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Future direction of Sundstrand Electric Power

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FUTURE DIRECTION OF SUNDSTRAND ELECTRIC POWER

by

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CASE SUMMARY

This case study focuses on whether Sundstrand should take the next evolutionary step in the aircraft electrical power market. This step is incorporation of Electrical Load Management Centers (ELMC's) into its existing product lines. This paper will focus on four possible alternatives. The first alternative is to not expand in this direction. Whenever a venture is considered the potential benefits must out-weigh the potential risks or cost of entry. The second and third alternatives are very similar. Purchase a corporation that produces ELMC systems or a corporation that has technology similar to ELMC systems. These options are less favorable if Sundstrand already has technology and experience similar to ELMC's or if internal development would be a more cost effective solution. The last option is to internally develop, market, and sell ELMC systems. A study of Sundstrand's technical and financial resources will be necessary to determine if this is a feasible option.

The ELMC market is on the verge of significant growth. The most cost effective solution is for Sundstrand to use its talent, experience, and customer base to establish itself in this market. Sundstrand has the knowledge and experience to internally develop, market, and sell ELMC's as a part of the aircraft electrical power generation systems it now produces.

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LIST OF ABBREVIATIONS

CSD - Constant Speed Drive

ELMC - Electrical Load Management Center

EPGS - Electrical Power Generation System

IDG - Integrated Drive Generator

KVA - 1000 Volt-Amps

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Section I

Introduction

This case study involved the future direction of the Electric Power Division of Sundstrand. This division builds state of the art aircraft Electrical Power Generation Systems (EPGS). Sundstrand supplies these systems for virtually every aircraft in the western world. Appendix A charts some of the aircraft on which Sundstrand EPGS were and are used.

The EPGS consists of an Integrated Drive Generator (IDG) mounted on every engine on the aircraft, one Generator Control Unit per IDG, and one Auxiliary Generator. The IDG converts variable input speed from the aircraft engine into constant frequency electrical power. The Auxiliary Generator is a secondary source of electric power for the aircraft should an engine or IDG failure occur. The auxiliary generator is also used for ground operation when the engines are not operating. The Generator Control Unit monitors and controls these units.

Sundstrand began producing constant speed drives in the late 1940s for military aircraft most notably the B-36 Bomber. At that time Sundstrand produced a gearbox that converted the variable speed produced by the engine into constant output speed. This constant output speed was then used to run a constant speed constant frequency generator. The generator was manufactured by one of several companies. The whole system was controlled by yet another corporation. These systems were fairly simple by today's standards so

the electrical distribution was handled by the aircraft manufacturer.

In the 1960's Sundstrand began to produce IDGs which combined the gearbox and generator into one package. This produced a smaller, lighter weight system by combining the two components. This also expanded Sundstrand's product line and increased its content on each aircraft. The combined system also reduced the number of vendors with which the aircraft manufacturer had to deal. This also reduced the finger pointing between vendors when there were failures on the aircraft. At this time the system was still controlled by a separate vendor.

The third step was again logical. In the late 1970s Boeing requested that Sundstrand begin to develop EPGSs. This meant that Sundstrand would not only develop IDGs but integrate the system controls as well. Considering Boeing was and still is Sundstrand's largest customer they quickly agreed. At that time the electrical load distribution was handled by the aircraft manufacturer.

Aircraft require systems to manage the distribution of electrical power. This is an Electrical Load Management Center (ELMC). Since Sundstrand produces electrical power the next evolutionary step is to distribute that power. The past few years have seen the growth or emergence of the ELMC market. Until recently the distribution of electrical power on aircraft was relatively basic. This is now an expanding field worth increasing rewards. Aircraft manufacturers are looking outside for help in this market

and Sundstrand should decide now if it wants a piece of this market.

Hence this report was the fundamental investigation of whether Sundstrand should take that evolutionary step and expand into the ELMC market. Four possible alternatives were the focus of this investigation.

1. One option that must always be considered is whether this market is worth expanding into. Prior to making any decision the perceived risks of not entering the ELMC market must be considered. If it is found that all of Sundstrand's EPGS customers will expect/require EPGS vendors to supply ELMC's in the future Sundstrand had better find some way to design, develop, and sell these systems fast.

2. The next logical approach is to consider purchasing one of the corporations that currently builds ELMCs. This would also be an opportune time to evaluate whether Sundstrand can beat the competition at their own game. If they feel the competition has an insurmountable lead it would be unwise to enter into the ELMC market on their own. Therefore purchase of an existing company would be warranted if this product is to be pursued. Specific minimum financial criteria for any purchase consideration must be established. What financial impact any purchase might have on Sundstrand must also be considered.

3. Another approach would be for Sundstrand to purchase a corporation that has technology similar to ELMCs. When looking at this alternative the main criteria

for evaluation must be that the company expands on Sundstrand's current technological base and not just complement it. This is a long standing and valid management decree.

4. The last alternative would be for Sundstrand to develop ELMC Technology on its own. The estimated time to develop this system will need to be determined. Does Sundstrand have the personnel with the technological expertise to tackle this problem? If they do not have the personnel should they train current personnel or look outside for this talent? Is the complexity and cost of developing this type of system within Sundstrand's current developmental budget? Will upper management be receptive to the high cost of developing a new product line at this time?

The ELMC

What is an ELMC and what does it do? Simply put an ELMC manages the distribution of electrical power on an aircraft. There are one to four IDG's per aircraft. Therefore the ELMC must decide which IDG supplies electrical power to what electrical load. An electrical load is any piece of equipment that requires electrical power. This equipment ranges from the computers used to navigate and fly the plane to the lights and air-conditioning for passengers in commercial aircraft or weapons systems on military aircraft. In an emergency the ELMC decides which loads are automatically shut off and

which loads stay on. This ability to prioritize ensures critical electrical loads never lose power.

In modern commercial aircraft the need for ELMCs are becoming increasingly important due to the advanced cockpits and automated systems. The aircraft computers are now programmed with the necessary information to make hundreds of routine and not so routine decisions without human intervention. This has reduced the work-load enough to eliminate the need for a flight engineer. The aircraft computers perform the flight engineer's tasks and many other tasks normally done by the crew. With today's computers the ELMC is an automated system requiring little human intervention.

The same transition can be seen in military aircraft. Traditionally the electrical systems on military aircraft were very basic and the electrical needs equally basic. As these aircraft increased in sophistication so did the pilot's work-load. Many argue that today's military aircraft are so complex that it is too difficult for the pilots to master all aspects of their operation. The level of sophistication and mission requirements of today's aircraft require total concentration by the pilot. This means the pilot can no longer attend to such mundane tasks as aircraft electrical load management and must rely on the ELMC to perform this function.

Currently ELMCs control electrical load shedding for the aircraft when overload conditions exist. An overload condition is when the electrical load required of the IDG

surpasses the design limits. For instance if an IDG is designed to produce 90 KVA (90,000 Volt-Amps) and is asked to furnish 120 KVA the present ELMC will shed or eliminate noncritical electrical loads until the total load required is less that 90 KVA. Present ELMCs indiscriminately slash noncritical electrical loads until the total load is often well below the rated (90 KVA in this example) load. The next generation ELMC will not just slash loads indiscriminately. It will look at the load profile and cut just enough to bring the system down to the design limits. The system will also have the ability of reconnecting electrical loads as the load profile changes during the remainder of the flight. Most of the current systems have no provision for re-establishing loads once removed.

Noncritical loads on commercial aircraft are galley and entertainment type loads. Cutting this type of a load is an inconvenience but really does not effect the outcome of the flight. However new ELMCs will minimize customer inconvenience which after all is the name of the game. Airlines are striving to furnish the best service possible without impacting aircraft safety.

Present electrical load management on commercial aircraft is performed by three basic systems. These are the Bus Power Control Unit, ELMC unit, and the Aircraft Wiring Harness computer logic. Each of these systems is made by different corporations. Having three different companies building different components that interface so closely is a programming nightmare. Multiple vendors also

lead to redundancy which adds weight, complexity, and cost. By designing an ELMC to perform all of these functions Sundstrand can increase its content on every aircraft sold.

The benefits to the customer are significant. The aircraft manufacturers can now look to one contractor where they had to look to three before. Sundstrand will now be able to sell a system that is smaller, lighter, and with fewer interface problems than current designs.

Sophisticated computer logic is tough enough to develop without having to accept and receive commands from other companies' hardware. By one company developing the entire system it reduces complexity by reducing the interface requirements which eases program coordination. This all adds up to reduced cost, size, and weight while increasing reliability.

Increased reliability will reduce the number of dispatch delays for an aircraft. When an aircraft is delayed due to mechanical difficulties it is considered a dispatch delay. Beginning in the summer of 1987 the Federal Aviation Authority commenced recording airline on time performance and publicizes these findings. Keeping dispatch delays at a minimum is an important goal of every airline. Touting the increased reliability of new aircraft designs will be a large selling point for the aircraft manufacturers as well as Sundstrand.

Incorporating the next generation ELMCs is extremely important for military aircraft. If systems critical to combat but not critical to flight are cut due to aircraft

overloads it makes meeting mission objectives more difficult if not impossible. In this situation having greater flexibility in which loads are removed and reconnected can make the difference between completing the mission or scrubbing it.

ELMC Market Size

Both the military and commercial aircraft markets will realize substantial benefits from the use of sophisticated ELMCs. The next question is what is the size of future markets? The 1980s saw the United States undergo the largest peace time military build up in history. This makes one ask what is the need for new aircraft systems in the 1990s? Under the Reagan Administration the Armed Services developed requirements for several new aircraft some of which are not yet finalized. The Navy and Air Force developed requirements for replacements of their tactical fighters and attack aircraft. From these requirements the Advanced Tactical Fighter, Advanced Tactical Attack, and Light Attack Helicopter aircraft programs evolved. Each of these programs will be extremely complex and expensive to produce.

Congress has mandated that the possibility of updating current aircraft to do the same job for less money be investigated. This mandate has generated at least three more programs designated the F-14X, F-15X, and the F-16X. These will be significant advancements over their current

designs. Even with these new military contracts the budget deficit is forcing reduced military spending.

Whatever programs survive the budget cuts will furnish millions of dollars to the corporation that wins the ELMC contracts. By branching out in to ELMCs Sundstrand will reduce the impact to sales due to decreased military spending by incorporating more Sundstrand product on every aircraft. The contract proposals for the lucrative ELMCs will soon be up for bid. Sundstrand must decide how to approach the ELMC market concerning these possible contracts.

The commercial market is currently enjoying a boom due to the aging airline fleets. Aircraft manufacturers can not keep pace with airline demand for new aircraft. What this boom has created is three brand new commercial aircraft programs. These programs are the 777, MD-90, and the MD-12. Each of these aircraft will require the latest in ELMC technology. Sundstrand can apply the technology learned in developing the military systems to the commercial aircraft market. This will increase Sundstrand's aircraft content and sales.

In this climate updating older aircraft with new ELMCs will not be a profitable venture. Airlines are only interested in increasing the longevity of existing aircraft until new more cost effective aircraft are available. Therefore the only updates will be to increase aircraft life or reduce noise. The Federal Aviation Authority and airports are implementing tougher restrictions concerning

aircraft noise levels. If airlines want to use existing aircraft, updates will be necessary to comply with the restrictions. Four possible alternatives for Sundstrand's entrance into the ELMC market are the focus of this study.

Section II

Sundstrand's Options

This section will explore four of Sundstrand's options concerning expansion into the ELMC market. The first option is to not expand into the ELMC market. The second option is to purchase an ELMC producer. The third option would be to purchase a corporation with technology similar to ELMCs. The final option covered would be for Sundstrand to develop ELMC technology on its own.

Do Not Expand Into Market

When considering the development of a new product a corporation must determine if the product is necessary. In this case Sundstrand must consider the contracts that may be lost if ELMC's are not a part of their product line. Sundstrand Marketing Management estimated that 15% of future Electric Power contracts will be lost if Sundstrand does not market ELMC's as part of their aircraft electrical power product line. Considering that the Electric Power Department is the major source of income for the Aerospace Division this would be a critical loss. "Electric power generating equipment remains the Company's most important product line in terms of sales and profits. Sundstrand systems are standard equipment on new-generation commercial aircraft from every airframe supplier, including the Boeing 747-400, 757, 767 and the forthcoming 777; McDonnell Douglas MD-11; Fokker 50 and 100; and the entire Airbus Industrie family of aircraft: the Airbus A300-600, A310,

A320, A321, A330 and A340." (Sundstrand 1990 Annual Report, p.15)

The following table is the estimated size of the ELMC market. The numbers have been provided by Sundstrand's marketing department. The numbers listed are only similar to the actual estimates and show the general trends. The actual estimates were not made available for this document:

Year	Sales in millions
1994	1
1995	6
1996	10
1997	15
1998	26
1999	45
2000	65
2001	78

These figures represent an ELMC market that will undergo dramatic growth in the near future. Considering Sundstrand's dominant role in aircraft electric power it is reasonable to assume that Sundstrand could obtain a sizeable percentage of those sales. By developing a competitive product and using its strong market position Sundstrand could easily win 60% of industry sales in this area. Sundstrand's early entrance into this market will ensure its leadership position in ELMC's as it has in the EPGS marketplace.

Recently Sundstrand lost a major contract to a competitor. The competitor proposed a group of systems not

just an electrical power system for the aircraft. The competitor offered an integrated cockpit that combined all the different types of systems they produced. Proposals that offer the customer several systems integrated into one package reduce the number of vendors with which the manufacturer and end user must deal. This simplifies program management, manufacturing, and maintenance for the end user. Anytime a corporation can make life easy for its customers its customers will make life easy for them.

The integrated system approach can be expanded across Sundstrand to incorporate all of the product lines. Quoting customers a package of equipment allows certain products to get on the aircraft that individually would not have made it. The Mechanical and Fluid Systems divisions could benefit from this marketing approach. Incorporating Sundstrand's actuators, gearboxes, and fuel pumps into this marketing effort may place those components on aircraft they otherwise would not have been on. That very strategy is largely responsible for Sundstrand's superior product losing out to a competitor on a recent proposal. Sundstrand's ELMC systems would give the customer one more reason to choose Sundstrand.

Sundstrand maintains a market leadership position as a supplier of EPGS's for the aerospace industry. Sundstrand does this through the use of hydro-mechanical systems. Recently customers have asked for systems utilizing power electronics rather than hydro-mechanical systems to generate electrical power. Sundstrand does not dominate

this market as it does with its traditional hydro-mechanical systems. A large obstacle to the entrance into the power electronic market is the industry perception of Sundstrand. Industry believes Sundstrand is very good with hydro-mechanical systems but has little experience with power electronic systems.

Sundstrand is working very hard to develop systems using power electronics. There are many similarities between the power electronic and ELMC systems. The development of ELMC systems can go a long way to demonstrating Sundstrand's ability to deal with electronic systems for the aerospace electrical power and power distribution market.

The two types of systems would complement each other very well and therefore help to sell one another. The fact that Sundstrand would be concurrently developing both systems would help generate interest and establish credibility in each. This further emphasizes the importance of entering this market. Sundstrand currently has the resources and manpower to develop both. This will increase Sundstrand's sales.

It is imperative that Sundstrand develop ELMC systems. Every effort should be taken to aggressively penetrate this market to ensure Sundstrand's leadership position in aerospace electrical power. In fact there is no good reason for Sundstrand to stay out of the ELMC market.

Purchase ELMC Producer

Sundstrand could attempt to purchase a corporation that currently produces ELMC systems. This would give Sundstrand an immediate entrance into the ELMC market. There are four main competitors in the ELMC market.

All of the competitors could fight off Sundstrand to one degree or another if they so desired. Getting into a leveraged buyout situation would seriously drain Sundstrand's cash resources. Sundstrand's 220 million dollar settlement with the government concerning contract violations has made cash resources a serious concern to upper management. Low cash reserves would limit Sundstrand's ability to finance Internal Research and Development efforts. In the aerospace industry Internal Research and Development is a way of life and reducing or eliminating it can be fatal. Companies are always looking for the latest and greatest in all products. This makes leading edge technology crucial to continued prosperity in this industry. The internal research and develop department is where leading edge technology is normally developed. Therefore the purchase of an ELMC producer could limit the corporation's cash resources and threaten Sundstrand's ability to finance internal research and development. Any reduction in internal research and development spending is not in the corporation's long term best interest.

Sundstrand purchased Turbomach in July of 1985 to gain immediate entrance into the Auxiliary Power market for

aircraft. Having no experience in this market the purchase option was exercised. Turbomach has had a long and painful turnaround that is anything but complete or certain. While there was and still is significant potential in this market, Turbomach was losing money when purchased and is taking far longer to turn around than expected. The promised land of sales and technical solutions is also behind schedule. The financial difficulties encountered in this aquisition have not been forgotten. It would be unwise to place the company in that position again.

An offshoot of the purchase option is a joint partnership with one of the established ELMC manufacturers. The overriding problem here is the lack of control Sundstrand would have over the ELMC manufacturer chosen. If Sundstrand follows the market strategy of integrating all product lines into one cohesive marketing effort tighter control would be needed over all aspects of operation. This will be necessary to overcome the technical problems normally encountered when corporations buy corporations. Tighter control over the combined marketing effort will allow quick adjustments to the ever changing market which Sundstrand serves.

The following is a list of the four corporations that produce ELMC's. Much of the financial information on these companies is highly proprietary and therefore estimates from industry professionals were used to develop financial theories:

McDonnell Douglas Electronic Corp.

McDonnell Douglas Electronic Corporation located in St. Charles Missouri is a subsidiary of McDonnell Douglas Aircraft Corporation. They build various avionic systems for both military and commercial aircraft. This company is not only extremely large but services only McDonnell Douglas. Purchase of this company would only open sales to McDonnell Douglas aircraft that require ELMC systems. There is absolutely no marketing or advertising expertise within the Electronic portion of McDonnell Douglas to expand its customer base.

According to Dun and Bradstreet, McDonnell Douglas's financial condition was only fair and they listed their general business trend to be down. "According to published reports, comparative operating results for the year ended December 31, 1990 are as follows: net income (loss) of $306,000,000 compared to net income (loss) of $219,000,000 for the comparable period on the prior year. According to published reports, subject accessed the pension fund for an after-tax gain of $370 million to its 1990 balance sheet. The purchase allowed subject to remove hundreds of millions of dollars in liabilities from its balance sheet" (Dun and Bradstreet, 04/16/91, p. 1). Without taking such a measure the year end bottom line would have looked much worse.

McDonnell Douglas's military contracts have been severely reduced by the cuts in defense spending. This combined with their recent loss on the Advanced Technology Fighter proposal makes the military portion of their

aircraft sales look extremely bleak. The commercial market for other companies such as Boeing and Airbus is soaring. While McDonnell Douglas's commercial market is also in financial trouble. This is due to development cost overruns on their new commercial airliner the MD-11 and production difficulties with the MD-80 airliner which has been in production for several years. "So tangled are the assembly lines that Douglas lost money building the ten-year-old MD-80 in the first half of 1989" (Henkoff, 1989, p. 80).

The Electronic portion of McDonnell Douglas has helped carry the company as of late. "Revenues remained relatively flat for 1989 as a 16% revenue increase in the company missiles, space and electronic systems was for the most part offset by a 2% decrease in revenues in combat aircraft and a 3% decrease in revenues in transport aircraft" (Dun and Bradstreet, 04/16/91, p.8). Under the current circumstances McDonnell Douglas will not want to sell one of the few portions of its business that is increasing in revenues. This is especially true if that subunit is helping to cancel losses in its core business.

Even if McDonnell Douglas Electronic Corporation was for sale the price would be substantial. McDonnell Douglas reported 77 million dollars for income for discontinued operations in 1990 (Dun and Bradstreet, 04/16/91, p.6-7). No numbers were available for the actual size of either of the two subunits sold in 1989 or their relative size with respect to McDonnell Douglas Electronics. Without hard

numbers it can be assumed that any subunit that can help to offset the declining revenues in McDonnell Douglas's aircraft sales would be at least as big as either of their health and/or networking system subunits. On this assumption one can place a 38.5 million dollar price on McDonnell Douglas Electronic Corporation (50% of the 77 million dollars.)

Resdel Engineering Corporation

Resdel is located in Arcadia, California and manufacturers Electronic Data Encryption Devices. They employ 150 and were purchased by the Dowty Corporation in 1989 for 5.7 million dollars over book value. Industry sources state that Resdel was actively seeking to be purchased in 1989. This was largely due to cash flow problems in 1988 resulting from several contract losses. This willingness to sell makes sense considering the favorable purchase price negotiated by Dowty. It is also interesting to note that Dowty has a partnership in some way with Smith's Industries. Smith's Industries is another purchase alternative that will be discussed later. The actual book value was not available but one can assume the corporation was not sold for anything near twice its book value. That assumption places Resdel's purchase price over $11,400,000 at least.

Smith's Industries

Smith's is located in England and manufactures flight computers, navigational systems, head-up displays, health monitoring systems, and other products. Industry sources

believe that Dowty is working or has a partnership with Smith's. The possible combination of Resdel, Dowty, and Smith's could present a formidable competitor. It also seems that Dowty is looking to increase its market share through aquisition which is consistent with the industry sources used for this paper. Dowty would fight any attempt to purchase one of its subsidiaries. At any rate this would place the purchase price of Smith's Industries around Resdel's, well over the 11 million dollar range.

Leach Power Management Group

Leach produces various types of solid state relays for aircraft as well as other aircraft subsystems and is located in Buena Park, California. The corporation consists of Leach Relay located in Buena Park and Leach Relay Europe located in Germany. They employ approximately 2000 and 3000 respectively. Projected sales for 1990 where 60 and 80 million dollars respectively. Their Dun and Bradstreet rating is 4A2 signifying a very strong company with excellent credit. Dun and Bradstreet estimated their net worth (Assets - Liabilities) at 100 million dollars. Their market value is substantially higher.

Leach is a family run business. This is accomplished by the family owning a controlling interest in the stock. Owning a controlling interest in a firm's stock ensures all purchase options are by agreement. In this case it would mean very favorable terms for Leach. Those terms would be near if not in excess of the 100 million dollar net worth estimate.

The two subsidiaries that make up Leach Power Management Group are currently pooling their resources to fund internal research and development programs. There is a strong desire to remain independent and pass the company down through the controlling family. With controlling interest in the stock it would be hard to stop this until the controlling family is willing to entertain outside offers. This and the price tag will make any purchase option of Leach unlikely.

The CEO and Segment Executive Vice-President have stated that any acquisition must expand Sundstrand's product line not just increase its customer base. In this case the two least expensive options are over 11 million dollars. Because of the current economic downturn in the aerospace industry Sundstrand is down sizing in every area to increase efficiency and eliminate waste. Some of these steps include work force reductions and decreases in manufacturing capacity. Spending 11 million dollars on a corporation that would increase production and personnel above current levels is contrary to this down sizing policy. Any new product lines or other assets gained would not fit with the current business strategy.

Sundstrand possesses the ability to build ELMC systems as stated previously so any purchase proposal would face strong criticism from the start. Combine this fact with the high cost of acquisition and recent settlement with the government and the purchase of an ELMC Manufacture is not a favorable option.

Purchase Corporation With Technology Similar To ELMC's

Sundstrand could purchase a corporation that builds systems similar to ELMC systems. At first this seems like a reasonable option but after further analysis the merits of this approach are few and weak. The main advantage is not arousing the current ELMC competitors by Sundstrand's entrance into this market.

The negative aspects of this approach are very similar to those for purchasing a corporation that currently builds ELMC systems. There would be a large capital expenditure that would reduce the cash on hand for financing other operations. This would also increase the financial leverage of the corporation. Increasing how leveraged a firm is reduces its ability to fight off a takeover attempt. This will reduce the capital or lending power of the firm.

If buying a corporation that already produces ELMC systems is not a good idea buying one that produces similar products is not sound judgement either. Sundstrand already has technology that is somewhat similar with their Wulfsberg Electronics and Sundstrand Data Control divisions. Purchasing a corporation of this sort will not expand the company's market or product base enough to warrant the capital expenditure. As stated earlier upper management's opinion is that acquisition should only be considered when it expands the product line. If Sundstrand

has the in-house talent to independently pursue the market this option should not be recommended.

Sundstrand Develop ELMC On Own

Define The Task At Hand

Several questions need to be answered concerning this subject:

Development Time Required

What is the time required to develop a system of this complexity? It is estimated that if under contract new programs of this nature will take two to three years to develop. Non-contracted programs tend to be more general in nature and as such do not have specific goals or schedules.

Contracted programs are defined programs with agreed upon schedules, costs, and performance parameters. The customer and Sundstrand negotiate all critical issues pertaining too the program. The development costs are partially, or completely funded by the customer. Non-contracted programs are strictly funded by Sundstrand and have no specific customer. Being internally funded it is easy to change performance limits, criteria, and schedule without outside approval. This vagueness and lack of control allows this type program to stretch out longer than necessary.

Personnel Requirements

What personnel will be needed to develop this system and does Sundstrand have these personnel? To answer this

question several of Sundstrand's system engineers were consulted. The system engineers are responsible for customer and vendor interface concerning areas of this nature. Because of this system engineers are the most qualified personnel in the company to comment on the requirements and complications ELMCs will present. The general consensus is that Sundstrand possesses the necessary personnel to design an ELMC. There will be training required of some personnel but Sundstrand has the technical expertise to tackle such a problem with little or no outside help. The learning curve these systems will present is really no worse than many of the new and difficult tasks that were successfully undertaken in the past.

Boeing is already pushing Sundstrand to develop a minor ELMC system to retrofit onto its 757 commercial airliner. This signals one of the industry leaders confidence in Sundstrand's ability to field a quality ELMC system. This request has initiated Sundstrand's entrance into this market on a very small and minor scale. This small program will help train Sundstrand personnel for this new technology. Sundstrand must now decide if it is willing to take the next major step.

The other option is to steal personnel away from other ELMC manufactures. This is routinely done to Sundstrand. One of Sundstrand's competitors hires a head-hunting service to probe Sundstrand personnel and find people with specific talents that are willing to change jobs for the

right money or other benefits. Competitors have placed ads in the local newspaper asking for engineering personnel to walk in and interview for positions designing and developing aerospace electrical power systems. In affect trying to hire Sundstrand personnel for their own firm. Sundstrand obtaining a few key individuals would help with the early technical difficulties.

Cost And Complexity

Is the complexity and cost of such a system within Sundstrand's development budget? There are always risks associated with new technology but providing high technology aerospace products is what Sundstrand has done for many years. Expanding on this expertise should not be considered extremely risky. However Sundstrand must be confident that it can produce such systems at a price that will be competitive. Sundstrand has a reputation for making highly sophisticated and reliable but expensive products. Frequently Sundstrand's products far exceed the customer's performance goals. It is therefore no surprise that Sundstrand's products cost more than the competition. Customers are finding the phrase "you get what you pay for" old and tiresome. Developing quality products that meet all performance and price objectives without significantly exceeding expectations is what Sundstrand is now setting out to do.

Sundstrand is restructuring its product lines to reduce cost while maintaining superior performance. One way to reduce the cost of such a program would be to team

up with another corporation in this venture. The United States Air Force has two teams competing for the Advanced Tactical Fighter contract. Each team consists of three contractors that are working together to develop the aircraft. A venture of this sort reduces each corporation's investment capital and technical risk. The major draw back with this type of approach is sharing and developing technological secrets with past, present, and future competitors. Sundstrand has always been tight-lipped about its proprietary information and there has been no indication of a change in this attitude. Sundstrand has an internal research and development budget process which determined that 1.1 million dollars is necessary to complete this program. The process and analysis used to determine this figure is covered later in this report.

Financial And Technical Risks

Will upper management be receptive to the financial and technical risks this project poses? Sundstrand has never shied away from technical challenges. The corporation was and hopefully still is known for its engineering expertise. Sundstrand takes pride in being able to succeed in areas where others fail. Sundstrand management should have no problem with accepting the risks this project poses.

The IDG is a good example of this. After over forty years of production Sundstrand is still the only manufacture of IDG's. Sundstrand's IDG continually maintains profit levels above the norm in the aerospace

industry. Any time a corporation is receiving any thing above a normal accounting profit other corporations will attempt to enter the market. The technical difficulties encountered in developing IDG's has been significant enough to eliminate traditional competition. Sundstrand's past acquisitions of Sundstrand Data Control and Wulfsberg Electronics can lend the expertise necessary to design, develop,and qualify ELMC systems. With this help and Sundstrand's willingness to handle new technical challenges upper management should be receptive to this project.

All aircraft must be certified by the Federal Aviation Authority. Part of this process is aircraft flight testing which is monitored by the Federal Aviation Authority. Also every major subcomponent must pass a series of qualification tests prior to placement on the aircraft. The exact nature of the qualification tests are determined by the aircraft manufacturer. Any ELMC system will need to pass a Sundstrand run qualification test program prior to sale for any military or commercial aircraft.

Potential Benefits

Sundstrand as the leading electric power manufacturer as well as other aircraft systems can take advantage of their wide product stable by making the "new" Sundstrand Aerospace a total company marketing effort. Sundstrand divisions such as Sundstrand Data Control and Wulfsberg Electronics have a great deal of expertise in current avionics. The future aircraft systems will be so interdependent that Sundstrand can take full advantage of

all their divisions to bring to bear on the marketplace quality products and superior customer service.

The Sundstrand product content percentage of each airplane could be increased significantly using this market strategy. By bringing the most current technologies together in fluid pumping, mechanical, electrical power, auxiliary power units, and avionics Sundstrand can provide a formidable marketing advantage to its customers. This approach can ensure Sundstrand's continued success in the aerospace industry. This follows Sundstrand's management position for many years. "Extensive research and development programs and product refinement play key roles in Sundstrand's aerospace activities. The Company has been actively expanding its markets by developing systems where it had previously supplied single components. Other developmental programs include the expansion of product range and capability so that existing products can be used in more applications" (Sundstrand Annual Report, p.8).

Sundstrand electric power has an excellent customer service reputation. By bringing in the customer (airlines or the military) early in the design process Sundstrand will develop products that better meet the customer's needs. Integrating Sundstrand's combined aerospace technology and customer service into one marketing strategy will position them as a significant supplier for future aircraft programs. The airlines and military are always seeking ways to deal with fewer vendors and the advances in

our technologies developed at Sundstrand will allow that to happen efficiently and smoothly.

When considering whether or not to develop the system it could be broken down into discreet components where make or buy decisions could be made. This has been done in the past with remote oil level sensors and differential pressure indicators. Both items send messages to the cockpit. The first indicates the oil level in the IDG. The second signals when the pressure drop across the IDG filter is too great indicating a dirty filter. Both of these items are largely defined and designed in house but manufactured to Sundstrand's specifications by outside vendors. These vendors have the technical expertise and similar product lines to build these components profitably. Sundstrand could manufacture these items but at a far greater cost than their current purchase price. Further analysis of individual subcomponents is beyond the scope of this report. A full financial analysis follows shortly.

By developing ELMC technology Sundstrand will help establish itself in the power electronic market. As mentioned it is critical that Sundstrand jump into both of these markets. The best option will be for Sundstrand to develop this technology on its own.

Sundstrand has a long proven ability to do what no one else can do. Sundstrand seeks technical challenges that will extend their leadership position as a supplier of aircraft electrical power systems and high technology systems for the aerospace industry. The opening statement

for the market leadership portion of Sundstrand's 1987 annual report clearly states this philosophy. "To maintain its position as a market leader, Sundstrand invests in programs which require significant research, development engineering, and processing expertise. Previously funded research and development programs have provided the technology-based products now being marketed by the Company and current research expenditures are expected to yield improved products which will anticipate the needs of our customers" (Sundstrand 1987 Annual Report, p.5). With this corporate attitude Sundstrand is ready to design, develop, market, and above all sell ELMC systems for commercial and military aircraft!

Internal development of an ELMC system is an excellent option. To determine if this is the best option a financial analysis of the corporation and an internal development budget must be created. This will allow for a cost comparison against the next best option.

Financial Analysis

Sundstrand's financial performance has always been excellent. This once again was evident from the opening statement in the Annual Report 1990. "Your Company had another excellent year in 1990, as Sundstrand once more achieved record sales and earnings. Sales rose to $1,559.8 million, a 5.5 percent gain over 1989, as the strength of our commercial aerospace and industrial markets more than offset cutbacks in military procurement" (Sundstrand 1990 Annual Report, p. 3). The following is a list of a few

1990 key financial statistics. All dollar values listed in millions.

Net Sales	$1,559.8
Operating Profit	$ 243.5
Working Capital	$ 570.3
Current Ratio	2.7
Total Assets	$1,581.9
Long-term Debt	$ 369.9
Total Debt	$ 369.9
Shareholders' Equity	$ 624.5
Total Debt/ Total Equity	37.2%

These figures for the previous seven years are included as appendix B (Sundstrand 1990 Annual Report, p.58.).

From reviewing appendix B one can see that Sundstrand has maintained a steady increase in net sales and working capital over the past eight years. There were wild swings in operating profits between 1989 and 1987 due to a 220 million dollar settlement with the government over various contract disputes. The 7.7 million dollar loss reported in 1988 is primarily due to the dispute and subsequent settlement over various charging practices and accounting standards.

The adjustment in operating profits between 1987 and 1989 was not the result of an extremely poor year or wasteful management. Sundstrand was aware of the pending settlement and made financial provisions for these fines in 1986 and 1988. "1988 and 1986 include $125.9 million and $61.5 million, respectively, of provisions for resolution

of government contracts disputes. 1988 also includes $64.5 million for the current year effect of the change in accounting of long-term contracts" (Sundstrand 1988 Annual Report, p.30). "1988 includes a provision of $22.5 million before income taxes for potential interest charges related to resolution of previously disclosed tax disputes" (Sundstrand 1988 Annual Report, p. 30). After allowing for the loss provisions previously stated the operating profits do follow a steadily rising slope excluding 1987. The decline in 1987 is due to a $34.2 million before tax nonrecurring loss in the aerospace segment (Sundstrand 1988 Annual Report).

The numbers above and appendix B outline Sundstrand's steady and impressive growth in an industry that frequently experiences wild swings in both profits and sales. Maintaining a current ratio at or above 2.0 for six out of the last eight years is difficult in the aerospace industry. Sundstrand continually earns respectable profits and maintains solid total assets. "The best measure of earnings performance without regard to the sources of assets is the relationship of net operating income to operating assets, which is known as the rate of return on operating assets" (Hermanson, Edwards, and Rayburn p.668). Sundstrand had a 26.4% rate of return on operating assets in 1990 ($236.8 million/ $896.3 million, Sundstrand 1990 Annual Report, p.42-44).

These profits finance internal research and development projects to ensure a varied and technically

superior product line for years to come. The total debt to capital ratio remains steady which is a reflection of the company's policy of continual reinvestment to avoid obsolescence in a fast paced field. This eliminates the need for massive modernization to remain competitive in a quickly changing aerospace market place. With a debt to equity ratio of 37.2% for 1990 Sundstrand has numerous options if outside capital becomes necessary any time soon.

Sundstrand's philosophy of expanding its presence in the aircraft electrical power market and devotion to research and development is evident in several of their Annual Reports. "In addition, research and development expenditures support the Company's objective of growth through expanded system content" (Sundstrand 1989 Annual Report, p.6). "Sundstrand continues to invest significantly in product research and development and to pursue new and proprietary technologies and products" (Sundstrand 1990 Annual Report, p.13).

"Total research and development expenditures for the years 1990, 1989 and 1988 were $170.3 million, $180.3 million and $170.5 million, respectively, of which $46.3 million, $53.8 million and $56.4 million, respectively, were costs funded by customers" (Sundstrand 1990 Annual Report, p.54). When considering the previous years' financial performance and past internal research expenditures it is reasonable to assume that at least $170 million can be set aside for internal research and development in 1991. With approximately $50 million funded

by Sundstrand's customers. Considering management's willingness to invest in the companies core business, Aircraft Electrical Power, it should not be difficult to obtain the necessary funds for this development program. "Electric power generating equipment remains the Company's most important product line in terms of sales and profits. Sundstrand systems are standard equipment on new-generation commercial aircraft from every airframe supplier" (Sundstrand 1990 Annual Report, p.15).

The other major research and development programs are long term development projects such as a new torpedo motor for the Navy, Systems for the NASA Space Station, and development work to increase Sundstrand's market penetration in the Auxiliary Power Market for Aircraft. With the torpedo and auxiliary power programs moving toward production the need for internal research and development funds is decreasing. This will release funds for the ELMC effort.

Internal Development Budget

If Sundstrand is to develop an ELMC system on their own an estimate outlining the manpower requirements, program schedule, and budget must be developed. This will allow for a direct comparison of this option against the others discussed in this paper. The first step is to define the task in detail.

Any ELMC will be a part of a total aircraft electrical power system. For the purpose of this study only the ELMC will be discussed. All the other relevant portions of the

system will be unaffected by the decision on how to proceed with the ELMC and therefore are not relevant.

For Sundstrand to develop an ELMC system on their own the research and development department will be heavily involved initially. Corporations frequently instigate proof of concept programs to prove significant technical theories and problems. This type of program looks into the major portions of a new system or product. This type of investigation only plans and studies the theories and design principles required to develop a full scale system. Frequently it is necessary to build small scale components to verify and test the theories developed during this phase. These programs are usually short in duration typically being six months to two years. The information obtained from these programs is used to accurately asses the risks and technical challenges the new technology poses. Corporations then use this information as a basis for estimates on full scale development programs if the corporation decides to market the product.

For this application a six month proof of concept program will be adequate. Six months is sufficient due to the similarity to existing Sundstrand technology. In addition Sundstrand is developing a small and technically simple ELMC system to retrofit on to the 757 aircraft at Boeing's request. Therefore six months is sufficient to complete this program. While this not as sophisticated as the full scale system it will lend valuable information to the proof of concept study. A six month proof of concept

program will be an adequate investigation of the new technology.

Before the proof of concept program can be agreed upon and funded by management a budget outlining the manpower, hardware dollars, and schedule must be developed. Figure one outlines these issues and the cost of 190,000 dollars.

Proof of Concept

Figure one outlines the schedule and manpower requirements for the proof of concept program. The major costs for a program of this nature will be manpower and hardware. Typically these programs have between two and six personnel. Because of the small but important scope of this program four people should suffice. They will handle the functions outlined by figure one. The experience and length of service with the company for these four people will vary as will their salaries. This is also true of the full scale development personnel discussed later. The four personnel are estimated to complete this task in six months. That means the company will pay for two man-years of effort. Sundstrand has a specific dollar value used to estimate manpower which is considered proprietary and is not available to the writer. For the purpose of this paper a figure will be assumed and should be considered realistic but not factual ($45,000 per man year). Hardware purchases while expensive will be few in nature. Conservative estimates place these costs at 80,000 dollars for the six month effort. The fees for any consultants should be

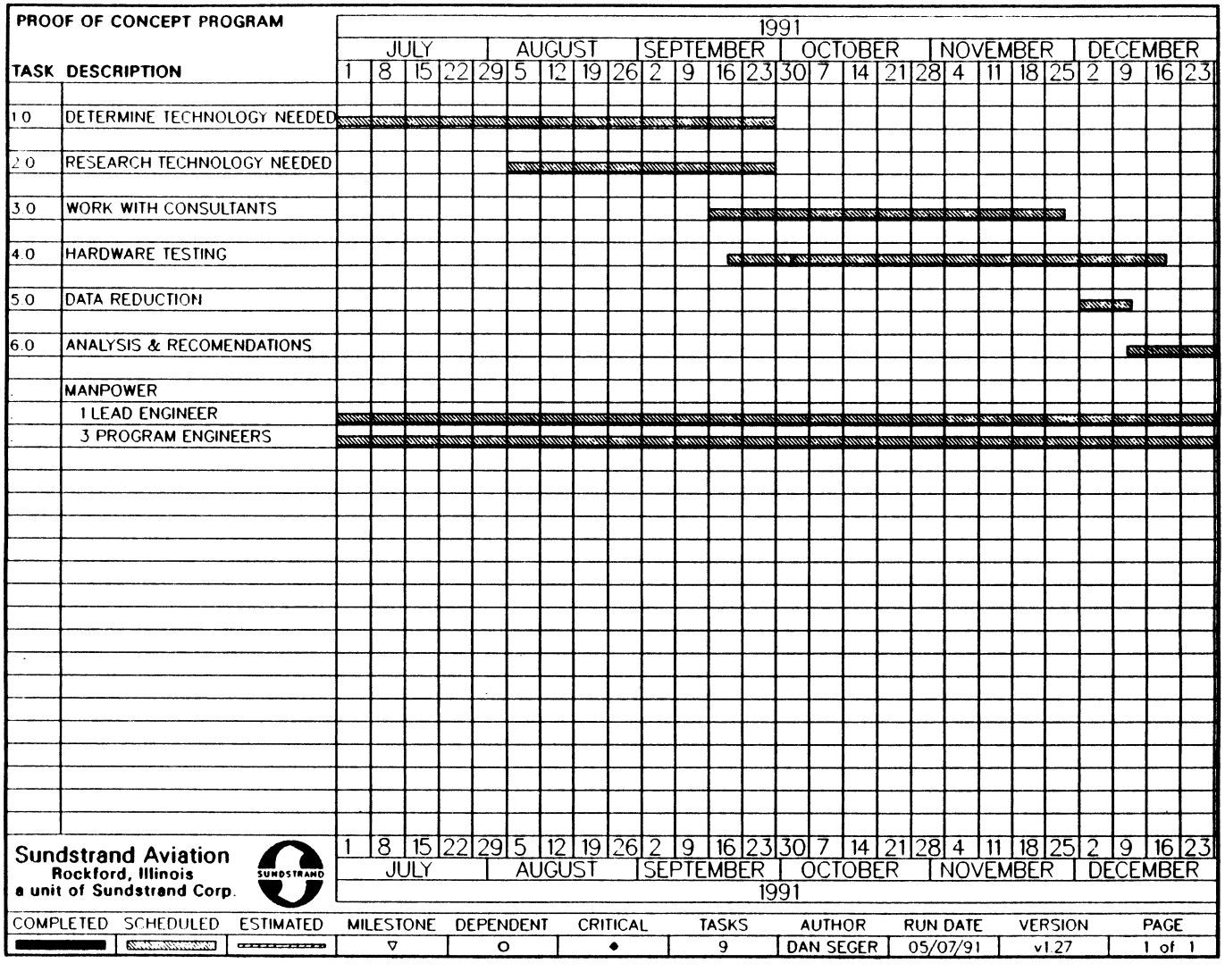
PROOF OF CONCEPT PROGRAM
1991
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
TASK DESCRIPTION
1 8 15 22 29 5 12 19 26 2 9 16 23 30 7 14 21 28 4 11 18 25 2 9 16 23
1.0 DETERMINE TECHNOLOGY NEEDED
2.0 RESEARCH TECHNOLOGY NEEDED
3.0 WORK WITH CONSULTANTS
4.0 HARDWARE TESTING
5.0 DATA REDUCTION
6.0 ANALYSIS & RECOMENDATIONS
MANPOWER
1 LEAD ENGINEER
3 PROGRAM ENGINEERS
Sundstrand Aviation
Rockford, Illinois
a unit of Sundstrand Corp.
SUNDSTRAND
COMPLETED SCHEDULED ESTIMATED
MILESTONE DEPENDENT CRITICAL TASKS AUTHOR RUN DATE VERSION PAGE
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FIGURE 1

minimal so an estimate of 20,000 dollars will be used. The total costs are listed below:

Man Power	$45,000 x 2 =	$90,000
Hardware		$80,000
Consultant		$20,000
Total		$190,000

Full Scale Development

When the proof of concept program is complete the company can review the final recommendations as well as programs of similar scope to determine a budget proposal for the full scale development program. The full scale development program will take the technical information learned from the proof of concept study and develop full scale hardware to test and qualify for use on an aircraft. Once qualified it will go into production and be sold to the aircraft manufacturer. The budget will not include other portions of the electrical power system nor will it include hardware development costs. In any option the cost of development hardware will be relatively equal and therefore not considered. The proof of concept hardware was considered because that portion of the program would not be necessary if other options were exercised. The man power budget rates will be considered equal for both budgets presented. Figure two outlines the man power expenditures for the span of the program. 183 man months will be required which equates to 15.25 years of man power.

The full scale development spans from the estimate all the way through aircraft certification upon completion of

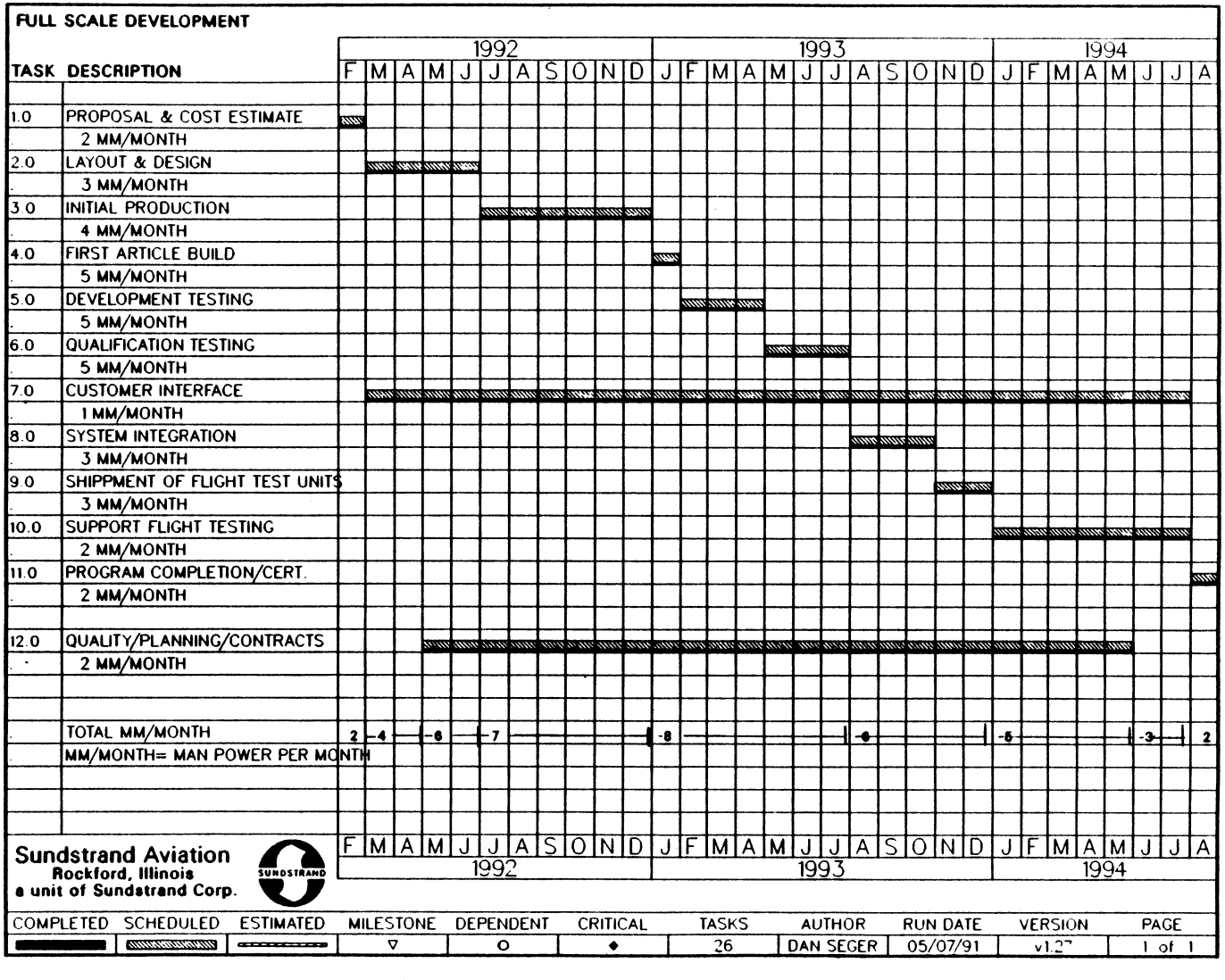
FULL SCALE DEVELOPMENT
1992
1993
1994
TASK DESCRIPTION
F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A
1.0 PROPOSAL & COST ESTIMATE
2 MM/MONTH
2.0 LAYOUT & DESIGN
3 MM/MONTH
3.0 INITIAL PRODUCTION
4 MM/MONTH
4.0 FIRST ARTICLE BUILD
5 MM/MONTH
5.0 DEVELOPMENT TESTING
5 MM/MONTH
6.0 QUALIFICATION TESTING
5 MM/MONTH
7.0 CUSTOMER INTERFACE
1 MM/MONTH
8.0 SYSTEM INTEGRATION
3 MM/MONTH
9.0 SHIPPMENT OF FLIGHT TEST UNITS
3 MM/MONTH
10.0 SUPPORT FLIGHT TESTING
2 MM/MONTH
11.0 PROGRAM COMPLETION/CERT.
2 MM/MONTH
12.0 QUALITY/PLANNING/CONTRACTS
2 MM/MONTH
TOTAL MM/MONTH
2 4 6 7 8 6 5 3 2
MM/MONTH= MAN POWER PER MONTH
Sundstrand Aviation
Rockford, Illinois
a unit of Sundstrand Corp.
SUNDSTRAND
COMPLETED SCHEDULED ESTIMATED MILESTONE DEPENDENT CRITICAL TASKS AUTHOR RUN DATE VERSION PAGE
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FIGURE 2

flight testing. This encompasses design, manufacture, build, development and qualification testing, and flight testing support. Figure two outlines this schedule.

As the program progresses through the various phases the manpower requirements will vary. During a full scale development program there is significant quality, planning, and contract manpower required. These individuals handle specific problems in their functional areas during the life of a program.

Other costs that arise are drafting and personnel training. Again these costs are proprietary and unavailable to the writer. Because of this estimates will be made based on program knowledge and experience. Drafting tends to be very heavy during the design and initial production phases of a program and drops off quickly once that phase is complete. For this study a drafting budget of 50,000 dollars will be allotted. Training for new hardware will be significant throughout the program because of the new technology. 100,000 dollars should be budgeted for training. The total costs for the full scale development program are outlined as follows:

Man power	$45,000 x 15.25 =	$686,250
Drafting		$ 50,000
Training		$100,000
Total		$836,250

When adding the cost of both the full scale development program and the proof of concept program the total cost for internal development of an ELMC is 1,026,250

dollars. With allowance for budget overruns this option will cost 1.1 million dollars. The other three options are either not practical or more expensive. Not expanding into the ELMC market is not a viable option as discussed earlier. Purchase of a corporation that builds ELMC systems would cost at least 11 million dollars which far exceeds the 1.1 million dollars this option presents. Purchase of a corporation with similar technology buys Sundstrand nothing. Sundstrand's current technology is already similar to ELMC systems. Section III covers the conclusions and recommendations in more detail.

Section III

Conclusions and Recommendations

After reviewing the options presented it is obvious that Sundstrand should internally develop ELMC systems. It may be necessary and beneficial to look outside for technical expertise in a few key areas. The bulk of technical expertise and knowledge already exists at Sundstrand. Outside training of key personnel will help elevate or minimize the difficulties normally encountered in the development of high technology hardware.

The other three options discussed did not offer the same benefits at such a low cost as the internal development option. Purchasing a corporation would be a long and risky process that would cost at least 11 million dollars. The 1.1 million dollar budget necessary to internally develop ELMC systems is significantly less. In addition any purchase option would offer minimal if any improvement or expansion of Sundstrand's customer base. Sundstrand already sells EPGS on almost every new aircraft so its name and market position are already firmly entrenched.

Not expanding into the ELMC market may force existing customers to look elsewhere. In this search the corporation could end up with a different EPGS. The sales figures for the ELMC market are now growing at a rate that would make those lost sales significant enough to impact Sundstrand's current core business.

The time is right for Sundstrand to enter the ELMC market. Sundstrand has the talent to do this on its own. Sundstrand's strong marketing, customer support, and reputation for excellence in the industry can lead to the same market domination the IDG has had for the last 40 years!

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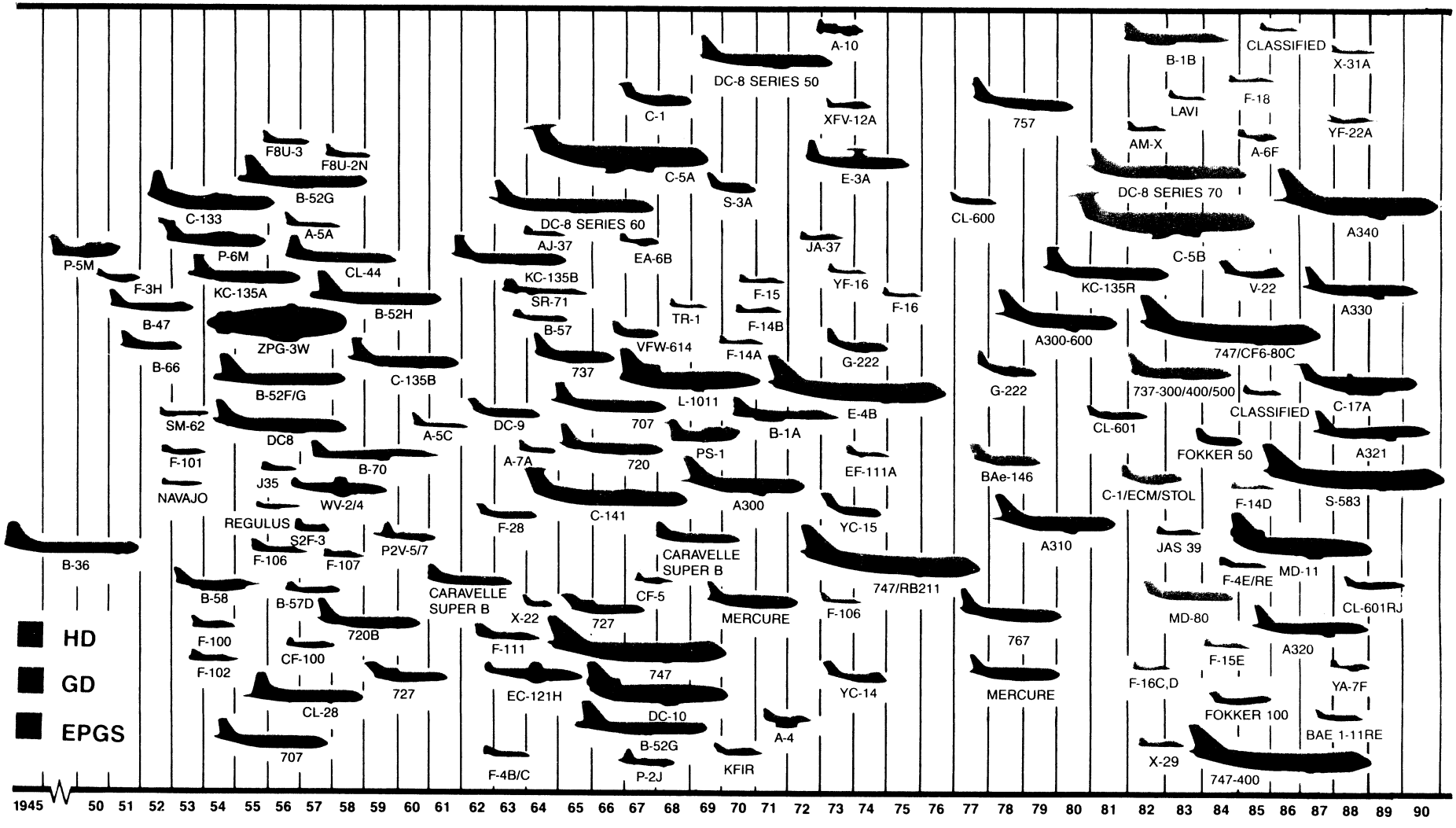
APPENDIX A

Sundstrand CSD and EPGS Applications



Sundstrand Electric Power Systems

ROCKFORD, ILLINOIS 61125
a division of Sundstrand Corporation

SUNDSTRAND

9022125/0190

APPENDIX B

SELECTED FINANCIAL DATA

Year ended December 31, (Dollar amounts in millions except per share data)	1989	1988[f]	1987[g]	1986[h]	1985	1984	1983
Net sales	$1,516.9	$1,401.8	$1,365.4	$1,433.9	$1,284.2	$1,042.0	$909.3
Operating profit (loss)	$ 263.6	$ (7.7)	$ 100.3	$ 100.5	$ 152.1	$ 125.0	$ 92.1
Working capital	$ 456.7	$ 360.8	$ 362.5	$ 420.8	$ 288.2	$ 278.7	$306.2
Current ratio	2.1	1.7	2.0	2.6	1.9	2.1	2.7
Total assets	$1,499.0	$1,560.3	$1,504.9	$1,404.5	$1,311.2	$1,089.9	$916.7
Long-term debt	$ 258.5	$ 307.6	$ 300.0	$ 308.9	$ 238.1	$ 174.4	$131.5
Total debt	$ 355.7	$ 369.3	$ 366.3	$ 317.2	$ 320.0	$ 219.3	$154.3
Shareholders' equity	$ 573.0	$ 589.5	$ 595.0	$ 604.7	$ 589.1	$ 535.8	$500.4
Ratio of total debt to total capital	38.3%	38.5%	38.1%	34.4%	35.2%	29.0%	23.6%

[f] 1988 includes provisions of $125.9 million before taxes and $79.6 million after taxes ($2.16 per share) for settlement of government contracts disputes and $64.5 million before taxes and $39.8 million after taxes ($1.08 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 $16.5 million ($.72 per share), for the change in accounting for long-term contracts.

[g] 1987 includes a provision of $34.2 million before taxes and $19.3 million after taxes ($.52 per share) for nonrecurring losses in the aerospace segment.

[h] 1986 includes a loss provision of $61.5 million before taxes and $31.7 million after taxes ($.85 per share) for the resolution of government contracts disputes in the Company's aerospace segment.