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Implementing a Product Lifecycle Management Solution

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Project Paper Revision History

Revision History

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Abstract

Aviation Technology Group, Inc. (ATG) is currently preparing for a lengthy FAA certification process that will require detailed documentation and verification of the accuracy of all components that will belong to the aircraft being developed (the Javelin). This includes but is not limited to contracts, detailed design specifications, CAD files, test and verification results, revision tracking, and effectivity of all components used in each aircraft.

The company has recently flown its first non-conforming prototype and will be building subsequent test articles, which will be used for the FAA certification process of the Javelin. In order to organize all of this information and be able to maintain many different complex relationships between multiple part revisions and different configurations of the aircraft, the company decided to seek out a commercial off the shelf solution (COTS). The initial attempts at an in-house system proved to be too time and resource intensive to build and too costly to maintain and expand, given the limited capabilities of a Microsoft Access based solution.

This project encompassed the evaluation, selection, and implementation of a Product Lifecycle Management (PLM)

software solution that would fulfill the needs of ATG’s data management requirements.

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1 Chapter One: Executive Summary

1.1 Statement of the problem

ATG is a startup aerospace company designing and certifying its first aircraft, the Javelin. The Javelin is a two-seat, twin-turbofan, executive “sport” jet. The Javelin has a tandem seating configuration with the style of a military fighter jet. The introduction of such an aircraft into the civil aviation market is considered a very risky project because of the niche market it is targeting. In order to mitigate the financial risk of this project, staffing and financial resources are very limited. One of the company’s main goals is to remain lean and agile in order to keep overhead costs down while remaining competitive with much larger companies. This can be achieved through automation and the use of current technologies. The company’s philosophy supports the use of the latest technologies in all aspects of the company. The use of newer technologies is what makes the Javelin unique among its competitors. While the company has no immediate competitors, it is the goal of ATG to create a niche market in the middle of an up and coming very light jet market.

The FAA certification required of all new commercially sold aircraft is notorious for its rigorous requirements and lengthy processes. On average, an aircraft may take

three years to certify barring any major problems. Many aircraft have taken up to ten years to complete the certification process due to a lack of funding, poor internal processes, and technical roadblocks. Because of the lengthy process, maintaining documentation over this duration is critical to successfully completing it. Employee turnover is common in many startup companies, but no part of the documentation or collective knowledge can get lost or misplaced due to a flux in staffing. As a result, having a well defined and enforced process for maintaining documentation is essential to any certification process.

The types of things that must be tracked or maintained include the entire spectrum of data found in any engineering firm. Typical forms of data include:

- Computer-Aided Design (CAD) files in their native formats
- Supporting specification documents related to these CAD files or the systems they represent
- Supplier and/or manufacturer information on all components stored in the system
- Any contracts or statements of work related to the design, modification, or acceptance of these CAD files or their related hardware

- Project scheduling information for all of the subcontractors and their related aircraft systems
- Project accounting data for tracking budget-to-actual costing related to the project
- Design reviews and acceptance approvals
- Maintaining configuration control between the Engineering Bill of Materials (EBOM), Manufacturing Bill of Materials (MBOM), and As-built Bill of Materials (ABOM)
- Maintaining effectivity of each component used on every serialized aircraft produced

1.2 Need for the Project

Previously, the types of information mentioned were being maintained in many different data formats and in many different systems by various engineering managers. There was no single location for all data and no single method of filing and maintaining that data. Each Engineering subsystems manager maintained their own data under the top level Engineering department network share. There was an established naming convention for all documents, but it required looking up the proper code in a lengthy Word document to find the format, then looking on the network to find the next available number for the document. Our

vendors had a different naming scheme, which even further complicated the problem of filing and locating documents.

CAD files are the most important types of files that need to be stored because they contain the actual design data for the aircraft. As CAD files came in, they needed to be stored in their native formats to protect the integrity of the file (meaning they can not be converted into a supported file format that we are able to open because that would alter the integrity of the file.) Because we cannot open many of the CAD files, it made verifying their contents difficult, if not impossible. The cost of adding a CAD station for every type of system, used by all of our subcontractors, was too cost prohibitive, not to mention we lacked the internal staff to run those various CAD packages. Therefore, a method of being able to quickly preview the contents of a file without having to open each one was needed.

An in-house Access database had been developed, to track the relationship between FAA requirements and the internally created documents that supported the implementation of those requirements. This database proved to be difficult at best to maintain and the internal links often broke when the files were renamed or moved to a different location on the network; making maintenance of

the links a constant source of frustration for its creators. Having a database that could dynamically adjust to changes in documents was needed in order to save many hours required to maintain the current solution.

The formats of the documents used throughout the project came from many different vendors. Because of this, having a system that supported those various formats was critical to the selection process. The types of document formats that needed to be maintained included:

- Microsoft Word documents
- Microsoft Excel spreadsheets
- Microsoft Project schedules
- Microsoft Visio diagrams
- Unigraphics CAD files
- CATIA v4 & v5 CAD files
- Solidworks CAD files
- ProEngineer CAD files

The above mentioned were just a few of the issues that concerned management when preparing for the certification process. With everyone already overloaded on work and only two administrative personnel to support the entire engineering department, there were not enough hours or people resources available to maintain the continuously growing mountain of documents. Currently the aircraft is in

the prototype stage so many processes have yet to be developed internally. However, as the project shifts from prototype design to actual certification design, rigid controls need to be in place, prior to beginning the certification process.

This project encompassed the implementation of a Product Lifecycle Management system that will be used to help maintain all of the required documentation related to the Javelin's development and the relationships between the thousands of components that will need to be reviewed in order to complete the FAA certification in 2008. The initial system included a complete stand-alone system that will support future add-ons and integrations with other external systems. It also provided a web-based portal and supported existing database technologies that the company already had in place. Upper management expressed its support for the system and approved the budget based on initial proposals by two different competing vendors.

1.3 Project Scope

The project only included the initial implementation of the PLM solution. Other requirements were defined only for the selection of the system and were beyond the scope of this project's implementation. Any added customizations, integration, and add-on packages that are scheduled for a

later date were not a part of this project since the budgets for those future expansions have not yet been approved. They are mentioned only to note that they pertain to the next evolution of the system.

1.4 Definitions, Abbreviations, Acronyms

Term	Definition
PLM	Product Lifecycle Management
PDM	Product Data Manager
COTS	Commercial Off-The-Shelf
CAD	Computer Aided Design
COO	Chief Operations Officer
FAA	Federal Aviation Administration
EBOM	Engineering Build of Materials
MBOM	Manufacturing Build of Materials
ABOM	Actual Build of Materials
SDLC	Software Development Life Cycle
ERP	Enterprise Resource Planning
EPM	Enterprise Project Management
OOTB	Out Of The Box

1.5 Summary

ATG is striving to be the best in everything it does. The success of the Javelin will determine the fate of the entire organization’s future. As a result, the investment in a complete PLM solution was made as an investment in the

company’s future. In order to remain lean and agile, technology is going to be utilized to help streamline engineering processes and minimize the amount of administrative overhead required to successfully complete the FAA’s certification process.

2 Chapter Two: Review of Literature

2.1 Pre-research On The Project

Since the IT Manager (the author of this paper) was not originally involved in the initiation of this project, he was unaware of any formal research done regarding the types of PDM systems available. The employee, who originally started looking into the various systems that were available, is no longer employed at ATG and was not available for interviewing for the purposes of this paper.

The IT Manager was involved in participating in the onsite demonstrations that were given at the ATG office during the selection period. Both UGS and MSC representatives came out and discussed their PLM solutions and demonstrated their product data manager (PDM) product lines. PDM systems are usually associated with the CAD management systems that fall within the umbrella of PLM systems. PDM systems are specific to engineering data management. PLM systems encompass the entire product lifecycle of a product’s develop, from concept to end-of-life support.

UGS demonstrated their PLM suite named TeamCenter. The product that we were most interested in was their TeamCenter Engineering Portal, a PDM system that combined workflows, document management, and a centralized

repository for CAD data. MSC demonstrated Dassault Systemes' SmarTeam PDM system.

After having both companies come out twice to demonstrate interfaces and discuss capabilities and pricing, all of those employees present at the demonstrations unanimously voted to go with the UGS TeamCenter product line. Since both systems supported mixed CAD environments, neither vendor had a competitive advantage based on ATG's existing CAD investments. Everyone felt that UGS' product delivered more features and provided a better graphical user interface (GUI) than the competing SmarTeam product.

2.2 Summary Of What Is Known/Unknown About The Project

One of the major hurdles the Engineering department had to address during this project was the determination of whether or not the software solution would meet all of our unique needs that are specific to ATG's ideal processes, as well as FAA requirements for document control and verification. As with any software project, the true capabilities often are not quite as robust or streamlined as the marketing literature and sales staff would have you believe. It's usually not until you begin to actually use the system that you learn its shortcomings and user

interface problems. Due to the nature of the timeline of this project there was little time to grasp the full capabilities of the product, prior to the system going live. And as always, there were user interface issues that came up as users began to use the system. The initial hope was that the system would have the potential to meet all of the current and future needs, and that it would do everything the sales team said it would.

The second major area of doubt lay in how the system would support the data integrity requirements for FAA certification. The system revolved around a fairly new file format called a JT file. The JT is a lightweight representation of a 3D CAD model. The JT file is accurate to within 8 places past the decimal (.00000001) and contains all externally viewable surfaces but does not contain any of the constraints, mathematical data or historical data that was used to create the original CAD model. It is also a read only format, similar to a Portable Document Format (PDF) that is typically used for text based documents. This format will allow geometrically accurate data from various CAD systems to be viewed and interrogated in a third party viewer without the need to translate any of the files into a common native CAD format. This new format allowed for better integration and design

capabilities between incompatible CAD systems, as well as the ability to view large scale assemblies. This eliminates much of the need for excessive computer processing required to open the models in their native CAD formats.

ATG intends to use the JT file formats for approval processes and inspection requirements, rather than being required to maintain CAD systems and skilled personnel for all systems from which their subcontractors will be delivering content. Since this file format is fairly new in the industry and not widely accepted, ATG will have to prove to the FAA, and get buy-in from them, that the format is a viable alternative to the older methods of converting or maintaining many different types of CAD platforms.

2.3 The Contribution This Project Will Make To The Field

This project will contribute to the Information Technology and Aerospace industries in two ways. First of all, the main objective of this project was the implementation of a PDM system, which is used as a repository and workflow management tool for engineering organizations that primarily require the use of CAD and formal documentation approval processes. This project will not only give insight in how to best implement a PDM system, but will also point out any pitfalls that an

organization, just beginning to implement such a system, might run into.

The second way that this project will advance the aerospace industry is in the way that data is stored, approved and accessed between internal personnel, external suppliers, and in working with the FAA certification authorities by means of electronic documentation rather than traditional paper drawings with attached signature sheets. The way ATG intends to use the system will allow inspectors to access data electronically from a remote location, interrogate the data for conformity inspection requirements, and view the audit trail associated with the approval of the data in question. This will minimize costly travel expenses for routine inspections and help streamline the certification process. It will also help reduce the administrative overhead of dealing with hard copy approvals, distribution of information, and physical storage of archival data.

3 Chapter Three: Methodology

3.1 Lifecycle Model to be followed

The project methodology that ATG set out to use for this project was a variation of the Systems Development Life Cycle (SDLC) using incremental development rather than a traditional waterfall methodology. ATG felt that this approach oriented them towards the most successful implementation of the project, since no person on the project management team has ever had experience in implementing a system of this nature. The approach was to take smaller steps and repeat the analysis, design, and implementation steps until the project was completed. While this approach would take longer, this approach ensured that the end product more closely reflected the intended results, rather than being forced to complete a system based on a schedule that does not benefit the company in the end.

This method also supported the internal growth of the company and its processes. At the time of this project the company was growing rapidly and as they brought in a more diverse pool of employees, the needs and desires to change existing procedures were constantly arising. Because this is the company’s first attempt at developing an aircraft, the detailed workflows and internal processes had not yet

been defined and put into use. By using the incremental approach, the engineering team could first get a chance to explore the PLM solution and determine how it could provide a framework to implement processes. Because these processes were not yet solidified, time would be required throughout the project to return to the analysis and design phases, which allowed the management team to revise their processes prior to going live with the system using real certification data.

3.2 Review Of The Deliverables

The deliverables for the project were a fully functioning production system as well as a complete test system that could be used for future product enhancement testing. The deliverables also included complete documentation of the system’s configurations as well as the software installation media and any manuals that accompanied them.

3.3 Resource Requirements

The resources for this project were rather intensive considering the limited staff that was available or knowledgeable about the product and/or the company’s processes. The internal resources required included an ATG assigned project manager, the Director of Engineering (key stakeholder), and representatives from each of the

Engineering subgroups (Avionics, Propulsion, Structures, Aerodynamics, Mechanical, Integration, Configuration Management, and Technical Documentation). The internal resources also included representatives from all departments that would be supporting or using the system once in place(Information Technology, Supply Chain Management, Quality Assurance, Manufacturing, and Flight Operations). External resources included a UGS appointed project manager, and an onsite developer that was responsible for installing and configuring the system. Additional UGS personnel were used for development support and work load distribution throughout the project.

3.4 Outcomes

The outcome of the project was to fully implement the selected PDM system with all of the necessary configurations required to support ATG’s use of the system and ensure that it supported the necessary requirements to assist in configuration management and certification of the Javelin. The project’s goal was to complete the project with a fully operational system that had adequate documentation and could be used immediately by the staff upon completion of the training during the implementation.

3.5 Summary

The nature and scale of this project lent itself to a

high risk project, due to the fact that the company had never implemented an enterprise-oriented system prior to this one. None of the personnel involved had been directly involved with defining the requirements for a system of this nature, even though many had worked with similar systems at previous companies. The definition of how the system should be used and how it needed to handle data was still unclear when the project began, since the company's business processes had not been formally defined and established as the target goal. This project also represented the largest expenditure on any technology investment that the company had made to date. Because of all these factors, the company chose an iterative type methodology to reduce some of the risk associated with the number of unknowns going into the project. This approach would allow the company to learn and grow as the implementation took place and the system took shape.

4 Chapter Four: Project History

4.1 How The Project Began

The project initially began in the fall of 2004 with a demonstration of both competing products. Upon deciding on the winning platform, the goal was to kick off the project as soon as resources were available from the software vendor’s implementation team. The engineer that was in charge of the CAD systems was let go from the company right after the project kickoff meeting. It was decided that the project would go ahead but in a phased approach rather than in one seamless duration. Once the implementation team had come out and installed the test system on the server equipment, the project was postponed due to an over commitment of internal resources and a shift in overall company objectives. The project was then shifted from December 2004 to March of 2005. In March of 2005 the project manager from UGS came out and met with the project team which consisted of the Structures manager as the project lead, the Configuration Manager as a team member, and the IT Manager as a technical representative. When the new project lead was unable to dedicate sufficient time to meeting with the UGS project manager, it was decided that our resources were still too pre-occupied to be able to effectively commit to the project. The project was then

shifted to May 2005. When May 2005 came around, it was decided that the IT Manager be put in charge of the project, both because he had the time to devote to the project and because he had the technical background to help bridge the gap between the technical implementation team and the internal business managers. ATG then decided to officially kick off the project on May 23, 2005.

4.2 How The Project Was Managed

The project was managed by both UGS and ATG resources. From UGS there was a project manager, one full time onsite resource, and a couple of resources available as needed. From ATG there was the IT Manager acting as the project manager, the Configuration Manager as a full time resource, the Director of Engineering as the core team leader, and other engineering staff that were available as needed. The IT Manager from ATG and the project manager from UGS were the two individuals that would be accountable for the system going-live within the proposed timeline and budget, since neither organization was prepared to commit any additional resources to the project should it fall behind.

As the project manager from ATG, the IT Manager called meetings with the project members on a routine basis. Some meetings were just to prepare people for what was going to be happening to give them a heads-up. Other meetings were

to discuss problems and investigate requirements further and follow-up on problems that might have come up in different areas. This was especially useful during the testing phase where the project team had a very limited number of testing days and included a group of end-users who were not involved in the core project team. Their lack of familiarity with the configuration of the system caused a lot of confusion and required a lot of mentoring during the testing phase. However, it would not have been practical to have had the project team do the testing alone, due to the amount of work that needed to be accomplished in the short amount of time that was available. By distributing the work to an alternate pool of users, the project team could more quickly follow-up on problems encountered with the implementation team from UGS.

Since the project manager from UGS was not onsite during most of the project, we had to have many conference calls with the onsite UGS team and ATG project team. The ATG project manager felt that this was somewhat of a waste of time, since the onsite team from UGS was up-to-date on the problems that we were facing and were usually already addressing them before the project manager was aware of the problem. This caused us to spend a lot of time rehashing issues that had come up and the actions that were taken to

get the project back on track. It was also problematic to work around different time zones and other projects' schedules since the UGS project manager was also in charge of another project being done concurrently with ATG's.

While the Project Manager felt that the core project team did a good job of staying on track and following up with other team members, he also felt that the managers of those team members did not get involved enough to understand what it was that their staff was doing. This caused some issues when a team member would get double-tasked with work from two different projects with conflicting schedules. If the direct supervisors had spent more time managing their staff a lot of the resource shortages experienced during the project could have been minimized to help support the success of the project.

4.3 Significant Events/Milestones In The Project

- Installation of the test system – This was the first phase of the project during the fall of 2004. This provided a test system that users could experiment with as well as provide a test platform for the UGS implementation team to test their customizations and configurations prior to compiling the final list for the production system.

- Gathering of Requirements – This phase was the most challenging since the organization had not fully designed or thought-out the business processes that the system was going to be designed to support. This was the critical piece that would determine whether or not the system would support its users in the way that it was envisioned when it was purchased.
- Configuration of the test system – Once the requirements had been gathered, UGS configured the test system so that users could test and validate the configurations prior to the production system being configured.
- End-User training – This was the onsite training that allowed all of the project team and end-users to get hands-on familiarity before the system went live. This was an instrumental step to ensuring that the testing group could successfully complete the test use-cases with minimal instruction.
- Testing the test system – The testing phase allowed the project team to see how their requirements affected the look and feel of the system. The testing team used this time to identify any gaps in the requirements definitions and to identify bugs with the new software.

- Installation and configuration of the production system – This phase involved identifying what features and capabilities would be migrated from the test system to the production system and validating that they worked in a clean installation. Several problems were identified at this stage, that were not noticed in the test system due to a reliance on “junk” configurations in the test system.
- Pre-Go Live end user training – This involved gathering all of the end-users and unveiling the final look and feel of the system. They focused on all of the areas of customization, so users could easily identify how their system differed from the system they used in their training sessions.
- Go Live – The system was turned on to all users. Onsite support was provided by UGS while users began to use the system. This was where the ownership of the system transferred from UGS to ATG. All subsequent support was to be provided thru internal staff or software product support.

4.4 Changes To The Project Plan

The project scope and planning were not sufficient to support the requirements of the key stakeholders. As a

result, the project plan was constantly changing as the requirements gathering phase continued to burn up man-days which caused the testing time to be decreased due to the finite project timeline. There was also considerable scope creep that had to be addressed since the definition of what was needed had changed significantly between the time the statement of work was written and the time that the project actually got started. The UGS and ATG project managers sat down and adjusted the schedule so that more time could be spent on configurations and customizations rather than on standard tasks such as testing, support, and basic installation. As a result, ATG had to assume responsibility by accepting the system knowing that the system’s thoroughness was not at a level it normally would have been had the correct requirements been identified in the statement of work. Additional time was inserted in the schedule to adjust for a lack of resources available from UGS at the start of the project and the unplanned training that ATG required to be added during the middle of the project. All of these changes affected the project plan that was in place prior to the project kick-off. However, some of these shifts in schedule helped accommodate the need for changes that benefited both UGS and ATG.

4.5 Did The Project Meet Its Goals

From a contractual standpoint, the project met its goals as outlined in the original statement of work. However the project did not meet all of the goals of its key stakeholders. Accurate requirements for the system were not in place prior to the statement of work and the related purchase contract being negotiated. As a result, the amount of services provided by UGS included in the project scope, were not sufficient to meet the desires of the key stakeholders. The project was completed within a reasonable amount of time, although slightly longer than originally estimated. The project stayed within the agreed project costs, with the exception of the additional onsite training that was added on by ATG. The final delivered system included more workflows, queries, and item types than the original statement of work required which was a bonus for ATG. The production system was up and running when the implementation team left, complete with documentation of how the system was configured and all of the customizations that were included. From a project management perspective the project was a success and delivered what was originally agreed upon by both companies. However, since the system did not meet the expectations of the key stakeholders, the project was considered by some to be a partial success.

4.6 What Went Right And Wrong In The Project

There were many things that went wrong during this project that will be discussed later, but there were also a few things that went right. The first thing was the selection of an appropriate project manager and project team. In the beginning the first two people assigned as the project manager from ATG were people without any background or understanding of systems analysis and design. They looked at the project from a purely engineering point of view. They didn't fully understand how to go from point A to point B in a logical fashion by understanding who was going to use the system and how they would need to use it. The IT Manager, the third person assigned to take on the project manager role, brought systems analysis skills gained through his formal education as well as a technical understanding of the product's architecture. He was able to utilize these technical skills as well as his project management skills to take control of the project and get it back on track. One key skill utilized was the ability to mediate between the technical staff and the project team and communicate their needs in a manner that could be understood by both parties involved. Being able to distinguish between pure technical hurdles or pure business requirements allowed him to be able to help understand how

the two could or, in some cases, could not match up to make the system work.

The second thing that went right during the project was getting the right personnel from UGS to assist ATG during the design process. The experienced resources that were originally assigned to ATG were not available by the time the project was kicked off for the third and final attempt. ATG was provided with someone new to UGS and thus had no previous experience doing an implementation from the vendor's perspective. Finding this unacceptable, the IT Manager contacted UGS and made his concerns known about the ability of the UGS resource to provide the leadership needed to get the project moving. UGS immediately pulled a resource off of another project and sent him to ATG to take charge of the onsite development work. This person was instrumental in getting things done in a timely manner, helping the project team more accurately define their requirements, and walking them through any technical issues that arose. With a solid team in place the project team was then in good shape to get the project done on time.

The third thing that went right during the project was the management support from the new Chief Operations Officer (COO) that came onboard to ATG just prior to the project kicking off. Prior to his arrival, none of the

upper level executives demonstrated a significant level of interest in the project. They were more concerned with why they were spending so much money for a system that wasn't being utilized. When the COO was briefed on the project he immediately expressed support for the project and stated his willingness to do whatever he could to get the Project Manager the resources required to make the project happen. This was a great benefit because the COO reassigned some duties among the management team, thereby freeing up the Director of Engineering so that he could get more directly involved with the project since he was the key stakeholder. The COO's prior company had implemented a similar product from another vendor which helped him to understand the importance of the system and its role in allowing the organization to move forward.

While the project was successful, there were many things that did not go according to plan throughout the project. Many of these resulted from unrealistic timelines and inadequate resources. The problems encountered during the project will be addressed in the "Lessons Learned From The Project Experience" section of this paper and thus are not covered in detail in this section.

4.7 Project Variables And Their Impact On The Project

The project variable yielding the greatest impact on

the project was the design requirements. The requirements define the scope of any project. However, in the case of this project, the statement of work was written well before the requirements had solidified. This caused many problems in determining which features were absolutely necessary, which would have to be left for the next evolution of the project, or which would be cut out all together. Because many of the desired requirements were not met, the key stakeholders were not very satisfied with the way the system was delivered in respect to how they envisioned it.

The next major variable was the timeline to go-live. Due to a few other higher priority projects at ATG, the start date of this project was pushed back three times before ATG and UGS finally committed to a feasible timeline. This wasted a lot of time for those resources involved at the start of the project. It also made it difficult to stay within the original scope of the project since the requirements were changing as the organization was growing. The chosen timeline conflicted with other events that took away precious time needed with stakeholders and resources that were being double tasked.

The third major variable was the resources themselves. Availability and capability were the two aspects to the resource problems. The first aspect was availability. The

Engineering department was under staffed well before the project began. There were at least three major concurrent projects each competing for the same resources over a two month time frame. This made it difficult to get the level of work out of them that the project team really needed. But, given that the clock had already started ticking, there were no other options but to make due with the resources that were available.

The second aspect to lacking resources was the skill levels of the resources involved. Before the project began the Project Manager identified some key areas of weakness that needed to be addressed since the personnel in those areas were critical to making the project go smoothly. He was unsuccessful in getting any additional outside resources that had been requested and therefore had to deal with the people that he had at his disposal. Since the key area of this system revolves around CAD management, the project team needed a strong CAD driver to help test the functionality of the system. The first Project Manager of this project was the lead CAD user who would have been capable of testing the system. However, since he was terminated prior to the project getting started, he was no longer available to fulfill this vital role. Three of ATG’s skilled contract engineers were all busy working on

aircraft design and were not allowed to be pulled off of their current assignments to work on this project. The only available CAD user was also the least experienced with CAD design tools. He did not have a solid foundation as to how CAD and PDM systems work together to assist in the design process. Consequently, this individual was unable to work without strict supervision and did not get a majority of his testing done in the allotted time. This meant that we would go live without a thorough test of the intended design processes and CAD integration abilities of the system. The Project Manager believes that this alone was the biggest failure in the project. This is because once the system was operational ATG didn’t have anyone on staff that could validate whether or not it would perform the way that it needed to in order to support the business. A couple of months after the project completed ATG was still under staffed and trying to hire someone that could fill the lead CAD role and help document the standards and procedures that all subsequent CAD drivers would need to follow when using the system. It is key to not only have the resources available to fulfill all of the project team roles, but also to make sure that these resources are appropriately skilled to make the most use of the time available for the project.

4.8 Findings/Analysis Results

After completing the project an analysis revealed several factors significant to the project's successes and failures. Most factors interrelate with one another and no single issue was to be assigned to the project's successes or failures. The project was not properly planned from the beginning. The appropriate types of resources were not available before committing to a timeline for completion. The volume of resources was not available to get the ideal amount of work done or to thoroughly test. There was a lack of interest or involvement from the mid-level managers within the Engineering department who were precisely the ones that would be most affected by the system once it began to be used to control their processes. While the project completed according to its contractual obligations, it did not meet the full expectations of its stakeholders because formal requirements were not accurately defined at the beginning of the project. A final and major factor identified is that the company as a single organization, needed to prioritize and focus on all of the projects in one big picture, rather than each sub group trying to accomplish their projects while trying to utilize the same resources that are being used concurrently on other projects.

4.9 Summary Of Results

From a project management perspective, the project was very successful given all of the problems that it faced from the beginning, in addition to the fact that it was completed within a reasonable amount of time and within budget. Most of the factors mentioned have the potential to stop a project or cause it to fail miserably. While ATG faced all of these obstacles they were still able to persevere and create a workable solution that met their basic needs. It allowed them to start getting a Return On Investment (ROI), by utilizing the system, even if the system wasn’t perfect. Pulling together as a team and helping out where each person could, brought the project team into a cohesive workgroup that was able to implement a functional system. A key characteristic in becoming a good project manager is learning from experiences and using that knowledge on future projects in order to avoid problems before they occur. The project manager must help the team to focus on creating a functional system rather than on trying to create the perfect system.

5 Chapter Five: Lessons Learned

5.1 Lessons Learned From The Project Experience.

5.1.1 Planning

One of the biggest road blocks to starting this project was a lack of planning by all those involved. The original parties involved were the head of Supply Chain Management (SCM) from ATG, the sales team from UGS and the lead CAD designer that would be using the system. The engineer was concerned about getting the technology that he needed and was less concerned with the business processes that were driving the need for the software. The head of Supply Chain was concerned with getting the best price on the complete package rather than focusing on what was included in the package in regards to how it supports the stakeholders' needs and the processes required to meet those needs. The sales team from UGS was primarily concerned with making the sale and getting their foot in the door with the system and didn't really have a clear understanding of what the business' current position was, since none of the key stakeholders were involved in the purchase negotiations. The level of effort required to complete the project was completely underestimated. What really needed to be accomplished was being over simplified by those involved. The key stakeholder in the project, the

Director of Engineering, was not very involved in determining the initial scope of the project because he had assigned the responsibility to the CAD Designer, rather than expressing the complexity of his needs and the processes the system needed to support and ensuring that those issues were being addressed. Overall, a lack of detailed planning and a rush to get the system going was a major fault with the start of this project. Without adequate planning and realistic goals a project can never meet its stakeholders' expectations or timeline requirements and still stay within the budget that has been targeted.

5.1.2 Clarification/Communication

A large part of implementing a new technology is in understanding what the capabilities and limitations of the technology are. There needs to be a clear understanding of what the organization desires the product to do, relative to what the product actually does out-of-the-box (OOTB). During the project the biggest point of contention was the fact that while the product "could" do what ATG wanted it to do; it could not do it OOTB. Most features that were standard OOTB features were not adequate enough to meeting the requirements of the intended use of the system. Each feature needed to be configured or required customization

beyond the basic functionality in order to perform adequately. This would require considerable time and cost to be added to the overall system that was not accounted for during the initial planning if it was to be required.

5.1.3 Stakeholder Involvement

One of the biggest battles the Project Manager fought in trying to get the project off the ground was getting the Engineering management team involved in the project. Most of them were over tasked with other duties and had unrealistic timelines to work with. In addition to their primary responsibilities that had a higher priority by upper management, they were also being asked to commit a considerable amount of time to the requirements definition and testing phase of the project. The lack of interest in the project due to its less immediate need was problematic for the project management team. This required that the Project Manager go to the COO to get support from upper management and mandate that a certain amount of time was to be committed to the project. As managers began to delegate their involvement to junior engineers the project team quickly reverted back to a group of people who had no idea what the system was for or what it was they were supposed to be doing to help design the system. At this point we had the COO approve the Director of Engineering as a full time

member of the project team for the initial requirements gathering phase since he was the key stakeholder that initiated the need for the project. This was an extremely valuable asset to the project team, as the key stakeholder, he had the vision of what the system needed to do as well as approval authority for what was acceptable as a deliverable configuration. Having the key stakeholder involved at the beginning of the project helped to accelerate the requirements gathering and level of detail for certain aspects of the system.

5.1.4 Interdepartmental Communications

One of the planning aspects mentioned early was the lack of detailed planning before scoping out the project. There was a lack of adequate communication between the Engineering executives and the Supply Chain Management executives in regards to the needs and desires of what the product should do. Engineering typically requires a considerable level of detail in processes and design capabilities. SCM typically is focused on timelines for deliverables and the bottom line when it comes to purchase negotiations. In order to properly negotiate a contract for the software and implementation services, both parties need to be involved and understand what the needs are. SCM’s understanding of what was needed by the Engineering

department was severely underestimated. This stemmed from the fact that the Engineering department was not initially familiar enough with the product and the implementation requirements to communicate those needs to SCM so that they could be included in the statement of work. If all parties had taken the time to thoroughly understand the requirements of the Engineering department, then a more realistic project scope could have been defined and budgeted for.

5.1.5 Timelines

One of the biggest underestimates in the initial project launch was a lack of understanding about what was going on throughout the organization as a whole and the resources available to work on this project. It was assumed that only a few people would be needed to work on the project since ATG was paying a considerable amount of money in implementation services for contracted labor. However, this was only a fraction of the actual labor involved in implementing the system. After the project initially began in December of 2004, the company decided to allocate all available resources to working on the prototype aircraft in order to accelerate the schedule for first flight. As a result, the project was put on hold indefinitely until more resources were available. Once again, the project was going

to be resumed in early 2005, but the time of the Engineering manager that was in charge of the project was limited by other obligations to point where he was unavailable to meet with the project manager from UGS to provide any useful input. This was obviously an unacceptable situation so the project was once again put on hold. The third time the project kicked off the IT Manager was put in charge of the project and was responsible for identifying needed resources. As mentioned earlier he was having trouble getting the management team from the Engineering department involved due to over commitments of their time. The major lesson learned is to be sure that you have adequate resources available and that if those resources are assigned to multiple projects that those projects have time lines that don’t conflict with one another.

5.1.6 Training

A large assumption during the project proposal stage was in assuming that the CAD designer in charge of the system would be the person to train the rest of the employees when the system was up and running. This was a train-the-trainer type scenario where a few key employees would attend training and then return to train the rest of their peers as the project progressed in order to minimize

the amount of time required of employees at offsite training facilities. Due to the fact that the CAD designer left the company prior to the project getting started, there was no longer an in-house expert to train the rest of the staff. There was also no funds budgeted for formal training of the employees. Once the IT Manager had been put in charge of the project and had become more familiar with the product, he soon realized that the complexity and breath of knowledge required to use the system was well beyond that which could be disseminated efficiently thru in-house training with the limited knowledge that the project members had learned during the implementation. As a result, he went to the COO and asked for additional funds for formal onsite training. This was a huge help in getting the appropriate staff trained in a very short amount of time while not requiring any travel by the employees that needed training. Some of these employees that were trained at this time became the testing group since they had the knowledge to go in and look for problems after learning how the system was supposed to work.

Training is an aspect of any new technology that must not be underestimated. If users don’t understand how to navigate around in a system, then they will soon avoid using the system or circumvent it thru manual processes.

5.1.7 End-user Involvement

As with any new system, having the actual end users of the system involved from the beginning will help to build a system that reflects the needs of the users as well as help give a sense of ownership of the system and buy-in as to its final configuration. From the beginning of the third project kickoff the Project Manager called frequent meetings with the project's team members which included the core project team (Directory of Engineer, Configuration Manager, COO, UGS Project Manager, and the IT Manager), optional core members (Engineering management team), and the implementation team (representative members from each area of Engineering, Manufacturing, SCM, Flight Ops, Program Mgmt, and IT). By having all members present and gathered in one place, the high level tasks and goals could be discussed so that everyone was aware of what was going on and what was expected of their area in order to complete the project. This helped to get the end users involved in discussions and feel like they were contributing to the system's design. This also helped to familiarize them with the system over time rather than unveiling the system once it had gone live and overwhelming them with information and a new complex user interface. End-user involvement is a critical part to any successful implementation. This helps

minimize the issues that come up due to features not being present that are expected by the users. It also helps with end user acceptance since they are involved with the system during the design phase.

5.1.8 Resource Pooling

As mentioned before, having the necessary resources available is the most essential part of being able to complete a project. One of the issues that came up was resources being over extended between multiple projects. The project team had some users that were more than willing to participate in the project, but once assigned a project task, their supervisor would assign them work on other tasks that took them away from their project duties. This caused some tasks to not be completed on time or not at all in some cases. The lesson learned here is that it is imperative to communicate the importance of the project tasks to the supervisors that are in charge of resources assigned to a project. While the supervisor may think that their resources' normal duties are more important than someone else's project, the reality is that during an implementation you're paying for the time of the software company's resources in addition to your own personnel. Time delays that affect both internal and external resources can increase the cost of the project significantly. It is

imperative to get the support of upper management to ensure that issues such as these get addressed quickly and that the proper resources are available to complete the project on time and within budget.

5.1.9 Budgeting

Proper budgeting is an important aspect of any project. However, understanding the proper budgeting method is critical to making sure that the project's goals can and will be accomplished. If a project is completed within budget, but does not meet its original project goals then it is probably going to be considered less successful than a project that is completed that meets all its goals and is moderately over-budget. If the project does not address the problem that it was originally initiated to solve, then it is useless, regardless of how much or how little was spent. SCM had negotiated for a discounted, fixed pricing style contract. However the scope of work that came along with the negotiated price was insufficient to accomplish the intended objectives of the key stakeholders. Therefore the time and labor provided by the software vendor was also fixed, regardless of how much of the project actually got completed. Because of this situation, a considerable number of requirements had to be dropped during the implementation since there was not adequate time and resources available

to successfully implement them. The more appropriate method would have been to negotiate a flexible discounted services rate estimated on number of days required to complete the project, but allowing for additional time at ATG's expense should additional requirements be identified during the project. Since the requirements were not properly defined in advance, the estimated days that were budgeted were significantly less than needed.

The lesson learned is that while budgets are important; don't let the bottom line force the project to fail before it is completed. Allow for problems and have a contingency plan to acquire more funding if the project begins to run over budget. This is a key area of concern in any project's risk management plan.

5.1.10 Management Support

Throughout the project the Project Manager encountered many obstacles in trying to complete the project. As a result, he often had to go to the COO to ask for additional staffing, funding, or enforcement. It is paramount that as a Project Manager you have the support of upper management for the project before it begins, otherwise you may find yourself without the resources you need to accomplish your objectives and being held accountable for the failure of the project even when the circumstances are out of your

control. Any project that does not have the support of management is doomed before it ever begins.

5.2 What Could Have Been Done Differently In The Project

Looking back at how the project went, there were many areas of the project that were not done the way that the Project Manager would have liked for them to be done. As a result, there were many lessons learned and things that he would have done differently if he had to do the project over again. These are definitely areas that he will be sure to focus on during future projects.

5.2.1 Thorough Understanding Of The Requirements

The biggest single phase of the project was the requirements definition phase. This took approximately three of the nine weeks during the implementation. The scope of the project was so underestimated that there was less than one week allocated to this task in the original project plan. Because extra time was used to more thoroughly understand the requirements, time was taken away from activities such as testing and post go-live mentoring. Two areas that hurt the company the most was once the system went live and the problems that were discovered that should have been addressed during testing. In future projects the IT Manager plans to ensure that all parties involved understand the scope of the requirements and that

thorough definition has been documented so that a proper schedule and budget can be determined.

5.2.2 Thorough Understanding Of Product Capabilities

In order to effectively understand all of the areas of a system that need careful thought, a thorough understanding of how the system is used is first needed. Having minimally seen the product during some of the sales demonstrations, the Project Manager had little understanding of how the product worked and what all of the different applications within it were for. Without knowing what a system's capabilities are, it is hard to design how the system needs to be configured and what types of use-cases need to be tested against. The project team had quite a learning curve trying to get up to speed on the system as they were defining our requirements for its usage. In the future, the Project Manager should insure that all members of the core project team get formal training before beginning to define how they want to use the system. This will help confirm or deny any assumptions that the users might have as to the system's capabilities and proposed uses.

5.2.3 Clear Explanation Of Implementation Services

One of the assumptions that caused the most frustration among ATG's project team was what was actually

included within the scope of the implementation services. Since the project team was not present during the negotiations of the implementation services they were unaware of what level of services were included. As they soon found out, the implementation services only included basic OOTB installations and population of standard data. It did not include any major configurations or customizations that are required by most customers. This meant that many of the capabilities that ATG had assumed would be available to use were not, because they had not specified them in advance to be added to the initial project scope. This goes back to knowing the system before you begin to define your requirements so that you can be sure to include all the features you need configured into the statement of work.

5.3 Did The Project Meet Initial Expectations?

Determining whether or not the project met its initial expectations depends somewhat on perspective. Assumptions were made from both ATG and UGS as to what the expected outcome of the project was to be. From a contractual obligation based on the initial project statement of work UGS fulfilled their obligations and met the expectations that they were required to meet. From this viewpoint the project was successful. However, from the viewpoint of ATG,

many of the areas of customization did not get completed since they were not explicitly defined in the statement of work. As the project picked up momentum it was obvious that the requirements that were being defined during the first stage of the project were well in excess of what was realistic based on the statement of work and project schedule.

As the project progressed, new requirements would be identified that lead to scope creep. After the project managers from both ATG and UGS discussed what options were available, ATG opted to drop many of the requirements due to budget and timeline, and UGS offered to add some additional functionality within the time that they had available. The outcome was a suitable compromise in order to support both organizations' needs for schedule and budget commitments. But whether the project met the initial expectations of the stakeholders and end users requires a slightly different perspective. The major stakeholders and end users that were involved in the project team had great visions of what they wanted the system to do.

Upon finding out that most of the expected features required advanced configurations or customizations, the project team quickly began to realize that many of these features were beyond the scope of work and would not be

able to be implemented during the initial implementation. Because of this, many of the users and stakeholders felt that they got a half built system rather than the fully capable system that they had envisioned. Having high expectations is part of human nature. However documenting those expectations and ensuring that they are addressed during the planning phase is critical to making sure that the scope of the project allows these expectations to be targeted. Otherwise the stakeholders might view the project as a failure even though technically it was a success.

5.4 Next Stage Of Evolution For The Project

Since many of the expected features were not able to be implemented during the first evolution of the system, there is already a scheduled follow-on project expected to begin in the fall of 2005 in order to expand the system's capabilities. These capabilities include:

- A part number format checker - This will allow the system to validate whether the new part number being entered by the user conforms to the formatting requirements defined by Engineering.
- Additional workflows - These are needed to complete the design processes that the system is designed to support. Only the first two of four workflows were

completed during the initial implementation due to time and budget constraints.

- Existing Workflow Enhancements – This will allow the workflows that were included with the original project to be enhanced to the level of functionality that was originally desired.
- Active Directory Integration – This will allow a user’s TeamCenter account to be linked to their network login so that passwords are kept in sync and password policies enforced.
- CAD Integration – This will provide additional integration between CATIA-based CAD systems and the TeamCenter system which does not come with the integration configured in an OOTB installation
- Change Management – This configuration is required to use the Change Management tools within TeamCenter to help support the change process later in the design process.
- Enhanced Audit Viewing – This capability will allow a professional looking report to be generated that shows the approval process and who approved or denied the item at each step. This will replace a signature page that traditionally would be attached to each drawing that is certified by the FAA.

- Interface Customizations – Any changes to the OOTB interface require customizations that can be rather involved due to the number of areas that these interfaces must be accessed from. This would include some minor tweaks to the interface to make item creation in the system more user friendly.

In addition to existing system enhancements, the decision has been made to install the manufacturing module for TeamCenter that will allow the manufacturing department to benefit from all the data already stored within TeamCenter Engineering. The TeamCenter Manufacturing implementation, although smaller in nature, will be similar to the TeamCenter Engineering implementation. Since the two systems use the same code to run, it is more like turning on existing functionality rather than building a new system.

Once the manufacturing portion has been installed the Finance and SCM departments will be implementing a new ERP system called Great Plains, which is owned by Microsoft. After the Accounting, Engineering, and Manufacturing systems are all live and working ATG will begin to integrate them using a new ERP connector that is currently being developed by Microsoft and UGS. This will allow all

of the enterprise systems to transfer data as efficiently as possible and eliminate errors due to human mistakes. This integration will be one of the most critical components of the whole system since it will need to maintain an accurate configuration of each aircraft built, down to the nut and bolt for a specific aircraft serial number. This is required to maintain the FAA's conformity requirements that ensure that what is certified matches what is in production. The information about what is actually installed on an aircraft is critical when investigating an incident, should an aircraft crash occur. All of these systems are part of the future expansion of the system that was put in place by this project. This project was the initial piece of a much larger enterprise system that ATG will be implementing.

5.5 Conclusions

From the Project Manager's perspective, overall the project was successful in that it was completed within a realistic time frame and only required minimal additional funding in order to get the users trained so that the system could be used more effectively as soon as it went live. In order for the system to be completely successful, all of the previously mentioned enhancements and add-ons need to be implemented in the near future so that once the

system is being used it will support the entire business' processes without interruption.

5.6 Summary

While the project did not go as smoothly as it could have it was an invaluable experience that will contribute to future projects that ATG pursues. There were many lessons learned on behalf of both ATG and UGS due to the unique nature of the requirements and maturity of ATG's organization. As a startup company, all business processes are being created from scratch as a need presents itself. This presented a problem to UGS' normal way of documenting existing processes and customizing the system to support them. Since ATG was basing its processes on the system's capabilities, they were developing their processes as they learned about the system's capabilities. Due to the fact that there were no current business processes in place and the fact that the ATG project team had little understanding of the system's OOTB functionality, the original scope of work for the implementation was severely underestimated. Due to the lack of information during the early stages of planning, the amount of services included in the services contract was not adequate enough to meet the expectations of the key stakeholders and end-users. This shortcoming caused many of the people involved in the project to view

the outcome of the project as only a partial success.

Since this was the first implementation of a major system that ATG had done, many areas of the company had to learn many lessons the hard way. This project provided a first hand account of what happens when good project management skills aren’t used during the initial planning of a project. There are many different sides to a project of this scale. Taking notes as problems arise will help to address those issues in future evolutions. It has been pointed out that there were many areas that caused problems, whether due to a lack of requirements, communication, or planning. The key to future success is that ATG learn from its mistakes as an organization and make the effort to more thoroughly plan before committing resources to a project of this scale in the future. If the thought processes are changed, ATG can look forward to many successful project completions on all of the related follow-on projects that are now on the horizon.