings are adequate for absorbing some distracting noise. Whereas, the partitions used in the office are ineffective in controlling noise, due to poor quality material and construction. It appears the only purpose for the partitions is to divide work spaces for the department's employees and help with the overall landscaping of the office.

Climate Control Issues

Creating the proper climate (i.e., temperature, humidity levels, etc.) is another issue for designing an ergonomically efficient office environment. It is important for an office building to have a properly working heating, ventilation, and air conditioning (HVAC) system so that the office climate does not fluctuate drastically. Minter (1989) states:

In examining the HVAC system, says Kruk, it is important to remember that offices may have been reconfigured in the building with no consideration of their new relationship to the ventilation system. Also, office computers put additional burdens on cooling systems. "A VDT throws off almost the same amount of heat as a human body," he notes. "You end up with these 'hot pockets,' where people become very uncomfortable. (p. 130)

The office area needs to be reviewed to determine the total amount of automated office equipment contained within the space. Once evaluated the HVAC system needs to be adjusted to compensate for this equipment. Also, the HVAC system needs to be designed with flexibility in mind, such as keeping air circulating throughout the entire office layout.

A variable air volume (VAV) system appears to be best suited for an "automated office", because it provides the proper amount of air conditioning and circulation to the entire office. In addition to the VAV system, individual employee workstations should have a controllable air flow and circulation system (i.e., adjustable fan unit) installed.

Temperature and humidity level factors play an important part in the "automated office". The proper temperature should fall somewhere between 70 and 75 degrees in the winter months and 78 and 82 degrees in the summer months (Scalet, 1988). Whereas, the proper humidity level needed to control static, especially with all of the

electronic devices, is somewhere around 50 percent (Scalet, 1988).

Climate Control Cost Issues. The cost factors involved in a HVAC system vary to the degree of the quality of the system purchased. After several attempts of trying to obtain cost information on ergonomically designed HVAC systems no success was made. Therefore, no cost factors will be given on this area within the facilities management evaluation.

The current HVAC system and its operating environment should be reviewed for upgrading or replacement. Upgrading the existing HVAC system could keep overall costs down, due to avoidance of removal and installation costs. A new HVAC system could be expensive to install, but overall operating costs might be lower in the long run.

Sundstrand's Systems Development Climate. Based on employee complaints it appears the air circulation in the office area is very unevenly distributed. Some areas are quite stagnant while others are well circulated, causing high levels of employee dissatisfaction with the current HVAC system.

The level of air purification within the department seems to be inadequate. The department prints out a large quantity computer printouts which create many airborne particles in the office. These particles appear to cause problems with the employee's vision (i.e., contact lens

wearer) and breathing. There have been many complaints of the air quality because of the airborne particles.

The office area temperature tends to fluctuate largely. Some areas will be hot, while others may be quite cool. The humidity level changes just as much. During the day in the summer months the level will be quite high, while at other times it will be much lower. Also, during the winter months static is quite a problem and static spraying must be done. Personal observation and employee complaints have helped to identify the above issues.

Furniture Design Issues

The design of office furniture can affect the entire office work force. Ergonomically designed office furniture allows a worker to maintain a chosen comfort position for a longer period of time. The furniture design must also be flexible and adaptable to the office environment.

There are basically three types of furniture systems in use by most ergonomically designed offices. The first is the panel-hung system (see Figure 4.1, Sopko, 1988). The second is the free standing modular system (see Figure 4.2, Kwiecinski, 1989). The third is the clustered modular system (see Figure 4.3, Kwiecinski, 1989).

Figure 4.1: Panel-Hung Furniture System.

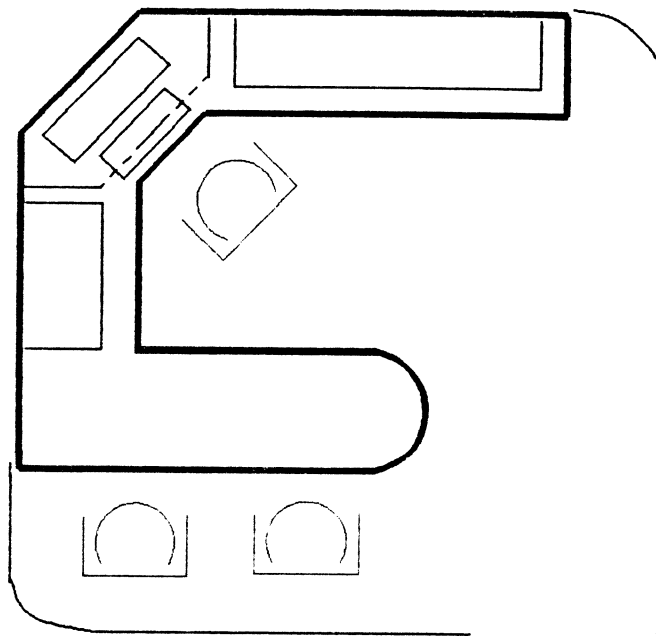


Figure 4.2: Free Standing Modular Furniture System.

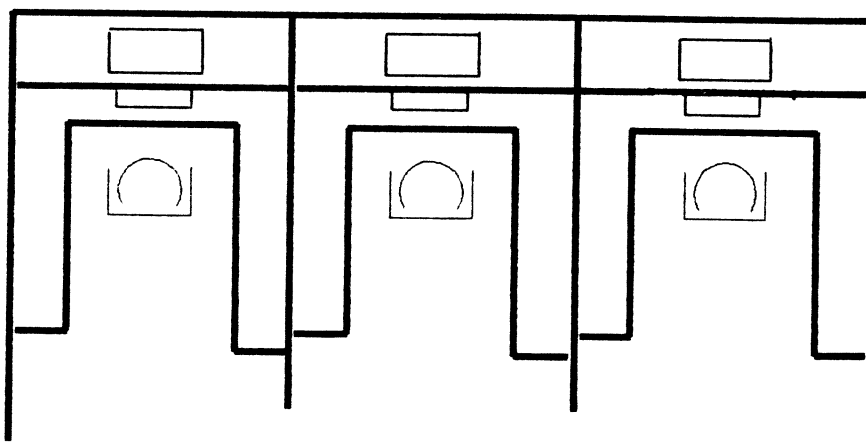
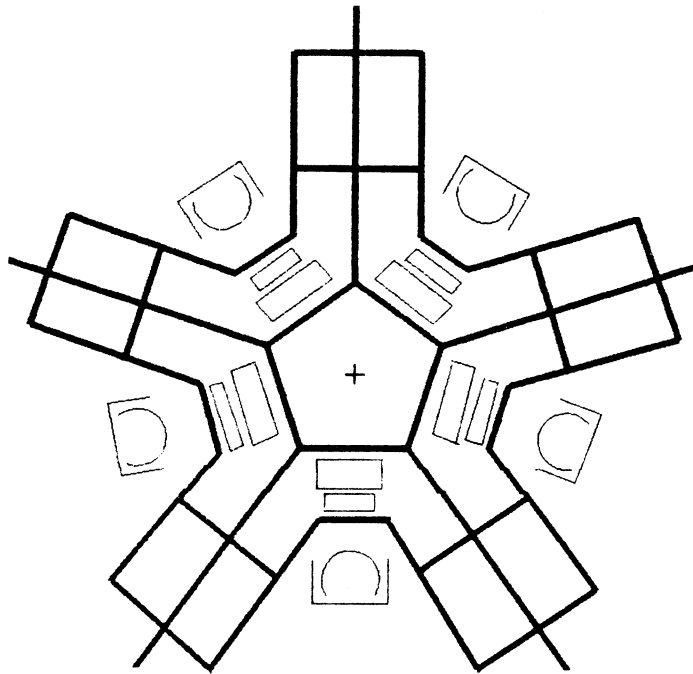


Figure 4.3: Clustered Modular Furniture System.



The growth of furniture systems has been tremendous over the past few years. It has been estimated that by 1993, 55% of the office furniture market will be captured by furniture systems (Brydone, 1988). This is largely due to the overall benefits provided by its use, such as: increased levels of privacy for the worker and increased space efficiency. Clustered systems are particularly good on space usage, because they provide more work space while using less actual square footage. Fernberg (1990) states:

... As space costs rise, for example, floor space-stingy cluster systems lead the systems furniture category because they offer 75 percent more work space, and America's passion for productivity accounts for the projected 17.8 percent annual growth rate of panel and modular systems - roughly one-third of total office furniture sales. By, 1997 Business Trend Analysts estimates, total sales for panel and modular furniture sales will reach \$12.5 billion as the market becomes satiated. (p. 72)

The design of office furniture has several other aspects. First, the individual units should integrate electrical support internally in the design. This allows for easier accessibility of power channels, improved cabling designs and more flexibility for computer components positioning. Next, the furniture units should use a matte finish to reduce the amount of glare on computer terminal screens. Finally, the furniture design should provide for ample amounts of work space and document storage space.

Another important component of furniture design is the employee's chair. According to Scalet (1988, p. 52), "... though typical office workers spend more time in their chairs than any other piece of furniture except their own bed." Thus, the office chair is one of the most important pieces of furniture and must be designed with proper ergonomics. The ergonomic office chair must have a properly contoured fit to provide support for the worker's back and legs. The entire unit must be adjustable by the operator and should include: seat pan tilt, backrest angle, seat height and backrest height adjustments. Also, the chair should allow for total freedom of movement and have a stable base with more than four legs on it.

Furniture Design Cost Issues. The previously discussed ergonomically designed furniture systems can cost anywhere from \$700 to \$2500 per individual workstation unit. Therefore, a cluster system of 5 workstations could cost

between \$3500 to \$12,500. The overall quality, style and special modifications to the units can add additional costs.

The costs of ergonomically designed chairs can vary just as much as furniture systems, where costs can vary anywhere between \$300 to \$1000 per chair. Once again the cost is based on the quality, style, additional features requested and materials used to produce the unit. Any special modifications requested by the purchaser will add additional costs to each unit ordered.

Sundstrand's Systems Development Furniture. There are no formal ergonomic furniture systems installed within the office. The company has issued standard office work desks which are suitable for a "paper flow" environment, not an "automated office" environment. Also, the desks are not flexible and moving them is quite cumbersome.

The overall amount of work space is inadequate for the current job tasks. The work tables that are provided for additional work space must be shared between two employees in many areas of the department. Therefore, a fair amount of coordination between the employees must be performed and the amount of space for each employee is extremely limited. Also, the tables are preset at a standard height and are non adjustable.

Individual storage facilities are provided in the standard issue desk and a standard two drawer document filing cabinet must be shared between employees. The

overall amount of document storage capacity is extremely limited for the job functions in the department.

The office chairs which are supplied for employees in the department are the standard issue type office chair of the 60's and 70's decades. They provide absolutely no contouring for the user and are very limited on their adjustability. The seat can swivel and be adjusted either up or down. The chair offers no lumbar support which is essential to the lower back and the seat pan is extremely large for any reasonable level of user comfort. Overall, the chairs are an extremely poor office design element.

Workstation Design Issues

The workstation design is composed of several previously discussed components, such as: furniture systems, chairs, lighting. An employee workstation needs the proper elements to be productive in an ergonomic environment. One of the most important areas within the design of a workstation is individual flexibility by the employee.

The workstation design must allow for sufficient work surface space for documents and other reference material. Also, the work surface should be smooth, evenly contoured and contain a mechanism that allows user controlled height adjustments. A recommended height of somewhere between 25 to 30 inches is adequate.

When designing the workstation layout it is important to consider the individual employee's physical aspects. The workstation should allow for plenty of leg and knee room for

convenient movement and the employee's feet should be touching the floor. A foot rest should be provided for use if necessary and seating must be adjustable.

The workstation in an ergonomically designed "automated office" centers around the use of computer equipment, specifically computer terminals. The terminal must allow for adjustments by the user, such as: tilting, swiveling and turning. The keyboard should be detachable, adjustable and positioned on an adjustable keyboard platform with padded wrist and palm areas. The positioning and distance of the computer terminal is important and should be situated somewhere between 18 and 20 inches from the user. Finally, a document holder should be provided and used as needed.

A final element that is important in the design of a workstation is the lighting surrounding the unit. It is important to provide the proper amount of task lighting for individual employee use. This lighting should be adjustable by the worker and used on source documents.

Workstation Design Cost Issues. Cost issues for this section are a composite mixture of several cost factors from previous sections (i.e., furniture system costs, chair costs, lighting costs). Detailed analysis of cost factors can be accomplished by reviewing the previous individual cost sections. Workstation costs can be calculated based on the accumulation of the individual workstation elements. The only element not discussed up to this point is computer equipment. Computer equipment prices depend strictly on the

type, quality and features which are required in the work environment. Therefore, it is difficult to outline a cost factor on this element.

Sundstrand's Systems Development Workstation Design.

Upon evaluating the overall workstation design it appears the design is not very flexible. Basically, what has happened within the department is that a computer terminal has been abruptly placed on a desk or work table and no effort has been taken to make a convenient or productive workstation.

Examining the workstation with physical employee aspects in mind provides further evidence of poor design. The overall leg room provided under the desk or the work table can be quite limited. Many of the desks face the building walls and depending on the size of the employee their legs can be cramped by the limited space. Also, when both employees are working at the work table leg room space is definitely limited. Finally, smaller sized workers are not provided with footrests and the available seating is only adjustable in height.

The computer equipment provided for employee use within the department is adequate in ergonomic design. The computer terminals are completely adjustable in any direction which the operator desires. The keyboards are detachable and adjustable, but they rest on the employee's desk or work table. No adjustable keyboard platform is provided for their use. The computer terminal viewing

distance can be adjusted by the worker. Also, document holders have not been provided for use in assisting workers with their daily work tasks. Finally, the lighting around the employee's workstation is relatively poor and no effort has been made to provide task lighting.

Health and Safety Aspects

A large percentage of growth in the job market has occurred in the service industry within America. Minter (1988) states:

... more and more workers are employed in the service industry sector, not manufacturing. Of the 21 million new jobs that the U.S. Bureau of Labor Statistics expects to be created between 1986 and 2000, some 20 million will be in the service industries. Manufacturing's share of total employment will decline to 14 percent by 2000. Says Dr. Leonard Kruk, director of Office Syntronics Research for the Shaw-Walker Co., an office furniture manufacturer: "the blue-collar worker is slowly disappearing." (p. 127)

With the number of people coming into the service industry and working in an office environment it is imperative that offices are designed with ergonomic properties to avoid health and safety problems.

Seeing the "automated office" clearing on the horizon several physical health aspects and problems have arisen. First, the Video Display Terminals (VDT's) constrain a user's body and force it to maintain a fixed position longer. The body's physical movement is limited and the potential for health problems increases. The common problem of eyestrain and stress are rapidly increasing in the

service industry, due to the use of VDT's and the physical office environment to which employees are exposed. Also, headaches, shoulder pains, backaches, and wrist problems are on the increase within the "automated office" (Scalet, 1988).

Second, a recent concept called "techno-stress" has come upon the horizon for the service industry (Council on Scientific Affairs, 1987). Basically, this derived type of stress occurs when people who once controlled the response time for work tasks performed can no longer do so. With the onset of computers in the office the speed in which the tasks are performed is much quicker. Problems also occur when employees must interact and request information from other people. The response time received from these requests are much slower than computer responses and employees are having difficulty adjusting to the time lags. Currently, no corrective measures exist to eliminate this unique type of stress.

Another interesting by-product of "office automation" is the development of another form of stress called "cyberphobia". According to the Council on Scientific Affairs (1987) "cyberphobia" occurs when:

... The worker may feel a loss of control, reduced status, fear of job loss, and less need or opportunity to participate in the affairs of the organization. In most instances where this occurs, the tasks have become more impersonal, repetitive, and boring; there is a real or imagined sense of work overload; individual skills are underutilized; responsibilities are reduced; and social interaction with fellow employees is

reduced or lacking. The situation is aggravated when one's performance is paced and/or measured by the machine. (p. 1510)

Many of the current physical ailments which are occurring within the office area relate directly to the positioning of the employee's body in their workstation. Neckaches, for example, are caused due to excessive movement of the upper body. The positioning of the source document has a direct relationship with the neck muscles and the level of comfort achieved at the workstation (Scalet, 1988). Also, a major stress on the body occurs when sitting for extended periods of time and most office jobs require the worker to do this. An interesting side note is that operators who suffer from various levels of stress and fatigue usually have negative perceptions towards their workstation design (Scalet, 1988).

Finally, there are a few additional health problems associated with the onset of the "automated office". Repetitive strain injury (RSI), also known as repetitive stress injury, is on the increase in many offices. The most serious type of this injury is carpal tunnel syndrome (CTS) (Samuels, Gardner and Fouts, 1989). This is a complete breakdown of the delicate components within the wrist and fingers and often requires surgery to correct. Also, there has been much research performed in the area of VDT radiation and its effect on the operator. Most of the results are inclusive at this time, but studies are continuing (Samuels et al., 1989).

Many of the health problems which occur in the "automated office" have solutions. A key element in eliminating many of the health problems in the service related industry is to properly design workstations with respect to job tasks and provide flexibility in the furniture systems used. Also, proper job task lighting must be provided which will eliminate many of the visual ailments (i.e., blurred vision, squinting, improper blinking) which are frequently experienced in the office environment. Reduction of employee fatigue can be eliminated through the use of daily "rest breaks" and varying job tasks performed during the work day. Also, it is important to thoroughly train employees in the proper use of ergonomic furniture and equipment. Finally, exercise routines should be incorporated in the daily work environment which will help to reduce stress, tension and muscle aches.

Concerns for Sundstrand

It is important for Sundstrand to incorporate safety and health aspects into the office design for several reasons. First, the total number of health insurance claims may increase, if the company chooses not incorporate health and safety features into the office design. Also, there will probably be increases in worker absences due to injury or illness. Both of these issues translate into higher costs and possible losses in net income for the company.

A few other areas within Sundstrand could be impacted by an office design if it does not incorporate health and

safety aspects. Employee job dissatisfaction could rise due to employee recognition of unsafe or unhealthy working conditions. In turn, this leads to increased employee turnover and higher new employee recruiting costs. Also, there may be possible legal actions against the company for improper working conditions. As the service industry continues to grow and office work standards are formalized, legal issues will come into the limelight for many companies.

Legal Issues Surrounding the Office Environment

With the onset of the "automated office" there are many legal concerns which must be defined. One of the first states in the U.S. to pass legislation for the "automated office" was Maine. It passed a law that would protect both public and private sector office employees from the elements of the office environment (Bettendorf, 1990). Along with Maine there have been six other states which have passed legislation pertaining to office machines and ergonomic standards in association with VDT use within the office. As of 1988 there have been 30 additional states that have begun to review similar legislation within the office environment. Finally, three countries: Germany, Norway and Sweden have set up strict standards in regards to ergonomic office environments and VDT usage.

Suffolk county in New York passed a law in 1988 which set up a precedence for future "automated office" and VDT

usage laws (Schatz, 1988). The law primarily provides ergonomic, health and safety features for employees who work for private businesses in the county. Included in this law are provisions for: rest breaks, ergonomic furniture, increased vision benefits and proper ergonomic furniture usage training. However, there also been large debates between company management and employees over some of safety issues surrounding the legislation.

Currently there are no federal laws pertaining to the development of a proper "automated office" environment for employees. However, there are several studies currently being conducted to determine the effects of an "automated office" environment. In addition, there have been recent efforts to help establish standards and guidelines for designing ergonomically effective offices and workstations. One such effort is the "Model Act" that would set up strict standards for "automated office" environments, such as, proper lighting levels, allowable types of furniture and workstation designs (Samuels et al., 1989). Setting the standards and guidelines for this type of office have been difficult and several states have begun to look at establishing laws that closely follow the elements of the "Model Act".

Private service industries have initiated several measures which should help to simplify the legal issues surrounding the "automated office" environment. Two initiatives are: providing alternative work assignments for

pregnant workers and other personnel which have physical health conditions that may be hampered by the office environment and creating voluntary office environment standards. Currently the private business sector believes that 50 different sets of state laws could cause mass confusion and therefore, one common set of laws would be easier under which to operate (Samuels et al., 1989).

Concerns for Sundstrand

State legislation on "office automation" could be very costly for Sundstrand. However, the overall benefits of office improvements mandated by legislation would begin to outweigh the initial costs. Also, the impact of legislation would bring Sundstrand up to the service industry level of standards. The improved environment would provide for more satisfying work experiences for employees.

Another important issue concerning legislation within the office environment effects Sundstrand's relationship with the US military, because a large percentage of the company's sales made by this customer. Thus, compliance to state and federal laws would be mandatory for business relations to continue. Also, Sundstrand promotes itself as being a "model contractor" and therefore, noncompliance towards any legislation pertaining to the "automated office" environment would go against the company's overall strategic objectives.

As Sundstrand continues to grow many of its business functions will be assisted by automation and many positions

in the company will be created where "office automation" can be instituted. A larger portion of the company's workers will be impacted by any legislation that may come about pertaining to this environment.

Elements of Cost

The cost for providing an ergonomically effective designed office environment can be quite expensive. However, the overall benefits received from the new environment quickly outweigh the costs. According to Kleinschrod (1988):

The Buffalo Organization of Scientific & Technical Innovation (BOSTI) study in 1984 showed that if professional and technical personnel perceive a drop in comfort of desks and chairs, productivity would fall at a cost of \$701 per employee based on salaries of \$31,600 a year. (p. 32)

If the above figure were applied to the total number of office employees at Sundstrand the cost in productivity losses for the company would amount to \$5,762,220 annually. This is assuming that all 8,220 current office employees perceive a drop in comfort. This amount is quite staggering and should not be looked upon lightly.

Further more Paznik (1987) shows how the cost of a furniture expenditure measures up to the overall monetary returns in the form of increased productivity received from the use of the unit. He states:

A \$3,500 expenditure to move an employee from an open bull-pen to a private area, with furniture improvements, returns \$7,836 in productivity improvements in five years. Furniture payback is in 18 months.

So the argument that ergonomic furniture is not worth the expense doesn't hold water, in spite of the fact that healthy furniture does cost more than conventional chairs and desks. (p. 12)

Since cost of developing an ergonomic office environment occur up front without any immediate tangible benefits, it is very difficult to sell the concept of an ergonomically designed office to executive management. The important element which should be stressed when selling the idea is that increased productivity will more than compensate the initial investment. Refer back to Table 4.1 to review some specific areas of productivity improvements.

Sundstrand's Financial Position

To provide an ergonomically efficient office environment capital expenditures must be made and these cash outlays can be quite extensive. An important aspect is whether or not Sundstrand can afford such an outlay of capital. This type of strategic decision must be made by executive management.

Determining the overall financial position of Sundstrand and deciding if the company can afford a large capital investment can be accomplished through past trend analysis. Sundstrand's (1990b) financial statements, (see Appendices C through G), provide information for various financial ratios. There are five different financial areas which have been evaluated, they are: liquidity, leverage, activity, profitability and growth. The trend analysis table, (see Appendix H), shows the various types of

calculated ratios for the years 1979 through 1989 (Sundstrand, 1990b).

Company Liquidity. The first area of evaluation is the liquidity of the company. The first set of ratios presented in Appendix H indicate whether the company has the ability to meet short-term financial obligations. Observation of the current ratio (CR) trend for Sundstrand shows the company has maintained a relatively good CR level. The industry range is set somewhere between 2 and 4 times to cover the short-term debts and Sundstrand is a somewhat on the low side (Pearce and Robinson, 1988).

Company Leverage. The next area of evaluation is the amount of leverage used by the company. Three ratios have been presented to assist in identifying Sundstrand's source of capital, they are: debt to total assets (D/TA), debt to equity (D/E) and long term debt to equity (LT-D/E).

In reviewing the D/TA ratio an important observation has arisen. The average D/TA in the trend analysis is around 23 percent. This average is quite good for the company compared to other companies in the same industry. This means that Sundstrand is not over extending itself on capital assets and therefore, an additional capital investment will cause a relatively small increase in the ratio.

Analyzing the D/E ratio shows quite a bit of fluctuation for the company over the past ten years. Also, the current D/E is fairly high and it shows that debt is

about 62% of its equity or about 40% of its total assets. If this avenue of cash acquisition is used for the investment in the office environment a thorough examination of the company's equity position must be completed.

Observing the LT-D/E ratio provides some additional insight into Sundstrand's financial position. The overall trend of the LT-D/E ratio has not varied much over the past ten years for Sundstrand. The ratio has basically averaged around 40 percent over the years and therefore, creditors to the company have financed around 40 percent of the company created long-term debt. This is a fairly good percentage for Sundstrand as compared to other competitive aerospace companies. Additional growth of this percentage should actually help the company overall.

Company Activity. The third area of ratio trend analysis is the activity levels within the company. This ratio will assist in determining how well Sundstrand is using its overall resources internally. The total asset turnover (TAT) is used to designate whether the company is generating enough sales for its current asset base. It appears that Sundstrand's TAT averages around 1.3. This ratio is quite good for the type of industry in which Sundstrand operates. Also, the company must carry large levels of certain inventories therefore, keeping the overall ratio for Sundstrand on the low side. Overall, the company appears to be using its resources well for internal operations.

Company Profitability. The fourth area for trend analysis is the profitability of the company. The ratios presented here will assist in indicating how well the firm is being managed. An important point to present is that stockholders pay particular attention to profitability ratios. Three ratios will be presented: return on total assets (ROTA), return on stockholders equity (ROSE) and earnings per share (EPS).

The ROTA, also known as return on investment (ROI), identifies the after-tax profits per dollar worth of assets for the company. Overall Sundstrand's ROTA is fairly good as compared to other companies in the same industry. Problems did occur 1988 when the government took legal action against Sundstrand over incorrect pricing contracts. Sundstrand appears to be back on track to a good financial position.

The ROSE measures the after-tax profits for stockholders investments within the company. Sundstrand's ROSE shows a good recovery for investors after the 1988 ordeal. The company has restored confidence within the firm's investors as can be seen by reviewing the 1989 ROSE ratio of 21%.

The EPS assists in evaluating the available earnings for the owners of the company's common stock. The EPS ratio has fluctuated over the past ten years with a decline starting around 1986. The drop in the EPS could have been the onset of the government pricing ordeal. Once again

Sundstrand appears to be recovering quite well from the 1988 incident. This can be seen from a -4.15 in 1988 to 6.17 in 1989.

Company Growth. The last area of trend analysis is the growth of the company. The ratios presented here help to identify how well the company is maintaining position within the overall economy. Five ratios will be presented in this section, they are: sales growth (SG), income growth (IG), earnings per share growth (EPSG), dividends per share growth (DPSG) and price earnings ratio growth (P/ERG).

Examining the various ratios identify important aspects of Sundstrand's overall growth. There appears to be considerable fluctuation in the SG, IG and EPSG ratios over the past ten years. This could indicate Sundstrand has difficulty reacting to changes in the national economy. This could also be due to the types of products that Sundstrand produces. Also, government legal actions have not help the overall growth situation for Sundstrand.

The DPSG ratio has shown no changes in growth over the past seven years for the company. This should indicate to the company's investors that Sundstrand shows steady earnings power.

The P/ERG tends to be more on the conservative side for this type of industry. Sundstrand's P/ERG ratios identify the company as a steady growth firm, but the pace of growth is moderate for this type of industry.

Financial Position Summary

Overall Sundstrand appears to have shown financial strength. This is true especially after the 1987-1988 incident with the government. It looks as if the company will be in a good position to financially afford a large capital investment expense in the upcoming years. This is based upon the profitability ratios in Appendix H.

From the past trend analysis the company shows relatively stable leverage and profitability ratios. This indicates Sundstrand should have no difficulty in implementing an overhaul in its office facilities. The analysis identifies the source of financing should come from a combination of short-term negotiable instruments and long-term debt such as bonds.

Financial forecasts for Sundstrand should indicate continued growth (i.e., financial, profit, size) for the firm. An area of change which the company might undergo is diversification in its product lines. This will create additional markets for the company to begin penetrating and capturing. Also, there might be changes in the customer base which the company currently services. There will probably be a larger increase in the commercial customer base as opposed to the military customer base. All of these changes will require a proper office environment to effectively and efficiently expedite the expanding business functions.

Business Perspectives

Upon analyzing the case study problem through a facilities management evaluation further insight must be given for a business perspective. Several business areas must be discussed, they are: company, management and personnel aspects. Each of these areas will be reviewed as they relate to the case study problem.

Company Aspects

There are several company aspects which should be examined so that the overall scope of the case study problem is fully analyzed. First, Sundstrand needs to weight the overall case study problem against other existing company problems. Such that the perceived benefits of resolving the case study problem must be weighed against other problem benefits. If the benefits prove to be high then Sundstrand should implement a resolution to the problem. Also, Sundstrand has limited resources, such as: finances, manpower, and physical facilities; each of these resources must be used by the company prudently when implementing problem solutions.

Second, the resolution of the case study problem must fall in line with existing company policies and beliefs. The overall long term strategies of the company are achieved through the use of company policies and beliefs. Therefore, the problem resolution must not deter the company from obtaining the long term strategies it has set.

Third, the owners of the company (i.e., stockholders) must be satisfied with the overall functioning of the company. If management chooses to implement a solution to the case study problem then the results need to provide payback to the company owners. Some types of payback for stockowners are: financial growth (i.e., dividends, profits) and company expansion (i.e., new products, new customers).

Finally, Sundstrand should review the results from other companies in the same industry which have implemented some sort of solution towards the case study problem. This will help to determine if the overall effort to resolve the problem is worth the time, money and manpower.

Management Aspects

A review of management aspects with respect to the case study problem will provide information for a complete analysis. First, Sundstrand management must make sure that a high level of employee job satisfaction is maintained. This will assist in keeping experienced employees within the company and will help to attract perspective new employees. The office environment plays a key role within this management directive and proper attention needs to be given to this area.

Second, company management has several operational goals which must be obtained, they are: maintain high product quality, continue to increase employee productivity; assist in keeping employee morale, loyalty, and team spirit up; and reduce the overall rate of operational errors (i.e.,

product design and development defects). The office environment interacts directly with each of these management operational goals and implementing a solution to the case study problem will provide direct assistance for management.

Next, following the current trends in business and manufacturing environments downsizing the company's operational efforts deems necessary to stay competitive. It is up to management to properly implement the required changes to accomplish this goal. Thus, reducing the overall actual square footage for office operations and increasing employee productivity at the same time falls right in line with this objective.

Finally, it is imperative that Sundstrand management insure that the most cost effective measures are applied towards the case study problem. This will assist in meeting company directives for its owners and will keep the overall cost of its products as low as possible.

Personnel Aspects

Understanding the case study problem as it relates towards personnel resources will provide additional direction into the analysis. Employees must be completely aware of the problem scope, management direction and current progress towards a resolution. Without employee involvement the total effect of the problem and its potential solutions may not be completely investigated.

Next, employee motivation, productivity and effectiveness are intertwined with the work environment. As

the overall level of the work environment deteriorates and becomes out-of-date, the levels of employee motivation, productivity and effectiveness should also diminish. This shows a direct correlation between these three variables and the work environment. Therefore, it is imperative that the work environment be maintained so that experienced, reliable and valuable employees are not lost.

Finally, employees and management must work as a team to resolve the case study problem. Working together will bring issues from each side of the problem out in the open and allow them to be addressed much sooner. Also, employees will have a better attitude towards management knowing that measures are being taken to improve the work environment.

SECTION 5

DISCUSSION OF POTENTIAL SOLUTIONS

Overview of Alternatives

Throughout the case study the Systems Development department has been used as a model to highlight and focus on the main problem. A brief review of section 3 within the case study will assist in reemphasizing the overall problem. The Systems Development department is not the only area affected by the outdated and ineffective work space. Most of the company's office facilities are experiencing some of the same types of conditions. There are a number of potential alternatives that Sundstrand could adopt and several of these are:

1. Build new ergonomically effective office facilities for its current office work force.
2. Lease ergonomically effective office facilities for its current office work force.
3. Contract current business operational functions outside of the company.
4. Renovate and remodel the current office facilities to create an ergonomically effective office environment for its current office work force.
5. Do nothing about the office environment and continue operating the firm under the current office environment.

Presentation of Alternatives

The following subsections of this case study describe the possible alternatives which could be implemented to alleviate the case study problem. Advantages and disadvantages to each alternative have been presented, as

well as, a presentation of overall cost factors. Also, deductive reasoning for not choosing a particular alternative have been examined.

Build New Office Locations

This particular alternative consists of building new office facilities that are ergonomically designed. Sundstrand would sell off or lease out their current office areas, including the fixtures and furniture. This will assist in compensating for the overall cost of the new office space. The new office facilities would incorporate all of the aspects previously discussed within the problem analysis section of the case study. Also, the new office area would have plenty of additional space for work force growth.

The estimated cost to provide for this alternative would be quite high and is based on the current amount of office space utilized within the company. Using the 60/40 rule, which is the percentage of office employees versus factory employees, approximately 4,756,400 square feet of office space becomes the base for calculating the total amount. The new office environment would reduce the amount of required space per worker by 50 percent, based on prevailing industry standards (Fernberg, 1990). Also, the growth span for the work force can be estimated at approximately 15 percent. The overall calculated amount would be 65 percent of the total current office space which computes to 3,091,660 square feet. Estimating the per

square footage cost for the new office facilities at \$150, based on current industry cost factors. Included in this price is interior construction and design costs. A review of Appendix I, Part A will assist in examining the total cost for this alternative. The entire Appendix I will provide an overall cost evaluation for each alternative.

There are several advantages to this alternative:

1. The new office area would be of proper ergonomic design, from the base components through the finishing touches.
2. The right groups of design professionals would be involved at the correct points in the design process.
3. The overall value of Sundstrand's assets would be increased by building modern and ergonomically designed office facilities.
4. The new office facility would provide psychological benefits by boosting the morale of office employees. This in turn aids in reducing overall error rates and increases levels of productivity.

There are several disadvantages to this alternative:

1. The attempt to either sell or lease the existing office space may fail. This would leave the company with unused assets.
2. The overall price of products would increase due to higher overhead costs which must be passed on to customers through product sales.
3. The overall cost to build the new facilities would be above and beyond the feasible limit for Sundstrand to handle at this point in time.
4. Office and manufacturing personnel would be physically separated throughout the product development cycle. This could drastically affect the level of communication which occurs during this process and ultimately slow down the product development cycle.

The main reason for not choosing this alternative is because the office employees would be separated from the manufacturing facilities. Thereby eliminating the overall cohesiveness of the office and manufacturing operations. Also, finding the proper type of tenants for the existing office facility could be quite difficult. Conflict of interest between the new tenant and the company must be avoided.

Leasing Ergonomically Designed Office Space

This alternative involves leasing ergonomically designed office space. The current office facilities could either be sold or leased to another business. This relieves Sundstrand of maintaining additional fixed asset costs for unused buildings. The new facilities would have all of the elements that are required to provide an ergonomic environment.

The overall cost to lease new office facilities will vary depending on the locations and total design features provided. After investigating the option of leasing office space cost figures were unattainable. Therefore, an estimated cost has been used for this alternative. Refer to Appendix I, Part B to review the total cost for this proposed solution.

There are several advantages to this alternative:

1. The new office area would be designed properly from the base components through the finishing touches.
2. The company would not have to hold the asset permanently on their accounting books.

3. Maintenance of the office complexes would be handled by the owners of the office buildings.
4. Any upgrades to the physical environment would also be provided by the lease owners.
5. The construction costs of providing an ergonomically efficient environment are eliminated.
6. The physical land and building asset inventory is reduced.

There are several disadvantages to this alternative:

1. The attempt to either sell or lease the existing office space may fail. This would leave the company with unused assets.
2. The actual location of the office facilities may not fit into prime operating locations for the company.
3. The company would not actually own the property or its land. They would not be able to make improvements on it without the consent of the lease owners.
4. The company could be charged excessively high lease rates to cover the development costs by the lease owners. These costs would in turn be passed on to the customer through higher prices.
5. Office and manufacturing personnel would be physically separated throughout the product development cycle. This could drastically affect the level of communication which occurs during this process and ultimately slow down the product development cycle.

The main reason for not choosing this alternative is because the ability to determine an office design and location which is suitable for the company could be difficult. It is likely the area surrounding the current office locations would not be possible and relocation would be necessary. This could cause considerable difficulties for personnel in the relocation process and moving costs

would be incurred. Also, office employees would be separated from the manufacturing facilities where vital information must be communicated between office and manufacturing employees.

Contract Work Outside of Firm

This alternative involves contracting out most of the current business functions which are performed within the office. This includes job functions like: Business Systems Development, Purchasing, Engineering, Material Planning, Production Planning, Accounting, Finance; Contract and Order Administration. Sundstrand could then sell off or lease out the current office space which is used for many of the above mentioned job functions.

The overall cost to contract outside the firm for the current job functions would depend on the availability, quality and functionality of the contracting firms. After attempting to investigate the area of outside contracting firms overall cost figures were unattainable. Therefore, an estimated cost has been used for this alternative. Refer to Appendix I, Part C to review the total cost for this proposed solution.

There are several advantages to this alternative:

1. The entire concept of an ergonomically efficient office could be eliminated because there would be no need for office facilities.
2. The company payroll would decrease because there would be less personnel involved inside the company.

3. Company benefits and insurance claims would decrease due to less employees within the firm.
4. The overall assets and liabilities of the firm would be reduced. This would allow the company to concentrate on providing better quality made products and with less overhead costs involved.
5. The maintenance and improvement cost for the current land and buildings would be eliminated.

There are several disadvantages to this alternative:

1. The attempt to either sell or lease the existing office space may fail. This would leave the company with unused assets.
2. The overall legal costs within the firm would increase dramatically due to additional outside agencies involved in the day to day operations of the company.
3. The ability to coordinate and control the job functions which have been contracted outside of the corporation would be extremely difficult.
4. There may be no qualified firms available to properly handle the types of job functions which the firm currently executes.
5. A loss of cohesiveness between each functional areas within the company might develop.
6. Overall costs of existing product structures would probably rise due to high contracting costs.
7. The company would lose an extremely proficient work force with years of qualified experience. This could effect market share and profits extensively.

This alternative was not chosen for the resolution for the following reasons. The overall organization and operating efficiency of the firm would be lost. Also, the cohesiveness and required level of communication which occurs between each of the functional areas would be reduced if not eliminated. This eventually causes the company to

begin losing market share and profits. The company's shareholders would not be pleased over this alternative. Finally, the net present value of the alternative shows a negative value and therefore, the company would lose money by choosing this alternative.

Renovate and Remodel Existing Facilities

This alternative involves using the current office facilities as a base design. The existing facilities would be redesigned using the concepts outlined within the problem analysis section. Therefore, the right components (i.e., proper lighting, furniture, chairs, acoustical measures, workstation designs) would be used in the current office environment. No additional office space would be needed for the current work force.

Further discussion of this alternative will be presented in the resolution section. A detailed implementation plan has been presented and address several of the topics discussed in the analysis section.

Continue Company Operations Without Changes

This alternative involves continuing the company operation without making changes to the existing office environment. The current work force would use the office facilities in their present condition and the scientific elements of an ergonomic office environment would not be incorporated. Therefore, the current problems which exist within the office space will not be eliminated.

The costs associated with this alternative are hard to determine. The development costs would be avoided. Although, additional intangible costs must be weighed. The cost of worker productivity is difficult to estimate and its eventual effects on net income for a company could be quite high. There is also the issue of higher insurance and medical costs which the firm must ultimately absorb. The overall costs with this alternative could continue to increase and become quite excessive for the company. Refer to Appendix I, Part D to review the estimated total cost for this proposed solution.

There are several advantages to this alternative:

1. No additional building, maintenance or renovation costs will be incurred for the company.
2. No levels of employee training would be required for an ergonomic office environment.
3. Disruption of work force during transition period would not be observed.
4. No additional costs for purchasing ergonomic fixtures (i.e., lighting, furniture, chairs, acoustical elements) would be incurred.

There are several disadvantages to this alternative:

1. The level of office employee dissatisfaction (i.e., morale) with the current work environment would continue to increase.
2. Worker productivity would continue to decline due to the existing office environment.
3. The level of health insurance claims may begin to increase because of the inadequate office environment to support office automation.
4. Employee turnaround could start to increase due to the inadequate work environment.

5. A loss of potential profits will be observed because the current office environment does not promote continued high levels of worker productivity.

This alternative was not chosen because it does not solve the current operating business problem. It is basically ignoring the current problem and its effect on the office work force. Also, this alternative would not place the company in good standing with its office employees. Employees supply an important amount of effort to create profits for the company. In the spirit of continuous improvement it would go against Sundstrand's corporate beliefs to ignore this business problem. Therefore, this is not a feasible solution to this case study problem.

SECTION 6
RESOLUTION AND IMPLEMENTATION

Resolution of Existing Problem

To alleviate the existing problem facing Sundstrand the alternative to renovate and remodel the existing office environment has been chosen. The most important reason for selecting this alternative is because the office and manufacturing facilities and personnel are kept together as a cohesive unit. This is vital for maintaining a leading edge over competing companies and for expediting the product manufacturing cycle. Also, the existing office facilities can be utilized without incurring any additional new land, building or leasing costs. Finally, it makes effective use of the existing environment while providing the current office work force with an improved environment.

The appropriateness of the selected alternative is evident by the total returns that Sundstrand would receive over the years. The most important return the company would receive is increased office worker productivity. A review of Table 4.1 would be appropriate in identifying the overall levels of increased productivity from the ergonomic office improvements the company would receive. Increased productivity converts into company profits by reducing the amount of indirect overhead product development costs. Also, it shows the company is concerned about the health, safety and welfare of its employees. Taking the current situation in hand and resolving it without major

complications to the office work force shows Sundstrand is proactive to change. In addition, it shows the company is continuously striving to improve the work experience for its employees. For without employees, both office and factory, the company would not be where it is today.

The selected alternative provides several advantages or benefits upon implementation, they are:

1. There would be no need to find new office locations to operate the business.
2. The overall disruption to the work force would be minimized. The current office employees would not have to commute to a different work location or relocate to a new city.
3. Increased physical asset values (i.e., buildings) would be achieved through this alternative. The existing office buildings would be modernized and brought up to industry standards. This would increase the overall value of the existing structures.
4. Effective and efficient utilization of the current office facilities would occur. This creates a lower product cost to the customer.
5. The overall total cost should be the lowest out of all the alternatives. This is speaking in terms of implementation costs for the company.
6. The total returns (i.e., profits) for the company should be quite high.

The cost of this alternative will vary depending on the quality of products purchase, the length of time between purchases and the extent of renovation. The Systems Development department can be used as a model for determining the overall company cost. The department currently occupies around 9,000 square feet. About 2,500

square feet of this space is designated for structural facilities (i.e., restrooms, stairways and entrances, aisles). The existing office space is occupied by 64 office employees and additional contract employees will soon occupy part of the office space. The estimated total number of employees occupying the office space is around 100.

Sundstrand needs to adjust their interior design and construction cost to around \$70 per square foot to cover the overall improvement costs. This is an estimated figure which is based upon current industry costs. This would almost double the current cost factor employed by the company. Refer to Appendix I, Part E to review the overall estimated costs for renovating the entire office space within the company. This alternative does not have the highest net present value but there are additional elements which must be included within the evaluation. For example, moving costs would be avoided and possibly higher property tax rates could also be avoided. Thus, this alternative has a few extra features to present within the overall scope.

The total cost of this resolution for the Systems Development department can be estimated at approximately \$417,750 which is about 2% of the overall calculated cost for the company (see Appendix I, Part F). This figure was computed by taking the total company cost and dividing it by the number of office employees. Next, this figure was multiplied by the current number of System Development department employees to derive the department cost.

The estimated total cost of enhancing the office environment for Sundstrand is somewhat high. The company would have to initiate some type of capital funding effort to provide the needed funds. Sundstrand would probably be in a good position to finance approximately 45% of the total cost through short-term commercial paper and should not go above 45% due to the cost of commercial paper. The remaining 55% of the cost could be funded through long-term negotiable bonds. This would allow the company to maintain a relatively good leverage ratio.

Another possibility for financial payment of this solution would be to gradually remodel each department when they are in the process of relocating to a new office area. At this time the development costs would be absorbed and would not financially drain the company. A drawback to this financing alternative is that the total return on investment for the company is much lower and takes longer to obtain.

An important matter to discuss is the pro forma statements for the company. It is quite difficult to estimate what these statements would look like. The main reasons behind this point are:

1. The main benefit to the company would be increased worker productivity. This is an intangible type of benefit to evaluate. An exact dollar amount might be difficult to obtain.
2. The profits which the company would achieve would not be realized for at least four to six years from the implementation process. Although profits can be estimated anywhere from \$20,000 to \$40,000 yearly increase. This is based on the 1989 net income figure increased by 15%. There are many other

variables that could effect the company financially and this estimated profit figure..

3. Projecting pro forma statements for the next year would show a large loss for the company. This would not be a fair judgment or evaluation of the proposed capital expenditure.
4. Much of the company's business is based on governmental spending policies. These policies change drastically from one year to the next. The policies would be difficult to project four to six years from now.

In place of pro forma statements a financial payback/breakeven evaluation will be supplied for the managerial strategic decision making process. Using some of the estimated figures from Appendix I, Part F, the annual savings of \$4,425 per office employee for productivity improvements will be used to calculate the payback period. Thus, in one year the company savings would be \$36,373,500, based on the current number of office employees. The payback period would be about 5.30 years, excluding inflation and financing costs. After reaching the payback period every subsequent year is converted into productivity profits for the firm. In addition, the relative useful life of the office improvements depends on the type, quality and care of the furniture and fixtures. Its estimated that the overall useful life of the office improvements would be somewhere around 10 to 15 years, based on current industry trends.

Along with overall increases in productivity and long-term profits for Sundstrand the company also benefits through lower employee health insurance claims costs and

employee absences due to illness. It is estimated that approximately 10% of office health insurance claims are due to the office environment (Datamation, 1988). For example, employees needing new or stronger prescriptions for glasses or contacts, due to the incorrect type and levels of office lighting.

Using the 1989 annual budgeted amount of \$335,674 for health insurance benefits for the Systems Development department Sundstrand's office environment related claims can be estimated (Calacci, 1989). The figure calculates to approximately \$4,568,187 in yearly estimated office environment related claims for Sundstrand (i.e., 10% of total health insurance claims for office employees). This is quite a savings figure for the company if the entire amount can be eliminated by redesigning the office environment.

In respect to legal issues surrounding the problem resolution the overall impact is difficult to determine. As state and federal governments receive more information relating to office environment effects on workers, the legal aspects will become more pronounced. It would behoove Sundstrand to implement office improvements according to some of the voluntary standards set up by private industries. It is just a matter of time before these voluntary standards become government legislation.

Implementation of Selected Alternative

To understand the entire implementation process the Systems Development department will continue to be used as a model for the discussion. The concepts and processes can then be transferred to the entire corporation for a full blown implementation effort. The implementation process has a series of phases which should be followed.

The first phase in the implementation process is to develop a design team, with members consisting of: department manager(s), line level managers, selected operative employees, buyers, office planning personnel, an outside design consultant and plant engineers. The team would be thoroughly trained in the scientific concepts of ergonomics. This will help them to properly evaluate the existing office environment.

The next phase involves evaluating the current office facilities by identifying and documenting deficiencies of the office environment. Seven main elements of ergonomic design would be thoroughly examined at this point, they are: office layout, general design concepts, lighting, acoustics, climate, furniture and workstation designs. An example for this phase would be to review the current types and levels of office lighting (using light monitors) and document any deficiencies.

The third phase of the process involves the design team actually creating the new ergonomic office environment. Each individual ergonomic area will be analyzed and the

proper fixtures will be chosen. Many of the proper ergonomic elements discussed within the problem analysis section would be installed. Some of the selected fixtures or concepts which should be chosen by the design team should include:

1. Using an open office layout and design the office with proximity and work flow in mind.
2. Using complementary color schemes.
3. Providing ample use of plants.
4. Replacing the direct lighting fixtures with parabolic fixtures.
5. Making use of indirect lighting fixtures where ever possible.
6. Providing task lighting at individual work stations.
7. Replacing ceiling tiles with sound absorbing tiles.
8. Possibly replacing windows with double or triple paned glass.
9. Providing an efficient Heating/Ventilation/Air Conditioning system.
10. Replacing existing operative employee furniture with clustered modular units. Refer to Figure 4.3 for an example.
11. Replace existing management furniture with panel hung modular units. Refer to Figure 4.1 for an example.
12. Purchasing ergonomically designed chairs.
13. Installing acoustical partitions which serve as sound absorbing and privacy instruments.
14. Providing proper window coverings (i.e., adjustable vertical window blinds).

The above list is not all inclusive and has been developed to provide some insight into what the design team should consider for an "automated office" environment. Refer to Appendix J to review the revised office layout using an ergonomic office design and some of the items mention above. There are other items which will need to be

reviewed and a decision on whether to replace the fixture must be made (i.e., carpeting, computer terminals).

The fourth phase of the process is the physical development of the new office environment. The existing office facility would be renovated in a systematic manner. For example, plant engineering personnel could begin the redesign by starting in one area of the office on a weekend and continuing until the entire department has been completed. This would be done to avoid any major inconveniences to the office employees in the construction area. Their well being and work output must not be drastically impaired during this phase of the implementation process.

The fifth phase of the process involves the educating and training of the office staff on the elements of ergonomics. They must also be trained on the proper use of the new office equipment. For instance, special training consultants could provide the needed instruction for employees on a small group or individual basis until the entire department has been properly trained. This phase is important because improper training or ignorance of the new environment will effect the overall provided benefits. Also, underachievement of potential company profits might be observed if training is neglected or improperly done.

The final phase of the implementation process requires management to execute an evaluation of the office employees in their new environment. This can be done through formal

surveys or possibly during employee performance evaluations. It is important for management to know if the entire effort was worth the overall cost and it keeps management involved throughout the entire process. Also, it gives employees the ability to air their viewpoints and possible problems with the new facilities.

Impact on the Organization

As with any major decision made within an organization the impact on the company must be evaluated. It is important to assess which areas of the company will be affected by the strategic decision. Thus, the decision to renovate and remodel the existing office environment will affect several areas within Sundstrand, they are: company finances, personnel (both current and future), physical assets, customers and management.

Company Finances

Company finances will be affected in several different ways. First, the company must spend a large initial sum of capital funding to convert the current office environment. This will drain capital resources for Sundstrand quite considerably. Next, a considerable amount of development and training time must be expended to complete the project. This adds up in overall total costs and therefore, it must be considered a financial impact on the company. Also, the company will begin to see monetary returns. The profits will affect the financial situation of the company.

Finally, health insurance costs should begin to decline (e.g., \$4,568,187 yearly) after the implementation process is complete.

Current Employees

The next area of impact on the company is current personnel and they will be affected by the resolution in several different ways. First, the employees will have to work around the construction while the development process is performed. Next, the employees must spend a fair amount of time to learn ergonomic concepts and how to effectively use the new office environment. This might affect their work output while the learning process is being completed, due to the imposed learning curve. Also, as the employees get acclimated to the new environment their productivity should begin to rise. In addition, the psychological aspects (i.e., morale, company participation, work pride) should begin to positively increase and ultimately show a net gain in the overall level of employee workmanship.

Future Employees

Sundstrand's potential employees will also be impacted by this solution. First, Sundstrand will have an additional selling feature to potential employees. Second, an ergonomic office environment may become a standard for the service industry. Therefore, Sundstrand will be up to industry standards and a model company for others to follow. Also, future employees will be assured of an office

environment that is safe, healthy and conducive to their needs.

Physical Assets

Sundstrand's physical assets will also be affected by the chosen solution. The current buildings which provide the office environment for many of Sundstrand's employees will be structurally and aesthetically improved. This will increase the value of these physical assets and provide a better working environment. Also, the depreciation values against the buildings should be increased because of the increased asset value. Finally, the overall life of the buildings will be extended because of the structural improvements.

Customers

Sundstrand's customers are another group that will be effected by the solution. Both commercial and military customers will eventually be able to purchase quality products made at a lower cost. This is due to lower overhead costs being applied to the products from increased worker productivity. Also, the customer will also enjoy better working relationships with the office employees. Employees will be pleased with their job functions and this will reflect onto the customer.

Management

The last area within the organization to be affected by the solution is company management. Management at all levels within Sundstrand will be involved in some manner

with initiating the design, implementation and post evaluation of the improved ergonomic office environment. Also, it is important for management to fully understand and promote the concepts of an ergonomic office facility. This group of individuals will be instrumental in making the new environment a success for Sundstrand.

SECTION 7
CONCLUSION

The office environment which Sundstrand currently provides will eventually damage the company overall. Changes must be incorporated to keep the company proactive, competitive and a market leader. Change is inevitable for companies and individuals, without it we would not grow and learn from our past decisions. Thus, Sundstrand needs to react to the case study problem because its employees are its most important asset. Without employees the company would not be where it is today.

It is vital for Sundstrand to stay competitive in a market which has developed quickly. Without changes and improvements in the organization the company will become complacent and eventually suffer a loss in vital market share. Therefore, incorporating an ergonomic office environment into the current office facilities will keep Sundstrand competitive. It will also keep the company current with the industry and most of all productive.

Another important point is that this change for Sundstrand works along side with the company's corporate-wide beliefs and its continuous improvement concepts. Time will show how the office improvements make Sundstrand a better place to work. A company that takes care of its employees creates a relationship which proves beneficial for both parties involved.

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APPENDIX A: Sundstrand's Product Lines

Aerospace

▶ Electric Power

Electrical power generating systems
 Integrated drive generator systems
 Microprocessor-based controls
 Controlled speed motors
 Emergency generating systems
 Generators
 Constant speed drives

▶ Engine Accessories

Pumps

Engine main fuel
 Lube and scavenge
 Augmentor
 Engine, turbo, electric-driven boost

Other Equipment

Oil coolers
 Valves
 Power lever controls
 Particle separation and cooling fans
 Engine start systems
 Cartridge and pneumatic starters

▶ Turbo Power

Aviation

Auxiliary power units
 Air turbine motors
 Monofuel emergency power units
 Ram air turbines*
 *License agreement with Dowty-Rotol, U.K.

Torpedo Propulsion Systems

▶ Actuation Systems

Active and Intermittent Duty Flight Controls

Leading and trailing edge
 Rudder and stabilizer
 Aileron, flap and spoiler
 Engine vectoring nozzle

Utility

Weapons and cargo bay door
 Weapon launcher
 Nose wheel steering
 Thrust reverser and engine vane
 Collective pitch

Space Systems

Missile hydraulic power units
 Auxiliary power systems
 Special fluid pumps

▶ Environmental Control

Environmental control and avionics cooling units
 Cooling and circulation fans

▶ Telecommunications

AM and FM transceivers
 Air/ground telecommunication equipment (Flitefone®)

▶ Avionics

Memory Systems and Recorders

Universal flight data and cockpit voice recorders
 Solid-state flight recorders
 Tape transfer units
 Mass storage units
 Miniature flexible discs
 Optical discs

Data Management and Communications

Flight data acquisition units
 Management control units
 On-board aircraft maintenance systems
 Aircraft data retrieval and analysis systems
 Aircraft communications addressing
 and reporting system
 Aircraft condition monitoring systems

Flight Safety

Ground proximity warning systems
 Wind shear warning systems
 Stall warning computers
 Landing aid systems
 Head-up displays

Instrumentation

Accelerometers and accelerometer systems
 Thermal switches
 Inclination meters and magnetometers
 Temperature controls

Navigation

Long range, low frequency type systems
 Navigation data bank
 Flight management systems
 Airborne flight information systems (AFIS)

Aerospace markets include: commercial airframe manufacturers and airlines, military aircraft, helicopters, business jets, missiles, space, governmental agencies and general industry.

Source: Sundstrand worldwide guide, Sundstrand, 1989b.

APPENDIX A (continued)

Industrial

▶ The Falk Corporation

Backstops
 Disc couplings†
 Flange mounted drives
 Flexible shaft couplings
 Fluid drives*
 Gear couplings
 High-speed drives
 Hydro-kinetic traction couplings*
 Marine drives**
 Mixer drives
 Mechanical transmissions
 Motoreducers
 Packaged hydraulic power systems
 Screw conveyor drives
 Shaft mounted drives
 Single helical gears
 Special gear drives
 Speed reducers
 Steel castings
 Weldments
 Worm drives
Markets include: minerals and metals; electricity, gas, and sanitary services; transportation; coal; cement and aggregate; chemical; wood and paper; grain and food processing.

†License agreement with Turboflex, U.K.

*License agreement with Sime-Valeo, France.

**Some under license with Renk, W. Germany.

▶ Fluid Handling

Sundyne® and Sunflo® centrifugal pumps
 Sundyne® compressors
 Sunflo® blowers
 Canned motor pumps*
Markets include: hydrocarbon processing, chemical processing, paper, reverse osmosis, and boiler-feed.
 *License agreement with the Nikkiso Company, Limited of Japan.

▶ Heat Transfer

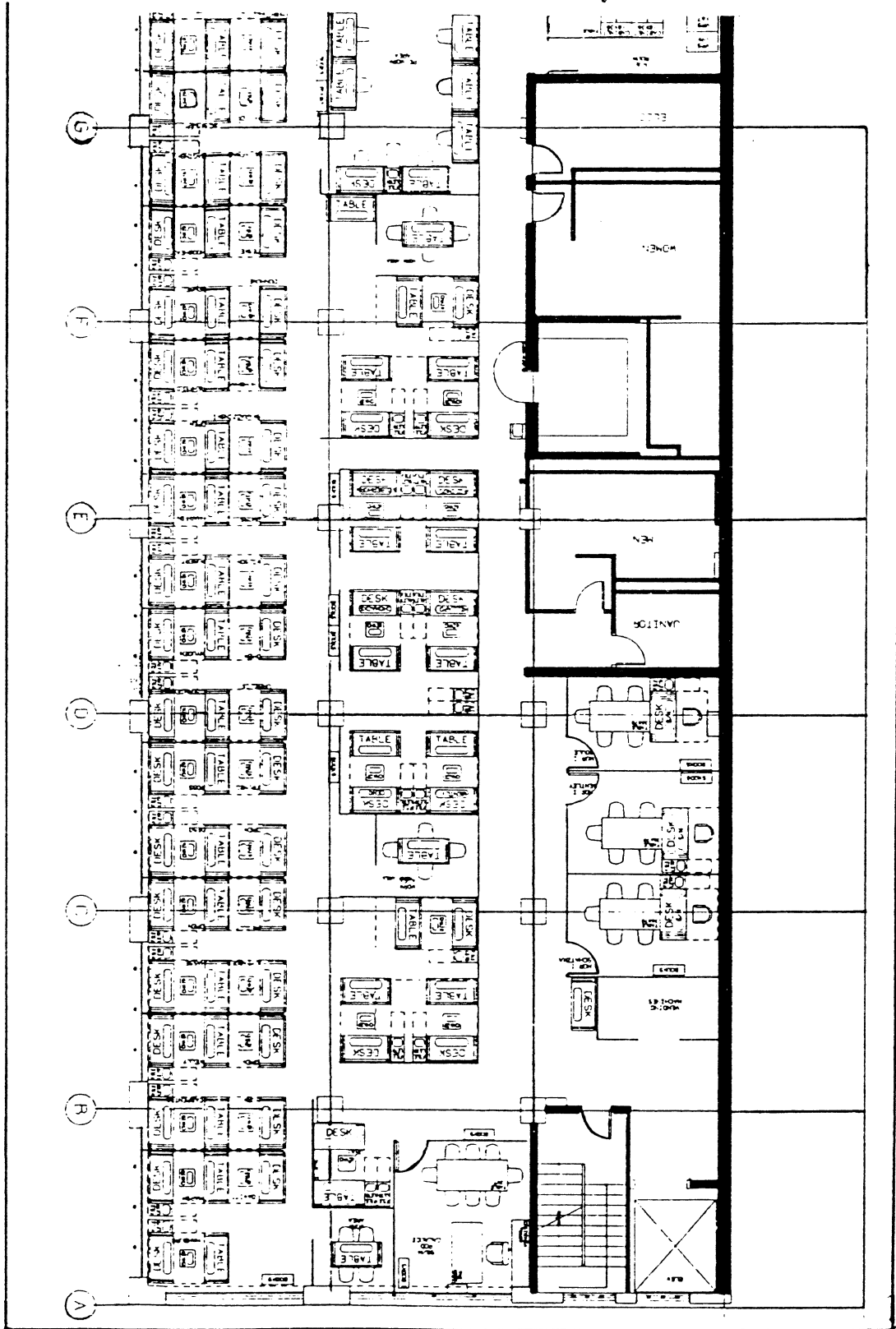
Copper/aluminum heat transfer surfaces
 Stainless steel/aluminum heat transfer surfaces
 Copper tubing
 Restrictor tubing
 Air conditioner and refrigeration feeder parts and manifolds
Markets include: automotive, residential, and commercial heating and air conditioning; commercial refrigeration.

▶ Sullair Corporation

Portable air compressors
 Pneumatic contractor tools*
 Stationary air compressors systems
 Dryer and filter systems
 Heat recovery systems
 Process and gas compressors
 Refrigeration compressors
 Vacuum systems
Markets include: manufacturing, general industry, construction, mining, and energy-related businesses.

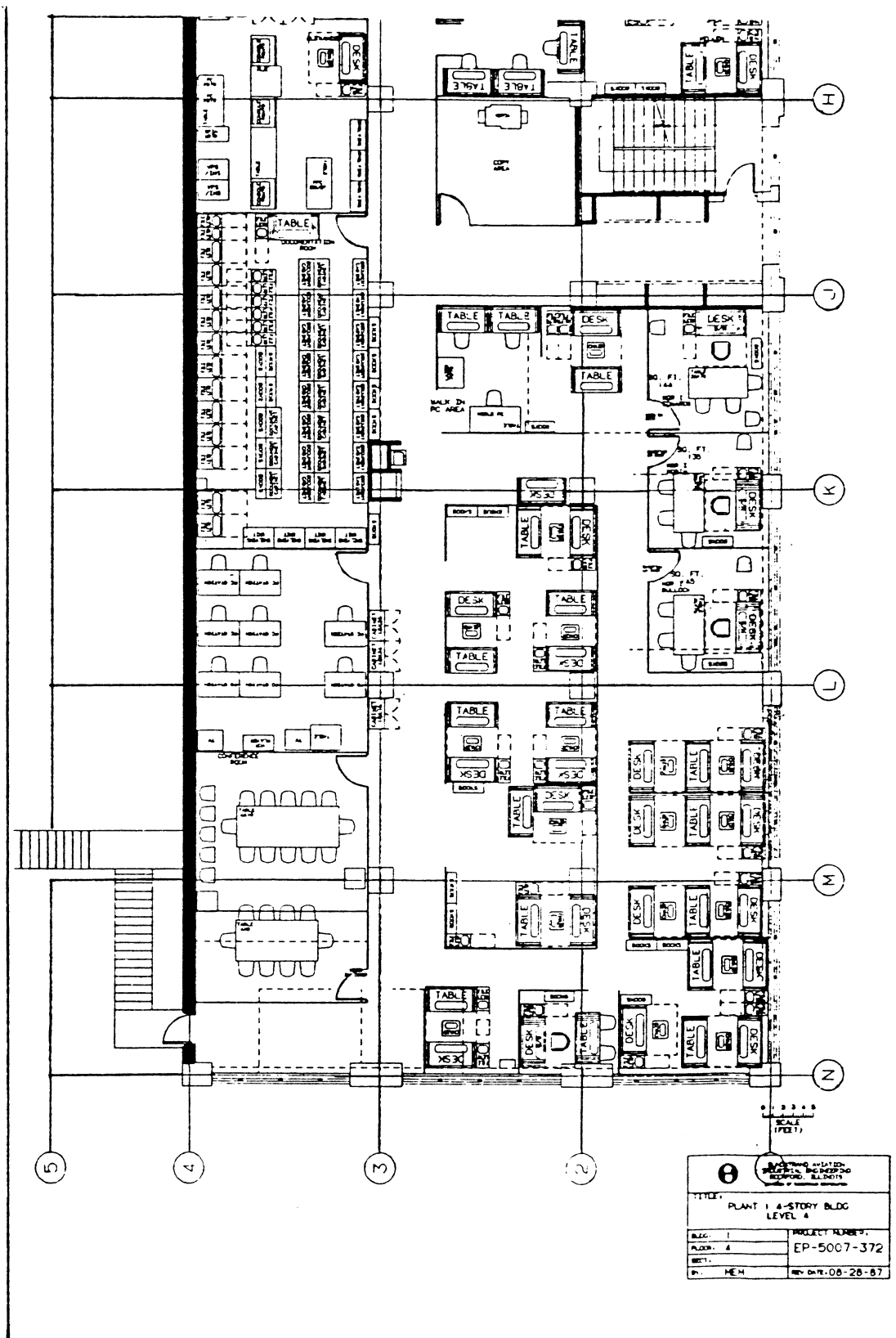
*Distribution agreement with Maco-Meudon, France.

APPENDIX B: Sundstrand's Systems Development
Current Office Layout



Source: Sundstrand Office Planning, Middleton, 1990.

APPENDIX B (continued)



TITLE: PLANT 1 4-STORY BLDG LEVEL 4	
FLOOR: 4	PROJECT NUMBER: EP-5007-372
REV. DATE: 08-28-87	BY: MEM

APPENDIX C: Sundstrand's Consolidated
Statement of Earnings

Consolidated Statement of Earnings

Sundstrand Corporation and Subsidiaries (SNS)

Year ended December 31,	1989	1988	1987
(Amounts in thousands except per share data)			
Net sales	\$1,595,398	\$1,477,289	\$1,365,482
Costs and expenses			
Costs of products sold	1,034,510	1,027,733	911,471
Marketing and administration	330,273	339,063	332,654
Aerospace loss provision	—	—	34,200
Provision for resolution of government contracts disputes	—	125,900	—
	<u>1,364,783</u>	<u>1,492,696</u>	<u>1,278,325</u>
Earnings (loss) before other income (deductions)	230,615	(15,407)	87,157
Other income (deductions)			
Royalties and commissions	4,150	2,821	2,682
Interest expense	(99,062)	(105,389)	(66,556)
Interest income	49,962	48,738	35,628
Gain on sale of Trans Com	16,637	—	—
Other, net	(1,650)	(10,971)	(2,931)
	<u>(29,963)</u>	<u>(64,801)</u>	<u>(31,177)</u>
Earnings (loss) before income taxes and cumulative effect of accounting change	200,652	(80,208)	55,980
Less income taxes	79,860	(30,100)	21,345
Earnings (loss) before cumulative effect of accounting change	120,792	(50,108)	34,635
Cumulative effect on prior years of change in method of accounting for long-term contracts, net of tax of \$16.5 million	—	(26,535)	—
Net earnings (loss)	120,792	(76,643)	34,635
Preferred stock dividends	6,638	—	—
Net earnings (loss) available for common shares	<u>\$ 114,154</u>	<u>\$ (76,643)</u>	<u>\$ 34,635</u>
Weighted average number of common shares outstanding	18,494	18,473	18,726
Earnings (loss) per share:			
Earnings (loss) before cumulative effect of accounting change	\$ 6.17	\$ (2.71)	\$ 1.85
Cumulative effect of change in accounting for long-term contracts	—	(1.44)	—
Net earnings (loss)	<u>\$ 6.17</u>	<u>\$ (4.15)</u>	<u>\$ 1.85</u>
Cash dividends per common share	<u>\$ 1.80</u>	<u>\$ 1.80</u>	<u>\$ 1.80</u>
Pro forma amounts assuming new method of accounting for long-term contracts is applied retroactively:			
Net earnings	\$ —	\$ —	\$ 19,974
Earnings per common share	\$ —	\$ —	\$ 1.07

See Notes to Consolidated Financial Statements

Source: Sundstrand 1989 Annual Report, Sundstrand, 1990b.

APPENDIX D: Sundstrand's Consolidated
Statement of Cash Flows

Consolidated Statement of Cash Flows

Sundstrand Corporation and Subsidiaries (SNS)

Year ended December 31, (Amounts in thousands)	1989	1988	1987
Cash flow from operating activities			
Net earnings (loss)	\$128,792	\$ (76,643)	\$ 34,635
Adjustments to reconcile net earnings (loss) to net cash provided			
Depreciation	86,597	85,167	80,193
Amortization	9,615	11,071	8,777
Deferred income taxes	29,077	(46,742)	4,623
Cumulative effect of accounting change	—	26,535	—
Provision for (settlements of) losses on long-term contracts	(11,898)	64,495	—
Provision for (settlements of) government contracts disputes	(57,800)	31,580	—
Aerospace loss provision	—	—	34,200
Change in operating assets and liabilities net of sale of Trans Com			
Increase in accounts receivable	(38,216)	(36,847)	(57,582)
(Increase) decrease in inventories	(52,731)	3,862	(47,180)
Increase in other assets	(1,454)	(4,609)	(8,494)
Increase (decrease) in accounts payable	(3,883)	24,075	10,227
Increase (decrease) in accrued expenses	23,089	(22,496)	18,025
Gain on sale of Trans Com	(16,637)	—	—
Other	(6,384)	1,297	156
Total adjustments	(40,625)	137,388	42,945
NET CASH PROVIDED BY OPERATING ACTIVITIES	80,167	60,745	77,580
Cash flow from investing activities			
Cash paid for intangible assets, property, plant and equipment, and leased equipment	(81,518)	(87,941)	(123,608)
Proceeds from sale of property, plant and equipment, and leased equipment	27,944	21,108	28,129
Proceeds from sale of interest in joint venture	45,278	—	—
Proceeds from sale of Trans Com	60,000	—	—
NET CASH PROVIDED BY (USED FOR) INVESTING ACTIVITIES	51,704	(66,833)	(95,479)
Cash flow from financing activities			
Net borrowings (payments) under line-of-credit agreements	35,858	(4,157)	63,619
Principal payments on long-term debt	(48,961)	(32,024)	(12,258)
Proceeds from issuance of long-term debt	—	—	4,000
Issuance (retirement) of preferred stock	(100,000)	100,000	—
Purchase of treasury stock	—	—	(14,159)
Dividends paid	(39,928)	(33,272)	(33,788)
NET CASH PROVIDED BY (USED FOR) FINANCING ACTIVITIES	(153,031)	30,547	7,414
Effect of exchange rate changes on cash	2,476	(1,325)	(737)
Increase (decrease) in cash and cash equivalents	(18,684)	23,134	(11,222)
Cash and cash equivalents at January 1	36,654	13,520	24,742
CASH AND CASH EQUIVALENTS AT DECEMBER 31	\$ 17,970	\$ 36,654	\$ 13,520
Supplemental cash flow information			
Interest paid	\$112,739	\$ 86,392	\$ 68,530
Income taxes paid	\$ 55,758	\$ 12,086	\$ 11,995

See Notes to Consolidated Financial Statements

Source: Sundstrand 1989 Annual Report, Sundstrand, 1990b.

APPENDIX E: Sundstrand's Consolidated
Balance Sheet

Consolidated Balance Sheet

Sundstrand Corporation and Subsidiaries (SWS)

December 31,	1989	1988
(Amounts in thousands)		
Assets		
Current Assets		
Cash and cash equivalents	\$ 17,970	\$ 36,654
Accounts receivable	317,605	291,482
Inventories, net of progress payments	428,818	390,116
Deferred income taxes	81,309	86,091
Other current assets	49,037	46,255
Total current assets	<u>894,739</u>	<u>850,598</u>
Property, Plant and Equipment, and Leased Equipment, Net	448,582	506,083
Intangible Assets	104,212	108,804
Other Assets	55,348	101,545
	<u>\$1,502,881</u>	<u>\$1,567,030</u>
Liabilities and Stockholders' Equity		
Current Liabilities		
Notes payable	\$ 97,159	\$ 61,691
Long-term debt due within one year	24,438	48,344
Accounts payable	98,040	111,651
Accrued salaries, wages and commissions	24,073	23,372
Contributions due retirement plans	16,920	18,643
Provision for losses on long-term contracts	60,720	72,618
Government contracts disputes provision	—	57,800
Other accrued liabilities	116,669	95,687
Total current liabilities	<u>438,019</u>	<u>489,806</u>
Deferred Income Taxes	226,058	206,433
Long-Term Debt (less current portion)	234,261	259,456
Other Liabilities	31,523	21,827
Stockholders' Equity		
Preferred stock, stated value \$100,000 per share; issued 1,000 shares	—	100,000
Common stock, par value \$1 per share; authorized 50,000,000 shares; issued 1989 and 1988—18,921,507 shares (including shares in treasury)	18,921	18,921
Additional contributed capital	136,343	133,506
Retained earnings	448,570	367,706
Foreign currency translation adjustment	(5,955)	(5,657)
Common stock in treasury (at cost); 1989—358,348 shares; 1988—428,398 shares	(13,753)	(16,335)
Unamortized value of restricted stock issued	(11,106)	(8,633)
	<u>573,020</u>	<u>589,508</u>
	<u>\$1,502,881</u>	<u>\$1,567,030</u>

See Notes to Consolidated Financial Statements

Source: Sundstrand 1989 Annual Report, Sundstrand, 1990b.

APPENDIX F: Sundstrand's Consolidated
Statement of Stockholders Equity

Consolidated Statement of Stockholders' Equity

Sundstrand Corporation and Subsidiaries (SNS)

December 31,	1989	1988	1987
(Amounts in thousands)			
Preferred Stock			
Balance at beginning of year	\$100,000	\$ —	\$ —
Stock issued	—	100,000	—
Stock redeemed	(100,000)	—	—
Balance at end of year	<u>\$ —</u>	<u>\$100,000</u>	<u>\$ —</u>
Common Stock			
Balance at beginning and end of year	<u>\$ 18,921</u>	<u>\$ 18,921</u>	<u>\$ 18,921</u>
Additional Contributed Capital			
Balance at beginning of year	\$133,506	\$132,077	\$130,921
Stock issued under employee stock plans	2,837	1,429	1,156
Balance at end of year	<u>\$136,343</u>	<u>\$133,506</u>	<u>\$132,077</u>
Retained Earnings			
Balance at beginning of year	\$367,706	\$477,621	\$476,774
Net earnings (loss)	120,792	(76,643)	34,635
Cash dividends paid	(39,928)	(33,272)	(33,788)
Balance at end of year	<u>\$448,570</u>	<u>\$367,706</u>	<u>\$477,621</u>
Foreign Currency Translation Adjustment			
Balance at beginning of year	\$ (5,657)	\$ (6,070)	\$ (7,152)
Adjustment for the year	(298)	413	1,082
Balance at end of year	<u>\$ (5,955)</u>	<u>\$ (5,657)</u>	<u>\$ (6,070)</u>
Treasury Stock			
Balance at beginning of year	\$ (16,335)	\$ (19,555)	\$ (5,705)
Purchase of 361,400 shares in 1987 for treasury	—	—	(14,159)
Stock issued under employee stock plans	3,112	3,315	689
Purchase of shares previously issued under restricted stock plans — 10,950, 1,750 and 6,360 shares, respectively	(530)	(95)	(380)
Balance at end of year	<u>\$ (13,753)</u>	<u>\$ (16,335)</u>	<u>\$ (19,555)</u>
Unamortized Value of Restricted Stock Issued			
Balance at beginning of year	\$ (8,633)	\$ (8,006)	\$ (9,090)
Stock issued under employee stock plans	(5,179)	(3,890)	(1,135)
Purchase of shares previously issued under restricted stock plans	314	71	285
Amortization of deferred compensation under restricted stock plans	2,392	3,192	1,934
Balance at end of year	<u>\$ (11,106)</u>	<u>\$ (8,633)</u>	<u>\$ (8,006)</u>

See Notes to Consolidated Financial Statements

Source: Sundstrand 1989 Annual Report, Sundstrand, 1990b.

APPENDIX G: Sundstrand's Selected
Financial Data (1979-1989)

Selected Financial Data, 1979-1989^(a)

Sundstrand Corporation and Subsidiaries (SNS)

Year ended December 31, (Dollar amounts in thousands except per share data)	1989 ^(a)	1988 ^{(a)(b)}	1987 ^(a)
Summary of Operations			
Net sales			
Aerospace	\$1,068,789	\$1,021,965	\$ 990,948
Industrial	526,609	455,324	374,534
Total	<u>\$1,595,398</u>	<u>\$1,477,289</u>	<u>\$1,365,482</u>
Operating profit (loss)			
Aerospace	\$ 182,471	\$ (59,951)	\$ 78,382
Industrial	82,397	54,116	21,877
Total	<u>\$ 264,868</u>	<u>\$ (5,835)</u>	<u>\$ 100,259</u>
Earnings (loss) before income taxes	\$ 200,652	\$ (80,208)	\$ 55,980
Net earnings (loss) before cumulative effect of accounting change	\$ 120,792	\$ (50,108)	\$ 34,635
Net earnings (loss)	\$ 120,792	\$ (76,643)	\$ 34,635
Return on average equity, after tax	21.5%	(14.1%)	5.8%
Per Share of Common Stock			
Earnings ^(c)	\$ 6.17	\$ (4.15)	\$ 1.85
Cash dividends	\$ 1.80	\$ 1.80	\$ 1.80
Market value - high	\$ 83.25	\$ 58.00	\$ 64.50
low	\$ 50.13	\$ 42.13	\$ 36.00
year-end	\$ 64.88	\$ 50.00	\$ 42.38
Book value	\$ 30.87	\$ 26.47	\$ 32.32
Year-End Financial Position			
Working capital	\$ 456,720	\$ 360,792	\$ 362,515
Current ratio	2.0	1.7	2.0
Total assets	\$1,502,881	\$1,567,030	\$1,504,856
Long-term debt	\$ 258,699	\$ 307,800	\$ 299,960
Total debt	\$ 355,858	\$ 369,491	\$ 366,306
Stockholders' equity	\$ 573,020	\$ 589,508	\$ 594,988
Ratio of total debt to total capital	38.3%	38.5%	38.1%
Other Data			
Orders received			
Aerospace	\$1,110,283	\$1,119,021	\$1,003,438
Industrial	531,567	497,818	396,877
Total	<u>\$1,641,850</u>	<u>\$1,616,839</u>	<u>\$1,400,315</u>
Unfilled orders			
Aerospace	\$1,030,330	\$1,031,986	\$ 965,370
Industrial	130,688	125,730	83,236
Total	<u>\$1,161,018</u>	<u>\$1,157,716</u>	<u>\$1,048,606</u>
Property, plant and equipment (excluding leased equipment):			
Additions, at cost	\$ 72,409	\$ 77,386	\$ 108,527
Depreciation	\$ 81,294	\$ 78,692	\$ 73,303
Approximate number of employees	13,700	13,800	14,200
Approximate number of stockholders of record	4,800	5,000	5,400

^(a)As previously disclosed, the Company pleaded guilty, in October 1988, to criminal charges, including charges that, between at least January 1, 1980, and January 1, 1987, two operating units of the Company had mischarged the government by submitting false claims in the form of progress billings to the U.S. Department of Defense which contained millions of dollars in unallowable and misallocated general and administrative costs, which claims were then known to be false. Users of these financial statements should be aware that the statements set forth for the years 1980 through 1986 include revenues that the Company has now admitted it should not have sought or received. This fact may affect the comparability of these financial statements with those of subsequent reporting periods.

^(b)1989 includes the gain on the sale of Sundstrand's Trans Com Systems division to Sony USA, Inc. of \$16.6 million before taxes and \$10.3 million after taxes (\$.56 per share). Provisions for interest charges for the anticipated resolution of certain tax disputes in 1989 and 1988 were \$19.0 million and \$22.5 million pre-tax and \$11.8 million (\$.64 per share) and \$13.9 million (\$.75 per share) after tax, respectively.

Source: Sundstrand 1989 Annual Report, Sundstrand, 1990b.

APPENDIX G (continued)

	1986 ^(a)	1985	1984	1983	1982	1981	1980	1979
\$ 968,040	\$ 805,863	\$ 648,178	\$567,017	\$560,060	\$ 524,309	\$ 479,376	\$ 351,099	
465,900	478,258	393,770	342,301	401,513	521,378	446,650	491,531	
<u>\$1,433,940</u>	<u>\$1,284,141</u>	<u>\$1,041,948</u>	<u>\$909,318</u>	<u>\$961,573</u>	<u>\$1,045,687</u>	<u>\$ 926,026</u>	<u>\$ 842,630</u>	
\$ 94,276	\$ 131,631	\$ 98,740	\$ 84,581	\$ 87,421	\$ 89,238	\$ 85,333	\$ 52,702	
6,215	20,487	26,341	7,478	25,787	95,721	76,345	71,517	
<u>\$ 100,491</u>	<u>\$ 152,118</u>	<u>\$ 125,081</u>	<u>\$ 92,059</u>	<u>\$113,208</u>	<u>\$ 184,959</u>	<u>\$ 161,678</u>	<u>\$ 124,219</u>	
\$ 66,415	\$ 119,692	\$ 111,650	\$ 70,563	\$105,351	\$ 156,541	\$ 121,857	\$ 100,175	
\$ 45,400	\$ 74,448	\$ 66,412	\$ 44,240	\$ 69,300	\$ 95,011	\$ 76,907	\$ 66,274	
\$ 45,400	\$ 74,448	\$ 66,412	\$ 44,240	\$ 69,300	\$ 95,011	\$ 76,907	\$ 66,274	
7.6%	13.2%	12.8%	8.9%	14.5%	22.1%	21.0%	21.4%	
\$ 2.42	\$ 4.02	\$ 3.63	\$ 2.42	\$ 3.77	\$ 5.15	\$ 4.21	\$ 3.67	
\$ 1.80	\$ 1.80	\$ 1.80	\$ 1.80	\$ 1.80	\$ 1.70	\$ 1.50	\$ 1.05	
\$ 64.38	\$ 54.75	\$ 52.00	\$ 51.75	\$ 46.00	\$ 58.25	\$ 59.50	\$ 40.00	
\$ 49.25	\$ 40.00	\$ 34.38	\$ 37.88	\$ 23.25	\$ 32.75	\$ 34.75	\$ 21.75	
\$ 53.25	\$ 54.50	\$ 44.50	\$ 48.75	\$ 44.00	\$ 42.00	\$ 56.50	\$ 38.00	
\$ 32.24	\$ 31.56	\$ 28.97	\$ 27.35	\$ 26.72	\$ 25.17	\$ 21.56	\$ 18.92	
\$ 420,783	\$ 288,209	\$ 278,724	\$306,207	\$303,233	\$ 349,246	\$ 344,701	\$ 265,038	
2.6	1.9	2.1	2.7	2.5	2.6	3.1	2.4	
<u>\$1,404,522</u>	<u>\$1,311,179</u>	<u>\$1,089,880</u>	<u>\$916,712</u>	<u>\$895,314</u>	<u>\$ 892,894</u>	<u>\$ 786,694</u>	<u>\$ 706,303</u>	
\$ 308,944	\$ 238,063	\$ 174,352	\$131,530	\$135,825	\$ 150,496	\$ 179,086	\$ 149,342	
\$ 317,165	\$ 320,000	\$ 219,313	\$154,318	\$175,663	\$ 182,235	\$ 185,242	\$ 187,621	
\$ 604,669	\$ 589,129	\$ 535,785	\$500,399	\$489,001	\$ 465,412	\$ 396,204	\$ 336,085	
34.4%	35.2%	29.0%	23.6%	26.4%	28.1%	31.9%	35.8%	
\$ 974,850	\$ 988,252	\$ 712,000	\$601,399	\$570,856	\$ 564,840	\$ 617,135	\$ 562,878	
471,301	479,065	397,034	351,536	335,272	514,772	432,637	478,512	
<u>\$1,446,151</u>	<u>\$1,467,317</u>	<u>\$1,109,034</u>	<u>\$952,935</u>	<u>\$906,128</u>	<u>\$1,079,612</u>	<u>\$1,049,772</u>	<u>\$1,041,390</u>	
\$ 952,880	\$ 946,010	\$ 763,641	\$699,819	\$665,437	\$ 654,641	\$ 614,110	\$ 476,351	
113,275	107,874	107,067	103,803	94,568	160,809	167,415	181,428	
<u>\$1,066,155</u>	<u>\$1,053,884</u>	<u>\$ 870,708</u>	<u>\$803,622</u>	<u>\$760,005</u>	<u>\$ 815,450</u>	<u>\$ 781,525</u>	<u>\$ 657,779</u>	
\$ 111,539	\$ 109,382	\$ 93,205	\$ 81,752	\$ 70,262	\$ 64,726	\$ 64,713	\$ 44,462	
\$ 70,843	\$ 59,811	\$ 51,754	\$ 46,687	\$ 41,714	\$ 36,256	\$ 30,483	\$ 29,535	
16,000	16,100	15,200	13,400	13,100	16,100	15,600	15,400	
5,900	6,900	7,500	7,400	8,300	9,400	8,900	8,600	

^(a)1988 includes provisions of \$125.9 million pre-tax and \$79.6 million after taxes (\$4.31 per share) for settlement of government contracts disputes and \$64.5 million pre-tax and \$39.8 million after taxes (\$2.15 per share) for the effect of the change in accounting for long-term contracts. 1988 also includes a cumulative effect provision of \$26.5 million net of tax of \$16.5 million (\$1.44 per share) for the change in accounting for long-term contracts.

^(b)1987 includes a provision of \$34.2 million pre-tax and \$19.3 million after taxes (\$1.03 per share) for nonrecurring losses in the Aerospace business segment.

^(c)1986 includes a loss provision of \$61.5 million pre-tax and \$31.7 million after taxes (\$1.69 per share) for the resolution of government contracts disputes in the Company's Aerospace business segment.

^(d)Earnings per share have been calculated based on the average number of common and common equivalent shares outstanding.

APPENDIX H: Past Trend Analysis of Sundstrand's
Financial Data

		----- YEAR -----										
		89	88	87	86	85	84	83	82	81	80	79
F I N A N C I A L R E T I N G S	LIQUIDITY											
	- CR	2.0	1.7	2.0	2.6	1.9	2.1	2.7	2.5	2.6	3.1	2.4
	LEVERAGE											
	- D/TA	23.6%	23.5%	24.3%	22.5%	24.4%	20.1%	16.8%	19.6%	20.4%	23.5%	26.5%
	- D/E	62.1%	62.6%	61.5%	52.4%	54.3%	40.9%	30.8%	35.9%	39.1%	46.7%	55.8%
	- LT-D/E	45.1%	52.2%	50.4%	51.0%	40.4%	32.5%	26.2%	27.7%	32.3%	45.2%	44.4%
	ACTIVITY											
	- TAT	1.06	.94	.91	1.02	.98	.96	.99	1.07	1.17	1.18	1.19
	PROFITABILITY											
	- ROTA-ROI	.08	-.05	.02	.03	.06	.06	.05	.08	.11	.10	.09
	- ROSE	21.0%	-13.0%	5.8%	7.5%	12.6%	12.3%	8.8%	14.1%	20.4%	19.4%	19.7%
	- EPS	6.17	-4.15	1.85	2.42	4.02	3.63	2.42	3.77	5.15	4.21	3.67
GROWTH												
- SG	7.9%	8.2%	-4.8%	11.7%	23.2%	14.6%	-5.4%	-8.0%	12.9%	9.9%		
- IG	-257.0%	-321.0%	-24.0%	-39.0%	11.0%	50.0%	-36.0%	-27.0%	22.0%	15.0%		
- EPSG	248.0%	-324.0%	-24.0%	-40.0%	11.0%	50.0%	-36.0%	-27.0%	22.0%	15.0%		
- DPSG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	58.8%	13.3%	42.8%		
- P/ERG	10.5	12.1	22.9	22.0	13.6	12.4	20.1	11.7	8.2	13.4	10.4	

Source: Calculated from Sundstrand 1989 Annual Report, Sundstrand, 1990b.

APPENDIX I: Cost Analysis for Alternatives -
Part A - (Build New Facility)

Time Periods in Years -->	1	2	3	4	5	6	7	8	9	10
Cash Inflows										
- Lease Existing Space	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800
- Gains from Productivity Improvements	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500
- Reduction in Health Insurance Claims	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000
- Sale of Short-term Commercial Paper	208,678,050	0	0	0	0	0	0	0	0	0
- Sale of Long-term Bonds	255,061,950	0	0	0	0	0	0	0	0	0
Net Inflows --->	538,076,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300
Cash Outflows										
- New Office Facility	463,749,000	0	0	0	0	0	0	0	0	0
- Cost of Acquired Capital										
- Short-term at 8%	16,694,900	16,694,900	16,694,900	0	0	0	0	0	0	0
- Long-term at 11%	0	0	0	0	0	0	0	0	0	72,770,959
- Capital Repayments										
- Short-term Paper	0	0	244,687,050	0	0	0	0	0	0	0
- Long-term Bonds	0	0	0	0	0	0	0	0	0	255,061,950
Net Outflows --->	480,443,900	16,694,900	225,381,950	0	0	0	0	0	0	327,832,909
Net Cash Flows --->	57,632,400	57,641,400	(151,045,650)	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	(253,496,609)

Net Present Value Analysis

Capital Cost at 10% -->	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855
Present Value at 10% --->	52,393,615	47,634,853	(113,480,597)	50,771,693	46,155,409	41,962,841	38,149,389	34,677,884	31,526,025	(97,722,943)

Net Present Value of Alternative ---> 132,068,169

Note: See Appendix I, Part P for a detailed explanation of calculated figures.

APPENDIX I (continued)
Part B - (Lease Office Space)

Time Periods in Years -->	1	2	3	4	5	6	7	8	9	10
Cash Inflows										
- Lease Existing Space	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800
- Gains from Productivity Improvements	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500
- Reduction in Health Insurance Claims	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000
Net Inflows --->	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300	74,336,300
Cash Outflows										
- Lease New Office Space	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220
Net Outflows --->	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220	52,758,220
Net Cash Flows --->	21,578,080	21,578,080	21,578,080	21,578,080	21,578,080	21,578,080	21,578,080	21,578,080	21,578,080	21,578,080

Net Present Value Analysis

Capital Cost at 10% -->	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855
Present Value at 10% --->	19,616,633	17,832,125	16,211,612	14,737,829	13,397,830	12,180,826	11,073,871	10,066,174	9,151,264	8,318,350

Net Present Value of Alternative ---> 132,586,513

Note: See Appendix I, Part F
for a detailed explanation
of calculated figures.

APPENDIX I (continued)
Part C - (Outsource Business Functions)

Time Periods in Years -->	1	2	3	4	5	6	7	8	9	10
Cash Inflows										
- Lease Existing Space	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800	33,394,800
- Eliminate Health Care Benefits	67,968,000	67,968,000	67,968,000	67,968,000	67,968,000	67,968,000	67,968,000	67,968,000	67,968,000	67,968,000
- Eliminate Office Payroll	236,000,000	236,000,000	236,000,000	236,000,000	236,000,000	236,000,000	236,000,000	236,000,000	236,000,000	236,000,000
Net Inflows --->	337,362,800	337,362,800	337,362,800	337,362,800	337,362,800	337,362,800	337,362,800	337,362,800	337,362,800	337,362,800
Cash Outflows										
- Contract Employee Costs	800,000,000	800,000,000	800,000,000	800,000,000	800,000,000	800,000,000	800,000,000	800,000,000	800,000,000	800,000,000
- Legal Administrative Costs	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
- Layoff Costs	40,000,000									
- Business Coordination Effort Costs	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Net Outflows --->	842,000,000	802,000,000	802,000,000	802,000,000	802,000,000	802,000,000	802,000,000	802,000,000	802,000,000	802,000,000
Net Cash Flows --->	(504,637,200)	(464,637,200)	(464,637,200)	(464,637,200)	(464,637,200)	(464,637,200)	(464,637,200)	(464,637,200)	(464,637,200)	(464,637,200)

Net Present Value Analysis										
Capital Cost at 10% -->	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855
Present Value at 10% --->	(458,765,679)	(383,976,182)	(349,081,928)	(317,347,208)	(288,493,237)	(262,287,699)	(238,451,811)	(216,753,254)	(197,052,637)	(179,117,641)
Net Present Value of Alternative --->	(2,891,327,275)									

Note: See Appendix I, Part F
for a detailed explanation
of calculated figures.

APPENDIX I (continued)
Part D - (Continue Current Operations)

Time Periods in Years -->	1	2	3	4	5	6	7	8	9	10
Cash Inflows										
Net Inflows --->	0	0	0	0	0	0	0	0	0	0
Cash Outflows										
- Loss of Productivity Improvements Savings	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500
- Loss of Reduction in Health Care Claims	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000
Net Outflows --->	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500
Net Cash Flows --->	(40,941,500)	(40,941,500)	(40,941,500)	(40,941,500)	(40,941,500)	(40,941,500)	(40,941,500)	(40,941,500)	(40,941,500)	(40,941,500)

Net Present Value Analysis

Capital Cost at 10% -->	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855
Present Value at 10% --->	(37,219,918)	(33,834,056)	(31,759,349)	(27,963,045)	(25,420,577)	(23,111,477)	(21,011,178)	(19,099,210)	(17,363,290)	(15,782,948)
Net Present Value of Alternative --->	(251,565,047)									

Note: See Appendix I, Part F
for a detailed explanation
of calculated figures.

APPENDIX I (continued)
Part E - (Renovate Existing Facilities)

Time Periods in Years -->	1	2	3	4	5	6	7	8	9	10
Cash Inflows										
- Gains from Productivity Improvements	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500	36,373,500
- Reduction in Health Insurance Claims	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000	4,568,000
- Sale of Short-term Commercial Paper	90,468,000	0	0	0	0	0	0	0	0	0
- Sale of Long-term Bonds	110,572,000	0	0	0	0	0	0	0	0	0
- Furniture Salvage Values	8,010,000									
Net Inflows --->	249,991,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500
Cash Outflows										
- Renovation Costs	201,040,000	0	0	0	0	0	0	0	0	0
- Cost of Acquired Capital										
- Short-term at 8%	7,237,440	7,237,440	7,237,440	0	0	0	0	0	0	0
- Long-term at 11%	0	0	0	0	0	0	0	0	0	30,881,653
- Capital Repayments										
- Short-term Paper	0	0	90,468,000	0	0	0	0	0	0	0
- Long-term Bonds	0	0	0	0	0	0	0	0	0	110,572,000
Net Outflows --->	208,277,440	7,237,440	97,705,440	0	0	0	0	0	0	141,453,653
Net Cash Flows --->	41,714,060	33,704,060	(56,763,940)	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	40,941,500	(100,512,153)

Net Present Value Analysis										
Capital Cost at 10% -->	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855
Present Value at 10% --->	37,922,252	27,853,035	(42,646,748)	27,963,045	25,420,577	23,111,477	21,011,178	19,099,210	17,363,290	(38,747,435)
Net Present Value of Alternative --->	118,349,880									

Note: See Appendix I, Part F
for a detailed explanation
of calculated figures.

APPENDIX I (continued)
Part F - (Calculations and Assumptions)

Calculated Figures

Lease Existing Space: Estimated lease value of \$333,948,000 divided by 10 years. This includes a \$100,000 annual maintenance fee.

Productivity Improvements: Average employee salary of \$29,500 X 15% productivity improvement equals \$4,425. Multiply this figure by 8,220 to equate a value \$36,373,500.

Reduction in Health Claims: Using the Systems Development department's 1990 budgeted group insurance program figure of \$335,674 and calculating an individual's claim amount of \$5,550. Then taking 10% of this figure for office related claims, this come to \$555. Multiply this by the total number of office employees, this equals \$4,568,000 annually.

New Office Facility: Using an industry estimated new office amount of \$150 per square foot and multiplying this figure by the estimated amount of required new office facility space of 3,091,660 square feet. The total dollar figure comes to \$463,749,000.

Leasing New Office Space: Using an estimated figure of approximately \$170 per square foot for ergonomically designed office space multiplied by the new square footage requirements of 3,091,660. Plus an annual maintenance fee of \$200,000 must be included in the total cost. The overall cost divided by ten years comes to \$52,758,220.

Eliminate Office Payroll: Using an estimated annual salary of \$29,500 per office employee times 8,000 equates to \$236,000,000 annually.

Contract Employee Costs: Using an estimated figure of approximately \$50 per hour multiplied by 40 hours per work week times 50 weeks in a year. This calculates to \$800,000,000 annually.

Legal Administrative Costs: This has been estimated at a lump sum of \$1,000,000 annually to keep contract worker agreements intact.

Business Coordination Effort Costs: This figure has been estimated at approximately \$1,000,000 annually to keep the various contracted business functions coordinated at Sundstrand on a annual basis. Areas included in this figure are application of appropriate business information systems.

APPENDIX I (continued)
Part F - (Calculations and Assumptions)

Layoff Costs: Have been estimated at approximately \$5,000 per employee. This amounts to a one time sum of \$40,000,000.

Furniture Salvage Values: This figure has been calculated by totaling the number of individual pieces of furniture in the Systems Development department and then multiplying the individual totals by the respective current salvage value. The total for Sundstrand was estimated by taking the per employee salvage value in the Systems Development department and then multiplying by 8,220 employees.

Current Salvage values are: Desk --> \$166.00, 2 File Cabinet --> \$90.00, Work Table --> \$107.00, Chair --> \$131.00 (Middleton, 1990).

Renovation Costs: This figure has been calculate by using the revised estimated required office space and multiplying it by the estimated interior design cost needed for improving Sundstrand. This calculation comes out as 3,091,660 X \$70, which equals \$201,040,000.

Assumptions

The overall cash flow analysis was based on ten years only, this is the lowest range for the useful life of the new office environment enhancements. Therefore, all lease payments and capital repayments have been defined within this time range. It is assumed that the extension of the cash flows beyond the 10 year limit will affect the overall distribution amounts of the above mentioned cash flows.

It has been assumed that an upfront capital payment for any renovations or new building assets will be made within the cash flow analysis.

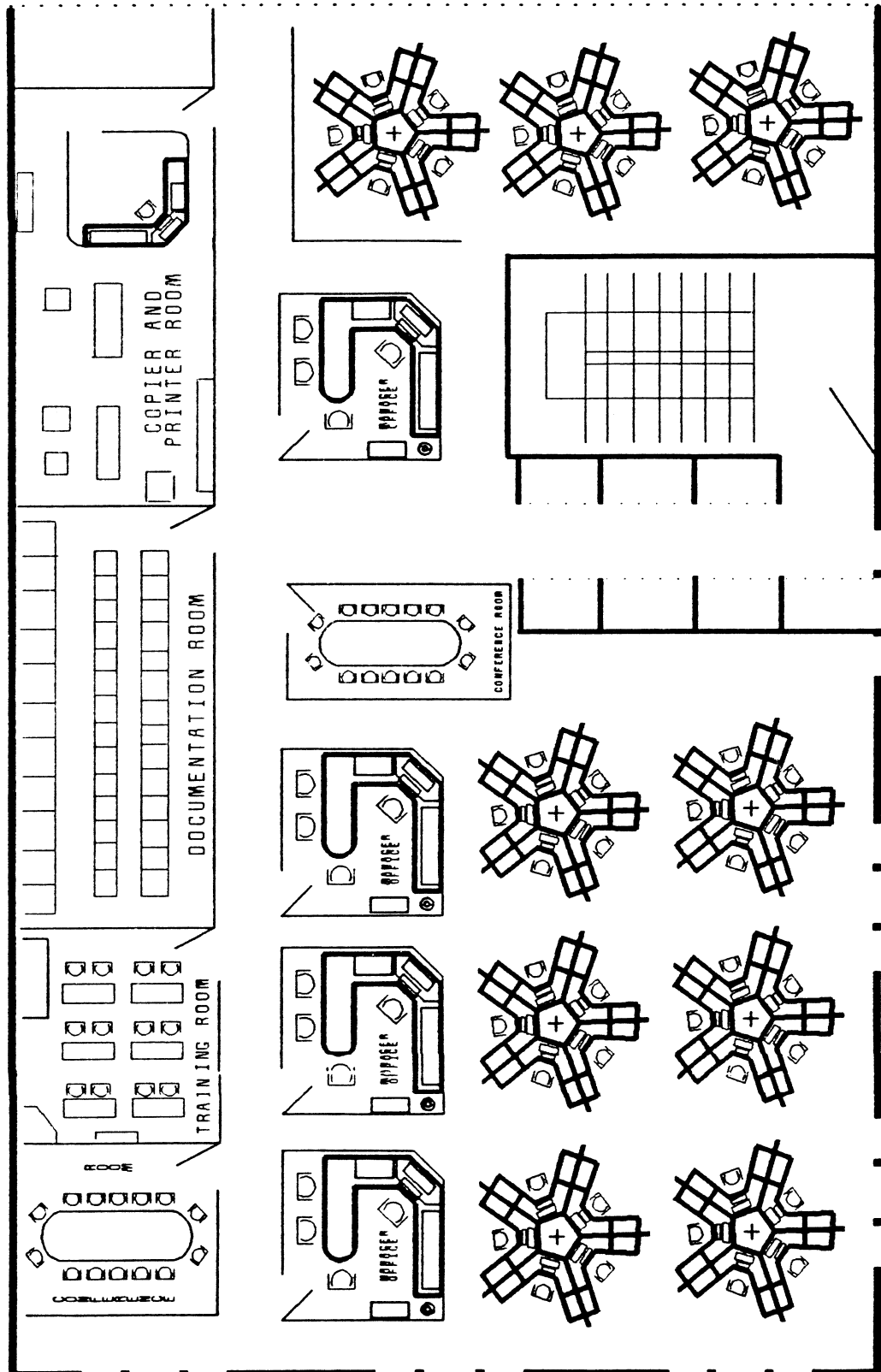
The interest rates applied (i.e., 8% short-term and 11% long-term) for the repayment of capital acquisition have been based on current industry trends.

The percentage breakdown between short-term and long-term capital has been based upon the analysis of Sundstrand's current financial position. The amount chosen for short-term capital is 45%, with a repayment factor of three years. The amount chosen for long-term capital is 55%, with a repayment factor of 10 years. A review of Appendix H and section 4, Elements of Cost will help to clarify this breakdown of capital cost.

APPENDIX I (continued)
Part F - (Calculations and Assumptions)

The net present value analysis was based upon a 10% cost of capital rate to calculate the cash flows. This figure was based upon Sundstrand's past financial position and the current industry trends.

APPENDIX J: Sundstrand's Systems Development
Revised Office Layout



APPENDIX J (continued)

