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Benefits from Funding the MSD Engineering List: A Fiscal Year 1999 Case Study

David L. Gehrich

BENEFITS FROM FUNDING THE
MSD ENGINEERING LIST:
A FISCAL YEAR 1999 CASE STUDY

THESIS

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AFIT/GLM/ENS/04-03

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BENEFITS FROM FUNDING THE MSD ENGINEERING LIST: A FISCAL YEAR 1999 CASE STUDY

THESIS

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BENEFITS FROM FUNDING THE MSD ENGINEERING LIST: A FISCAL YEAR 1999 CASE STUDY

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Abstract

Every year the Air Force Material Command (AFMC) funds the MSD Engineering list. The projects on the list are submitted by the Air Logistic Centers in order to address problems with the maintainability or reliability of a reparable part. AFMC funds the projects to determine the root cause of the problem and find the best solution to fix the part. Since the MSD Engineering list is funded in order to improve maintainability and reliability, not as a cost savings initiative, the actual benefits gained from the funds spent on the MSD Engineering list have not been identified.

This thesis uses the FY99 MSD Engineering list as a representative sample of all MSD Engineering lists to identify how much of the money spent on the projects actually results in a benefit to the Air Force. Additionally, this study attempts to determine if there are any factors that correlate with projects that benefit the Air Force, and any common factors in projects that did not benefit the Air Force. Finally, this project attempts to describe the types of benefit the Air Force receives from the MSD Engineering list.

Acknowledgements

When I found out the acknowledgements were optional I swore I would not write one extra word; "forget that optional stuff." However, as I inched closer to completing this thesis, I realized it would be criminal for me not to thank all the people that helped me through this. First, I'd like to thank Maj Anderson and Lt Col Arostegui for helping me get through the final weeks leading up to finishing this project. I also have to thank Mr. James Steiger who spent hours with me providing data and explaining the MSD process. I'd also like to thank all the POCs at the depots who provided information and were very enthusiastic about this project. I wish I could name them all, but space does not permit. Their names are all listed in Appendix B! Next, I have to thank Steve Gray, our class leader who kept nudging me in the right direction when I did not have a clue how I was going to find data. I also have to thank 1st Lt Jessica Joerger for loaning me a desk, never getting upset about the hours I spent monopolizing her phone, and laughing with me when I wanted to cry about all the wrong numbers I was calling. Finally, I have to thank my Mom. She proofed all my chapters even with short deadlines!

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BENEFITS FROM FUNDING THE

MSD ENGINEERING LIST:

A FISCAL YEAR 1999 CASE STUDY

I. Introduction

CHAPTER OVERVIEW

This chapter describes the purpose for conducting this study, and provides background describing how the problem addressed by this study developed. This chapter also provides a succinct statement of the problem followed by a description of why this project is being undertaken. Next, specific thesis questions are stated. Then the investigative questions needed to answer the thesis questions are stated. The methodology used to conduct this study is then described, followed by a discussion of the assumptions used in this thesis. Finally, the significance of the research is discussed along with the expected actions that will occur as a result of this study.

GENERAL ISSUE

Every year, the Air Logistics Centers (ALCs) submit project requests to the Air Force Materiel Command (AFMC) to address problems with parts that are not performing as required, or are no longer manufactured. AFMC combines and prioritizes all the projects. Material Support Division (MSD) funds are then used to fund projects based on the criticality of the project and the priority assigned by AFMC. Generally, AFMC only funds projects that immediately affect aircraft safety of flight or mission capability. Once these funds are obligated, there is little visibility of the benefit the Air Force receives by funding these projects.

BACKGROUND

Due to constricted budgets since the Cold War ended, the Air Force has been forced to move funds from modernization efforts to support day-to-day operations. Taking funds from modernization efforts decreases the new equipment the Air Force can develop and procure, which means Air Force equipment ages. As equipment ages, it becomes more difficult and more expensive to support. In turn, this requires more money to be pulled from modernization efforts and spent on supporting daily operations. This cycle is a large problem for the Air Force.

Diminishing Manufacturing Sources/Material Shortage (DMSMS) issues are part of the reason equipment becomes more expensive to maintain. These issues occur when there are no more companies making the parts the Air Force needs to repair/maintain equipment. There are two Department of Defense organizations, as well as an Air Force organization dedicated to addressing DMSMS issues. However, the Air Force does not have a funding system designated for DMSMS issues. The Item Manager is expected to program and fund these problems through their out-year budgets.

The MSD Engineering list is a source of funds the Item Mangers can use to address DMSMS issues. The MSD Engineering list is generated annually to address serious issues with parts in the Air Force inventory. Some parts are a problem because they do not perform as well as the Air Force expected. Other parts are problems because they are old. As parts grow older, it is increasingly difficult for the AF to purchase replacement parts. Eventually, parts become so old and obsolete that they are no longer manufactured. Unfortunately, the AF still needs these parts. In these instances, the AF has at least eight options. First, they can search for existing stock owned by companies that are not manufacturers of the item and attempt to purchase it from them. Second, they can attempt to reclaim parts that are subcomponents of items at Defense Reutilization and Marketing Service or depots that are deemed beyond economical repair. Third, the AF can use the next higher assembly part to replace the original part. Fourth, the AF can substitute with a part that may be less capable than the original part. Fifth, they can attempt to find aftermarket parts built by a company that was specifically authorized by the original manufacturer. Sixth, they can attempt to emulate the part by finding a manufacturing process that produces a substitute form, fit, function, and interface item. Seventh, the depots could attempt to make a lot buy, which is a large, one-time, purchase of the part before the manufacturer of the part permanently closes the assembly line. Finally, the AF can attempt to redesign the part. This is normally the most expensive method, but also often has the benefit of enhancing performance and increasing reliability and maintainability (McDermott, Shearer, & Tomczykowski, 1999).

Because of the cost and time it takes to redesign a part, reengineering is usually the AF's last resort (McDermott, Shearer, & Tomczykowski, 1999). Once the AF determines a part should be reengineered, it is usually several years before the part actually gets funded.

PROBLEM STATEMENT

Currently, there is no study demonstrating the benefits the Air Force receives from funding the MSD Engineering list. The Air Force spends upwards of $39 million each year to improve parts, but there is little visibility of the benefit gained through this investment. Additionally, there is limited visibility regarding what causes a project to fail or what types of benefits the Air Force receives from successful projects.

PURPOSE OF RESEARCH

This paper will attempt to show how much of the MSD Engineering list results in a benefit to the Air Force. Additionally, this study will attempt to determine what factors result in a beneficial project and what common factors result in a non-beneficial project. Finally, an attempt will be made to describe what benefits the Air Force receives from the projects and identify obstacles to determining the benefit received from these projects.

RESEARCH QUESTIONS

This paper will attempt to answer four questions.

1. How much of the MSD Engineering budget resulted in a benefit to the Air Force?
2. Are there any factors correlated with projects that resulted in a benefit to the Air Force?
3. Were there any common reasons projects failed to benefit the Air Force?
4. What type of benefits did the Air Force receive from successful projects?

In order to accomplish this study, the definition of "benefit" needs to be determined. For the purposes of this study, the Air Force receives a benefit from a MSD Engineering project any time a project results in an expected outcome. For example, if the Air Force funds a project to conduct a study to identify the best source of repair for a part, the project is beneficial if the study is completed. What the study concludes is not a factor to determining if the project was beneficial.

INVESTIGATIVE QUESTIONS

In order to answer the research questions, several investigative questions must be addressed.

Two questions must be answered in order to answer the first research question, "How much of the MSD Engineering budget results in a benefit to the Air Force?" The first question is "How much money did the Air Force spend on each project on the engineering list?" The second question is "Which projects resulted in a benefit to the Air Force?"

In order to answer the second research question, "Are there any factors that correlate with projects that result in a benefit to the Air Force?", the following questions much be answered "What were possible factors relating to success or failure of a project?" and "What factors were associated with each project?"

Answering the third research question, "Were there any common reasons why projects failed to benefit the Air Force?" requires the answer to the following question: "Why did each project fail?"

Finally, determining "What type of benefits did the Air Force receive from successful projects?" requires an answer to the question "What was the final outcome of each of the beneficial projects?"

METHODOLOGY

This project was approached as a case study based on the FY99 MSD Engineering list. The final status of as many projects as possible was determined by contacting the project point of contact (POC). The amount of money spent on the project was determined by either identifying the amount of money the project contract was let for, or by assuming all the money that AFMC allocated to the project was spent. Possible factors contributing to the success of a project were identified by studying the projects and available data. Conclusions regarding correlations between factors and results were determined using the Wilcoxon Rank Sum Test. Common causes for projects to fail were identified by contacting project POCs and asking them to describe why a project did not reach the desired conclusion. The benefit received from each project was determined by conducting telephone interviews with the project POCs.

ASSUMPTIONS

This approach relies on several reasonable assumptions. First, the amount of money spent on the contract is the amount of money spent on the project. This assumption is reasonable because this study does not attempt to quantify or otherwise account for time spent by administrators and engineers in preparing the project and documenting its status. Another assumption is that the POC's are familiar enough with the projects to recall the original purpose of the project. The original MSD project submission was used to validate the purpose of the projects. Finally, the assumption is made that the POC's are familiar enough with the projects to either remember or have notes regarding the outcome of the project. As these projects are a major effort for the POC's, this is also a reasonable assumption.

SCOPE AND LIMITATIONS

This thesis was limited to projects funded from the FY99 MSD Engineering list. In order to be able to accept the recommendations from this study, it must be assumed that the FY99 MSD Engineering list is representative of every MSD Engineering. Additionally, a final status could only be determined for 35 of the 50 projects funded on the list; therefore, it is possible this study does not portray an accurate summary of the FY99 MSD Engineering list. Finally, this project is limited by the selection of the definition for benefit used in this study. Other definitions of benefit are reasonable and possible.

SIGNIFICANCE OF RESEARCH

This research attempts to determine how much of the money the Air Force spent on the MSD Engineering list resulted in a benefit. This information will allow Air Force leaders to make an informed decision regarding funding levels for the MSD Engineering list. Additionally, this study attempted to determine if there were things that could be done which would increase the effectiveness of the MSD Engineering list. Finally, this project investigated what type of benefits the Air Force received from funding the MSD Engineering list. This will allow Air Force leaders to determine if they are receiving the benefits they expect from funding the MSD Engineering list.

EXPECTED RESULTS

Identifying the benefits received from funding the MSD Engineering list is expected to result in a more informed decision regarding the level of funding provided for the MSD Engineering list. Additionally, identifying why projects fail is expected to increase the ability of the project sponsors to avoid those pitfalls and generate more projects that benefit the Air Force.

SUMMARY AND CONCLUSIONS

This chapter described the general issue discussed in this paper, and presented the background. Then the problem this paper is addressing was outlined and the purpose of the research was described. Next, the research questions used to address this problem were explicitly stated along with the investigative questions needed to answer the thesis questions. Then the methodology used to answer the questions was described, followed by a discussion of the assumptions made while using this methodology. Finally, the significance of the research was discussed along with the expected actions that will occur as a result of this study.

The remaining chapters will present a literature review, the methodology used in this study, the findings and analysis, and a conclusion with recommendations. The literature review builds a background for this project. Chapter III, the methodology chapter, describes how the research data was collected and analyzed. Chapter IV presents findings and the analysis. Chapter V examines the results and presents recommendations for further study.

II. Literature Review

OVERVIEW

There are three overall goals for this chapter. The first goal is to outline one of the largest problems the Air Force has been facing for the last few years. The conflict is between funding operations utilizing aging systems with Diminishing Manufacturing Sources and Material Shortages (DMSMS) issues and funding modernization issues. The second goal is to examine some of the programs that are available within the Air Force to address this conflict. Finally, this paper will explain the purpose of Air Force Material Command's (AFMC) Material Support Division (MSD) program for funding reliability and maintainability improvement projects.

OPERATIONS VERSUS MODERNIZATION

Once the Cold War ended, the military budget faced almost immediate cutbacks in personnel and budgets (Cordesman, 1999). In fact, by 1999, US Forces and Defense spending were reduced by 40%. Additionally, "readiness and maintenance budgets were only funded at about 60 – 70% of the needed levels" (Cordesman, 1999:26). In 1998 General Ryan testified to the Senate Armed Services Committee that the cost of spare parts had outstripped the available funding which lead to a 50% increase in the cannibalization rate over the previous three years (Ryan, 1998).

The only way to fight this trend is to spend money to modernize the fleet. However, it takes money to keep the fleet operational. As more money is spent to keep current capabilities operational, less money is available to spend on modernizing equipment. If less money is spent to modernize equipment, the equipment becomes older and more expensive to maintain, which results in less money available to modernize aging weapons systems. This is a vicious cycle that pits maintaining current operations against investing in the future Air Force (see Figure 1 below).

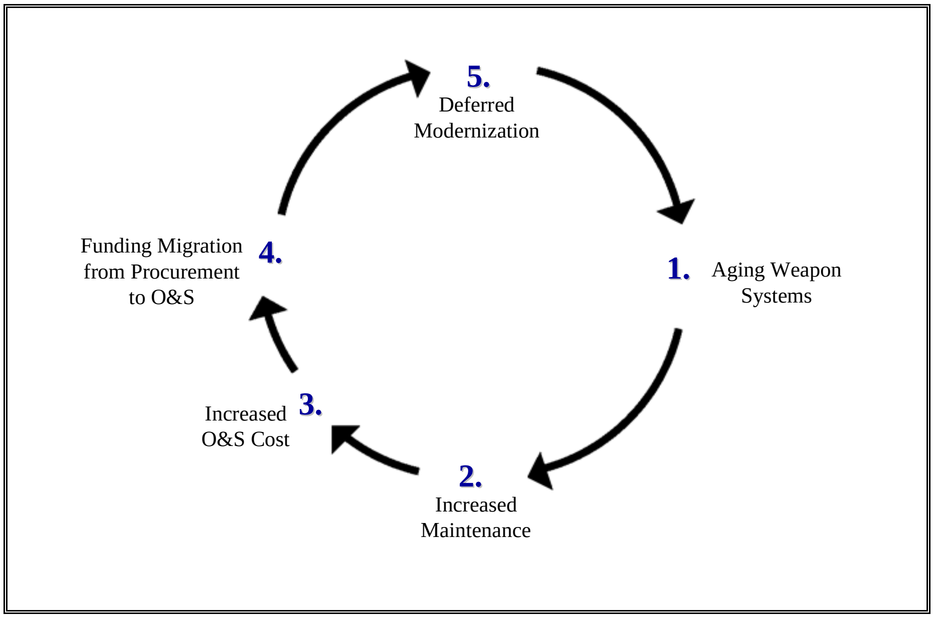

Figure 1. Cycle of Increasing O&S Costs (DAF, 2001)

DMSMS DRIVING FACTORS

One of the driving factors in the increasing cost to operate aging equipment in the Air Force is a mounting problem finding sources to procure or repair needed parts. This problem is known as Diminishing Manufacturing Sources and Material Shortages (DMSMS). The Department of Defense (DoD) defines DMSMS as “the loss or impending loss of manufacturers or suppliers of items or a shortage of raw material” (Defense Microelectronics Activity, 2004; DOD, 2003). This is not a new problem. It was first recognized in the 1950’s and formally addressed in 1959 with the creation of the Interservice Data Exchange Program (Wilson, 2002).

In recent years this problem has become even more pronounced as a result of four factors. First, the cycle life of technology has been decreasing. Second, the DoD no longer has the leverage to entice manufactures to extend the production life of a product. Third, the equipment the Air Force is utilizing today is, on average, much older than at any other time in its history. Fourth, as previously mentioned, shrinking budget authorizations make it increasingly more difficult to address DMSMS issues.

One reason the DMSMS problem has become more pronounced is that the cycle life of technology has shortened. For example, between 1992 and 2002 the expected life of a graphics chip dropped from 5 to 10 years to 6 to 24 months (Hixon, 2002). Once an item is deemed obsolete, manufacturers lose the ability to mass produce the product and gain economies of scale. Therefore, it becomes less and less profitable for companies to manufacture an old technology until the manufacturer decides not to create the product anymore. By definition, a part with no manufacturing source is a DMSMS issue.

Another reason the DMSMS has emerged as an increasing problem to the Air Force is that the DoD is no longer a primary customer of many electronic manufacturers. In the 1970's the DoD consumed 17% of all microcircuits, so manufacturers were willing to continue to produce "old" items for the military (DoD DMSMS Working Group, 2003). By 2003, however, the DoD purchased less than one tenth of a percent of all the microcircuits produced (DoD DMSMS Working Group, 2003). This means the military no longer has the leverage to convince manufacturers to extend the life of their product lines. If the DoD cannot leverage its purchasing power to convince manufacturers to keep the production line open, the items become a DMSMS issue.

A third reason DMSMS has become a growing problem for the Air Force is that the equipment used now is, on average, much older than at any other time in our history. For example, one system still being used on the A-10 was designed in the1960's and was originally scheduled to be retired in the 1990's. The current projected retirement date for the system is 2028 (Molton, 2004). This is not an isolated phenomenon. It extends to the Air Force's weapon systems such as the B-52. The first B-52 flight took place on 15 April, 1952. The B-52 is expected to remain in the Air Force inventory until at least 2030 (Air Force, 2004). In fact, the Chief of Staff of the Air Force noted that the average age of aircraft increased from 12 to 30 years between FY 1990 and 1998 (Ryan, 1998). Older equipment means aged parts and dated technology that translates into more DMSMS issues.

DMSMS STRATEGIES

The growing problem has lead to new approaches to handling DMSMS issues. The techniques can generally be classified as either proactive or reactive, although the categories are not mutually exclusive (Overstreet, 2002). Proactive approaches attempt to minimize DMSMS issues by identifying the possible problems early in the parts life-cycle. Reactive approaches attempt to minimize the impact of a DMSMS occurrence after a DMSMS issue is identified.

Most proactive methods involve planning for future DMSMS problems. After all, if you have parts with electronic components that are expected to last any more than a year, then you most likely are facing obsolescence issues (Husey, 2001). The earlier planning starts, the better off the company will be. In fact, if a company is planning to purchase a product rather than designing a new product, they should ensure that DMSMS issues are addressed in the request for proposal (Tomczykowski, 2003). On the other hand, if a company is designing a new product, DMSMS planning should be included in the design phase, especially since roughly 80% of the total life cycle cost is committed during the concept and design phases of a development project (Defense Standardization Program Office, 2001). Other proactive methods involve the use of information strategies that share obsolescence data and predict DMSMS occurrences (Livingston, 2001).

Unfortunately, in the Air Force most DMSMS issues are identified and addressed reactively (Overstreet, 2002). This means that DMSMS issues are not identified until the manufacturer affirms they will no longer produce a part. On occasion, DMSMS issues aren't identified until the Air Force attempts to purchase a replacement part, and discovers the manufacturer no longer carries the item (DMSMS Working Group, 2003). At this time the Air Force must decide how to address the problem. Air Force Material Command (AFMC) published a help guide in 2001. In it, it describes 14 possible approaches to address the DMSMS issue (AFMC, 2001). These 14 approaches are described below.

Form, Fit, and Function-Interface (F^3-I)

The Form, Fit, and Function-Interface approach is used during acquisition. It allows a contractor to change the design of a part as long as the original functions are maintained, and the part retains the same interfaces. In order to accomplish this, the contractor must be given performance specifications as opposed to military specifications. The contractor then has the freedom to design the part while taking advantage of new technologies and manufacturing practices. This also ensures the Air Force receives an item that will perform, at a minimum, the same functions the original part performed, and, optimally, better and more efficiently than before.

Encourage Existing Source

The Encourage Existing Source approach to satisfying the DMSMS event involves contacting the existing vendor to determine if there are any actions the Air Force can take which would entice them to produce the part. Possible enticements are price incentives and minimum buy quantities.

Alternate Source

The Alternate Source option requires the Air Force analyst to determine if another manufacturer has the capability to produce the DMSMS item to the same specifications as the original manufacturer. If an alternate source can provide the same part, then that company would become the primary source for the part.

Substitution

The Substitution option mitigates the DMSMS event by allowing a part that is similar to the original part to be used in place of the original part. The differences between the parts must be closely evaluated and tightly monitored to ensure the substitute part meets minimum requirements. It is entirely possible the substitute part will exceed the capabilities of the original part.

Redefine Requirement to Accept Commercial Item

In some cases it is possible to redefine the requirements of the original part to accept an existing commercial product. However, care must be taken to evaluate each similar item because quality and specifications for commercial parts that fulfill the same function vary. While the end result may appear to be within acceptable limits, unforeseen problems such as excessive strain may be placed on other parts causing a greater problem.

Emulation

At times, a replacement part can be created using current materials, designs, and manufacturing techniques. These parts can be an acceptable solution to the DMSMS situation as long as the part meets the Form, Fit, and Function criteria. The new part does not have to meet the original military specifications, as long as it can perform the required functions.

Life of Type (LOT)/Bridge Buy

Sometimes it is possible to purchase stocks from a manufacturer before the company actually shuts down its production line. When this occurs, the Air Force can place a large order with the manufacturer with the expectation that the stockpile will last until the system the part is used in is retired from the Air Force inventory. A similar option, called a Bridge Buy, is to make a smaller purchase that will allow the Air Force to continue operating with the old part until a permanent solution is selected and implemented.

Develop New Source

If the Air Force has complete technical specifications, but cannot identify a suitable after market source or a contractor to emulate the part, it can attempt to entice a new vendor to make the part. It is also possible that the Air Force could make this part, provided it can create the part less expensively than a vendor.

Reclamation

At times the DMSMS situation can be addressed by removing the parts from other parts that have previously been decommissioned. For example, a Fuel Consumption Computer can be taken from a decommissioned C-141 for use in a C-5. One important criterion in choosing this option is that there must be enough parts available in unused equipment to satisfy the expected demands for the part.

Redesign

If an end item has a high percentage of parts that are becoming unsupportable, for DMSMS or other reasons, a redesign may be appropriate. A redesign occurs when the next higher assembly is redesigned to perform the same tasks, but without the obsolete parts. This approach often has the added benefit of improving the capabilities and reliability of the next higher assembly. It is also one of the riskiest and most expensive approaches to addressing a DMSMS situation (ARINC, 2001).

Replacement

Another method of addressing a DMSMS issue is to replace the system for which the obsolete part is needed. This can have the advantage of adding the latest technology and capability to a system while eliminating a supportability issue.

Contractor Maintained Inventory

The Contractor Maintained Inventory approach is very similar to a lot buy, except the contractor maintains the inventory until the Air Force requests it. This can be appropriate when there are special handling, inspection, or storage requirements that a contractor can perform more efficiently than the Air Force.

Production Warranty

The Production Warranty option is similar to the Contractor Maintained Inventory option, except the Air Force does not purchase the stock in advance. The manufacturer is obligated to provide the part until the end of the warranty regardless of the number of parts the Air Force orders.

Reverse Engineering

The Reverse Engineering approach is appropriate when the Air Force does not have the original specifications for the part. In this situation, the Air Force can attempt to determine the specifications by testing and/or disassembling the original items. Once the Air Force has the technical data, it can determine how best to address the DMSMS issue.

FUNDING DMSMS PROJECTS

Addressing DMS issues requires funding. As mentioned in the beginning of this chapter, Air Force budgets have been shrinking, and are not large enough to fund R&M budgets or spare parts. Therefore, many budget items that would address DMSMS issues have not been funded. However, the Air Force realizes it will not be able to operate effectively in the future if it does not address some parts issues now. Several programs can be used to fund DMSMS projects. It is important to note that these programs are not solely intended to fund DMSMS projects; however, many DMSMS projects, especially high dollar projects, are addressed through the following programs.

One possible program is the Reduction in Total Operational Cost (R-TOC) program. The R-TOC program was developed in the late 1990's to address budget shortfalls by reducing the total cost of operations (Pallas and Novak, 2000). In order to accomplish this, the R-TOC program attempts to reduce the cost of products and processes used to purchase and operate weapon systems and infrastructure (DAF, 2001). These reductions begin with the acquisition process and extend through reducing operations and maintenance costs. "The aim is to realize significant cost reductions in order to free up budgetary Total Obligation Authority (TOA) to help fund urgent modernization priorities" (RTOC, 2001:p2). One method of realizing this goal is to provide an initial investment to modernize a piece of equipment now. A year later the upgrade should result in fiscal savings through improved reliability and lower operational costs. The saved money will then be used as an initial investment for another modernization program. This cycle of investment and reinvestment is referred to as the "Waterfall Effect" (Plowden, 2002). In order for this program to work, each project must result in a significant savings; therefore, selecting projects that have a high probability of returning large, quantifiable savings is an issue.

Another program available to fund DMSMS projects is the MSD Engineering List. This program finances the engineering of all AFMC MSD items used. Every year AFMC/LGIF sends a notice to every Air Logistics Center (ALC) to submit prioritized requests for funds for parts engineering projects. The due date is usually in the spring. MSD monies can only be used to fund development, production and maintenance projects that support an item managed by the Air Force Working Capital Fund Supply Management Activity Group. MSD funds cannot be used if the intent of the project is to upgrade the capabilities or change the form, fit, or function of the item. Additionally, MSD funds cannot be used on a non-MSD item (DAF, 2002). MSD items are budget code 8.

The justification for submitting a project should fit into one of four categories: Safety of Flight (SoF), Mission Critical Degradation-Existing (MCD-E), Mission Critical Degradation-Projected (MCD-P), or Reliability, Maintainability, and dependability (RM&D). A SoF project occurs only when an aircraft mishap is directly attributable to a deficiency in the design of the part. This is the highest justification for submitting a project. A MCD-E project occurs when a part problem prevents, or will prevent, a system from being able to perform its designated function within 36 months. This is the second highest project justification. A MCD-P project occurs when it is projected that a part problem will prevent a system from performing its designated function after 36 months. This is the third highest justification for a MSD project. A RM&D project occurs when a part is not performing as well as is expected and results in increased maintenance requirements but does not hinder the ability of the system to complete its mission. This is the lowest justification for submitting a project. The higher categorized projects will be funded first; i.e. all SoF projects will be funded before MCD-E projects are funded (AFMC, 2004).

Once all of the ALC's submit their projects, AFMC prioritizes the combined requests. AFMC ranks the projects within four categories with justification being the first criteria. Once AFMC receives their budget for MSD Engineering, they fund the projects by prioritization until all the money is obligated. There is never enough money to fund all the projects. In fact, it would be rare for all the MCD-E projects to be funded (Steiger, 2004).

MSD ENGINEERING EFFECTIVENESS

In contrast to the R-TOC program, operational necessity is the primary justification for funding these engineering efforts. The R-TOC program must have a return on investment in order to continue funding modernization efforts. The MSD Engineering program is not constrained by this requirement, which allows it to fund riskier projects. But this leads to the natural question "How much of the MSD Engineering budget results in a benefit to the Air Force?" This question has not been addressed in the past. Therefore, this thesis will attempt to answer this question.

CONCLUSION

This chapter discussed the conflict the Air Force faces when having to determine funding for modernization of future operations and capabilities or funding of current operations and how this conflict is exacerbated by the DMSMS problem. The causes of the DMSMS problem were explained and methods to address the problem were investigated. Two of the programs the Air Force has in place that are capable of addressing DMSMS issues were discussed. The point was made that the MSD Engineering program does not require a demonstrated return on investment. This observation leads to the natural question, the topic of this thesis, "How much of the MSD Engineering budget results in a benefit to the Air Force." The next chapter will discuss the approach that will be used to answer this question.

III. Methodology

OVERVIEW

This chapter describes the methodology used in conducting the research to answer the following questions:

1. How much of the MSD Engineering budget results in a benefit to the Air Force?
2. Are there any factors that correlate well with projects that resulted in a benefit to the Air Force?
3. Are there any common reasons why projects failed to benefit the Air Force?
4. What type of benefits did the Air Force receive from successful projects?

This chapter will include a discussion on what data was utilized to answer the research questions, and how the data was developed. Additionally, the method used to analyze the data and reach a conclusion was discussed in this chapter.

THESIS AND INVESTIGATIVE QUESTIONS

This thesis attempts to determine if the benefits the Air Force received from funding the MSD Engineering list can be determined. In order to answer this thesis question, four investigative questions, with related sub-questions, were studied. They are listed below.

1. How much of the MSD Engineering Budget resulted in a benefit to the Air Force?
    a. How much money was spent on each project?
    b. What was the desired result of the project?
    c. Was the desired result achieved?
    d. How much money was spent on beneficial projects?

2. Were there any factors that correlated with projects that resulted in a benefit to the Air Force?
    a. What were possible factors relating to success or failure of a project?
    b. What factors were associated with each project?
    c. Did the factors correlate with beneficial projects?

3. Were there any common reasons projects failed to benefit the Air Force?
    a. Which projects did not result in a benefit to the Air Force?
    b. What was the root cause for the project not benefiting the Air Force?
    c. Were there any recurring root causes?

4. What type of benefit did the Air Force receive from successful projects?
    a. What projects benefited the Air Force?
    b. What benefits did the Air Force receive from each project?

DATA SOURCES

The FY 1999 MSD Reengineering list was used as the basis of a case study for this paper. The FY99 list was chosen because the projects were funded long enough ago that most of the listed projects have been completed. An additional advantage of utilizing this list is that many of the original points of contact (POC's) are still available to comment on the end result of the project. The projects intended for study were all funded projects from the FY 1999 MSD Engineering list. POC's could not be found on several projects. Additionally, some projects were not complete. A final status could be determined for 35 of the 50 projects that were funded in FY99.

Once the elements for investigation were identified, the next step was to determine the best way to locate the information. Data elements were collected from one of three locations. The first source was the finalized FY99 MSD Engineering funded project list provided by AFMC/LGIF. The second source was a project update report submitted to AFMC/LGIF from the ALC's in January 2003. This source provided data on the majority of the money spent and identifies many of the POC's. The final data source was telephone and e-mail contacts with the POC's listed in the 2003 update reports. In some cases the POC identified in the update report could not be located, or no POC was listed in the paperwork. When that occurred, an effort was made to find the responsible individual by contacting the Item Manager responsible for the stock number being studied under the project. However, in some cases, no stock number was identified in the report. In those cases, an attempt was made to locate a knowledgeable contact by tracking down the office symbol that had been submitted with the report. Unfortunately, since FY99 the San Antonio ALC closed and the other ALC's have undergone multiple reorganizations. If a current and knowledgeable POC was identified, they were contacted via telephone to determine the history and the current or final status of the project. The content of the telephone contact was summarized and sent to the POC via an e-mail to ensure the situation and facts were clearly understood.

DATA ELEMENTS

Different data elements were needed to answer each of the thesis questions. This section explains what data elements were needed, and how the information was obtained. Before answering any of the thesis questions, the concept of benefit had to be defined. For the purposes of this paper, a MSD Engineering project benefits the Air Force if the project resulted in the expected end product. For example, if the purpose of the project was to redesign an item, and the output of the study was a newly designed item, then the project resulted in a benefit to the Air Force. This method makes no attempt to quantify or judge the resulting benefit of the redesigned part. This definition follows a natural progression from the outcome. It is difficult to determine the benefit received from adding a new capability to the Air Force, or the benefit associated with funding a study that determines no changes to the current process should be made.

Data Elements to determine how much of the budget resulted in a benefit

The first question addressed in this thesis is, "How much of the MSD Engineering budget resulted in a savings to the Air Force." In order to answer this question, several data elements were needed. They were: project goal, project cost, and project result.

The project goal is what the Air Logistics Center (ALC) hoped to accomplish by conducting the project. Generally, the project goals fell into one of three categories: "studies," "redesign effort," or "other." "Studies" determined the feasibility of redesigning a part or attempted to find the best solution to a problem. As long as the study came to a conclusion, it was considered a beneficial project for the Air Force. A "redesign effort" was generally the result of a study previously conducted to determine the best method of addressing a problem. A "redesign effort" was considered beneficial to the Air Force as long as a new, functional, part was produced at the end of the project. The "other" category contained the three project goals that did not meet the "study" or "redesign effort" criteria. The "project goal" data element was provided by the ALC's to AFMC when a request for funding was made. That data element was verified during the interview process with the POC's.

The second data element, project cost, was the amount of money spent on the project. When the project was initially approved, AFMC agreed to a specified amount. However, this was not always the amount of money spent on the project. In 2003 AFMC received project updates from the ALC's. The updates included the current status of the project and the amount of money spent on a contract to accomplish the project. The contract cost was used as the data element "money spent." If the contract price was not provided, it was assumed that the total amount originally funded by AFMC was spent. This data was pulled from the project update to the FY99 MSD Engineering list.

The final data element used to answer the first thesis question was the project outcome. There were two possible outcomes: 1) The goal of the project was accomplished, which is a benefit to the Air Force; or 2) The goal was not accomplished, which does not benefit the Air Force. As long as a study came to a conclusion, it was considered a beneficial project for the Air Force. As long as a redesign produced a new, functional, part it was considered a benefit to the Air Force. If these conditions were not met, the project was not considered a benefit to the Air Force. This information was obtained from the interview conducted with the project POCs.

Data elements needed to determine what factors correlated to a benefit

The second question addressed in this thesis was, "Are there any factors that correlate well with projects that resulted in a benefit to the Air Force?" In order to answer this question, factors had to be determined that might be correlated with successful projects. The factors selected were "project cost," "type of project," and "project sponsor." The project cost could be a factor because the amount of money spent on a project could be a proxy for the difficulty of the project; a more complex or more difficult project will be more expensive. The type of project could be a factor because some project types are more likely to be completed that others. For example, a study may have been more likely to be accomplished than a reverse engineering effort, and a reverse engineering effort may have been more likely to succeed than an effort to create a new capability for the Air

Force. Finally, the project sponsor could be a factor if some sponsors were more diligent in studying a problem before requesting MSD Engineering funds.

Four data elements were needed to answer this question: 1) project outcome, 2) project cost, 3) project type, and 4) project sponsor. The project outcome, project cost, and project type are discussed above. The project sponsor was the organization that requested the project be conducted. All projects were submitted from one of five ALCs: San Antonio ALC, Sacramento ALC, Ogden ALC, Oklahoma City ALC, or Warner Robins ALC. The submitting organization was included in the finalized FY99 MSD Engineering list as well as the project update report.

Data elements needed to determine common causes of unsuccessful projects

The third question addressed in the thesis was "Are there any common reasons why projects failed to benefit the Air Force?" In order to answer this question, three data elements were needed: "project goal," "project result," and "the reason the project did not benefit the Air Force." The project goal and project result are described above. The reason the project did not benefit the Air Force is the root cause for a project not being completed successfully. There are many possible reasons why projects may not be completed successfully. One reason is that the project ran out of money. Another possible reason is that the project was not yet technologically feasible. This data element was extracted from interviews with the project POCs.

Data elements needed to determine type of benefit received from successful projects

The final question addressed in this thesis was "What types of benefit does the Air Force receive from successful projects?" In order to answer this question, the project goal and project result were needed to determine which projects provided a benefit to the Air Force. These data elements were described above.

ANALYSIS

In order to answer the thesis questions, a spreadsheet was developed detailing each project. Each project row contains information about the amount spent on the project, the goal of the project, and whether the goal was met. Projects with an indeterminate status were removed from the spreadsheet. Projects deemed to have an indeterminate status included any project for which a POC could not be reached, that was not complete, or in which a POC did not respond. There were two instances where the POC was not contacted, but the projects were still counted as a benefit to the Air Force. The projects were reported as complete in the January 2003 update. AFMC priority number 3 improved the Air Force's ability to test landing gear systems, and AFMC priority number 21 was resolved before MSD funding was made available or spent. These projects were considered a benefit to the Air Force.

Analysis of How much of the budget benefited the Air Force

In order to determine "How much of the MSD Engineering budget resulted in a benefit to the Air Force," the master spreadsheet was sorted according to whether or not the project met its goal. The projects were separated and the money spent on each category summed. The total sum of money spent on projects that were completed successfully answered the first thesis question.

Analysis of what factors correlated with successful projects

A further analysis was conducted of each category to answer the question "Are there any factors that correlate well with projects that resulted in a benefit to the Air Force?" In order to determine if cost correlated well with successful projects, a Wilcoxon Rank Sum Test was conducted to test whether or not the sample distribution of successful projects was different than the sample distribution of unsuccessful projects. Cost was used as a continuous variable. Simple observation was sufficient to determine if project type correlated well with successful projects. An additional analysis was conducted to determine if cost and project type combined correlate well with successful projects. This hypothesis was tested using the Wilcoxon Rank Sum Test with cost as a continuous variable and reengineering effort as a subset of project type. Finally, the project sponsor was studied to see if there was a possible correlation to successful projects. Due to the small sample size, simple observation was the only method available to determine if there was a correlation between project sponsor and successful projects.

Analysis of what factors led to an unsuccessful project

In order to determine the root cause of unsuccessful projects, a summary of each unsuccessful project was listed, and the root cause of the project not being completed successfully was determined. The projects were then grouped, if possible, and the grouping discussed.

Analysis of what benefits were received from successful projects

In order to determine what types of benefits were received from the successful projects, every successful project was listed. Then the projects were categorized as quantifiable or non-quantifiable. Then the reason the project was quantifiable or unquantifiable was determined. This information resulted in the creation of several categories of benefits.

CONFOUNDS

This approach relies on several reasonable assumptions. First, the amount of money spent on the contract is the amount of money spent on the project. This assumption is reasonable because this study does not attempt to quantify or otherwise account for time spent by administrators and engineers in preparing the project and documenting its status. Another assumption is that the POC's are familiar enough with the projects to recall the original purpose of the project. The original MSD project submission was used to validate the purpose of the projects. Finally, the assumption is made that the POC's are familiar enough with the projects to either remember or have notes regarding the outcome of the project. As these projects are a major effort for the POC's, this is also a reasonable assumption.

One final confound that must be addressed is that the researcher interviewed each of the project POCs. Any time the researcher interacts with an individual providing information for a study, the researcher has the potential to influence the outcome of the research. This occurrence was mitigated by the general nature of the study being conducted. Many of the questions asked were "yes" or "no" type questions.

Additionally, the individuals being interviewed were experts in the area under study; therefore, they are less likely to be swayed by the researcher's intent. It is reasonable to conclude the researcher did not unduly influence the responses of the POC's interviewed.

CONCLUSION

This chapter discussed the approaches used to answer the questions: 1) "How much of the MSD Engineering budget resulted in a benefit for the Air Force?"; 2) "Are there any factors that correlate well with projects that resulted in a benefit to the Air Force?"; 3) "Are there any common reasons why projects failed to benefit the Air Force?"; and 4) "What type of benefits did the Air Force receive from successful projects?" The chapter first discussed the sources of information used to answer the questions. Then the type of data elements needed to answer the question was discussed. Next, the location of the data was described. Finally, the method used to analyze the data was discussed. The next chapter will present the results of the analysis.

IV. Analysis and Results

OVERVIEW

This chapter presents the results of the data collected. Additionally, it attempts to determine what factors may indicate if a project will benefit the Air Force. The two factors analyzed are “project cost” and “project type.” A qualitative analysis of the non-beneficial projects is then performed to identify any trends in the projects. Additionally, a qualitative analysis was conducted to identify and discuss the types of benefits gained from projects that were successfully completed. The chapter ends with conclusions.

RESULTS

A current status was available for a total of 35 (out of 50) projects funded in the FY99 MSD Engineering list. The total amount of money Air Force Material Command (AFMC) spent on these projects was $30,306,000.00.

Beneficial Projects

Twenty-five projects were funded that resulted in a benefit to the Air Force. A MSD Engineering project benefited the Air Force if the project resulted in the expected end product. For example, if the purpose of the project was to redesign an item, and the output of the project was a newly designed item, then the project resulted in a benefit to the Air Force. The sum of the money spent on projects that benefited the Air Force was $21,186,000.00. The beneficial projects are shown in Table 1.

Table 1. Projects that Resulted in a Benefit to the Air Force

AFMC Priority #	**Contracted or Funded (Millions)**	**Purpose of MSD Engineering Project**	**Benefit to Air Force?**
3	1.3	New landing gear testing capability	Y
5	0.247	Study to determine feasibility of redesigning circuit card	Y
6	0.18	Study to determine feasibility of redesigning Deflection Amplifier	Y
7	0.21	Study to find best repair source for CRT monitor	Y
8	0.179	Redesign Type X Power Supply	Y
9	0.15	Redesign RGDU Video Amplifier	Y
10	0.14	Study Feasibility of redesigning the Magnetic Focus Amplifier	Y
11	0.15	Study to find best repair source for High Volt PS	Y
12	0.18	Study to Identify (ID) cause of failures in 280V DC Power Supply	Y
15	1.5	Study to ID which leading failures need replaced	Y
16	3.93	Redesign Controller (LRU 10) (AN/ALQ-172)	Y
18	0.48	Inspection of B-1B Horizontal Stabilizers	Y
19	0.06	Study to solve high gear failure rate	Y
20	2.45	Redesign Antenna (LUR 8) (AN/ALQ-172)	Y
23	2.53	Redesign Receiver (LRU 1) (AN/ALQ-172)	Y
28	2.1	Redesign Transmitter (LRU 4) (AN/ALQ-172)	Y
29	1.24	Redesign Transmitter (LRU 2) (AN/ALQ-172)	Y
33	0.4	Replace High Voltage Power Supply	Y
37	2.6	Redesign Converter (LRU 7) (AN/ALQ-172)	Y
41	0.39	Redesign Monitor	Y
42	0.14	Study to ID cause of failures on a Bus Controller	Y
43	0.14	Study to ID cause of failures on a HF (High Frequency) Receiver	Y
44	0.14	Study to ID cause of failures on a HF Exciter	Y
45	0.15	Redesign 3 parts for SCADC Power Supply	Y
68	0.2	Redesign and test Primary Air Bleed Valve	Y
Total	21.186		

Non-Beneficial Projects

Ten funded projects resulted in no benefit to the Air Force. A MSD Engineering project did not benefit the Air Force if the project did not result in the expected end product. For example, if the purpose of the project was to redesign an item, and the output of the project was not a newly designed, working, item, then the project did not result in a benefit to the Air Force. AFMC funded the ten non-beneficial projects at a total cost of $9,120,000.00. These projects are listed in Table 2.

Table 2. Projects that Did Not Result in a Benefit to the Air Force

AFMC Priority #	**Contracted or Funded (Millions)**	**Purpose of MSD Engineering Project**	**Benefit to Air Force?**
14	0.28	Replacement for Frequency Synthesizer	N
22	1.65	Redesign Power Supply (LRU 3) (AN/ALR-20A)	N
25	0.77	Redesign and replace circuit cards in B-1B Test Set	N
27	2.15	Redesign Receiving Set (LRU 1) (AN/ALR-20A)	N
30	0.37	Redesign and replace Amplifier	N
32	0.55	Redesign Digital Word Generator	N
35	0.2	Redesign Fuel Savings Computer	N
38	2.15	Redesign Tuner (LRU 8) (AN/ALR-20A)	N
39	0.98	Redesign Tuner (LRU 9) (AN/ALR-20A)	N
60	0.02	Test ceramic wheel	N
Total	9.12		

Results Summary

Of the $30,306,000.00 spent on validated projects, 21,186,000.00, almost 70%, of the money was spent on projects that benefited the Air Force.   This percentage correlates well with the number of projects that were successfully completed; 25 of the 35 projects, or 71%. This clearly shows that, of the projects with confirmed end results, the majority of the money spent on MSD Engineering projects resulted in a benefit for the Air Force.

FACTOR ANALYSIS

This analysis will look at two possible factors that correlate with projects being beneficial to the Air Force. The three possible factors that may correlate with successful projects are the amount of money spent on the project, the project type, and the project sponsor. The amount of money spent is considered a proxy for the difficulty of the project. A more complex or more difficult project will be more expensive. The type of project may affect whether or not a project is beneficial to the Air Force because some project types are more likely to be completed than others. For example, a study may be more likely to be accomplished than a reverse engineering effort. The project sponsor may correlate with successful projects if one of the sponsors does a better job defining the project requirements, or identifies in advance the feasibility of completing the project.

Cost of Project

The majority of the projects funded on the MSD Engineering list were less than $500,000.00; 21 of 35 projects were under the half million dollar mark. Half of the remaining projects were between .5 and 1.5 million dollars. The remaining seven projects were funded for more than 1.5 million dollars. Figure 2 shows the ascending value of every project.

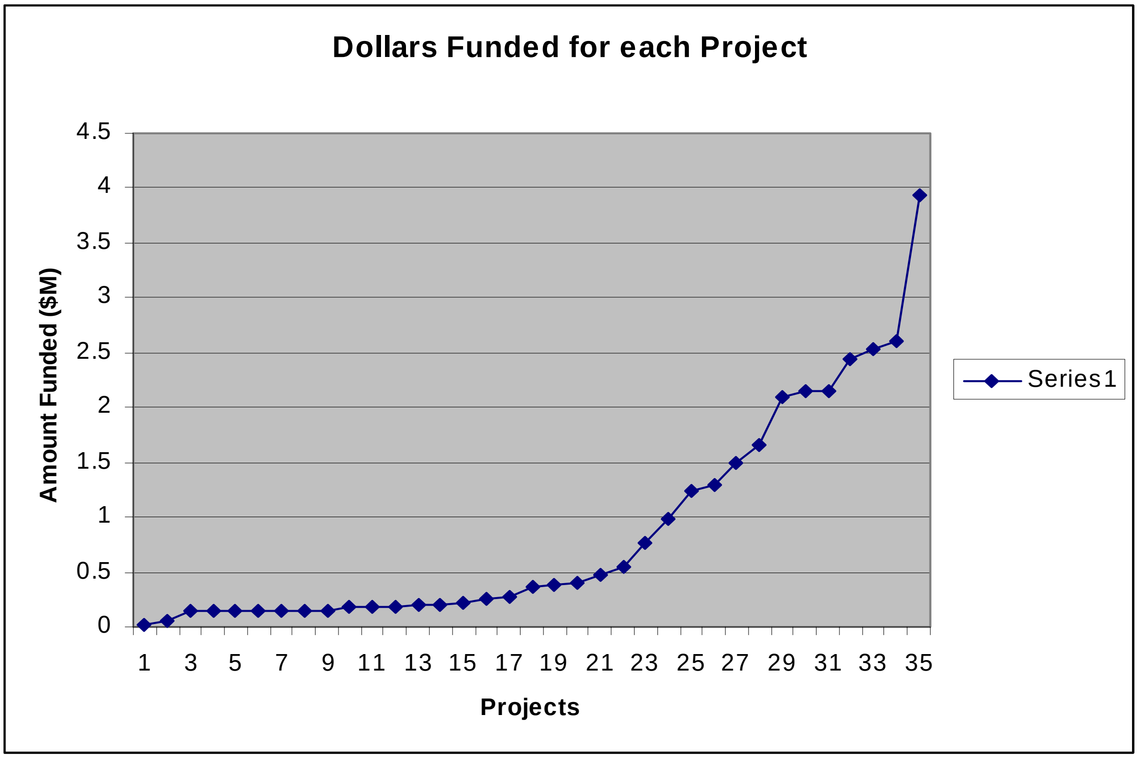

Figure 2. Project Ranked from Lowest to Highest Dollars Spent

The mean cost of a project that was completed successfully was $847,000. The mean cost of a project that did not benefit the Air Force was $912,000.00. A Wilcoxon-Rank Sum Test was conducted which showed that these two samples were not statistically different with an alpha value of .05. All statistic tests are shown in Appendix C.

This analysis shows that there is no evidence to support a correlation between the cost of a project and whether the project provided a benefit to the Air Force. The sample distributions of beneficial projects, according to money spent, was not significantly different from the sample distribution of non-beneficial projects across money spent. Additionally, if the continuous cost variable was limited to a maximum value of $500,000.00, there was still no difference between the beneficial and non-beneficial samples.

Project Type

All of the projects can be consolidated into three types: a study, an effort to redesign a part, or a catch-all “other” category. A study is a project that endeavors to answer a question regarding the feasibility of a course of action, or attempts to determine a best course of action. An effort to redesign a part is any project where the end goal is to find or develop a new part to replace an old part. By definition of an MSD Engineering project, all replacement parts must be Form, Fit and Functionally the same as the old part. Only three projects fell into the “other” category. One project was to conduct a test on a new product design (ceramic wheel). A second was to provide a new capability to the Air Force by creating a landing gear test set. The third project was to conduct an inspection of the B-1B tail-section. After FY99, inspections were not funded with MSD Engineering funds.

Eleven of the 35 projects were studies. All eleven studies were beneficial projects. This is partly due to the definition of benefit chosen for use in this paper. If the study was completed, it was, by definition, beneficial to the Air Force. Therefore, there was a strong correlation between funding a study and AFMC receiving a benefit from the project because it is rare for a company to quit in the performance of a study. Eleven successful with zero unsuccessful projects strongly suggests that the type of project, “study,” is strongly correlated to beneficial results for the Air Force.

Twenty-one of the 35 projects were redesign efforts. Nine of the redesign efforts did not benefit the Air Force. Twelve of the redesign efforts were beneficial to the Air Force. This shows that almost two of every three redesign projects benefited the Air Force. This is roughly the same ratio as the overall number of beneficial to non-beneficial projects.

There is no justification for stating that a redesign project is more likely to benefit the Air Force than any other type of project.

Three of the 35 projects fall into the “other” category. One of the “other” projects did not benefit the Air Force. It cost $20,000.00. Two of the “other” projects did benefit the Air Force; one cost $480,000.00 and the second cost $1,300,000.00. This sample size is too small to make any valid conclusions.

Cost and Project Type

Often a single factor analysis does not reveal a trend, but a combination of factors can reveal a trend. Therefore, the interaction between cost and project type was investigated. Investigating the link between studies and funding was not interesting because it was already shown that studies correlated well with beneficial projects. However, a link between cost of projects and the success of a redesign effort was investigated. The average cost of a redesign project was $1,210,000.00 with a standard deviation of $1,102,000.00. The average cost of a beneficial redesign project was $1,360,000.00 with a standard deviation of $1,307,000. The average cost of a non-beneficial redesign project was $1,011,000.00 with a standard deviation of $781,000. The difference between the mean of beneficial vs. non-beneficial projects is $25,000.00, almost 20%. However, the standard deviations were large which made it unwise to draw a conclusion regarding a difference in the samples. Therefore, the Wilcoxon Rank Test was employed on all redesign projects. It revealed that there was no statistical difference between the sample of redesign projects that resulted in a benefit to the Air Force and the sample of redesign projects that did not result in a benefit to the Air Force. Therefore, the conclusion was that project cost is not correlated to the success of a redesign effort.

Project Sponsor

One other factor that could correlate to project success is the sponsor of the project. Of the 35 FY99 MSD Engineering projects, one project was submitted from Ogden ALC, four projects from Oklahoma City ALC, five projects from San Antonio ALC, thirteen projects from Sacramento ALC, and twelve projects from Warner Robins ALC. There were not enough projects to be able to conduct a statistical test, but it is interesting to note that only one of the five projects sponsored by the San Antonio ALC resulted in a beneficial project. Conversely, all thirteen projects sponsored by Sacramento ALC resulted in a benefit to the Air Force. Nine of Sacramento's thirteen projects were studies, and two of Warner Robins' projects were studies. See Figure 3 for a complete break down of project results according to project sponsor.

Sponsor		Beneficial Projects	Non-Beneficial Projects	Total
OC ALC		2	2	4
SA ALC		1	4	5
SM ALC		13	0	13
WR ALC		7	5	12
Totals		23	11	34

Figure 3. Project Result by Sponsor

Factor Summary

An investigation into the factors that may show a correlation to successful projects provided several interesting insights. The investigation showed that the cost of a project does not correlate with the likelihood of success for a project. Additionally, when the type of project was investigated, it was shown that a study did correlate strongly with successful projects; however, a project to redesign a part was an inconclusive indicator of success. There were not enough “other” projects to make any valid conclusions about their relation to successful projects. When cost and type of project were considered together, it was shown that project cost was not correlated with the success of a redesign effort. Finally, it was observed that Sacramento ALC seemed to sponsor more beneficial projects than the other ALCs, but San Antonio seemed to sponsor a higher percentage of non-beneficial projects.

QUALITATIVE ANALYSIS OF NON-BENEFICIAL PROJECTS

Ten projects did not provide a benefit to the Air Force; they are listed in Table 3. The following is a description of why the projects did not provide a benefit to the Air Force.

The purpose of AFMC priority # 22 was to redesign obsolete parts on an LRU in a B-52 electronic suite. However, when AFMC priority #’s 27, 38, and 39 (which were funded to redesign other obsolete parts on the same electronics suite) were also approved, the ALC decided, instead of bandaging current problems on the old suite, it would combine the funds into one large project and replace the entire electronics suite. This approach had the added benefit of eliminating all obsolescence issues in the suite, not just the obsolescence issues addressed in the FY99 MSD Engineering list. The ALC pursued modifying a Navy electronics suite that performed a similar function as the B-52's current system. Unfortunately, the new design did not adequately replace the capabilities of the old system, and did not function or fit as well as expected. These deficiencies were too costly to overcome and the replacement was postponed until further funding could be obtained in FY03. This project ended without any improvements to the system until Operations and Maintenance Funds could be programmed and used in FY03. This project, in total, was funded at a total cost of $6,930,000.00.

Table 3. List of all Non-Beneficial MSD Engineering Projects

AFMC Priority #	Contracted or Funded (Millions)	Purpose of MSD Engineering Project
14	0.28	Replacement for Frequency Synthesizer
22	1.65	Redesign Power Supply (LRU 3) (AN/ALR-20A)
25	0.77	Redesign and replace six circuit cards on B-1B Test Set
27	2.15	Redesign Receiving Set (LRU 1) (AN/ALR-20A)
30	0.37	Redesign and replace Amplifier
32	0.55	Redesign Digital Word Generator
35	0.2	Redesign Fuel Savings Computer
38	2.15	Redesign Tuner (LRU 8) (AN/ALR-20A)
39	0.98	Redesign Tuner (LRU 9) (AN/ALR-20A)
60	0.02	Test ceramic wheel

The purpose of AFMC priority # 25 was to fund the redesign and replacement of the six circuit cards in the B-1B Intermediate Automated Test Set that failed most often. Unfortunately, the contractor could not provide the promised product. The contractor defaulted on the contract and went bankrupt without delivering a product to the Air Force. This project was funded for $77,000.00.

The purpose of AFMC priority # 30 was to replace an amplifier due to a lack of availability of replacement parts. The project found a Form Fit and Function replacement. Unfortunately, the replacement was plagued with small problems before catastrophically failing. The contractor that provided the new amplifier is now out of business. The project was funded for $37,000.00.

The purpose of AFMC priority # 35 was to redesign the Fuel Savings Computer on the C-5/C-141. The old part was failing, and there was no repair capability, and no source for purchasing identical Form, Fit and Function items. The contract was let with OO-ALC/TISDM functioning as a contractor. The redesigned circuit card was due to be completed in Dec '99. However, the design was never completed. The fuel savings computer requirement was eventually satisfied by removing serviceable assets from C-141s that were being decommissioned. This project was funded at a cost of $200,000.00.

The purpose of AFMC priority # 60 was to test the design of a new ceramic wheel for use in B-52 engine starters. However, the test was never concluded because the Air Force withdrew the assets it had loaned to the contractor to conduct the test. This project was funded for $20,000.00.

The purpose of AFMC priority # 14 was to design a replacement frequency synthesizer. Because proprietary right laws prevented the Air Force from getting the specifications for the part, a replacement could not be reengineered. This effort failed, and the Air Force pursued an alternate solution of replacing the end item, a test system. The project was funded at a cost of $28,000.00.

The purpose of AFMC priority # 32 was to provide a Form Fit and Function replacement for the Digital Word Generator (DWG). The old DWG had a very high failure rate, and the original manufacturer no longer built the item. However, this item could not be redesigned with the money available. The project scope was changed to redesign some of the critical pieces that failed most often. The project was funded at a cost of $550,000.00.

As seen from these descriptions, projects failed for several reasons. Four projects (AFMC priority #'s 22, 27, 38, and 39) were combined into one large project which failed because the technology sought could not meet the goals of the projects, and it was too expensive to fix the technology issues. Two other projects (AFMC priority #'s 25 and 30) failed because the contractor committed to designing a better product than they could deliver. An additional two projects (AFMC priority #'s 35 and 60) failed because the government failed to provide promised products. For AFMC priority 35, the government, OO-ALC/TISDM functioning as a contractor, never provided the new design it promised. For AFMC priority # 60, the depot withdrew testing assets before the tests were complete. A ninth project (AFMC priority #14) failed because legal considerations prevented the Air Force from acquiring the specifications for the original part. The final project (AFMC priority #32) could not be completed because it was under-funded. These results show no clear pattern for anticipating which projects will not benefit the Air Force. However, two recommendations that could help reduce the number of non-beneficial projects are: 1) the Air Force could plan around MSD Engineering projects so that it does not have to back out of projects, and 2) make certain technical specifications are available before any contract that requires the specifications is let. The three non-beneficial projects that could have been avoided by following these two recommendations cost $500,000.00.

QUALITATIVE ANALYSIS OF BENEFICIAL PROJECTS

A project could result in several types of benefits for the Air Force. Some benefits were difficult to quantify. For example, some projects provided a new capability to the Air Force. Other projects simply resulted in the Air Force being able to continue current operations. Another possible type of non-quantifiable result occurs when the project recommends a future course of action. Additionally, a recommendation to do nothing can benefit the Air Force. These projects are discussed in the "Non-quantitative Project Benefits" section below.

Other projects could provide a quantifiable savings from one of two sources: a reduction in the cost to repair/purchase a part, or an increase in the reliability of the part. Unfortunately, the quantifiable savings from many of the projects is not observable because of system problems. However, three projects were measurable, and showed a good return on investment.

Finally, some beneficial projects did not actually provide a benefit to the Air Force. This occurred when the new part or recommended action from the project was not used. These projects are discussed in the "Beneficial Projects that Resulted in No Benefit" section. See Table 4 for the types of benefits received from all projects deemed beneficial in this paper.

Table 4. Type of Benefit for all Beneficial Projects

AFMC Priority #	Contracted or Funded (Millions)	Status	Benefit Type
11	0.15	Existing method is best	Non-Quantitative - No change
15	1.5	Not in field long enough	Non-Quantitative-Continue Ops
18	0.48	Inspection complete	Non-Quantitative-Continue Ops
3	1.3	New part Fielded	Non-Quantitative-New Capability
5	0.247	Not yet fielded	Non-Quantitative-Resulted in a Redesign Project
12	0.18	Not in field long enough	Non-Quantitative-Resulted in a Redesign Project
43	0.14	Not in field long enough	Non-Quantitative-Resulted in a Redesign Project
44	0.14	Not in field long enough	Non-Quantitative-Resulted in a Redesign Project
7	0.21	New repair is in use	Quantitative - Cost Improvement
6	0.18	No action will be taken	Quantitative - None
8	0.179	No action will be taken	Quantitative - None
9	0.15	No action will be taken	Quantitative - None
10	0.14	No action will be taken	Quantitative - None
41	0.39	New parts fielded	Quantitative-Reliability & Cost Improved
19	0.06	New part fielded	Quantitative-Reliability Improved
42	0.14	New process created	Quantitative-Reliability Improved
16	3.93	Not in field long enough	Quantitative – No Data
20	2.45	Not in field long enough	Quantitative – No Data
23	2.53	Not in field long enough	Quantitative – No Data
28	2.1	Not in field long enough	Quantitative – No Data
29	1.24	Not in field long enough	Quantitative – No Data
33	0.4	Not in field long enough	Quantitative – No Data
37	2.6	Not in field long enough	Quantitative – No Data
45	0.15	New part in testing	Quantitative – No Data
68	0.2	new part in testing	Quantitative – No Data

Projects Providing only Non-Quantitative Benefits

A quantitative definition of "benefit" would generally be preferred to the nominal order benefit used in this analysis. However, some benefits are not easily quantifiable because they 1) provide a new capability to the Air Force, 2) facilitate continuation of current operations, 3) suggest further actions, or 4) recommend no change to current procedures.

Only one project, AFMC priority # 3, provided the Air Force with a new capability. This capability was added by creating a new test set to test landing gear systems. The project cost $1,300,000.00, but there is no readily apparent method of computing a savings, or a return on investment, from this project.

The only benefit provided by two of the projects, AFMC priority #'s 15 and 18, was the ability for the Air Force to continue operating with existing capabilities. The goal of AFMC priority # 15 was to identify the leading parts causing an increase in the number of unusable carcasses in the Pave Penny Detector program and fund a reengineering effort to replace the top five problem items. The reengineering effort built new parts to the same specifications as the old parts, and is not expected to result in any cost reduction or increase in reliability. This project cost $1,500,000.00. The goal of AFMC priority # 18 was to conduct an inspection of B-1B bombers. This project was completed successfully to allow the bomber to continue flying safely. The inspection cost $480,000.00. It is very difficult to identify savings that resulted from these projects, but maintaining the operational capability of the system is important to the Air Force achieving its combat readiness goals.

In some cases, a project was beneficial because it provided direction for a future course of action. AFMC priority #'s 5, 12, 43 and 44 are examples of this type of project. AFMC priority # 5 resulted in a follow-on project to redesign a circuit card. The other three projects resulted in follow-on projects that created and implemented a modification to the system originally studied. Modifications cannot be funded through the MSD Engineering list. None of these projects directly resulted in a quantifiable benefit to the Air Force, but the follow-on efforts, which would not have occurred without the initial studies, should provide a quantifiable benefit. The modifications and redesigned part from the follow-on studies are just now reaching the field, and no data is available to show the benefit they created.

In one case, a project resulted in a benefit because it showed no improvement was needed in the current system. AFMC priority # 11 was funded to determine the best source of supply for repair of a high voltage power supply. However, the study determined that the current source of repair was providing the best service, and no change was needed. This project did not result in a quantifiable benefit to the Air Force, but demonstrated the Air Force would have made a bad decision if it changed the source of repair. The project cost $150,000.00.

It is very difficult to attribute quantifiable savings to these projects, therefore it is difficult to determine a savings or return on investment for these projects. However, there are many different types of benefits, and the inability to measure a benefit is not justification for considering it non-beneficial. The Air Force needs many of these beneficial projects, even if no measurable benefit can be identified.

Projects Providing Quantitative Benefits

Usually, quantifiable benefits are the result of one of two types of improvements: a reduction in the cost to repair an item, or a reduction in the frequency of repairs. It should be possible to collect this data to determine what type of return on investment the Air Force received from funding the MSD Engineering list. However, for the FY99 MSD Engineering list, the data was not available to make this comparison on many of the projects. Another problem with quantifying the benefits is the delay between when a part is ready for purchase and when it is actually purchased. It was possible to measure the savings on four projects; a decrease in cost from a reengineering effort, a reduction in cost from a study, an increase in reliability on a reengineering effort, and an increase in reliability from a study.

Contrary to the assumption made in selecting FY99 as the representative year for this study, many of the solutions identified in these projects were either not yet fielded or not completely fielded. Therefore, data was frequently not available regarding quantifiable benefits achieved by funding these projects. In fact, 11 of the 12 beneficial redesign efforts have not yet shown a quantifiable benefit. Two of the redesign efforts, AFMC priorities 45 and 68, are still being tested. One data collection obstacle is that the new part often has the same stock number as the original part; as the new parts are introduced there is no way to differentiate between the performance of the old and new parts. Another data collection problem is represented by AFMC priority # 33, which successfully identified and modified a Commercial Off The Shelf (COTS) power supply to replace an old power supply. The new part was given a new stock number. However, the old stock number was deleted, and the pertinent cost data is gone. Without cost comparison data, the Air Force cannot quantify the savings or return on investment from this project.

Six projects, AFMC priorities #'s 16, 20, 23, 28, 29, and 37, successfully redesigned and tested new parts that are expected to be more reliable than the original parts. However, the Air Force has only purchased two assets from AFMC priority # 16, and three assets from AFMC priority # 20. These parts were not assigned a new stock number, therefore benefits will be very difficult to track. Therefore, it is likely the Air Force will never be able to quantify the benefits from these six projects.

Another problem with AFMC priority #'s 16, 20, 23, 28, 29, and 37 is the delay between when the project was complete, and when the new parts will be purchased. This delay is attributed to the D200 system that validates the requirement and authorizes the purchase. This is a problem for four reasons. First, it makes it difficult to determine/quantify in a timely fashion what benefits are received from funding the list. Second, it delays the savings the Air Force could be receiving from increased reliability and decreased repair costs. Third, due to the rapid turnover in technology, by the time the part is purchased it could already be approaching obsolescence. Finally, spending money to reengineer a part that won't be purchased for a couple years means that money is not spent on parts that need to be reengineered and purchased as soon as possible.

An example of a reengineering effort that resulted in a measurable reduction in the cost to repair an item was AFMC priority 41. This project was initiated in order to ensure continued operation of the MILSTAR system. Specifically, the program did not have enough monitors or printers to be able to continue operations until the scheduled system retirement date. This project funded the redesign of the monitor and qualified a COTS printer to satisfy the requirements. The monitors have not been in service long enough to determine a new failure rate or repair cost, but the old monitors failed twice a year and cost $20,005.76 to repair. The COTS printer has been in operation for three years and has not yet failed. The old printer broke once a year, and cost $3,216.00 to repair. Therefore, the project provided a quantifiable benefit of at least $3,216.00 through an increase in reliability of the printer. The project cost $390,000.00. This leads to a return on investment, based solely on reduction in printer repair costs, of 121 years. It is important to recall that this project was funded to retain the capabilities of the MILSTAR system, not to reduce costs.

An example of a study that resulted in a measurable reduction in the cost to repair an item was AFMC priority # 7 that was a study to identify a new source of repair for 19" CRT monitors. The new source of repair reduced the price per repair from $15,820 in 1999 to a current cost of $2,500. This is a savings of $13,320 per repair and the Air Force repaired 22 CRT over the last year for a savings of $293,000. The project cost was $275,000. This project was actually initiated in an effort to continue operations when the original equipment manufacturer announced its intention to cease producing the CRT.

AFMC priorities #'s 19 and 42 are examples of projects that resulted in a quantifiable benefit due to an increase in reliability. AFMC priority # 19 funded a study to identify and fix a recurring problem with a roll resolver. The study identified a deficient design in the number 6 gear and fixed the problem by recasting the part in stainless steel. Since the fix was implemented, there have been no failures with the gear. Since the part cost $1,053.00 to repair and it was repaired 38 times a year, this project resulted in a savings of $40,014.00 per year. The project cost was $60,000.00. The Air Force saw a monetary benefit from this project a year and a half after the project was completed.

Another example of a project that provided a benefit due to increased reliability was AFMC priority # 42. This study investigated the cause of recurring failures on a part and determined that poor maintenance practices were the cause. This problem was corrected with more education. In 1999 the item had to be repaired six times. The item has not been repaired in the three years since the new guidance was implemented. The current repair cost for the item is $1,120; therefore, the Air Force is saving at least $6,720.00 per year. It is relevant to note that the study cost $143,000.00, which means it will be 21 years before the Air Force sees a monetary benefit from reduced repairs. This makes a statement of benefit based on quantitative monetary benefit hard to support.

However, the total savings from these four projects was $341,000.00 per year, and the sum of the project costs was $768,000.00. This indicates the Air Force will receive a return on investment on these four projects in approximately 2.3 years. Unfortunately, because of the small sample size, it is difficult to draw certain conclusions from this. However, it would be very interesting to be able to determine a return on investment for all the quantifiable projects, and then determine a return on investment based on all the projects funded.

The Air Force could determine the return on investment if several things occurred. First, if reengineered parts were given a new stock number it would be possible to determine the new cost and improved reliability of the new parts. Two, data must be kept on the old stock numbers. This means not deleting a stock number as soon as it is replaced, and keeping information on all stock numbers for longer than three years.

Neither of these efforts should prove to be a large obstacle because computer storage space continues to get less expensive.

Beneficial Projects that Resulted in No Benefit

One final class of beneficial projects must be discussed. AFMC priority #'s 6, 8, 9, and 10 were successful because they resulted in a redesigned part, but the part will never be used. After the parts were redesigned, different funding was received to upgrade the end item that all four of these projects were supporting. The upgrade obviated the need for the redesigned parts. In essence, these beneficial projects will never provide a benefit to the Air Force. These four projects were funded for a total cost of $649,000.00.

Summary of Qualitative Analysis of Beneficial Projects

Beneficial projects can be quantifiable or non-quantifiable. Some projects are non-quantifiable because they result in a new capability, they allow the Air Force to retain current capabilities, or they provide a recommended course of action. Non-quantifiable projects are still beneficial to the Air Force. Quantitative savings generally come from a reduction in repair/purchase cost or an increase in reliability. Unfortunately, many projects that should have resulted in a quantifiable benefit did not because the system was not set up to capture the savings. Generating quantifiable savings does not guarantee the Air Force will save money by funding the project; sometimes it is a long time until the savings received offsets the project costs, and sometimes the need for the project is obviated by other events. However, taken in aggregate, the small sample size of projects that did provide a measurable benefit showed a return on investment of less that 2.5 years.

SUMMARY

This chapter presented the results of data collection, which showed that roughly 70% of the funded projects resulted in a benefit, provided a final result was determined for the project. Additionally, an attempt was made to determine what factors may lead to a project benefiting or not benefiting the Air Force. The three factors analyzed were "project cost," "project type," and "project sponsor." The analysis showed that cost and redesign projects were not correlated to the success of projects, but studies were highly correlated with successful projects. Additionally, projects from SM ALC were more likely to be successful, and projects from SA ALC were less likely to be successful. Next, a qualitative analysis of the unsuccessful projects was conducted. It showed that there does not appear to be any significant trends that could help predict which projects were unlikely to benefit the Air Force. Finally, a qualitative analysis of the beneficial projects was conducted. The point was made that benefits can be quantifiable and non-quantifiable, and that both types of benefits are important to the Air Force. Additionally, it was shown that many projects should have been measurable, but were not because the systems are not in place to ensure the data is collectable. The point was also made that significant delays between when a project is complete and when a part is purchased can be a problem. Finally, quantifiable projects can show a return on investment, even though the primary reason for funding the projects was to enable the Air Force to continue to operate with current capabilities. The next chapter will consider the implications of these results as well as discuss other possible areas for research.

V. Discussion, Conclusions and Recommendations

INTRODUCTION

This chapter will provide a recap of the goals of this paper, and how those goals were approached. Additionally, the answers to the research questions will be presented. Finally, areas for further research will be identified.

DISCUSSION

This study investigated the question "How much of the MSD Engineering budget resulted in a benefit to the Air Force?" This paper also attempted to answer the question "Are there any factors that correlate well with projects that resulted in a benefit to the Air Force?" and, conversely, "Are there any common reasons why projects failed to benefit the Air Force?" Finally, the question of "What type of benefits did the Air Force receive from the projects?" was addressed.

In order to answer these questions, the definition of a benefit was defined. For the purposes of this paper, a MSD Engineering project results in a benefit to the Air Force if the goal of a project is achieved. For example, if the Air Force requests a study be conducted to determine the best method of addressing a problem, and the Air Force receives a study, then the Air Force receives a benefit from the MSD Engineering project, even if the study recommends that no change be made to the current methods in place.

How much of the MSD Engineering budget results in a benefit to the Air Force?

To determine what type of benefit was desired from the project, the original project requests were reviewed, and the desired outcome of the MSD Engineering project was determined, and verified by interviewing the current POC for the project. The interview also provided the current status of the project which was used to determine if a benefit was received from the project. A 2003 follow up report to the FY99 MSD Engineering list was used to determine how much money was spent on each project. Using this data, it was determined that over 70% of the MSD Engineering budget was spent on projects that benefited the Air Force.

Are there factors that indicate which projects are likely to benefit the Air Force?

Two factors were identified that might indicate whether a project was likely to benefit the Air Force. The factors were the cost of the project, and the type of project funded. Statistical analysis showed that the cost of the project did not correlate with successful projects. Of the two types of project sub-factors, “study” and “redesign effort,” only “studies” correlated well with successful projects.

Are there any common reasons why projects failed to benefit the Air Force?

In order to attempt to identify reasons why projects failed, the failed projects were listed, and the cause of the project failure determined. Then common factors were identified. No specific common traits were identified that might help the Air Force identify what projects are more likely to fail.

There are, however, two recommendations. First, the Air Force should ensure it has all the data necessary for a contractor to complete his contractual obligations before the contract is let. This will ensure the Air Force does not spend money on a project that it will not benefit from. Second, the Air Force should not commit to a project it cannot support. There was one project in which the Air Force paid money to a contractor to conduct tests using Air Force owned equipment, however, before the tests were completed, the Air Force reclaimed the test equipment making it impossible for the contractor to finish the tests. In another case, one of the depots was contracted to redesign a part. Unfortunately, the new design was never delivered. Avoiding these problems could enhance the effectiveness of the MSD Engineering program.

What type of benefits did the Air Force receive from the projects?

This paper analyzed the benefits provided by the projects and categorized them into quantifiable or non-quantifiable categories. Non-quantifiable projects benefited the Air Force in several manners. Some projects provided the Air Force with a new capability. Other projects prevented the Air Force from losing the ability to use some of its current capabilities. Still other non-quantifiable benefits resulted from studies that recommended a course of action for future improvements to operations. Quantifiable benefits were received by reducing repair costs or increasing reliability of the part. However, there were many projects that should have provided quantifiable benefits, but did not because the systems to collect the data are not in place. This study identified two possible solutions that would allow the benefits from those projects to be quantified. First, when new assets are introduced, they should be assigned a new stock number so they are tracked separately to allow visibility of improvements resulting from the reengineering effort. Second, data on the old stock number should be kept longer by not deleting the old stock number. Additionally, data on old stock numbers should be kept for more than three years. Especially since it often takes more than three years to identify the problem, determine the solution, fund the solution, and implement the solution. By the time the solution is in place, the data is no longer available to determine a savings and return on investment.

An additional issue is that many of the projects were not yet fielded because the D200 had not authorized purchase of new assets; this delays the savings the Air Force receives from these projects. Due to the rapid change in technology, a four-year delay may also lead to an obsolescence problem with a part that was already redesigned to address obsolescence of an old part. Additionally, there may be an opportunity cost associated with obligating funds to a project before it needs to be addressed which prevents those funds from being spent on other projects.

Finally, not all of the projects identified as beneficial in this study actually resulted in a benefit to the Air Force. There were four successful projects that reengineered parts to continue operation of the same end item. All four of the projects created a new part; however, other modernization funds were provided to replace the end item. This resulted in the creation of four prototypes that will not be used by the Air Force. In essence, these prototypes will not provide a benefit to the Air Force even though the projects did benefit the Air Force, as the term "benefit" is defined in this study.

FURTHER RESEARCH

There are many areas that will need research in the future. One area is to attempt to determine a better method to quantify the benefit the Air Force receives from funding the list. Another is to study the optimal time to fund MSD projects. AFMC may want a study that addresses the criteria used to prioritize projects for funding. The process the Air Force uses for funding DMSMS problems is another area for investigation. Finally, the assumption that FY99 is representative of all MSD Engineering lists is a foundation for using the results of this study, and should be verified.

The purpose of this paper was to investigate the benefits the Air Force receives from the MSD Engineering list. It addressed this subject by asking "How much of the MSD Reengineering budget resulted in a benefit to the Air Force?" Now that it has been shown that 70% of the budget results in a benefit to the Air Force, there is a need to quantify the benefits the Air Force receives from the MSD Engineering list. Three things need to happen in order for that to occur. First, the definition of a benefit to the Air Force should be studied in more detail. Second, a "common denominator" which will allow comparisons to be made between the different types of benefits: providing a new capability; being able to continue operations; suggesting a future course of action; and gaining an improved part. Finally, the problem of identifying the actual benefits from using an improved part must be addressed. The actual benefits include all relevant savings such as maintenance, transportation, packing and crating, and aircraft availability as well as the savings from decreased parts cost or increased reliability.

Another area for possible research is identifying the appropriate time to fund a MSD Engineering project. Many of the FY99 projects have not yet resulted in a benefit because the parts have not been introduced to the field. This is due to the D200 not indicating a requirement for more spares parts in the Air Force inventory. This leads to the questions "Why is the Air Force completing a redesign effort years before the part is actually needed? Can the actual requirement date for a new part be forecasted?" Other questions are relevant from a cost standpoint, "Is the Air Force spending money on a solution that will be outdated before it is implemented? Is the Air Force creating a solution that will have to be fixed again in a few years when the part is actually needed? Is there an opportunity cost related to spending the money to receive a product not yet required verses spending the money on another modernization effort?" Each of these questions is important for future research.

The criterion used to determine which projects are funded is another area for study. The majority of the projects funded in this effort were submitted in order to be able to continue current operations. However, one of the main factors AFMC uses to prioritize the projects is projected return on investment (ROI). This leads to the questions "What is AFMC's primary goal in funding these projects?" and "Are the criteria used to rank the projects helping AFMC achieve its goals?" Two additional questions: "If ROI is one of the goals, is AFMC validating the submitted ROI data to ensure the system is not being abused?" and, "What actions can AFMC take to ensure the ROI information is as accurate as possible?" The answers to these questions could help ensure the goals of the MSD Engineering program are met.

Additionally, as discussed in Chapter II, many of the projects on this list are submitted in response to DMSMS problems. The Department of Defense has two offices dedicated to address DMSMS issues. The Air Force has an office and an AFI specifically dedicated to the problem. However, the Air Force's current approach to funding DMSMS solutions is to wait for each weapon system manager to budget for a solution through the POM process. This creates a large lag between when the DMSMS problem is identified and when the problem is addressed. However, if the Air Force designated special money to address DMSMS issues, the time between identifying the problem and funding the solution could be reduced. The reduced turn-around time could provide a significant savings to the Air Force. In order to determine if the Air Force could receive significant savings, several questions must be addressed. The first question is "What is the scope of the DMSMS problem facing the Air Force?" The second question is "How much money does the Air Force save by fixing a DMSMS problem?" Finally, "Would dedicating a specific pool of money to address DMSMS issues result in a faster problem resolution?" The answers to those questions could provide the Air Force with an opportunity to save money.

Finally, the results of this project are predicated upon the assumption that the FY99 MSD Engineering list is representative of every year's MSD Engineering list. The veracity of this assumption should be studied by analyzing the mix of projects, studies versus redesign efforts, which were funded in other years, as well as the amount of money spent on the MSD Engineering list in other years.

There are many areas of study left for investigation. One area would be to attempt to better quantify the benefit the Air Force receives from MSD Engineering projects. Another area might be to determine the best time to fund projects. A third would be to analyze the criteria used to prioritize MSD Engineering projects. An additional area of study should address how the Air Force plans and funds solutions to DMSMS problems. Finally, determining the applicability of the results of this paper is an important area for study.

SUMMARY

This study identified the benefits received from funding the MSD Engineering list. It showed that 70% of the funds spent on the MSD Engineering list resulted in projects beneficial to the Air Force. Additionally, it showed that studies correlate well to beneficial projects. However, there does not appear to be any other indicators that correlate to beneficial or non-beneficial projects. Finally, the benefit the Air Force receives can by quantifiable or non-quantifiable. Non-quantifiable benefits result from projects that provide a new capability, a recommended course of action, or the ability to maintain current operational capabilities. Quantifiable benefits result from increased reliability or decreased costs. Some quantifiable benefits may not provide a significant ROI, and therefore may not truly provide a benefit to the Air Force. Finally, this paper suggested other research areas related to the project that should be investigated.

CONCLUSION

This thesis attempted to determine what benefits the Air Force received from funding the MSD Engineering list. Four questions were investigated in order to answer this question. 1) How much of the money spent on the MSD Engineering list results in a benefit to the Air Force. 2) Were there any factors correlated with projects that benefited the Air Force? 3) Were there any common reasons projects failed to benefit the Air Force? 4) What type of benefits did the Air Force receive from successful projects? In order to answer these questions, the FY99 MSD Engineering list was used to as a representative sample of all MSD Engineering list.

This study concluded that the Air Force received a benefit from roughly 70 percent of the money spent on the projects. Additionally, it was shown that studies and projects funded by SM ALC correlated to beneficial projects. Based on this finding, it is recommended that ALCs should benchmark MS ALC's MSD Engineering processes.

Research into the third investigative question showed that there were several common factors that resulted in unsuccessful projects. However, many of these factors could be overcome if the Air Force provided the resources necessary to complete the project. Finally, the answer to the final research question, “What type of benefits did the Air Force receive from funding the MSD Engineering list?” showed that almost every project resulted in a non-quantitative benefit. However, there were several projects that resulted in a quantitative benefit as well. Additionally, more projects would have resulted in a quantifiable benefit if the systems were in place to collect the data. In order to collect the data, the Air Force should require all new parts resulting from a MSD Engineering project to be assigned a new stock number, and mandate the data from the old stock number be kept long enough to identify the savings achieved from using the new part.

Appendix A: Interview Questions

Questions asked of every Point of Contact:

INTRODUCTION:

Good afternoon. My name is Capt Gehrich. I am a student at the Air Force Institute of Technology working on my Master's Thesis. I am trying to show that the Air Force would receive a good return on investment if it fully funded the MSD Engineering list every year. In order to show this, I am focusing on the projects that were funded on the FY99 list. I am going to conduct a comparison between how much the Air Force was paying to operate with the system before the reengineering and how much the Air Force is paying to operate with the system currently, after the reengineering. My data from the FY99 list indicates you were a POC for one of the projects funded in 1999. May I ask you some questions?

QUESTIONS:

1. What was the purpose of the MSD project?

2. What was the result of the MSD project?

3. How did the result occur?

4. If a part was reengineered, is it currently fielded?

    a. If no, then why wasn't the part fielded?
        i. Is the part going to be fielded?
        ii. What benefits do you expect from the part once it is fielded?

    b. If yes, then what has the impact of the new part been?

        i. Is there a reduction in the cost to repair the item?
        ii. Is there an increase to the reliability of the item?
        iii. What other benefits has the

5. If the project was to conduct a study, what were the results of the study?

    a. What further actions were taken because of this study?

6. Do you have current data regarding the number of times the items currently breaks per year?

7. Do you have current data regarding the current cost to repair the item?

8. Do you have current data regarding the number of time the new part fails per year?

9. Do you have current data regarding the cost per repair for the new item?

10. Do you have a current cost for procuring new items, and how many items were procured?

11. Was the old part completely removed from the Air Force inventory?

WRAP UP:

Those are all the questions that I had. I would like to thank you for your time today. Soon I'll e-mail a summary describing what I believe you related to me about this project. Please review the summary to ensure I understood what you told me and ensure I did not misinterpret anything you said. Once again, thank you for your time.

Appendix B: Project Summary

AFMC Priority #: 2 ***Benefited Air Force?:*** Ind

Project Title: Upgrade #4 and #7 Foreflaps, C/KC-135

Prupose:

Result: Could not identify a POC. No NSN available to try to find an IM, and no office symbol to try to find a new POC.

Cost: This project cost $30,000

Approval Could not identify a POC.

AFMC Priority #: 3 ***Benefited Air Force?:*** Yes

Project Title: Landing Gear Systems Engineering/Test Support

Prupose: Design new landing gear test system.

Result: This project improved the AF's ability to test landing gear systems; however, no direct, quantifiable, savings to the AF was realized.

Cost: This project was funded for $1,300,000.00.

Approval POC not contacted.

AFMC Priority #: 4 ***Benefited Air Force?:*** Ind

Project Title: AN/ALQ-184 High Voltage Power Supply (HVPS)

Prupose: The original goal of this project was to A) develop the capability to troubleshoot and repair High Voltage Power Supplies (HVPS) in the ALQ-184 and B) develop a spare source for the HVPS transformer and diode bridge.

Result: In the past, three vendors supplied the HVPS, however, there are no current vendors of the item.   Therefore, the capability to repair the item is critical. The transformer and diode bridge are two critical pieces of the HVPS that were performing poorly.

Funds from this MSD project were first spent in an attempt to reverse engineer the HVPS. However, Rantec, one of the original HVPS manufacturers, offered to sell the original designs to the Air Force. The Air Force spent $150,000 (non-MSD money) to purchase the specifications and other assets from Rantec.

MSD funds were next spent to find diode bridge and transformer vendors. Hadley was identified as the lowest successful bidder for the transformer. No one was found to provide a diode bridge. The cost to purchase a new transformer from Hadley is $3,300.00.

Funds were also spent to build test sets to test the new transformer and, if a vendor was found, the new diode bridges. These test sets were successfully developed, and transferred to the Navy depot.

Hadley provided eleven transformers for testing at a cost to the AF of $55,000. These transformers were successfully tested and approved for use in repairing the HVPS.

Finally, this project provided some documentation on operating the new test equipment and repairing the HVPS with the newly available Hadley transformers.

This project provided a new source of supply for the transformer and created a repair capability in the DoD for this item. The new repair capability is more expensive than using commercially available repair options. However, the Department of Defense will keep the organic repair capability because it does not believe one repair source is capable of keeping up with the demand for repair during war. The current price to repair the HVPS at the Navy depot is $20,300. The item was last repaired by a contractor in FY00 at a cost of $15,670.

Cost: This project cost $850,000.00.

Approval Project description approved by Ms. Connie Chavez, Electronics Engineer, on 4 Mar 04.

AFMC Priority #: 5 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 (RGDU Driver CCA)

Prupose: This MSD money funded a project to determine the feasibility of reengineering an RGDU Driver circuit card.

Result: This project resulted in a successful study that resulted in further reengineering efforts that designed a new circuit card design.

Cost: The new card has not yet been fielded, so there is no purchase cost or reliability data for the new card. The new card did perform reliably during intensive testing. At present, this card is designed to be discarded after use instead of repaired, so there is no repair cost.

The LRC for the old card is $4,305.00 for the 25 repaired between 1 Jul 02 - 30 Jun 03. There were a total of 90 repaired 1 Jul 01 - 30 Jun 02. The number of repair performed is dependent on both need and available funds.

This study cost $247,000.00

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 6 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 Deflection Amplifier)

Prupose: This MSD money funded a project to determine the feasibility of reengineering a Deflection Amplifier.

Result: The study found it is possible to redesign the card, and it would cost approximately $6,000.00 per card to purchase. However, the Latest Repair Cost is $2,770.00 and there are plans to redesign the LRU that uses the deflection amplifier. Therefore, the program office chose not to pursue purchasing new amplifier.

Cost: The LRC for the Deflection Amplifier is $2,770.00 and 0 assets were repaired from 1 JUL 00 through 30 JUN 03. There were sufficient stocks of "A" condition assets to preclude the need to pay for repairs.

This study was funded for $180,000.00

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 7 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 (25" CRT)

Prupose: The study was funded to find another source of supply for the unique 25 inch Cathode Ray Tube (CRT).

Result: The study identified only two possible sources for replacement CRTs. The OEM, LEXEL Corporation, and Thomas Electronics, a small firm that specializes in CRT design, production, and repair. Since the OEM's desire to no longer produce this CRT was what precipitated the project in the first place, they were not a candidate for the follow on development work. Thomas Electronics developed a replacement phosphor and, while working this project, demonstrated their ability to refurbish exhausted CRTs. This is done by simply replacing the worn our electron gun assembly. Their repairs consist of replacing the electron gun, precision pre-alignment (and potting) of the CRT in the assembly chassis. This cost has averaged just under $2500 for each RGDU CRT Assembly. The re-gunned CRTs perform almost as good as new tubes. The difference is discernable only with precision, calibrated test equipment. As a result of this project, this vendor was approved as a Source of Repair for the RGDU CRT Assembly, the assembly in which the CRT is mounted.

Cost: The Latest Repair Cost of $3,247 (of which the $2500 refurbishing is a part) is contrasted with the FY99 repair cost of $15,820 which included the replacement of the CRT with a new OEM CRT which cost $13,500. Refurbishment does not improve the mean time between failures. However, it does give the repaired RGDU CRT Assembly another 10,000 hours of operational time, the same as if a brand new OEM tube was installed, for a minimal cost.

The LRC for the CRT is $3,247.00 and 22 assets were repaired over the last year.

This project cost $214,000. The savings to the USAF on this effort over the last year have been estimated to be over $275,000.

Approval	Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 8 ***Benefited Air Force?:*** Yes

Project Title:	Engineering Study AN/TYQ-23 (TYPE-X Power Supply)
Prupose:	This project was funded to find a Form, Fit, Function (FFF) replacement for the current power-supply.
Result:	A new prototype was developed from this study that met the FFF requirements. However, further (non-MSD) funds became available to purchase the V5 upgrade to the end item. Therefore, the program office decided not to purchase the redesigned power supply because they are purchasing the upgraded end item.
Cost:	The LRC for the power supply is $2,976.00 and 83 assets were repaired over the last 3 years, only 5 of those were repaired during the year (1 Jul 02 - 30 Jun 03). This project was funded for $179,000.00.
Approval	Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 9 ***Benefited Air Force?:*** Yes

Project Title:	Engineering Study AN/TYQ-23 (RGDU Video Amplifier)
Prupose:	MSD funds were used to study the feasibility of redesigning the Video Amplifier.
Result:	A prototype was designed. However, funds were never allocated to purchase the prototype. Unexplainably, the failure rate of the part tapered off. Additionally, further (non-MSD) funds became available to purchase the Victor 5 upgrade to the end item.

Therefore, the program office decided not to attempt to upgrade the Video Amplifier.

Cost: The LRC for the Amplifier is $1,754.00 and 12 assets were repaired over the last year (1 Jul 02 - 30 Jun 03). There were 49 assets repair between 1 Jul 00 - 30 Jun03.

This project was funded for $148,000.00.

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 10 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 (Magnetic Focus Amplifier)

Prupose: MSD funds were used to study the feasibility of redesigning the Magnetic Focus Amplifier.

Result: A prototype was designed but funds were never allocated to purchase the prototype. Then further (non-MSD) funds became available to purchase the V5 upgrade to the end item. Therefore, the program office decided not to attempt to upgrade the Magnetic Focus Amplifier.

Cost: The LRC for the Amplifier is $3,556.00 and 19 assets were repaired over the last year (1 Jul 02 - 30 Jun 03), with 59 assets repaired from 1 Jul 00 - 30 Jun 03.

This project was funded for $137,000.00.

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 11 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 (High Voltage Programmable Power Supply)

Prupose: MSD money was used to attempt to identify a new source of repair for this item.

Result: However, it was determined that the original manufacturer was providing optimal service by performing extensive failure analysis

and

providing corrective fixes and upgrades when appropriate. Additionally, further (non-MSD) funds became available to purchase the Victor 5 upgrade to the end item. Therefore, the program office decided to continue using the OEM until the upgraded end item obviated the need for the high voltage programmable power supply.

Cost: The LRC for the Power Supply is $6,6065.50 and 0 assets were repaired over the last year (1 Jul 02 - 30 Jun 03), with 39 assets repaired over the period form 1 Jul 00 - 30 Jun 03).

This study was funded for $150,000.00

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 12 ***Benefited Air Force?:*** Yes

Project Title: Redesign Study AN/TYQ-23 (280VDC P/S)

Prupose: This project was to study recurring failures in the 280 Volt Direct Current Power Supply.

Result: It was determined that the failures were due to under-designed shut down and discharge circuitry, which caused several components to overheat and fail.

A low cost, field level modification was developed with MSD Engineering funds and the modification kits funded with 3080 monies. The modification has not been completely implemented yet, but it appears to be decreasing the number of failures. There has been only one failure attributable to the modification and initial analysis indicates poor quality maintenance practices by the installer of the modification to be the leading cause of the unit failure. Otherwise, there have been no failures in the systems with the modifications. The fielding of the modification began less than a year ago.

Cost:	The LRC for the Power Supply is $1358.87 and 0 assets were repaired over the last year. This study cost $179,000.00
Approval	Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #:	14 ***Benefited Air Force?:*** No
Project Title:	Form, Fit and Function Replacement of Gigatronics 900 Frequency Synthesizer
Prupose:	The goal of this project was to design a replacement for a frequency synthesizer.
Result:	A replacement could not be created due to proprietary right laws preventing access to specifications for the parent item. Therefore, this project was terminated. The Air Force pursued an alternate solution of replacing the entire test system.
Cost:	This project was funded for $280,205.00
Approval	Project description approved by Mr. Raymond Ng, Electronics Engineer, on 10 Feb 04.

AFMC Priority #: 15 ***Benefited Air Force?:*** Yes

Project Title: Pave Penny Detector Upgrade (A-10 Aircraft)

Prupose: This project funded a study to identify the leading parts causing an increase in the number of unusable carcasses in the Pave Penny Detector program and funded a reengineering effort for the top five leading contributors.

Result: The parts were evaluated based on the ability to purchase replacement parts, the part's failure rate, and the number of spares currently available. The Pave Penny system is a reparable system; however, the parts that were failing were not reparable, and, for the parts that were reengineered, there was no existing source for manufacture of these circa 1960 parts.

The failure rates for the original parts are as follows:

Crystal Oscillator:	12/year
Photo Diode:	18/year
Axis-crossover:	15/year
Digital Correlator:	12/year
Pulse Processor	15/year

This project enabled the Pave Penny system to continue operating on the A-10 aircraft. The reliability of the parts is expected to increase slightly because the parts are new; these parts were reengineered based on the original specs, and improved reliability was not specifically designed into the new parts. However, as a side benefit, the new parts have increased the capability of the system by roughly doubling the system's signal detection range. In later years, eight more problem items identified in this study were reengineered.

The Pave Penny system was originally scheduled to be replaced in the 1990's. It is now scheduled to be decommissioned in 2028.

Cost: There is no data on the cost to repair the old items because they are not reparables; there is no cost to procure the old items because there are no manufacturing sources for the items. Additionally, there is no cost to purchase the new items because the purchasing contract has not yet been established; the new items are also not reparable.

This project cost $1,500,000.00.

Approval Project description approved by Mr. Hal Molton, Pave Penny Program Manager, on 10 Feb 04.

AFMC Priority #: 16 ***Benefited Air Force?:*** Yes

Project Title: AN/ALQ-172 (V) Controller (LRU 10) Improvement

Prupose: Improve/replace high failing parts.

Result: Provided new 10A13/15, 10PS1, 10A1, and ASICS.

Cost: This project cost $3,930,000.00.

Approval Information provided by Mr. Bob Boyle on 21 Feb 04.

AFMC Priority #: 17 ***Benefited Air Force?:*** Ind

Project Title: Forward Forced Air Fan

Prupose:

Result: Could not identify a POC. No NSN available to try to find an IM, and no office symbol to try to find a new POC.

Cost: This project cost $450,000

Approval Could not identify a POC.

AFMC Priority #: 18 ***Benefited Air Force?:*** Yes

Project Title: B-1B Horizontal Stabilizer Inspection Disposition

Prupose: Project funded an inspection for horizontal stabilizers on the B-1B.

Result: This was not a reengineering project. Apparently, for this year, the engineers were told not to use 583 (Sustaining Engineering) money to fund inspections. Their guidance was to use MSD dollars to fund inspections. The guidance was changed the following year. Inspection was completed successfully.

Cost: Project was funded for $480,000.00

Approval Project description approved by Mr. John Morgan on 5 Feb 04.

AFMC Priority #: 19 ***Benefited Air Force?:*** Yes

Project Title: AN/AAQ-18 Resolver Assembly Improvement Program (MH-153J/MC130E)

Prupose: This project investigated a recurring failure with the number 6 gear in

the MH-153J and the MC-120E.

Result: The new gear is a preferred item placed in the next higher assembly, therefore data is not specifically tracked for the new gear. However, no failures have been reported since replacement of the gear in the next higher assembly.

Cost: In 1999, the aluminum gear failed 38 times and cost $1,053 to repair for a total cost of $40,014.00.

This project was funded for $60,000.

Approval Project description approved by Dave Richards, Electronics Engineer and Linda Quick, Item Manager on 11 Feb 04.

AFMC Priority #:	20	***Benefited Air Force?:***	Yes
Project Title:	AN/ALQ-172 (V) Antenna (LRU 8) Improvement		
Prupose:	Improve/replace high failing parts.		
Result:	Provided new ACU, Down Converter, and Bit Limiter for LRU 8. An ACU has been procured.		
Cost:	This project cost $2,450,000.00.		
Approval	Information provided by Mr. Bob Boyle on 21 Feb 04.		

AFMC Priority #:	21	***Benefited Air Force?:***	Ind
Project Title:	AN/AAQ-15 & AN/AAQ-17 Side Cover (MC-130P, AC-130U, AC-130H, C-141 SOLL II)		
Prupose:	Deficiency was resolved before MSD funds were received.		
Result:	Deficiency was resolved before MSD funds were received.		
Cost:	This project cost $30,000		
Approval	Could not contact a POC, however documentation states that the deficiency was resolved before MSD funds were received		

AFMC Priority #:	22	***Benefited Air Force?:***	No
Project Title:	AN/ALR-20A Power Supply (LRU 3) Improvement		
Prupose:	This project was combined with AFMC Priority #s 27, 38, and 39 which were originally intended to redesign obsolete parts on LRUs 1, 3, 8, and 9 of the AN/ALR-20A system.		
Result:	The ALC decided it would be better to combine the funds to support the Situational Awareness Defensive Improvement (SADI) which was a new system designed to replace the ALR-20A. Creating a new system would mitigate all obsolesce issues and provide a system that was easier to maintain with greater reliability and capability.		

The SADI was designed for the Navy. Unfortunately, the design did not adequately replace the capabilities of the AN/ALR-20A system, and did not function as expected. These deficiencies that were too costly to overcome, and the SADI project was postponed until further funding could be obtained in FY03. Additionally, the SADI system's role is being extended which will require more modifications to the system and delay fielding even more.

Therefore, the parts obsolescence issues for LRUs 8 and 9 were addressed with 583 (O&M) funds in FY03. Engineering efforts to replace these parts are still on-going. The first delivery is expected in May 04. The new parts are expected to reduce the number of repairs per year by 200 – 300%. The repair cost is expected to remain about the same. However, since none of the new parts have been fielded yet, these savings have not been quantified.

Cost:

In 1999 36 LRU-8s were repaired at a cost of $1,133 per repair and 83 LRU-9s were repaired at a cost of $1,133 per repair. The Latest Repair Cost (LRC) in the D043 for LRU-8 is $1,161.50, and the LRC in the D043 for LRU-9 is $1,298.00.

The program manager expects LRUs 1 and 3 to be funded for upgrade next year. In 1999 91 LRU-1s were repaired at a cost of $1,526.00 per repair, and 54 LRU-3s were repaired at a cost of $766.00 per repair. The LRC in the D043 for LRU-1 is $2,381.00, and the LRC in the D043 for LRU-9 is $1,896.00

The MSD portion of this effort cost 6,930,000.00.

Approval

Project description approved by Mr. David Duncan, Lead Systems Engineer for the AN/ALR-20A, on 10 Feb 04.

AFMC Priority #: 23 ***Benefited Air Force?:*** Yes

Project Title: AN/ALQ-172 (V) Receiver (LRU 1) Improvement

Prupose: Improve/replace high failing parts.

Result: Provided new 1PS1, A51A3, and ASICS.

Cost: This project cost $2,530,000.00.

Approval Information provided by Mr. Bob Boyle on 21 Feb 04.

AFMC Priority #: 24 ***Benefited Air Force?:*** Ind

Project Title: Common Large Area Display Set (CLADS)

Prupose: Redesign Monitor used on E-3

Result: Overall project was successful, but how this MSD Engineering project fit into the 10 year overall project could not be determined.

Cost: This project cots $500,000.00.

Approval Contacted Mr. Bob Zwicki.

AFMC Priority #: 25 ***Benefited Air Force?:*** No

Project Title: Re-Engineering of B-1B IATE CCAs

Prupose: Project was to fund the redesign and replacement of six circuit cards in the B-1B Intermediate Automated Test Set (IATES) that failed most often.

Result: The contractor could not provide promised product. The contractor defaulted on the contract and went bankrupt without delivering a product to the Air Force.

Since then, the project has been awarded to two other contractors. The second contractor also failed. The scope of the project was reduced to replacing two of the six poorly performing circuit cards and a new project was awarded to a third contractor. The program manager expects two new cards to be delivered this year. Procurement of additional circuit cards will be determined by D200 computations.

Cost: There is no current cost estimate for repair or procurement of circuit cards. One of the circuit cards currently fails 72 times a year; the new card is expected to improve to 18 times a year. The other card fails 45 times per year and is expected to improve to 10 failures per year.

The Original Equipment Manufacturer (OEM) created a new design to replace a one of the remaining four poorly performing circuit cards. The Air Force is negotiating with the OEM to procure 151 cards over the next three years at a projected cost of $42,888.00 per card. The first card is expected to be delivered in Jan ’06.

The first project, covered by MSD funds, cost $800,000.00 (The total money spent, so far, for this redesign, is $2.4 million.)

Approval Project description approved by Mr. Jack Tomlin, Logistics Management Specialist, on 18 Feb 04.

AFMC Priority #: 26 ***Benefited Air Force?:*** Ind

Project Title: E-3 Radome Coating

Prupose: Could not identify a POC. No NSN available to try to find an IM, and no office symbol to try to find a new POC.

Result: Could not identify a POC. No NSN available to try to find an IM, and no office symbol to try to find a new POC.

Cost: This project cost $200,000.00

Approval Could not identify a POC.

AFMC Priority #: 27 ***Benefited Air Force?:*** No

Project Title: AN/ALR-20A Receiving Set Controller (LRU 1) Improvement

Prupose: See AFMC Priority # 22.

Result: See AFMC Priority # 22.

Cost: The MSD portion of this effort cost $2,150,000.00.

Approval Project description approved by Mr. Dave Duncan, Lead Systems Engineer for the AN/ALR-20A, on 10 Feb 04.

AFMC Priority #: 28 ***Benefited Air Force?:*** Yes

Project Title: AN/ALQ-172 (V) Transmitter (LRU 4) Improvement

Prupose: Improve/replace high failing parts.

Result: Provided new 4AR1, 4A3, and 4A20.

Cost: This project cost $2,100,000.00.

Approval Information provided by Mr. Bob Boyle on 21 Feb 04.

AFMC Priority #: 29 ***Benefited Air Force?:*** Yes

Project Title: AN/ALQ-172 (V) Transmitter (LRU 2) Improvement

Prupose: Improve/replace high failing parts.

Result: Provided new 2A4HVPS and Lin Mods

Cost: This project cost $1,240,000.00.

Approval Information provided by Mr. Bob Boyle on 21 Feb 04.

AFMC Priority #: 30 ***Benefited Air Force?:*** No

Project Title: Form, Fit, and Function Replacement of Special Function Amplifier (AMP)

Prupose: This project was initiated to replace an amplifier because there are no more pieces available to repair the amplifier.

Result: The project found a Form Fit and Function replacement; unfortunately, the replacement was plagued with small problems before catastrophically failing. The contractor that provided the new item is now out of business.

Cost: The original repair cost was $5,410.25 per unit and 4 units were repaired per year at a total cost of $21,641. Recently, the Air Force contracted to have three amplifiers repaired by using parts from two other amplifiers at a cost of $20,886/amplifier repaired. There are no more spares available to use as a source for repair pieces.

This MSD project was funded for $372,812.66.

Approval Project description approved by Mr. Patrick Putman, Equipment Specialist, on 9 Feb 04.

AFMC Priority #: 31 ***Benefited Air Force?:*** Ind

Project Title: Form, Fit, and Function Replacement of Digital Waveform Analyzer (DIG)

Prupose:

Result:

Cost: This project was funded for $535,310.00

Approval Pat Putnam is POC, final status could not be determined.

AFMC Priority #: 32 ***Benefited Air Force?:*** No

Project Title: Form, Fit, and Function Replacement of Digital Word Generator (DWG)

Prupose: This project was initiated to provide a Form Fit and Function replacement for the DWG. The old DWG had a very high failure rate, and the original manufacturer no longer built the item.

Result: This item could not be redesigned with the money available; therefore the project scope was changed to redesign only the highest failing components in the DWG.

Cost: The DWG originally was failing 94 times per year and cost $2,650.00 for each repair. The Latest Repair Cost in the Do43 for the DWG is $54,314.72.

This project was funded for $549,055.12.

Approval Project description sent to Ms Rangle, Item Manger, and Mr. Pat Putnam, Equipment Specialist, on 15 Feb 04.

AFMC Priority #: 33 ***Benefited Air Force?:*** Yes

Project Title: Form, Fit, and Function Replacement of DC High Voltage Power Supply (HVPS)

Prupose: This project was initiated to provide a Form, Fit and Function replacement for a High Voltage Power Supply.

Result: This project resulted in the modification of a Commercial Off the Shelf (COTS) item.

Cost: The new item cost $7,900.00 to purchase. Unfortunately, there is no information available for the repair cost or failure rate of the old item because the stock number was deleted. The new part has not been used long enough to generate a repair cost or failure rate. This project cost $400,000.00.

Approval Project description approved by Mr. Pat Putnam, Equipment Specialist on 4 March 04.

AFMC Priority #: 34 ***Benefited Air Force?:*** Ind

Project Title: IFF R/T Transmitter Chain Assembly

Prupose:

Result:

Cost: This project cost $500,000.00

Approval Mr. Tom Schley responded, but could not get info before 3 March 04 (thesis due 5 March 04)

AFMC Priority #: 35 ***Benefited Air Force?:*** No

Project Title: Fuel Saving Computer CCA Redesign

Prupose: This project was initiated to redesign the Fuel Saving Computer on the C-5/C-141. The old part was failing, and there was no repair capability, and no source for purchasing identical Form, Fit and Function items.

Result: The contract was let with OO-ALC/TISDM functioning as the contractor. The redesigned circuit card was due to be completed in Dec '99. However, the design was never completed. The fuel savings computer requirement was satisfied by removing serviceable assets from C-141s that were being decommissioned.

Cost: This project was funded for $199,750

Approval Project description approved by Brian Hendry, Electronics Engineer on 9 Feb 04.

AFMC Priority #: 37 ***Benefited Air Force?:*** Yes

Project Title: AN/ALQ-172 (V) Converter (LRU 7) Improvement

Prupose: Improve/replace high failing parts.

Result: Provided new Bit Enhancement, 7PS1, and 7A2-7A13.

Cost: This project cost $2,650,000.00.

Approval Information provided by Mr. Bob Boyle on 21 Feb 04.

AFMC Priority #: 38 ***Benefited Air Force?:*** No

Project Title: AN/ALR-20A Radio Frequency Tuner (LRU 8) Improvement

Prupose: See AFMC Priority # 22.

Result: See AFMC Priority # 22.

Cost: The MSD portion of this effort cost $2,150,000.00.

Approval Project description approved by Mr. Dave Duncan, Lead Systems Engineer for the AN/ALR-20A, on 10 Feb 04.

AFMC Priority #: 39 ***Benefited Air Force?:*** No

Project Title: AN/ALR-20A Radio Frequency Tuner (LRU 9) Improvement

Prupose: See AFMC Priority # 22.

Result: See AFMC Priority # 22.

Cost: The MSD portion of this effort cost $980,000.00.

Approval Project description approved by Mr. Dave Duncan, Lead Systems Engineer for the AN/ALR-20A, on 10 Feb 04.

AFMC Priority #: 41 ***Benefited Air Force?:*** Yes

Project Title: Feasibility Study (Milstar)

Prupose: In 1999, Compaq informed the military they would no longer be performing repairs on some MILSTAR assets. In response to this, the weapon system user funded Raytheon to perform a study to identify possible reliability problems on the MILSTAR program and suggest solutions to any problems. This MSD project is a result of the study.

Raytheon determined the support problems would not be due to poor reliability of the end items, but a lack of replacement components for the end item. The study proposed four possible solutions to address the supportability issues. The government selected Solution Three which recommended purchasing monitors and printers; with those additions, there will be enough spares to support the system until it is replaced. This project funded the redesign of a 19” monitor.

Result: The new monitors were specially designed to meet AF requirements for mobile use: they are Hardened/HEMP/TEMPEST/Ruggedized. Before the reengineering effort, an average of two monitors broke each year. It currently costs $20,005.76 to repair the old monitor as it fails.

Four new, reengineered, monitors were purchased. Additionally, monitors being used in the more “friendly” fixed locations were replaced with COTS monitors (not part of this project). This allows the monitors that were being used at the fixed site to be used as spares to support the “old” monitors used in the “unfriendly” mobile environment. The new monitors are used as spares in the “unfriendly” environment and have started being used in the last three months.

Cost: The AF purchased three new printers. These printers are a commercially available item. Before the reengineering effort one printer was repaired each year at a cost of $3,216. All the old printers have been replaced. No new printers have failed since being replaced three years ago. The new printers cost $4,600 each.

The AF spent $390,044 for the study, and since has procured 4 monitors at a cost of $312,000, and 3 printers at a cost of $13,800. The Latest Repair Cost (LRC) on the ‘04 DO43 for the old printer is $3,216.00 and the LRC for the new printer is $1,190.02. The LRC for the old monitor is $22.005.76, and $14,941.75 for the new monitor.

Approval Project description approved by Mr. Donald Gorman, Prime Mission Control Segment Engineer, on 9 Feb 04.

AFMC Priority #: 42 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 (BUS Controller)

Prupose: This project funded a study to determine the cause of recurring failures on the Bus Controller.

Result: The study determined the failures were due to poor maintenance housekeeping practices, which allowed dust to build up on the bus controller. The dust insulated the controller resulting in the parts overheating and failing.

The MAJCOM and AFMC sent notices out to the using units to reinforce the importance of maintenance practices. The failure rates dropped to zero and have been for over three years (1 Jul 00 – 30 Jun 03).

Cost: The LRC for the controller is $1,120.00 and 0 assets were repaired over the last year.

This study cost $143,000.00.

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 43 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 (HF Receiver)

Prupose: This project was combined with AFMC Priority # 44 to study recurring failures in the receiver and exciter.

Result: It was determined that most failures were attributed to an antenna coupler and the lack of rack cooling.

A replacement coupler was identified but requires a change to the wiring inside the shelter in the form of an adapter cable. This change forces this effort to become a modification, which is paid for by 3030 funds. The cost was prohibitive and the using command decided not to pursue. The HF Rack Cooling mod was developed using MSD Engineering funds and the kits purchased with 3080 modification funds. The modifications are currently being installed and is not yet complete.

Cost: Project was funded for $141,000.00

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 44 ***Benefited Air Force?:*** Yes

Project Title: Engineering Study AN/TYQ-23 (HF Exciter)

Prupose: This study was conducted in conjunction with AFMC Priority number 43.

Result: This project combined with AFMC priority # 43.

Cost: The project cost $138,000.00.

Approval Project description approved by Mr. Steve Broffel, OPS IPT Systems Engineer, on 17 Feb 04.

AFMC Priority #: 45 ***Benefited Air Force?:*** Yes

Project Title: SCADC Parts Obsolescence

Prupose: This project was funded to redesign three parts in the Standard Central Air Data Computer power supply.

Result: One part is waiting testing, and two parts have successfully completed testing and are awaiting manufacturing. None of the parts will be fielded until all three parts are ready to be fielded.

Cost: There is no data regarding the old cost per item or the number of times the item failed per year. Additionally, a contract for purchasing new parts has not yet been established; therefore there is no cost for procurement. Finally, since the parts have not yet been fielded, there is not data for the number of parts that fail per year or the cost to repair the parts.

This project cost $150,000.00.

Approval Project description resent to Mr. Gary Reimer, Electronics Engineer, on 15 Feb 04.

AFMC Priority #: 46 ***Benefited Air Force?:*** Ind

Project Title: Air Cycle Machine

Prupose: Project was to develop new capability/design

Result: Project is not yet complete

Cost: This project was funded for $1,500,000.

Approval Project description approved by Mr. Matt Poursaba on 25 Feb 04.

AFMC Priority #: 56 ***Benefited Air Force?:*** Ind

Project Title: Radar Receiver Transmitter

Prupose:

Result:

Cost: This project cost $3,750,000.00

Approval Could not contact Mr. Steve Burk.

AFMC Priority #: 58 ***Benefited Air Force?:*** Ind

Project Title: Roll Resolver

Prupose:

Result:

Cost: This project cost $90,000.00

Approval Could not contact Mr. Steve Burk.

AFMC Priority #: 60 ***Benefited Air Force?:*** No

Project Title: Ceramic Turbine Wheel Program

Prupose: This project was initiated to test a new ceramic wheel to be used in B-52 engine starters.

Result: Small ceramic wheels are frequently used in automobile turbos. However, creating a larger ceramic wheel has provided a difficult challenge. The Air Force spent approximately $1,000,000.00 to try to create a larger ceramic wheel. This effort failed. A second effort was initiated by the Defense Advanced Research Projects Agency (DARPA) and the National Aeronautical and Space Administration (NASA). They funded between $500,000 and $1,000,000.00 to acquire this capability. The Air Force was the managing partner in this effort, but provided no funds.

This MSD project was initiated to test the output of the second project. However, the test was never concluded because the Air Force withdrew the assets it had loaned to the contractor.

Cost: This contract cost $16,482.19.

Approval Project description approved by Mr. Jim Heggen, Mechanical Engineer, on 13 Feb 04.

AFMC Priority #: 61 ***Benefited Air Force?:*** Ind

Project Title: Antenna Coupler

Prupose:

Result:

Cost: This project cost $100,000.00

Approval Mr. Tom Schley responded, but could not get info before 3 March 04 (thesis due 5 March 04)

AFMC Priority #: 62 ***Benefited Air Force?:*** Ind

Project Title: Klystron

Prupose:

Result:

Cost: This project cost $150,000.00.

Approval Mr. Tom Schley responded, but could not get info before 3 March 04 (thesis due 5 March 04)

AFMC Priority #: 67 ***Benefited Air Force?:*** Ind

Project Title: O2 Repair Facility Cleaning Capability Study

Prupose: Could not identify a POC. No NSN available to try to find an IM, and no office symbol to try to find a new POC.

Result: Could not identify a POC. No NSN available to try to find an IM, and no office symbol to try to find a new POC.

Cost: This project cost $480,000.00

Approval Could not identify a POC.

AFMC Priority #: 68 ***Benefited Air Force?:*** Yes

Project Title: Primary Bleed Air Valve Replacement

Prupose: This project funded the redesign and testing of the primary bleed air valve in the F-15 engine.

Result: This MSD project funded the creation and testing of a new valve design. Twenty-four prototype valves were created by modifying existing valves.

This project added knowledge to the AF that will be utilized in three other air bleed valves.

To date, 24 F-15s have flown with the new part for at least 2 and as many as 3 years without a failure.

Cost: The Air Force is negotiating a contract to modify 560 valves per year for the next three years, starting this year. No data will be available regarding modification costs for the new part until the contract is complete.

	The old part cost $1,904 to fix and was repaired 623 times a year for a total cost of $1,186,192 per year. This project cost $200,000.00.
Approval	Project description approved by Jeanne Hanson, Logistics Management Specialist, on 11 Feb 04

AFMC Priority #:	69	***Benefited Air Force?:***	Ind
Project Title:	Water Separator Replacement		
Prupose:			
Result:	This project is not complete. No data is available for original repair cost or number of repairs per year.		
Cost:	This contract was let for $750,000.		
Approval	Project description approved by Mr. Matt Poursaba on 25 Feb 04.		

Appendix C Statistical Tests

The statistics program JMP was used to determine if the separate samples were normal. Below are the normal quartile plots demonstrating normality, or lack thereof.

Entire population

This normal quantile plot of all 35 projects shows the amount of money spent on the projects was not distributed normally.   See Figure 4.

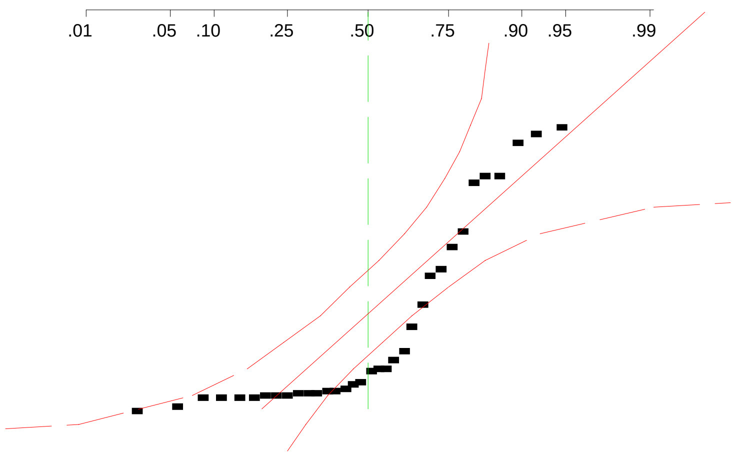

Figure 4. Normal Quantile Plot for Money Spent on all Projects

Non-beneficial Projects

This normal quantile plot of the 10 non-beneficial projects shows that the amount of money spent on non-beneficial projects was distributed normally.   See Figure 5

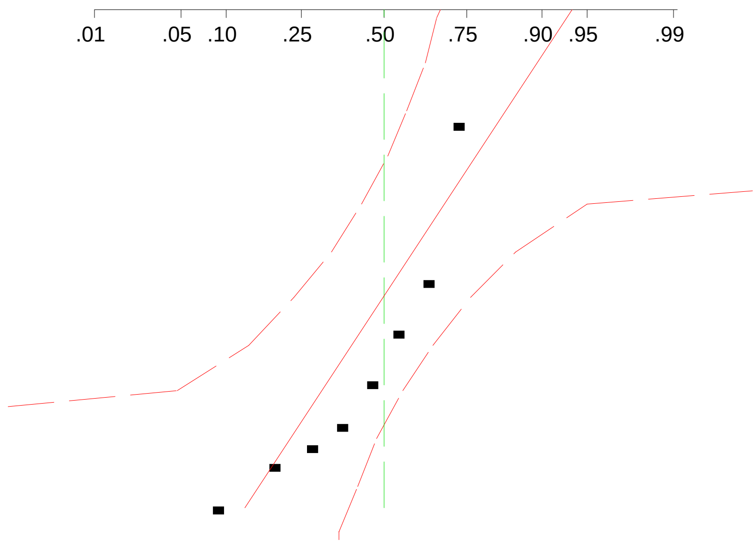

Figure 5. Normal Quantile Plot for Money Spent on all Non-beneficial Projects

Beneficial Projects

This normal quantile plot of the 25 beneficial projects shows that the amount of money spent on beneficial projects was not distributed normally. See Figure 6.

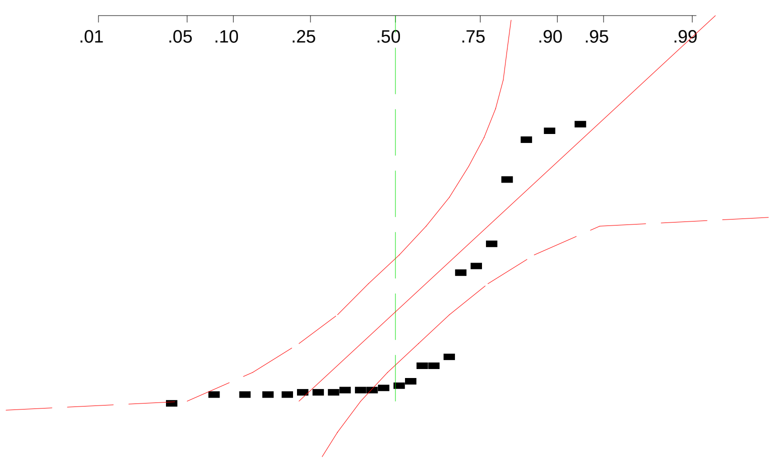

Figure 6. Normal Quantile Plot for Money Spent on all Beneficial Projects

Only Study Projects

This normal quantile plot of the 11 beneficial projects that were studies shows that the amount of money spent on studies was not distributed normally. See Figure 7.

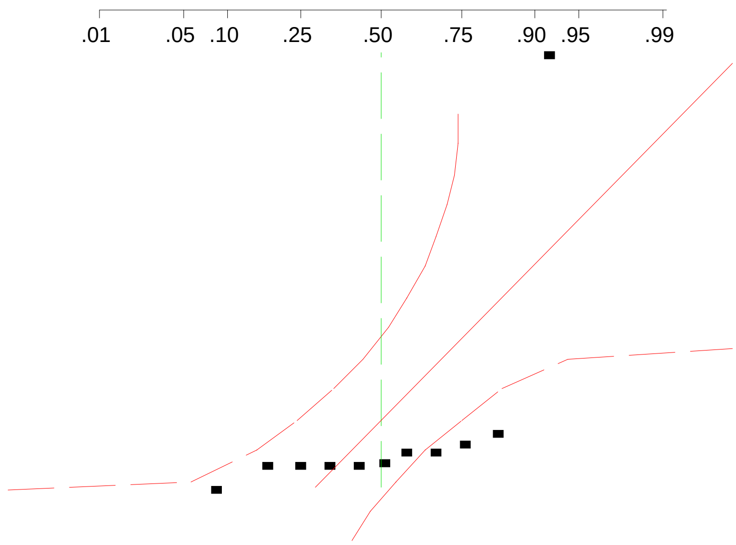

Figure 7. Normal Quantile Plot for Money Spent on all Beneficial Study Projects

Beneficial Projects; No Studies

This normal quantile plot of the 14 beneficial projects, that were not studies, shows that the amount of money spent on non-study, beneficial projects was distributed normally. See Figure 8.

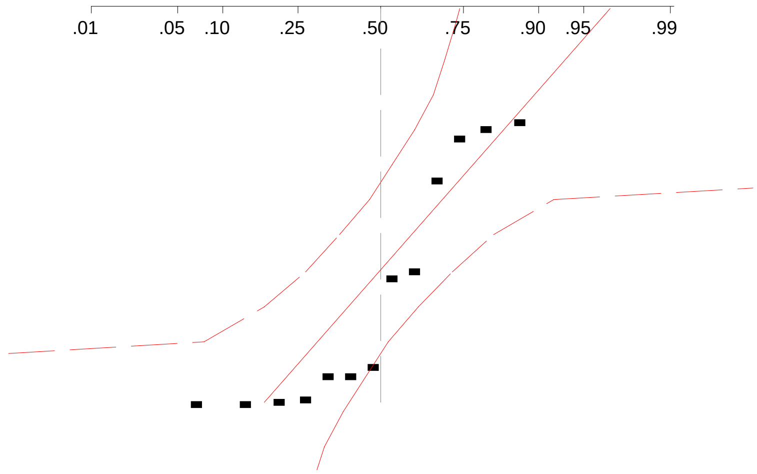

Figure 8. Normal Quantile Plot for Money Spent on Beneficial, Non-study Projects

All Projects except Studies

This normal quantile plot of the 24 projects that were not studies, shows the amount of money spent on non-study projects was not distributed normally. See Figure 9.

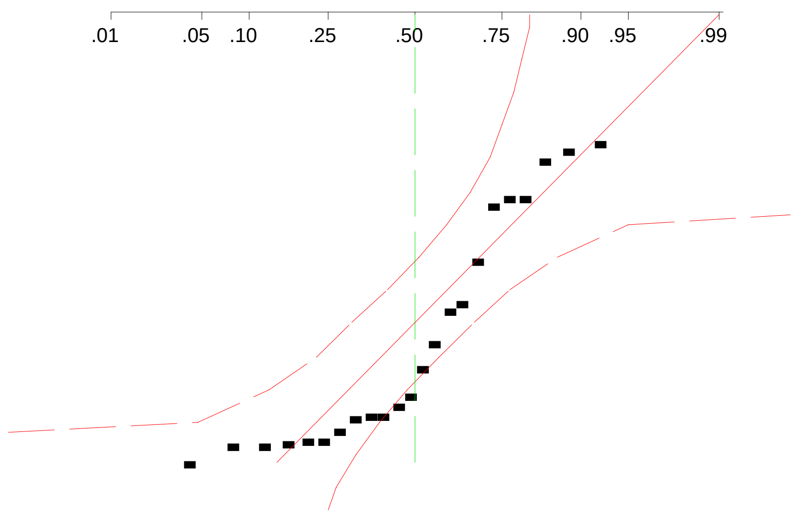

Figure 9. Normal Quantile Plot for Money Spent on Non-study Projects

Wilcoxon Rank Sum Test

Because most of the sub-populations were not normal, samples were tested using the Wilcoxon Rank Sum Test. This test is appropriate for testing the equivalence of two probability distributions when the form of the underlying population is not known. In this test, the combined sample values were rank ordered. Then the samples were separated, and the sum of the ranks of each sample was determined. The smaller sample sum is the test statistic (McClave, Benson, & Sinich, 2001). The critical values for the test were taken from <u>Handbook of Tables for Probability and Statistics</u> (Beyer, 1968).

Wilcoxon Rank Sum Test for Money Funded for Beneficial vs Non-Beneficial Projects

All the projects were ordered according to the amount funded and then rank ordered. In the case of a tie, all projects were assigned an average value (McClave, Benson, & Sinich, 2001). The projects were then separated according to whether they provided a benefit to the Air Force (See Table 5). The sum of the ranks for the separated projects was then calculated; the rank sum for non-beneficial projects was 207.5 and the sum for the projects that benefited the Air Force was 422.5. Therefore, the test statistic was 207.5. The null hypothesis was that the two probability distributions were the same; and the alternate was that the distributions were different. From Beyer's statistic table for a sample size of 10 for the small sum and a sample size of 25 for the larger sum and an alpha of .05 for a two tailed test, the lower critical value was 158, and the upper critical value was 402. Therefore, the null hypothesis could not be rejected, and we concluded the two samples are not statistically different.

Table 5. Wilcoxon Ranks Sum for all Projects

Contracted or Funded (Millions)	Purpose of MSD Engineering Project	Benefit to Air Force?	Rank
0.02	Test ceramic wheel	N	1
0.2	Redesign Fuel Savings Computer	N	13.5
0.28	Replacement for Frequency Synthesizer	N	17
0.37	Redesign and replace Amplifier	N	18
0.55	Redesign Digital Word Generator	N	22
0.77	Redesign and replace six circuit cards on B-1B Test Set	N	23
0.98	Redesign Tuner (LRU 9) (AN/ALR-20A)	N	24
1.65	Redesign Power Supply (LRU 3) (AN/ALR-20A)	N	28
2.15	Redesign Receiving Set (LRU 1) (AN/ALR-20A)	N	30
2.15	Redesign Tuner (LRU 8) (AN/ALR-20A)	N	31
0.06	Study to solve high gear failure rate	Y	2
0.14	Study Feasibility of redesigning the Magnetic Focus Amplifier	Y	4.5
0.14	Study to ID cause of recurring failures on a Bus Controller	Y	4.5
0.14	Study to ID cause of recurring failures on a High Frequency Receiver	Y	4.5
0.14	Sutdy to ID cause of recurring failures on a High Frequency Exciter	Y	4.5
0.15	Redesign 3 parts for SCADC Power Supply	Y	8
0.15	Redesign RGDU Video Amplifier	Y	8
0.15	Study to identify new or best source of repair for High Voltage PS	Y	8
0.179	Redesign Type X Power Supply	Y	10
0.18	Study to determine feasibility of redesigning Deflection Amplifier	Y	11.5
0.18	Study to ID cause of recurring failures in 280V DC Power Supply	Y	11.5
0.2	Redesign and test Primary Air Bleed Valve	Y	13.5
0.21	Study to find best source of repair for 25" CRT monitor	Y	15
0.247	Study to determine feasibility of redesigning circuit card	Y	16
0.39	Redesign Monitor	Y	19
0.4	Replace High Voltage Power Supply	Y	20
0.48	Inspection of B-1B Horizontal Stabilizers	Y	21
1.24	Redesign Transmitter (LRU 2) (AN/ALQ-172)	Y	25
1.3	New landing gear testing capability	Y	26
1.5	Study to ID which leading failures need replaced	Y	27
2.1	Redesign Transmitter (LRU 4) (AN/ALQ-172)	Y	29
2.45	Redesign Antenna (LUR 8) (AN/ALQ-172)	Y	32
2.53	Redesign Receiver (LRU 1) (AN/ALQ-172)	Y	33
2.6	Redesign Converter (LRU 7) (AN/ALQ-172)	Y	34
3.93	Redesign Controller (LRU 10) (AN/ALQ-172)	Y	35
		sum =	630

Wilcoxon Rank Test for Money Funded on Beneficial vs. Non-Beneficial Projects < .5M

All projects funded for less than $500,000.00 were rank ordered according to the amount funded. In the case of a tie, all projects were assigned an average value (McClave, Benson, & Sinich, 2001). The projects were then separated according to whether they benefited the Air Force or not (See Table 6). The sum of the ranks for the separated projects was then calculated; the rank sum for beneficial study projects was 181.5, and the sum for non-beneficial projects was 49.5. Therefore, the test statistic was 49.5. The null hypothesis was that the two probability distributions were the same; and the alternate was that the distributions were different. From Beyer's statistic table for a sample size of 4 for the small sum and a sample size of 17 for the larger sum and an alpha of .05 for a two tailed test, the lower critical value was 25, and the upper critical value was 79. Since the test statistic is within the critical value range, we cannot reject the null hypothesis and must conclude the two samples are not statistically different.

Table 6. **Wilcoxon Ranks for all Projects < .5M**

Contracted or Funded (Millions)	Purpose of MSD Engineering Project	Benefit to Air Force?	Rank
0.02	Test ceramic wheel	N	1
0.2	Redesign Fuel Savings Computer	N	13.5
0.28	Replacement for Frequency Synthesizer	N	17
0.37	Redesign and replace Amplifier	N	18
0.06	Study to solve high gear failure rate	Y	2
0.14	Study Feasibility of redesigning the Magnetic Focus Amplifier	Y	4.5
0.14	Study to ID cause of recurring failures on a Bus Controller	Y	4.5
0.14	Study to ID cause of recurring failures on a High Frequency Receiver	Y	4.5
0.14	Sutdy to ID cause of recurring failures on a High Frequency Exciter	Y	4.5
0.15	Redesign 3 parts for SCADC Power Supply	Y	8
0.15	Redesign RGDU Video Amplifier	Y	8
0.15	Study to identify new or best source of repair for High Voltage PS	Y	8
0.179	Redesign Type X Power Supply	Y	10
0.18	Study to determine feasibility of redesigning Deflection Amplifier	Y	11.5
0.18	Study to ID cause of recurring failures in 280V DC Power Supply	Y	11.5
0.2	Redesign and test Primary Air Bleed Valve	Y	13.5
0.21	Study to find best source of repair for 25" CRT monitor	Y	15
0.247	Study to determine feasibility of redesigning circuit card	Y	16
0.39	Redesign Monitor	Y	19
0.4	Replace High Voltage Power Supply	Y	20
0.48	Inspection of B-1B Horizontal Stabilizers	Y	21
		sum =	231

Redesign Projects

All redesign projects were rank ordered according to the amount funded. In the case of a tie, all projects were assigned an average value (McClave, Benson, & Sinich, 2001). The projects were then separated according to whether they benefited the Air Force or not (See Table 7). The sum of the ranks for the separated projects was then calculated; the rank sum for beneficial study projects was 133.5, and the sum for non-beneficial projects was 97.5. Therefore, the test statistic was 97.5. The null hypothesis was that the two probability distributions were the same; and the alternate was that the distributions were different. From Beyer's statistic table for a sample size of 9 for the small sum and a sample size of 12 for the larger sum and an alpha of .05 for a two tailed test, the lower critical value was 96, and the upper critical value was 183. Since the test statistic is within the critical value range, we cannot reject the null hypothesis and must conclude the two samples are not statistically different. It is worth pointing out that the test value was only 1.5 higher than the lower critical value. As the critical range was 87, this narrowly falls within the "cannot reject hypothesis" range.

Table 7. Wilcoxon Ranks for all Redesign Projects

Contracted or Funded (Millions)	Purpose of MSD Engineering Project	Benefit to Air Force?	Rank
0.2	Redesign Fuel Savings Computer	N	4.5
0.28	Replacement for Frequency Synthesizer	N	6
0.37	Redesign and replace Amplifier	N	7
0.55	Redesign Digital Word Generator	N	10
0.77	Redesign and replace six circuit cards on B-1B Test Set	N	11
0.98	Redesign Tuner (LRU 9) (AN/ALR-20A)	N	12
1.65	Redesign Power Supply (LRU 3) (AN/ALR-20A)	N	14
2.15	Redesign Receiving Set (LRU 1) (AN/ALR-20A)	N	16.5
2.15	Redesign Tuner (LRU 8) (AN/ALR-20A)	N	16.5
0.15	Redesign 3 parts for SCADC Power Supply	Y	1.5
0.15	Redesign RGDU Video Amplifier	Y	1.5
0.179	Redesign Type X Power Supply	Y	3
0.2	Redesign and test Primary Air Bleed Valve	Y	4.5
0.39	Redesign Monitor	Y	8
0.4	Replace High Voltage Power Supply	Y	9
1.24	Redesign Transmitter (LRU 2) (AN/ALQ-172)	Y	13
2.1	Redesign Transmitter (LRU 4) (AN/ALQ-172)	Y	15
2.45	Redesign Antenna (LUR 8) (AN/ALQ-172)	Y	18
2.53	Redesign Receiver (LRU 1) (AN/ALQ-172)	Y	19
2.6	Redesign Converter (LRU 7) (AN/ALQ-172)	Y	20
3.93	Redesign Controller (LRU 10) (AN/ALQ-172)	Y	21
		sum =	231

Bibliography

Air Force Material Command (AFMC). *Case Resolution Guide, Version 2.0*. Produced for Air Force Materiel Command under contracts F33618-D-5119 and F33615-00-D-5543. Dayton OH: Universal Technology Corporation (UTC), 31 March 2001.

Air Force Material Command (AFMC). *AFMC Improved Item Replacement Program (IIRP) Guidance and Procedures.* AFMCI 21-201. Dayton: HQ AFMC, 1 October 1996.

Air Force Material Command (AFMC). *Diminishing Manufacturing Sources and Materiel Shortages (DMSMS) Program.* AFMCI23-103. Dayton: HQ AFMC, 13 October 2003.

Air Force Material Command (AFMC). "MSD Engineering Guidance." Attached to MSD Engineering project call from AFMC/LGI to ALCs. Wright-Patterson AFB OH, 23 Jan 04.

Air Force web-site. "B-52H STRATOFORTRESS LONG-RANGE MULTI-ROLE BOMBER." http://www.airforce-technology.com/projects/b52/. 10 February 04.

Beyer, William H. *Handbook of Tables for Probability and Statistics* (2nd Edition). Cleveland OH: The Chemical Rubber Company, 1968.

Boyle, Bob A. Systems Engineer, WRACL/LSRAB, Warner-Robins Air Logistics Center (ALC) GA. Telephone interview. 10 February 2004

Boyle, Bob A. "FY99 MSD Engineering." Electronic Message. 0536Z, 21 February 2004.

Broffel, Steven. OPS IPT Systems Engineer, OO-ALC/LHY, Ogden ALC UT. Telephone interview. 2 February 2004

Broffel, Steven, "Project narrative in E-mail Version." Electronic Message. 0930Z, 17 February 2004.

Chavez, Connie J. Systems Engineer, WRACL/LSELP, Warner-Robins Air Logistics Center (ALC) GA. Telephone interview. 3 March 2004

Cordesman, Anthony H. *Trends in US Military Forces and Defense Spending: Peace Dividend or Underfunding?.* Center for Strategic and International Studies, 1800 K Street N.W., Washington DC, July 1999.

Defense MicroElectronics Activity (DMEA). *DMSMS Acquisition Guidelines; Implementing Parts Obsolescence Management Contractual Requirements (Revision 3).* Produced for Defense MicroElectronics Activity under contract DMEA90-00-F-0003. McClellan AFB CA: ARINC, December 2001.

Defense Microelectronics Activity "DMSMS & Microelectronics Obsolescence" from the website located at http://www.dmea.osd.mil/dms.html. 11 Feb 04.

Defense MicroElectronics Activity (DMEA). *Resolution Cost Metrics For Diminishing Manufacturing Sources and Material Shortages*. Produced for Defense MicroElectronics Activity under contract GS-35F-4825G. McClellan AFB CA: ARINC, 31 December 2001.

Defense Standardization Program Office. *Life Cycle Cost Savings Through Parts Management.* SD-19. June 2001

Department of the Air Force. *Budget Guidance and Procedures*. AFI65-601. Washingtion: HQ USAF, 24 December 2002.

Department of the Air Force. *Improving Air and Space Ewuipment Reliability and Maintainability*. AFI21-118. Washingtion: HQ USAF, 2 October 2003.

Department of the Air Force. *Reduction in Total Ownership Cost Guidebook (Version 2.1).* 31 October 2001. Taken from http://www.safaq.rtoc.hq.af.mil/tools.cfm. On 10 February 2004.

Department of Defense. *DoD Supply Chain Material Management Regulation.* DoD 4140.1-R. Washington: Office of the Under Secretary of Defense for Logistics and Management, 23 May 2003.

Department of Defense DMSMS Working Group. "DMSMS Tutorial." Presented at the 2003 DMSMS Conference on 18 August 2003

Department of Defense DMSMS Working Group. "Proactive DMSMS Management of DoD Weapon Systems." Unpublished presentation. N. pag. https://logistics.navair.navy.mil/training/library/DMSMSbrief031021.ppt. 11 February 2004.

Duncan, David, Lead System Engineer, AN/ALR-20A. WRACL/LSERB, Warner Robins ALC GA. Telephone interview. 29 January 2004.

Duncan, David. "Thesis Data Request." Electornic Message. 0848Z, 10 February 2004.

Gorman, Donald W. SMC Det11/MCL, Sacramento CA. Telephone interview. 2 February 2004

Gorman, Donald W. "Thesis Data." Electronic Message. 0459Z, 9 February 2004.

Hamilton, Philip and Chin, Gorky. "Aging Military Electronics: What Can the Pentagon Do?" *National Defense*, v85:34. March 2001.

Hanson, Jeanne A. OC-ALC/LGEEM, Oklahoma City ALC OK. Telephone interview. 6 February 2004

Hanson, Jeanne A. "Thesis data request." Electronic Message. 0119Z, 13 February 2004.

Heggen, Jim C. Mechanical Engineer, OO-ALC/LGERC, Ogden ALC UT. Telephone interview. 6 February 2004

Heggen, Jim C. "Telecon2/6/04." Electronic Message. 1051Z, 13 February 2004.

Hendry, Brian J. Mechanical Engineer, OO-ALC/LGERN, Ogden ALC UT. Telephone interview. 6 February 2004

Hendry, Brian J. "Thesis project." Electronic Message. 0650Z, 14 January 2004.

Hixon, Jim. "Surviving Graphics Chip Chaos." *COTS Journal*. Vol 4, no 2:44. February 2002.

Husey, Mark. "Avoiding Component Obsolescence." *Printed Circuit Design.* V19:28. September 2001. Defense Microelectronics Activity.

Livingston, Henry. "GEB1: Diminishing Manufacturing Sources and Material Shortages (DMSMS) Management Practices." Arlington VA: Electronic Industries Alliance, 2001.

McDermott, Jack, Shearer, Jennifer, Tomczykowski, Walter. *Resolution Cost Factors For Diminishing Manufacturing Sources and Material Shortages*. Contract GS-35F-4825G Task Order DMEA90-98-F-0018. Annapolis MD: ARINC, February 1999.

McClave, James T., Benson, George P., Sincich, Terry. *Statistics For Business and Economics* (8th Edition). Upper Saddle River (NJ): Prentice Hall Incorporated, 2001.

Molton, Hal. Pave Penny Program Manager, WRALC/LSTPL. Warner Robins ALC GA. Telephone interview. 8 February 04.

Molton, Hal. "Thesis/project description." Electronic message. 0623Z 10 February 04.

Morgan, John E. OC-ALC/BSBEF, Oklahoma City ALC OK. Telephone interview. 29 January 2004.

Morgan, John E. "Thesis summary." Electronic Message. 0710Z, 2 February 2004.

Ng, Raymond S. Electronics Engineer, WRALC/LEEB. Warner Robins ALC GA. Telephone interview. 29 January 2004.

Ng, Raymond S. "Thesis project." Electronic Message. 0542Z, 11 February 2004.

Overstreet, Robert E. "Process Mapping a Diminishing Manufacturing Sources and MaterielShortages Reactive Management Strategy: A Case Study." MS thesis, AFIT/GLM/ENS/02-12. School of Engineering and Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, March 2002 (AD-A399873)

Pallas, Spiros and Novak, Mike. "Reduction of Total Ownership Costs (R-TOC): Recent History and Future Prospects." *PM*, 29:60-66 (November-December 2000).

Plowden, Lee, R-TOC Program Director. "PBD 721 Status." Briefing to Mr. Durante (SAF/AQX) on 11 February 2002. http://www.safaq.rtoc.hq.af.mil/library.cfm. Accessed 12 February 2004.

Poursaba, Matt M. ECS Lead Engineer, OC-ALC/LGERC. Oklahoma City ALC OK. Telephone interview. 29 January 2004.

Poursaba, Matt M. "Project summary for thesis." Electronic Message. 0640Z, 25 February 2004.

Putman, Patrick J. Equipment Specialist, WRALC/LEADB. Warner Robins ALC GA. Telephone interview. 4 February 2004.

Putman, Patrick J. "DWG and HVPS." Electronic Message. 0832Z, 3 March 2004.

Putman, Patrick J. "Project summary for thesis." Electronic Message. 0340Z, 25 February 2004.

Reimer, Gary D. Electronics Engineer, OC-ALC/LGERN. Oklahoma City ALC OK. Telephone interview. 27 January 2004.

Reimer, Gary D. "SCADC 99.pdf." Electronic Mesasge. 1247Z 28 January 2004.

Richards, Dave. WRALC/LUNE. Warner Robins ALC GA. Telephone interview. 26 January 2004.

Richards, Dave. "test message." Electronic Message. 0541Z, 3 February 2004.

Ryan, Michael E. Chief of Staff, US Air Force. "Statement Before the Senate Armed Services Committee." September 29, 1998.

Schley, Tom. Senior Engineer, OC-ALC/PSWRB. Oklahoma City ALC OK. Telephone interview. 27 January 2004.

Schley, Tom. "Thesis data request." Electronic Message. 0149Z 26 February 2004.

Steiger, James T. MSD Engineering List Project Manager, AFMC/LGIF, Wright-Patterson AFB OH. Personal Interview. 12 December 03.

Tomczykowski, W.J. "A study on component obsolescence mitigation strategies and their impact on R&M." *Reliability and Maintainability Symposium, 2003. Annual*, ARINC Eng. Services, Annapolis MD, Pages:332-338. 2003.

Tomlin, Jack J. Logistics Management Specialist. WRALC/LEACA. Warner Robins ALC GA. Telephone interview. 6 February 2004.

Tomlin, Jack J. "MSD project summary." Electronic Message. 0342Z, 18 February 2004.

Wilson, JR. "Global War on Terrorism Intensifies the Problem of Obsolete Parts." *Military and Aerospace Electronics*, Vol. 13, no. 11: 18-21, 23, 24. 2002.

Vita

Capt Gehrich attended Hernando High School and graduated in the top five percent of his class in 1991. After graduation from high school, Capt Gehrich attended the University of Notre Dame. He earned a Bachelor of Science in Environmental Engineering in May 1996. Capt Gehrich received his commission on 18 May 1996 and was assigned to the 55th Supply Squadron, Offutt AFB, Nebraska, on 28 May 1998.

While stationed at Offutt, Capt Gehrich served as the Fuels Management Flight Commander, and Squadron Section Commander, and the Material Storage and Distribution Flight Commander. Capt Gehrich PCS'd to Soto Cano Air Base, Honduras in June 1999 to serve as the Sub Area Petroleum Officer (SAPO). Capt Gehrich departed Soto Cano in June 2000 and attended Squadron Officer School while en-route to RAF Lakenheath. While at RAF Lakenheath he served as the Material Storage and Distribution Flight Commander before deploying to Prince Sultan Air Base for 90 days. When he returned he was assigned to the Fuels Management Flight and worked in the Supply Readiness Control Center after September 11th 2001.

In August 2002 he began the Logistics Management Program at the Air Force Institute of Technology. Upon graduation, he will be assigned to the Logistics Management Agency, Gunter Annex, Maxwell Alabama.

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14. ABSTRACT
Every year the Air Force Material Command (AFMC) funds the MSD Engineering list. The projects on the list are submitted by the Air Logistic Centers in order to address problems with the maintainability or reliability of a reparable part. AFMC funds the projects to determine the root cause of the problem and find the best solution to fix the part. Since the MSD Engineering list is funded in order to improve maintainability and reliability, not as a cost savings initiative, the actual benefits gained from the funds spent on the MSD Engineering list have not been identified.

This thesis uses the FY99 MSD Engineering list as a representative sample of all MSD Engineering lists to identify how much of the money spent on the projects actually results in a benefit to the Air Force. Additionally, this study attempts to determine if there are any factors that correlate with projects that benefit the Air Force, and any common factors in projects that did not benefit the Air Force. Finally, this project attempts to describe the types of benefit the Air Force receives from the MSD Engineering list.

15. SUBJECT TERMS
MSD Engineering, Benefit, DMSMS

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