Teaching Old Dogs New Tricks

Robert A. Bardo
Lockheed Martin Missiles and Fire Control
P.O. Box 650003 M/S EM-90
Dallas, TX 75265-0003
bob.bardo@lmco.com

Phillip J. Brown
Systems Engineering Associates, Inc.
P.O. Box 763220
Dallas, TX 75376-3220
phil.brown@seConcepts.com

Abstract

Downsizing, and consolidation of previously independent companies, has produced a clash of cultures in many companies. The problem is exacerbated by "home-grown" product development cultures that have been around for decades and often fail to adequately integrate new disciplines such as software engineering and systems engineering.

Over the years, the pace and complexity of technological development has increased. Mergers have brought together more companies with differing processes. New standards like the Software-Capability Maturity Model® (SW-CMM®) and Capability Maturity Model Integration® (CMMI®) have been introduced. All these changes have increased the need for developing and instituting new, integrated, and more repeatable engineering processes. Methods of introducing, and gaining acceptance of, these new processes are becoming very important to the continued competitiveness of many companies.

At issue is how best to get a diverse workforce to work together to achieve extraordinary goals.

Lockheed Martin Missiles and Fire Control (LMMFC), faced with integrating two former competitors, embarked in 1999 on a course to develop a common product development culture. A primary forcing function was the use of Carnegie Mellon University's Capability Maturity Model Integration (CMMI®) standard. The resulting new processes are enabling employees to achieve higher goals -- by increasing productivity, maximizing use of information, using proven simplified processes, increasing re-use, and decreasing re-work. Results to date indicate a “One Company, One Team” mentality is rapidly becoming the norm at LMMFC.

Introduction

Changing organizational behavior is a formidable challenge. Trying to change an entire industry is even more difficult. Yet, that is precisely what organizations within the U.S. Department of Defense have been promoting since the late 1950s (Morais & Mar, 2003). Recently, these common threads are contained in the many initiatives to gain organizational and employee “buy-in” of a common integrated Product Development Process (PDP).

In the consolidation of the defense industry that occurred after the break-up of the USSR, many of the major defense companies acquired a large number of companies with disparate, and in some cases conflicting, corporate cultures. They are now propagating uniformity across these operating entities. To achieve this objective, Lockheed Martin Corporation established an Integrated Engineering Process (IEP) standard to provide a common process framework across the enterprise. It issued Corporate Policy Statement CPS-023 defining the requirements, set a

timetable for compliance, and specified the use of Carnegie Mellon University's Capability Maturity Model Integration® (CMMI®) as the tool for measuring business unit maturity.

Many INCOSE members have been at the forefront of promoting the value of improved product development processes across a wide swath of industry, including several in recent years (Armstrong, 2003; Morais & Mar, 2003; Sheard & Schoening, 2002; Withlin and Rebentisch, 2003). Others have shared their experiences in the work they have done to change cultural attitudes (Evers & Miller, 2003; Langenberg and Gieskes, 2002; Rout, et al., 2001; Wray, 2002). Reported below is the story of how one Lockheed Martin business unit, Lockheed Martin Missiles and Fire Control (LMMFC), implemented an improved system for developing products.

The Changing Product Development Culture

The fifty years beginning around 1870 saw an unprecedented stream of new products introduced in the United States (Hughes, 1990). Individual inventors whose hallmark was a hunt-and-try approach necessitated, in the absence of theory, by the need to hypothesize and experiment developed a majority of these. These highly individualized processes led to the development of product inventions such as Alexander Graham Bell's telephone, the Wright Brothers' powered aircraft, Elmer Sperry's gyrocompass, and Thomas Edison's incandescent lamp, phonograph, and motion picture system.

Increasing systems complexity, and a growing body of theoretical knowledge, gradually shifted the emphasis in product development from inventive individuals to small teams of engineers and craftsmen. Companies began to form engineering departments or industrial research laboratories to develop new products. World War I -- with its introduction of new military products such as tanks, aircraft, diesel-electric powered submarines, aircraft carriers, and complex naval gunfire controls -- accelerated the transition to more systematic engineering processes. While experimentation and testing remained an essential element of product development, they were now but one part of a larger sequence of operations.

Another sea change in product development occurred in the years immediately following World War II (Hughes, 1998). Synthesizing lessons learned in the years up to and including the war, a small group of influential engineers and scientists began promoting what they called the systems approach. The Atlas intercontinental ballistic missile became one of the first projects in which a product was developed with this approach. The year was 1954. A significant by-product of this and a few other early projects was a set of integrated management procedures that became the basis for MIL-Standard 499, Systems Engineering Management.

Fast forward to today. The pace at which new technologies are being introduced is increasing. At the same time, these technologies introduce more complexity to the product development process. Corporate leaders are recognizing the risks of relying on the heroic efforts of a limited number of talented employees to hunt-and-try their way to an acceptable solution.

Unleashing the creative talents of all the employees on product development teams requires a development framework that is understood by all, and that provides a reservoir of time-proven, well-defined processes. Teaching the old dogs these new tricks requires the right process and the right training materials, and takes time.

Catalysts for Change

Lockheed Martin Missiles and Fire Control (LMMFC) is the result of the combining, in July 1999, of previously absorbed operating entities in Orlando, Florida, and Dallas, Texas. The two entities had similar, but not overlapping, product lines. At the time of the Dallas-Orlando integration, Orlando had about 4,500 employees and Dallas about 2,500 employees. Figure 1 traces LMMFC's lineage. Cutting operating costs, through elimination of redundant personnel and introduction of more efficient and common procedures, was a major objective of integrating the Orlando and Dallas operations.

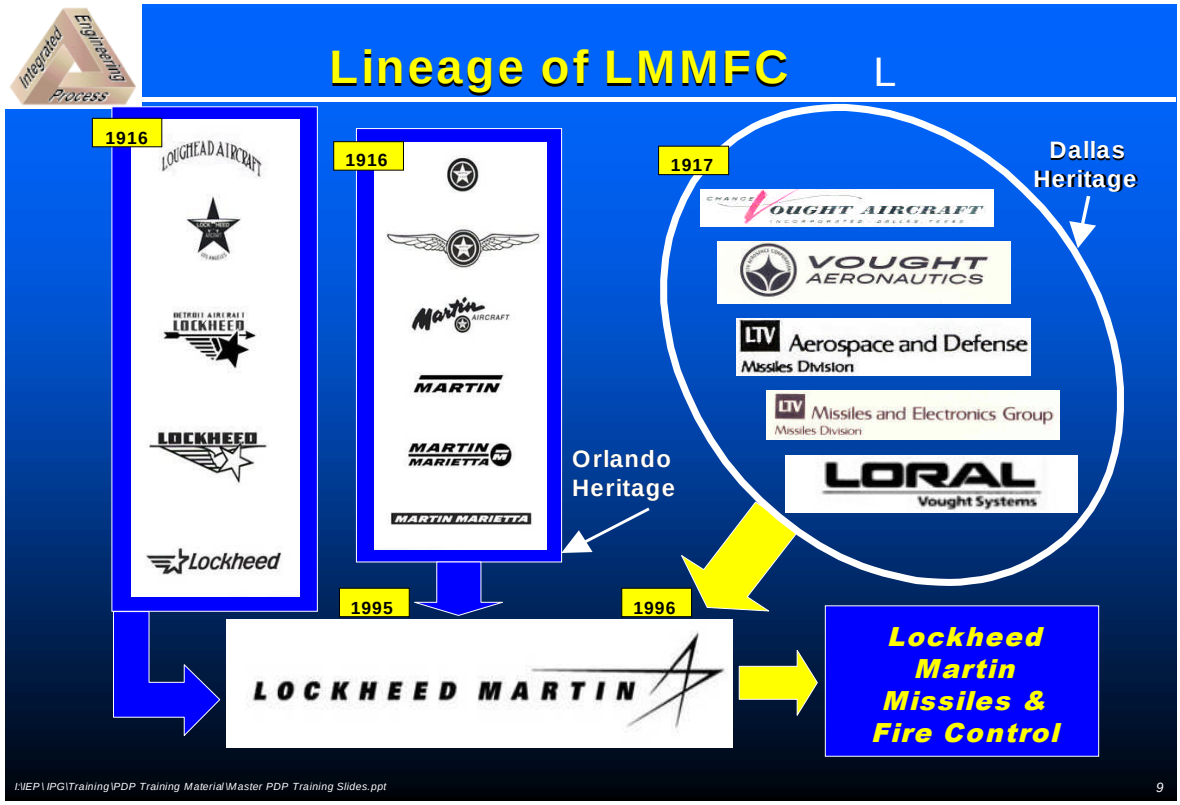

Figure 1. LMMFC has a Distinguished Lineage

Some major products of the combined company are:

- Army Tactical Missile System (Army TACMS),
- Javelin,
- Joint Air-to-Surface Standoff Missile (JASSM),
- Low Altitude Navigation and Targeting Infrared for Night (LANTIRN),
- Multiple Launch Rocket System (MLRS), and the
- Patriot Advanced Capability-3 (PAC-3) air and missile defense system.

Lockheed Martin prides itself as being "One Company, One Team" and so there was no better time to bring the two former competitors together, both in culture and in processes. Lockheed Martin initiated a Corporate-level effort to standardize engineering processes across the

Corporation behind a Lockheed Martin Integrated Engineering Process (LM-IEP). The goal was to raise the maturity levels and performance of the operating companies' systems, software, and hardware engineering processes, and of their program management processes, to CMMI® Level 5. SW-CMM® was one of the early initiatives, and then was followed by a move toward EIA/IS-731 Systems Engineering process improvement. CMMI® arose before a good start could be made with EIA/IS-731, however, and the move was made to become compliant with CMMI® instead. CMMI® is a framework of engineering best practices, and requires a repository to store all program information. Using a CMMI®-compliant process allows for uniformly executing engineering best practices and making all program information instantaneously available to all employees. While the process is being executed, objective evidence is produced and stored to show that the process is being followed. CMMI® compliance is becoming more important as a discriminator for competing for contracts. Lockheed Martin has committed to its customers to operate with CMMI®-compliant processes.

At the same time, the need throughout industry for generating better requirements was becoming clearer. Industry studies indicated that 80% of all defects are inserted into the product during the requirements phase, and that about 50% of all effort on a typical U.S. program is re-work. To avoid this, studies also show that at least 12-15% of total program funds should be spent on requirements definition to get the lowest percentage overrun. Throughout industry, there are program managers who tend to rush through the critical early parts of their program in order to get quickly to the exciting test phase. As a result, since it should take about eight months to prepare for a test, those managers end up rushing into integration and test so that they can start *earlier* on *more* problems! Programs need to spend the time up front to define and review the requirements -- to ensure that they are creating valid and proper requirements, before advancing to the other phases of the programs.

To realize corporate management's improved productivity objective required getting employees of the two former competitors to speak, think, and work within the framework of a common product development process.

To this end, a joint task force, composed of subject matter experts from both organizations, was chartered to develop and implement a common product development process.

Cultural Differences

The two major components of Lockheed Martin Missiles and Fire Control had been competitors for 41 years. The "Lockheed Martin Vought Systems" (Dallas) business grew out of the LTV heritage, and the "Lockheed Martin Electronics and Missiles" (Orlando) business sprang from the Martin-Marietta heritage. Being competitors for many years created a general sense of mistrust among some of the employees, but the management team of the newly created Missiles and Fire Control business were adamant that cultural differences be quickly overcome for the sake of the continued success of the enterprise.

These cultural differences are the result of the three companies having developed separately over an 80-year period before combining. Loughead Aircraft Manufacturing Company had formed in 1916, The Glenn L. Martin Company in 1916, and The Lewis & Vought Corporation in 1917.

- Employees at the Orlando site have a more direct interpersonal approach, along with a can-do attitude. Dallas employees mix southern manners and the can-do, no-limits spirit of the wild west into a friendly, team-oriented atmosphere.
- The Dallas site has fewer, but larger, programs that are longer term, enabling a focus on long term engineering development and high quality. The Orlando site has many smaller shorter-term programs, resulting in an emphasis on marketing and manufacturing, as well as high quality engineering.
- Organizational structures of the two sites were also different – although both are matrix organizations, combining both functional and program organizations, and although both have strong program organizations, Orlando has had more emphasis on the program side. The functional side of the Orlando matrix organization is now being expanded.
- Each had a significant turning point in the mid-1970s. In Dallas, two large programs came to an end (A-7 attack aircraft and F-8 fighter aircraft) and the next large program (US Navy F-18) was lost. Dallas employment fell from about 30,000 to 12,000. In Orlando, total employment in the early 1970s was about 18,000 -- with most of those on either the Pershing or Sprint programs. The SALT II agreement made between the Soviet Union and the US in 1973 resulted in immediate termination of Sprint, and employment plunged from 18,000 to 3,000 in nine months. Management reactions to these events were different. In Dallas, management focused employees on winning multiple medium-sized programs for stability, with emphasis on designing and delivering products of the highest possible quality. In Orlando, the strategy was to pursue many small programs (each requiring a quick response), so that the loss of any one program would not devastate the company's employment. Emphasis was also on the highest product quality.

As a result of these and other cultural differences, an atmosphere of initial mistrust existed when the two sites were first integrated. It was gradually realized that these differences were in fact strengths, as each site learns much from the other.

Statistics show that executing a successful merger is not easy. In fact, it is widely reported that at least seven out of ten mergers fail (e.g., MODAL Pty. Ltd., 2002; Warsh and Porter, 2002). A major source of merger failure (Weber and Camerer) is the difference in cultures between the merging companies that make it difficult for members of the merged companies to see things in the same way. Employees in each of company often prefer the "old way of doing things" – due to learning costs, inertia, "not invented here", etc. – and so may intentionally resist adopting each other's practices. In Weber and Camerer's experiments, "subjects over-estimate the performance of the merged firm and attribute the decrease in performance to members of the other firm rather than to situational difficulties created by conflicting culture."

A company's culture is implicitly known by its employees – e.g., in financial focus, operating boundaries, decision authority and responsibilities, and reward and punishment (Harwell, 2001). "Arrow (1974) discusses culture as 'codes' developed by organizations to help coordinate activity and points out that these codes are path-dependent and may therefore differ greatly between firms, even though each is efficient. Cremer (1993, p. 354) builds on Arrow's concept of codes to define culture …as 'the part of the stock of knowledge that is shared by a substantial portion of the employees of the firm, but not by the general population from which they are drawn.' In Cremer's model, the organization must respond to outside messages in a coordinated

manner and this is less costly to accomplish when the stock of shared knowledge is greater, because of less time needed for communication."

The number one challenge for the Lockheed Martin MFC management team was to accomplish a seamless transition to a single integrated entity of two businesses from different heritages, with minimal impact to the customers and employees of both organizations. To that end, senior staffs from both locations met quite frequently to lay out a strategy for the integration, focusing on not moving ahead too rapidly, but rather taking the time to assure that processes and procedures were effective at all locations. No specific timeframe for accomplishing full integration was ever promulgated.

What was promulgated, through frequent communication, was that "customer focus and customer satisfaction" were the main drivers for the Missiles and Fire Control combination. It was aimed at presenting a "single face to customers" in providing a quality product at an affordable cost. Through consolidating product lines, the idea was to provide current and future customers with integrated solutions through the strength of a combined focus and combined synergies. Where there used to be direct competition, the company was now free to work together and remain customer focused and competitive.

Some of the integration efforts took longer than others, while others were operating seamlessly between the locations in short order. Throughout the integration process, work groups in both Dallas and Orlando were transferring and adopting best practices with everyday frequency to capitalize on the synergies both entities could offer.

Where one organization had a weakness, the other provided strength. Where one had an established "best practice," it was quickly identified and flowed across to the other for implementation. Although the changes were difficult from the employees' perspectives, it soon became apparent to them that united, the company could be a stronger competitor in the industry.

The success of the integration is illustrated by the exponential business growth of LMMFC. Total revenues have increased more than 200 percent in the past three to four years while reducing operating costs from eliminating redundancies and consolidating functions.

Overcoming Cultural Differences

To overcome cultural differences, Missiles and Fire Control (MFC) initiated a multi-faceted strategy (Figure 2).

The Engineering Process Improvement team at MFC was integrated at all levels. The Director was in Orlando, and the Leads and Deputies for Systems Engineering, Software Engineering, and Hardware Engineering were split between Dallas and Orlando. The Deputies were from the opposite site than the Leads. People reporting to each level were also from both sites. The Director spent alternating weeks in Dallas and Orlando, to equally divide personal management attention between personnel at the two sites, and to personally address senior management concerns at both sites. Initially, more face-to-face team meetings were held so that the team members could first get to know each other personally, and to discover that the terms they were using described equivalent functions, but went by different names. The team developed a joint vocabulary and documented it in a glossary. The team also jointly developed a team vision and charter, and "rules of engagement" to encourage discussion among themselves. Face-to-face working groups and Kaizen events were held to plan, develop work products, and review and

improve processes. With time, team members became comfortable with each other and were able to progress to teleconferences via NetMeeting (Figure 3), to collaborate on MFC's Product Development Process and to ensure enterprise compliance to Capability Maturity Model Integration® (CMMI®). By then, they were familiar with each other's personalities and could easily identify who was talking at the other end of the telephone line. At least once a month, some team members would travel to the other site for meetings and to conduct business; this would help maintain the personal relationships developed earlier.

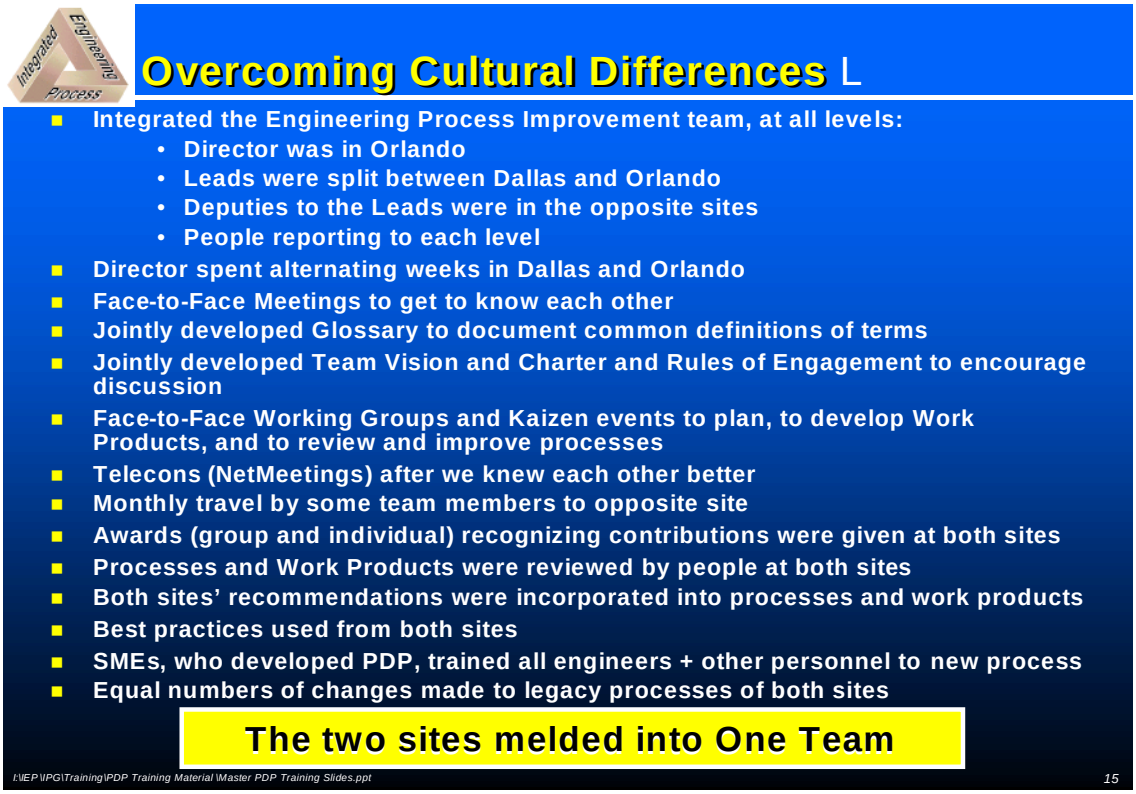

Figure 2. To overcome cultural differences, Missiles and Fire Control (MFC) initiated a multi-faceted strategy.

Group and individual awards were given to acknowledge the contributions of people in both locations. Team members and personnel from multiple programs at both sites reviewed the processes and work products that were written. Recommendations and best practices from both sites were incorporated into the PDP. Subject matter experts who had developed the PDP trained the engineers and other personnel at both sites. The process improvement site lead in Orlando said, "I think the CMMI® effort has been a catalyst for engineering change between the Dallas and Orlando locations. It has allowed us to better understand each other's processes and merge the best practices from each into a common set." In the end, the process that was jointly developed resulted in only a few changes, and in about equal numbers, to the legacy process of each site. The two sites had melded into One Team.

Process Development

An early task force decision, consistent with LM corporate direction, was to use Carnegie Mellon's Capability Maturity Model Integration® (CMMI®) as the yardstick for measuring and evaluating specific project use of well-established systems, software, and hardware engineering practices. The CMMI® model provided the basis for a jointly acceptable PDP architecture. And, CMMI® became the forcing function for setting PDP development priorities and devising the implementation strategy.

Figure 3. Today's communication technology enabled geographically dispersed team members to regularly communicate and interact in real time.

Figure 4 illustrates how processes from both the Dallas and Orlando sites were merged and migrated into one Product Development Process (PDP). The first effort involved the software processes. The Software Engineering Practices Manuals (EPMs) in Orlando were combined with the Software Processes (SWPs) in Dallas to form a unified process that was then harmonized into a jointly accepted Organizational Standard Software Process (OSSP). Next, a common Systems Engineering process for both sites was developed, and was evaluated in a pilot program exercise. The Software Engineering and Systems Engineering processes were brought together, along with the hardware (Mechanical and Electrical) engineering processes from both Dallas and Orlando, and the Integrated Product and Process Development (IPPD) and Supplier Sourcing, under the CMMI® framework. Best practices, lessons learned, and other command media (i.e., policies and procedures) from other Lockheed Martin companies and the Corporation were also exploited to form the best possible common integrated Product Development Process.

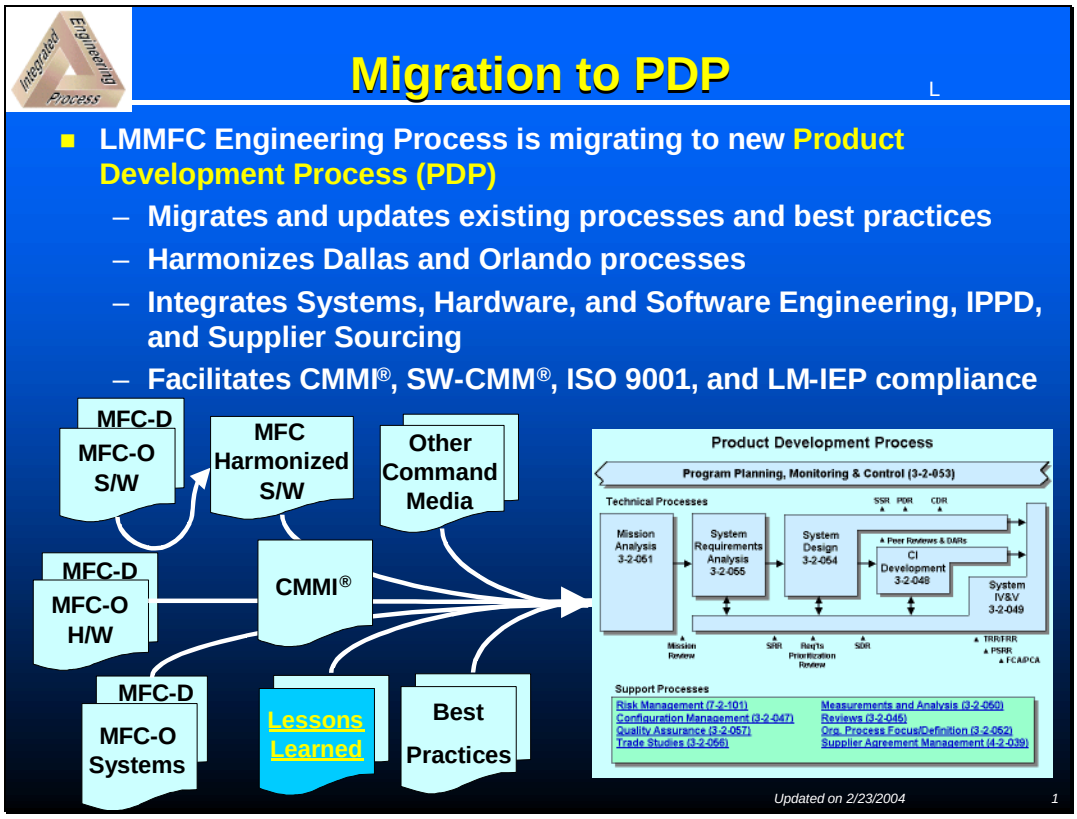

Figure 4. LMMFC's PDP was crafted using the best process ideas from both Dallas and Orlando. Also incorporated were lessons learned, best practices across the Corporation, and other command media (i.e., policies and procedures).

The PDP facilitates compliance with CMMI®, and also with SW-CMM® (since MFC has programs that are still operating to SW-CMM®), ISO 9001, and the Corporate LM-IEP. Traceability of the PDP to these other standards is periodically reviewed, as the PDP and the standards change and/or expand.

The PDP is composed of five technical processes that are initiated by the overarching support process -- Program Planning, Monitoring, and Control (PPMC). The technical processes are Mission Analysis; System Requirements Analysis; System Design; Configuration Item Development; and Product Integration, Verification, and Validation. Support processes other than PPMC include: Configuration Management, Measurement and Analysis, Organizational Process Focus and Definition, Quality Assurance, Reviews, Risk Management, Supplier Agreement Management, and Trade Studies.

Figures 5 and 6 present the concept of graphically accessing PDP resources in one central, on-line location, via a user-friendly web-based system. It allows the near instantaneous electronic retrieval of any technical or support process, its work product descriptions, its associated templates and examples, the glossary, role responsibilities and role definitions, and intranet and internet resources. This website is becoming increasingly used, with larger increases after the personnel working a new program start are trained. The total hits on the website are now over

5900. Starting out slowly when the PDP was first introduced, the average daily number of hits since introduction was about 30-40 per day in September-November 2003, and rose to 55 per day by mid-March 2004.

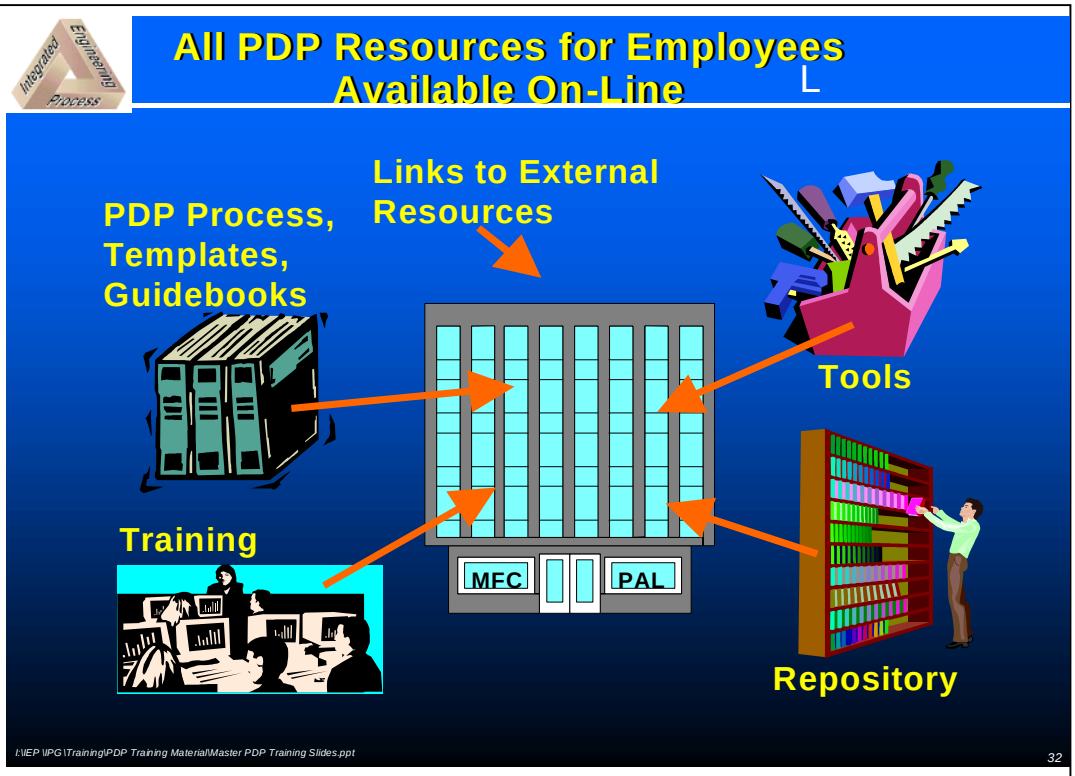

Figure 5. All employees access the entire PDP database via the web.

PDP-to-LM-IEP Traceability

Lockheed Martin has asked its Companies to correlate their organizational standard processes to the Corporate standard, the LM-IEP. Besides CMMI® V.1.1, the LM-IEP is compliant with ANSI/EIA-632 (13 technical processes for engineering a system), ISO 9001:2000 (Quality Management Systems process standard), ISO/IEC-12207 (Software Life Cycle Processes), LM-HWLCPS (Lockheed Martin Hardware Life Cycle Process Standard), ISO/IEC-15288 (22 System Life Cycle Processes for hardware, software and human interfaces), and IEEE 1220 (Standard for Application and Management of the Systems Engineering Process).

A gap analysis versus the LM-IEP was recently accomplished at Lockheed Martin Missiles and Fire Control. Few gaps were found between the PDP and the LM-IEP.

Example gaps that were discovered include such things as the need to: perform Peer Reviews on additional work products, put greater emphasis on hardware re-use and COTS, and expand the use of requirements decisions.

The gaps found were resolved and incorporated into PDP Version 3.0, released in March 2004. The result is that MFC is fully aligned with what Lockheed Martin is aiming to accomplish across the Corporation.

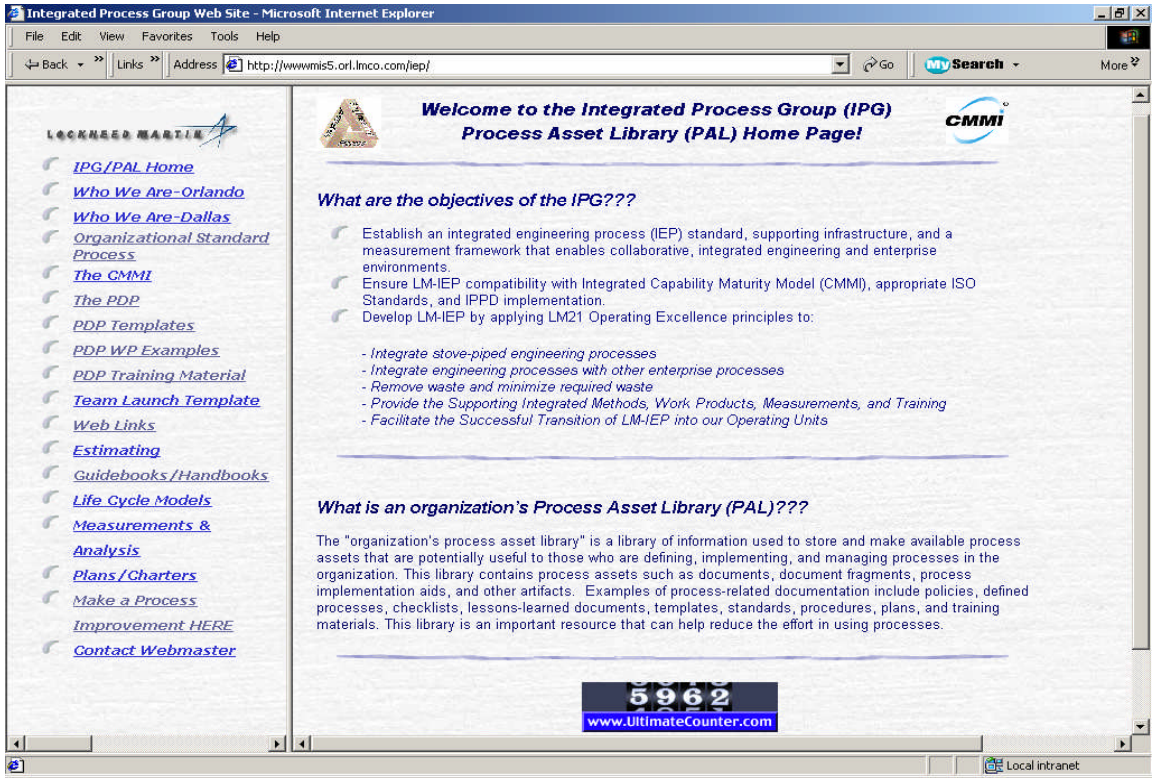

Figure 6. LMMFC's PAL is the gateway to the PDP database.

Accomplishments

PDP implementation is in the fourth year of a six-year plan. Employee and program management awareness of the joint vocabulary and harmonized development procedures is growing. Labor- and time-saving templates, work product descriptions, and process task steps for speeding the work of developing work products, such as Systems Engineering Management Plans (SEMPs), are available on-line and are being used. Tailored PDPs for existing programs have been developed and endorsed by program management and senior engineering management. New programs are inviting task force team members to help them prepare plans for using the PDP. Behavior of individuals and program management is beginning to change across LMMFC.

Many people across the company (e.g., those working on pilot programs and on the new starts) have been trained during the first year (from October 2002 through October 2003). Figure 7 shows the continual trend of training, totaling about 2300 employees in 95 classes during the first year. This has continued into 2004, with just a few hundred left to train.

In June 2003, four pilot programs and the PDP team itself were evaluated.

- From these evaluations, 115 process corrective actions were opened, with the expectation all will be closed by mid-July. "The pilot program groups' support for transitioning to the PDP, providing evidence of following the PDP and quickly responding to the team findings, while continuing to perform their regular program duties, has been excellent," said the Dallas PDP site lead.

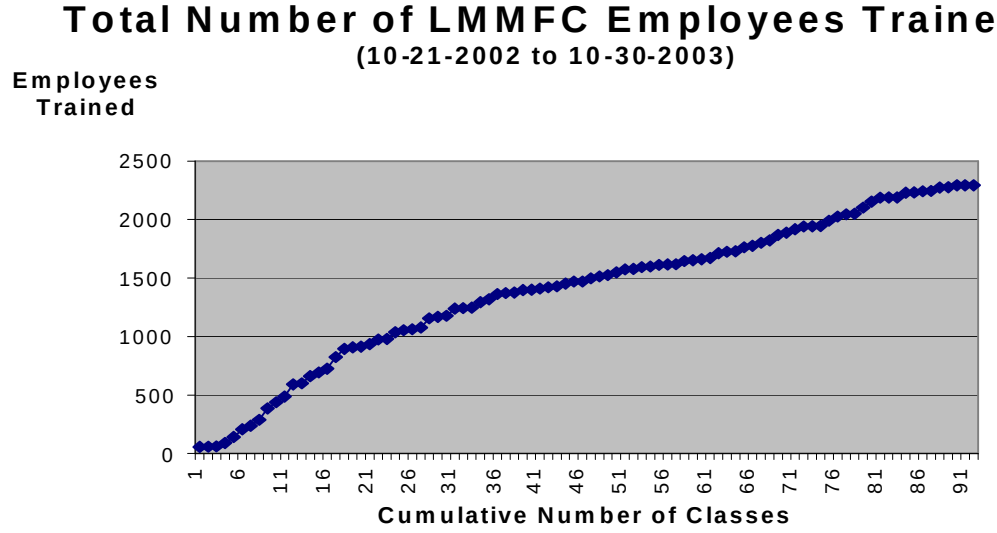

Figure 7. Company-wide PDP training is to be completed in June 2004, and has changed perspectives.

- "CMMI® certification is essential to winning new business in today's highly competitive business environment," said the Software Engineering lead on the PDP project. "CMMI® has become a source selection criterion on proposals, indicating to Government decision makers that we have processes in place to deliver a predictable, high-quality product. The CMMI® structure has already helped us in illustrating that we have stable processes in place for future proposals."
- "Integrating CMMI® has required a cultural change in the way we do business. One of the new requirements is increased structure for Integrated Product Teams (IPTs) to ensure that all participants have a shared vision and that responsibilities are clearly defined for who's doing what in achieving that vision," said the PDP Hardware Engineering enterprise lead.

People working the Programs that are using the PDP earnestly support it –

- The Technical Director for Strike Weapons said, “I am an advocate for the PDP. Ensuring that all our engineers are following a standard set of best-practice processes is the right thing to do for the company and our customers. The CMMI® framework ensures that all participants have a shared vision and that responsibilities are clearly defined for who's doing what in achieving that vision. CMMI® makes good business sense and I encourage everyone to embrace it."

- The Program Manager for the Guided MLRS Unitary program sees the benefits of adopting and following the CMMI® -compliant Product Development Process. "With the PDP, we will still produce drawings, write reports, follow technical directives and hold meetings," he said. "The difference is that it requires a little more rigorous documentation. The benefit is that as the program matures, we have detailed documentation in place that will allow us to make easier decisions in addressing issues and make continuous improvements down the road."

In October 2003, a Maintenance Review done by an audit team determined compliance to CMMI® Level 3 via the Continuous Appraisal Method (CAM). The team of auditors included two people from Lockheed Martin Mission Systems, and two from MFC. In addition, two Standard CMMI® Appraisal Method for Process Improvement (SCAMPI℠) Lead Assessors from Hill Air Force Base in Utah participated as observers. Four MFC programs were assessed. Dallas and Orlando functional organizations representing Quality and Mission Success, Finance, Human Resources, and Technical Operations were also evaluated. During the audit out-briefing, the appraisal team leader noted that the team's final rating was a bit anti-climactic because throughout the Maintenance Review, it was obvious that MFC had prepared and met the criteria. He said MFC's strong suit was that a common set of best practices has now been institutionalized at MFC. One of the observers from Hill Air Force Base said he has been involved in SEI, CMMI®, and SCAMPI℠ assessment for 12 years now and the feedback he hears most is that the CMMI® Level 3 assessment doesn't mean anything if it is done simply in a "check the box" fashion. "It is obvious that that was not done here at MFC," he said. "By implementing your common PDP in a disciplined fashion, it is apparent that you have institutionalized the process. It is through institutionalization that CMMI® Level 3 really brings value to the table."

What's Next?

Now that the PDP has been successfully implemented, several tasks loom on the horizon.

First, training continues. The remainder of the engineers and other professionals must be trained on the Product Development Process. As part of this, as each new program start arises, that program's personnel must be trained on the PDP and on the specific tailored implementation of the PDP on their program.

Second, live briefings for training are being modified to build computer-based education (CBE) classes. Courses for PDP training include introductory courses, as well as courses for program leads, for practitioners in systems, hardware, and software engineering, for risk management, and for estimating.

Third, a SCAMPI℠ appraisal will be conducted by July 2004, to provide an external assessment.

Fourth, the PDP must be kept up-to-date. The PDP will be maintained -- as DOD Acquisition policies change, and as new and evolving standards emerge. The PDP will be updated -- to incorporate program-suggested PDP improvements and changes, to incorporate resolutions of Evaluation Findings from the CAM evaluation, to close the few gaps between the LM-IEP and the PDP, and to add CMMI® Level 5 Capability to the PDP.

Fifth, there are tasks that must be performed after the PDP is updated. The delta PDP must be trained to all program personnel. Then, the extended PDP will be rolled out to all programs.

After a time period of PDP execution by the programs, the programs will be evaluated internally via QA audits.

Finally, the PDP process institutionalization to CMMI® Level 4 and 5 will be externally assessed via the SCAMPI℠ method.

Summary

Merging companies with differing processes and vocabularies, in an environment of increasing competition, requires the development of processes that not only are common, repeatable, and understandable, but also are marked by high productivity, lower cycle time, and acceptability to the engineering population.

Gaining acceptance of the new integrated processes requires the use of many strategies, including the involvement of many stakeholders across the enterprise, the ability of all participants to feel the worth of their voices, the development of positive personal relationships, and the nurturing of trust.

Results to date confirm that old dogs *are* capable of being taught new tricks.

Afterword

Many thoughtful proponents of systems engineering are concerned about the CMMI® emphasis on process. One of their very valid concerns is that workers will use defined processes and templates as a crutch to avoid thinking. And in the end, create counter-productive paper mills.

But that risk is more than offset, in the authors' view, by the productivity gains accrued from aligning the thinking and vocabulary of the entire product development team, the majority of whom either:

- have never heard of systems engineering,
- are not interested in systems engineering, or
- see no value in thinking in terms of systems.

The PDP implemented at Lockheed Martin Missiles and Fire Control tells the engineers what to do, not how to do it. Hours of hunting down what must be done, or what must be included in a work product, is no longer necessary, as that information is available instantaneously and electronically via the website. That gives the engineers more time to work on the creative part of product development – the "How."

Management guru Peter Drucker wrote about organizations:

"The purpose of an organization is to enable common men to do uncommon things.

No organization can depend on genius; the supply is always scarce and unreliable. It is the test of an organization to make ordinary human beings perform better than they seem capable of, to bring out whatever strength there is in its members, and to use each man's strength to help all the other members perform. It is the task of organization at the same time to neutralize the individual weaknesses of its members. The test of an organization is the spirit of performance. The spirit of performance requires that there be full scope for individual excellence. The focus must be on the strengths of a man -- on what he can do rather than on what he cannot do." (Drucker, 1974)

This, in a nutshell, is what implementation of the PDP is all about.

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Author Biographies

Bob Bardo is a Senior Manager in Research Engineering at Lockheed Martin Missiles and Fire Control. He has 36 years' experience in Systems Engineering at the company and its predecessors. Mr. Bardo has worked on the systems engineering of all the major defense systems produced by the Dallas site of the company during the last 36 years, including the Army TACMS missile system, the Line-of-Sight Anti Tank system (LOSAT), the PAC-3 air and missile defense system, the Multiple Launch Rocket System (MLRS), and the A-7 attack aircraft. He earned a Bachelor of Science in Electrical Engineering from Southern Methodist University (SMU) and a Master of Business Administration (MBA) from the Stanford University Graduate School of Business. He is a member of both the American Institute of Aeronautics and Astronautics (AIAA) and INCOSE. He has been involved in the development of his company's Product Development Process (PDP) and the Corporate LM-IEP.

Phil Brown is president and a principal in Systems Engineering Associates, a consulting group specializing in exploiting information technology advances to improve engineering and business processes. Prior to forming SE Associates, he gained 31 years of experience in applying systems engineering to a variety of weapons systems programs. He earned a Bachelor of Civil Engineering from Georgia Tech and an M.S. in Industrial and Systems Engineering from the Ohio State University. He is active in both the Texas Society of Professional Engineers (TSPE) and INCOSE. INCOSE service includes membership on the Metrics TC and the Education and Research TC, which he currently co-chairs. He has been a player in helping get the SE Certification endeavor started, in birthing the Guide to the Systems Engineering Body of Knowledge and in building the case for INCOSE applying to become a participating member of the Accreditation Board of Engineering and Technology.