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## Executive Summary

**Title:** Process Improvement at the F/A-18 Organizational Maintenance Activity

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**Thesis:** Process Improvement can be applied at the OMA to improve planned and unplanned maintenance with Lean, Six Sigma and Theory of Constraints. All maintenance practices can be improved rather easily with the application of Lean Process and more complicated and in depth maintenance practices, such as Phase Inspections, can be streamlined following analysis and implementation of Six Sigma and Theory of Constraints. As written, the Marine Corps' Continuous Process Improvement (CPI) structure, policies, and culture are not conducive to the implementation of CPI at all levels.

**Discussion:** All services have implemented Continuous Process Improvement per Secretary of Defense Mandate. While each service has taken slightly different approaches, all utilize a combination of Lean, Six Sigma, or Theory of Constraints which are proven practices with quantifiable time and dollar savings in private industry. In 2007, the Marine Requirements Oversight Council (MROC) designated nine High Impact Core Value Streams that will be targets specifically for Process Improvement. The only aviation value stream to be recognized is Aviation Material Life Cycle Management. Interestingly, this value stream has been the subject of Process Improvement since 1999 under a Naval Air Systems Command sponsored program titled AIRSpeed. While the intent is to map value streams to target lower echelon processes for CPI, Aviation Material Live Cycle Management focuses primarily on the supply and logistics portion of aviation maintenance thereby leaving many maintenance practices untouched. Significantly, the U.S. Air Force has implemented their version of CPI, Air Force Smart Operations for the 21<sup>st</sup> Century (AFSO21), at all levels and multiple maintenance processes to include phase inspections on the F-15 Eagle, an aircraft not too dissimilar to the F/A-18 Hornet. Additionally, the Air Force has contracted Bearing Point, a management and technology consulting firm, to provide a means to identify processes and apply CPI at lower levels. Contrarily, the Department of Defense Lean Report to the Congressional Defense Committees states that value streams are to be identified by executive leaders meanwhile identifying in the same document that CPI will empower employees to identify and eliminate waste. These smaller processes that will only be identified by process owners, the maintenance officers and non-commissioned officers, will provide the largest reward for the least investment unlike the strategic value streams identified by the MROC.

**Conclusion:** Process Improvement can be applied at the OMA through using all facets of AIRSpeed for different processes. The current initiative to tie AIRSpeed from depot, to intermediate to organizational maintenance activities is a good start however the focus is too narrow. Lean and Six Sigma have direct application to planned maintenance and have the potential for significant savings through better maintenance practices. Finally, the Marine Corps needs to develop a system for the lower end users to identify processes for CPI without complete reliance on the MROC in order to maximize the implementation of CPI throughout in accordance with the Secretary of Defense and Secretary of the Navy's intent.

## *Table of Contents*

|                                                                   | Page |
|-------------------------------------------------------------------|------|
| DISCLAIMER .....                                                  | i    |
| LIST OF ILLUSTRATIONS .....                                       | ii   |
| PREFACE .....                                                     | iii  |
| INTRODUCTION .....                                                | 1    |
| MANDATES .....                                                    | 2    |
| Department of Defense .....                                       | 2    |
| Department of the Navy .....                                      | 3    |
| THEORIES DEFINED .....                                            | 3    |
| Lean Manufacturing .....                                          | 4    |
| Six Sigma .....                                                   | 5    |
| Theory of Constraints .....                                       | 6    |
| NAVAL AVIATION ENTERPRISE .....                                   | 6    |
| AIRSpeed .....                                                    | 7    |
| MARINE CASE STUDY .....                                           | 8    |
| AIR FORCE SMART OPERATIONS FOR THE 21 <sup>ST</sup> CENTURY ..... | 10   |
| SURVEY .....                                                      | 14   |
| IMPLEMENTATION .....                                              | 16   |
| CONCLUSIONS .....                                                 | 20   |
| RECOMMENDATIONS .....                                             | 22   |
| APPENDIX A: MAINTENANCE OFFICER SURVEY .....                      | 27   |
| BIBLIOGRAPHY .....                                                | 29   |

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*Illustrations*

Page

|                                                           |    |
|-----------------------------------------------------------|----|
| Figure 1. <i>Lean Applied to Maintenance Spaces</i> ..... | 26 |
|-----------------------------------------------------------|----|

## *Preface*

In December of 2006, I had the opportunity to tour the Planned Maintenance Interval (PMI) line at Naval Air Station North Island along with the squadron commander and several key maintenance personnel. During the year prior, the PMI line had endured a complete overhaul in order to increase productivity and shorten the time required to complete the PMI on F/A-18A-F aircraft by implementing Lean and Six Sigma, practices that have their roots in corporate production. Lean, which has its roots with Toyota, focuses on the elimination of waste, while Six Sigma aims at reducing variation in a process. At the completion of the tour, the squadron commander indicated that he wanted to implement Lean Six Sigma with our maintenance practices. While great in theory, there were significant shortfalls to his ad hoc approach. Process Improvement has several significant requirements to be successful, notably, analysis and training of which neither were planned to be accomplished for this task. I decided then that it would be important to research where Process Improvement could be applied at the OMA but also to highlight the necessary training and analysis for the uninitiated maintenance officer or commanding officer.

Robert Liston from the Marine Corps University was instrumental in formulating the survey and compiling feedback from fleet maintenance officers. Additionally, Major Joseph Heilhecker AFSSO21 Program Office, Captain Lee Comerford ACC AFSSO21 Action Officer, and GS15 Kirk Nicholas from the Marine CPI Office offered great assistance and insight into Process Improvement and its application at their respective services. Finally, Dr. Craig Swanson volunteered his valuable time to provide guidance and editing for this project and would not have been completed without his assistance.

For several years, Marine Aviation Logistics Squadrons have attacked inefficiency at the Intermediate Maintenance Level (IMA) through the application of AIRSpeed, a program based on Lean, Six Sigma, and Theory of Constraints and designed to improve maintenance practices through process improvement. Process Improvement has been proven to work in the civilian sector in many applications and has additionally recently been applied to Naval Air Depot (NADEP) for Planned Maintenance Intervals and Center Barrel Replacement of the F/A-18. The first Marine Organizational Maintenance Activity (OMA) to officially implement AIRSpeed was VMMT-204, the MV-22 Osprey Fleet Replacement Squadron. While this is significant, the application of Process Improvement in a deploying squadron has yet to be accomplished. Significant differences must be recognized between deploying and non-deploying squadrons when it comes to Process Improvement. Process Improvement can be applied at the OMA to improve planned and unplanned maintenance with Lean, Six Sigma and Theory of Constraints. All maintenance practices can be improved rather easily with the application of Lean Process and more complicated and in depth maintenance practices, such as Phase Inspections, can be streamlined following analysis and implementation of Six Sigma and Theory of Constraints. As written, the Marine Corps' Continuous Process Improvement (CPI) structure, policies, and culture are not conducive to the implementation of CPI at all levels. The successful application of CPI will be a force multiplier, saving substantial time, money, and manpower that will increase both aircraft and personnel readiness with minimal upfront cost.

AIRSpeed has been implemented at all Marine Aviation Logistics Squadrons (MALs), maintenance practices at the F/A-18 squadron level have been relatively unchanged and have not seen the benefit of business transformation. As the fleet ages and aircraft parts are in short supply, it is imperative to reduce waste in our maintenance practices. There are likely



applications of process improvement, specifically Lean combined with Six Sigma, at the OMA. However, different than at the IMA, the OMA needs a deployable solution to be feasible and effective. Some other significant challenges to implementing Process Improvement at the IMA will be notable and include addition to the already stretched training schedule, turnover of personnel, and standardization throughout the Navy and Marine Corps Fleet.

### **DoD Requirement**

The overall mandate from defense executives is to transform individuals and organizations from doing "business as usual" to "business un-usual" and to create positive change for defense business processes.<sup>1</sup>

On 31 March 2007, the Department of Defense (DoD) conducted a Continuous Process Improvement / Lean Six Sigma (LSS) offsite discussing the baseline of the DoD CPI/LSS activities.<sup>2</sup> This seminar led Secretary of Defense Gordon England to direct the establishment of the DoD CPI/LSS Program Office under the Deputy Under Secretary of Business Transformation and was chartered to be the driving force for DoD wide CPI/LSS activities.<sup>3</sup> Notably, Secretary England recognized that "Aggressive implementation of CPI/LSS within all levels of DoD will go a long way to support our overall business transformation efforts."<sup>4</sup> In accordance with this idea, the Secretary has mandated that each service accomplish several key tasks. First is the assignment of a "focal point to coordinate with the DoD CPI/LSS Program Office." The Navy, Air Force, and Army have previously established NAVAIR Enterprise AIRSpeed, Air Force Smart Operations for the 21<sup>st</sup> Century (AFSO21), and the Army Business Transformation Center respectively. An additional requirement in training is to establish a training plan that results in 1 percent LSS black belt certification and 5 percent green belt certification to include "top-rated staff members."<sup>5</sup>

## **Navy Requirement**

In response to Secretary England's memorandum, Secretary of the Navy Donald Winter issued a letter on 3 May 2007 highlighting the Navy's transformation through LSS. Secretary Winter points out that in addition to the task of having a Navy that is equipped and prepared to fight wars, he is likewise responsible for meeting the challenge of "additional fiscal pressures that lead us to better stewardship of taxpayer dollars where greater efficiency leads to improved effectiveness."<sup>6</sup> While Secretary Winter relates Process Improvement directly to saving in terms of taxpayer dollars, he importantly notes that it likewise leads to improved effectiveness which arguably results in a more effective war fighting force further accomplishing his primary task of a Navy equipped and prepared to fight wars. Secretary Winter also notes that from his experience, he has "found that both buyers and suppliers who employed Lean Six Sigma (LSS) experienced better efficiencies, increased morale, and higher levels of performance."<sup>7</sup> He additionally points out that the Navy and Marine Corps have already been employing LSS with great success and have likewise trained over "500 black belts and 1,500 green belts that have facilitated over 2,800 events and projects . . . averaged a 4:1 return on investment."<sup>8</sup> Secretary Winter's mission tasking is simple in the memorandum with a mission statement to create "more readiness and assets within our budget through LSS."<sup>9</sup>

## **LSS/TOC Defined**

According to Dr. Edwards Deming<sup>10</sup>, quality problems generally are "in the process, not the person" and further concludes that 85 percent of problems are inherent in the way work is accomplished and therefore on 15 percent was the fault of the individual.<sup>11</sup> A process is defined

as “A collection of activities that together produce a usable product or service by applying resources from one or more functional areas.”<sup>12</sup> Likewise, Continuous Process Improvement is not a practice but a policy that involves and empowers the individual and is defined as “A policy that encourages, mandates, and/or empowers employees to find ways to improve process and product performance measures on an ongoing basis.”<sup>13</sup> Here, the discussion is on Process Improvement utilizing proven the business practices of Lean, Six Sigma, and Theory of Constraints.

In the 30 years following World War II, Japanese manufacturing processes made significant changes largely based on successes observed by American production processes during the war. Additionally, some of the successful techniques used by Henry Ford were adopted but also noted their significant shortcomings in employee structure and unions that were unworkable in Japan. Interestingly, it was the logistics philosophies of the Piggly Wiggly grocery chain that really motivated the automobile giant Toyota to improve its production processes. These changes propelled Toyota past the Ford motor company in 2004 and placed them as the number two automaker in production behind General Motors. Lean thinking or Lean manufacturing is synonymous with the Toyota production system and focuses on the elimination of waste. Waste “is defined as anything not necessary to produce the product or service.”<sup>14</sup> With lean, there are eight types of waste that are targeted for elimination; these are Defects, Over Production, Waiting, Non Standard Work, Transportation, Injuries, Motion, and Excess Inventory.<sup>15</sup> A tool for eliminating waste is 6S, which is derived from 5S, simply a method for “eliminating waste and maximizing value-added work.”<sup>16</sup> Likewise, 5S is “the method of workplace organization and visual controls popularized by Hiroyuki Hirano”, a noted author of several books on Process Improvement and Japanese manufacturing processes.<sup>17</sup> As applied to

Lean, the 6S's stand for Sort, Stabilize, Shine, Standardize, Sustain, and Safety. The end result should be an organized and effective work environment that promotes productivity while reducing accidents. Figure (1) illustrates an extreme example of 6S applied to the work environment while figure (2) shows the same idea applied to an Air Force F-15 hangar.

The focus of Six Sigma is on the reduction of variation. This is accomplished through a 5-step process including define, measure, analyze, improve, and control.<sup>18</sup> Significantly, Six Sigma requires the use of "statistical tools" and a "rigid and structured investigation methodology" in order to define the problem and identify where variation can be eliminated.<sup>19</sup> Applying Six Sigma will theoretically result in several improvements. "Quality is improved. Process investigation produces the re-evaluation of the value added status of many elements. Some elements are modified, while others are discontinued. Elements are refined and improved. Mistakes and opportunities for mistakes are reduced."<sup>20</sup> Six Sigma training consists of several different levels which are labeled as "belts" similar to martial arts levels and are targeted toward employees, project leaders, and quality leaders. The highest level is targeted toward quality leaders and is labeled the Master Black Belt. This training "includes detailed information about the concept, methodology, and tools as well as detailed statistics training and computer analysis tool use" for Six Sigma.<sup>21</sup> Project leaders are generally trained as Black Belts which, similar to Master Black Belt training, consists of training in concept, methodology, and the tools of Six Sigma. At the lowest level, the user level, is green belt training. Green Belts are generally the employees and this training is an abbreviated course that is similar to Black Belt training.<sup>22</sup> Information that is not covered in Green Belt training is expected to be covered by the unit's Black Belts when the needs arise.

The last Process Improvement theory that is pertinent to this discussion is Theory of Constraints (TOC). "TOC evolved from the theories and teachings of Dr. Eliyahu M. Goldratt, a physicist who realized that scientific principles and the rules of logic could be applied to a process in order to provide ongoing improvement for the system as a whole."<sup>23</sup> TOC, like Six Sigma, uses a 5-step process to identify weaknesses in a system where a system is "defined as a series of interdependent processes."<sup>24</sup> A constraint is likened to a weak link in a chain however in a process; a constraint is anything that causes the process to slow. Identification of any constraint and its subsequent removal will then facilitate speeding of the process. Unlike Six Sigma, the TOC 5-step process consists of identifying and exploiting the constraint, subordinating other processes to the constraint, elevating the constraint and finally repeating the cycle. Subordinating the constraint deals with the idea that processes that are later in the chain than the identified constraint are operating at a slower level due to the wait associated with the constraint. By subordinating the constraint, the remaining parts of the system work to elevate the constraint to operate at the capacity of the non-constraints. Bluntly stated, "TOC provides a tool that promotes common sense instead of common practice."<sup>25</sup>

### **Naval Aviation Enterprise / AIRSpeed**

The Naval Aviation Enterprise (NAE) consists of several commands including Commander Naval Air Forces, Naval Education Training Command, Naval Air Systems Command (NAVAIR), Naval Sea Systems Command, Naval Supply Systems Command (NAVSUP), and the Naval Inventory Control Point (NAVICP). "The NAE is a warfighting partnership where interdependent issues affecting multiple commands are resolved on an

Enterprise-wide basis.”<sup>26</sup> NAVAIR, NAVSUP, and NAVICP all have critical roles in the implementation and execution of AIRSpeed at different levels.

A major initiative of the NAE is the AIRSpeed program. AIRSpeed began in 1999 and consists of Depot AIRSpeed, Enterprise AIRSpeed, and NAVAIR AIRSpeed, each with distinctive yet similar goals. There are three aircraft Depots that serve the numerous squadrons and types of aircraft throughout the fleet which are located at Cherry Point North Carolina, Jacksonville Florida, and North Island California. The goal of Depot AIRSpeed is “to reduce cycle-time, improve productivity, and establish a culture of continuous process improvement.”<sup>27</sup> Actions at the Depot level consist of significant maintenance actions that cannot be undertaken at the organizational or intermediate level to include Planned Maintenance Intervals (PMI). The supply and logistics piece is covered by Enterprise AIRSpeed which “aligns Organizational, Intermediate, and Depot-Level supply replenishment and repair processes to the demands of the fleet operator, enabling the effective and efficient preparation of the right number of cost-wise, Ready-for-Tasking (RFT) aircraft required to perform the mission.”<sup>28</sup> The integration of OMA, IMA, and depot is intended to have resounding effects on not only supply but also operations. Another stated goal of Enterprise AIRSpeed when applied at all three levels is to “maintain the appropriate levels of readiness in both aircraft and personnel by incorporating the tools and methodologies of CPI in a collaborative endeavor between squadron maintenance, supply, ordnance, operations and the rest of the logistics system across the NAE.”<sup>29</sup> The third pillar of AIRSpeed is NAVAIR AIRSpeed which “extends the success already realized by Depot and Enterprise AIRSpeed to transactional and non-production service environments.”<sup>30</sup> NAVAIR AIRSpeed intends to change the way business is done at every level and significantly is intended to create and foster a culture of CPI.

## Marine Case Study/ E2E

“The Marine Requirements Oversight Council (MROC) serves as a senior Marine Corps leadership forum to advise and support the Commandant of the Marine Corps in the execution of his Title 10 USC responsibilities.” While the Marine Corps has been using AIRSpeed to improve Intermediate Level Maintenance since 1999 the MROC designated nine High Impact Core Value Streams (HICVS) and released this via a Marine Administrative Messages, MARADMIN, in January 2008.<sup>31</sup> “HICVS are strategic processes that support combat readiness and the warfighter.”<sup>32</sup> Among these nine HICVS, Aviation Material Life Cycle Management is the only aviation related process designated for CPI implementation. The assignment of this particular process at this time is merely a formality by the MROC since the process has applied CPI already. Despite this, the MROC’s designation does not preclude other processes from implementing CPI but at this time the Marine Corps order on CPI is still in production. The training requirement for Marine Corps CPI was established by the Secretary of the Navy who mandated “a goal to provide “CPI training to 100 percent of Flag/SES and Col/GS-15 (NSPS Equivalent) senior leaders by the end of 2007.”<sup>33</sup> Despite this, those officers at the Marine Expeditionary Force level or below, essentially all officers in the Fleet Marine Force, are not required to undergo CPI training until operational commitments due to Iraqi Freedom and Enduring Freedom permit. Specific to aviation, this negates the requirement to train the Group Commanders and there is no requirement to train Squadron Commanders on CPI despite the use of AIRSpeed in their units. Additionally, Maintenance Officers, while not the process champions, should be trained on CPI in order to ensure the proper implementation and success of the program.

3d Marine Aircraft Wing located at Marine Corps Air Station Miramar California defines its AIRSpeed Mission as "To identify and address interdependencies, manage and reduce variability, identify and manage constraints and eliminate waste to properly manage aircraft in 3d Marine Aircraft Wing to support the Marine and Sailor on the ground."<sup>34</sup> According to Chief Warrant Officer 4 Patrick Johnson, the 3d Marine Air Wing (MAW) AIRSpeed Officer, the Marine Corps is leading the initiative to tie Process Improvement between Depot, IMA, and the OMA.<sup>35</sup> In order to accomplish the intended design goals, CWO4 Johnson believes that it will take four to five months of implementation which will include training on Lean, Six Sigma, and TOC. This training will be a basic overview and targeted to the leadership, Staff Sergeants and above, and those involved in the process, most likely the work center supervisors, however at this time there is no intent to train any Green Belts at the OMA. That expertise will reside in the MAW and the MALS. Currently, 3d MAW has 4 Black Belts while MALS 11 has 1 Black Belt and 10 Green Belts.<sup>36</sup> Because AIRSpeed E2E is a process implementation and requires no infrastructure to support it there is no additional cost to the OMA and in theory will result in substantial savings in aircraft down time which equates to dollar cost savings in maintenance man hours. After Lean Six Sigma implementation under the AIRSpeed program at the F/A-18 Depot at Naval Air Station North Island in 2004, a tangible result was observed within the first year which according to CDR Lucka was a "20-50% reduction in Cycle Times...(and a) 10-25% reduction in labor hours (=dollars)."<sup>37</sup>

The integration of AIRSpeed at the OMA will have direct effects on the availability of aircraft which carry over to operations and training. These indirect results will pay huge dividends in an environment where actual flight time needs to be maximized with our aging



aircraft. "TMA AIRSpeed focuses on managing resources (people, equipment and parts) to ensure re-supply of RFI assets to a sized buffer within a time to reliably replenish."<sup>38</sup>

## **Air Force Smart Operations for the 21<sup>st</sup> Century**

With AFSO21, we are challenging all Airmen to examine processes and eliminate steps in business processes that add little or no value.<sup>39</sup>

Air Force Smart Operations 21 (AFSO21) is the United States Air Force approach to business transformation and process improvement with another critical factor that is unique to their service. In addition to the requirements set forth by the SECDEF, the Air Force is facing major cutbacks in personnel. Like AIRSpeed, AFSO21 is a business approach that utilizes the proven tools of Lean, Six Sigma, Theory of Constraints and additionally Business Process Reengineering that will result in an "increase in AF combat capability directly linked to the core AF mission."<sup>40</sup> The goal of AFSO21 is simply stated, "greater efficiency".<sup>41</sup> Additionally, AFSO21 has five concrete goals which it intends to achieve.

AFSO21 aims to:

- Deep-six stupid, unnecessary tasks.
- Keep more equipment ready for service.
- Shorten response times.
- Eliminate accidents, injuries, and breakdowns.
- Cut energy costs.<sup>42</sup>

The key tenet critical to AFSO21 success revolve around the success of the program is decentralized control. "AFSO21 gives USAF an organized way to improve efficiency by encouraging and allowing efficiency initiatives without layers and layers of review and comment."<sup>43</sup> The logic behind this is that the young Airmen are the ones who are most aware of

the inefficiencies in their practices therefore best suited to identify and correct them. Likewise, those young Airmen directly benefit from more efficient processes. "USAF is only too aware that bureaucracies have a way of thwarting progress."<sup>44</sup> This appears to be a difference of opinions between the Navy and Marine Corps and Air Force concerning identification of processes targeted for CPI. Appendix C of the DoD Lean Report to the Congressional Defense Committees states "Executive Leaders need to identify the key value streams or value levers from continuous process improvement efforts."<sup>45</sup> Further, the Marine Corps has charged the MROC to identify those value streams, HICVS, that are considered strategic processes. Additionally the "DoN recognizes that the process for selecting Lean Six Sigma projects needs to be rigorous and based on data."<sup>46</sup> While Six Sigma and TOC are very data analysis intensive, Lean is not. Lean has application in numerous and diverse situations from manufacturing and production to simple organization of office and administrative spaces. Contrary to the previous DoN statements, the same document to Congress outlines the tools associated with AIRSpeed "will empower employees to take control of their work processes. Employees will identify and eliminate waste, reduce cycle time, and improve quality."<sup>47</sup>

In addition to the quantitative results that Process Improvement can provide, the Air Force has identified another requirement that is vitally important to changing the mindset and attitudes of personnel to facilitate the idea of CPI. This requires the development of a "culture which promotes elimination of waste, sharing of best practices, and reduction of cycle times across all products and services, and involvement of all Airmen in the relentless pursuit of excellence."<sup>48</sup> The key tenet here is the development of a culture, not just the application of these business practices to a process. Understandably, creating this culture is vital to the continued success of CPI.

While the Air Force has applied Lean, Six Sigma, and TOC to many projects throughout their service, two should be specifically investigated and compared to operations in the Marine Corps OMA. In January 2007, the 1<sup>st</sup> Fighter Wing (FW) at Langley Air Force Base applied the 6S process to F-15C Phase Inspections in order to reduce the time required to complete this planned maintenance inspection and in order to increase the number of on time deliveries of aircraft back to flying status. The problem that this unit was faced with and focusing Lean on was that Phase Inspections were taking anywhere from 5 to 16 days to accomplish and producing only a 51 percent on time delivery of aircraft. The stated goal was a consistent five to six day turnaround time on inspections and an increase in on time deliveries to 75 percent. By applying 6S, the average time to completion for phase inspections was reduced from eight days to five and the on time delivery rate was increased from 51 percent to 75 percent.<sup>49</sup> All of this was accomplished without significant changes to maintenance practices but a focus on organization and flow.

Concurrent to the F-15 project, the 20<sup>th</sup> Fighter Wing at Shaw Air Force Base identified a need to decrease time and personnel requirements due to Air Force downsizing. As part of their AFSO21 request, they identified that the "20 FW needs to find efficiencies in aircraft maintenance operations to maintain combat capability despite a 12% cut in maintenance manning authorizations in FY07"<sup>50</sup> Importantly, the 20 FW identified 18 different processes to streamline using AFSO21 and recognized that the customers to benefit from the process were both the maintenance personnel and pilots. Accordingly, several planned maintenance activities and inspections were targeted to include Phase Inspections. In addition to the requirement to continue to provide aircraft while dealing with a 12 percent reduction in personnel, the stated goal was to increase aircraft mission capable rates from 82 percent to 85 percent.<sup>51</sup> While the

focus of Process Improvement with the 20 FW Phase Inspections was on Lean, Six Sigma could have application but would take significantly more research and training in order to implement it than Lean.

Additionally, lessons learned from this AFSO21 project were in the differences between value added and non value added work. This is an important concept when applied to reducing waste in a process. "Value is expressed in terms of how the specific product meets the customer's needs, at a specific price, at a specific time."<sup>52</sup> Again, here the customers are the maintenance personnel and the pilots. The value stream in this case is the phase inspection and next their needs to be a determination between value added and non value added activities. Effort should be made to eliminate those non value added activities that are also categorized as unnecessary. An example of a non value added but necessary activity was at Kunsan Air Base, Korea, "To begin work on a fighter, each (crew chief) had to push a heavy tool box from a central storage area out to a hardened shelter, a trip up to half a mile."<sup>53</sup> This necessary but non value added activity consumed two maintenance man hours per day alone. By simply storing the tools in the shelter, the non value added activity was eliminated. While an extreme example of waste that was eliminated, it is likewise an example of something simple that should have been easily removed. These are the "common-sense steps . . . Secretary of the Air Force Michael W. Wynne had in mind when he launched Air Force Smart Operations for the 21st Century in March 2006".<sup>54</sup>

Despite the significant cost savings potential that AFSO21 has, the Air Force has invested a substantial amount of money has been in private corporations for consultation, advisory and assistance, training and contractor support. A report in May 2007 detailed these spending showing a firm fixed price contracts awarded to Bearing Point for \$99,000,000, Mainstream GS

for \$90,000,000, and five year awards to the University of Tennessee for \$25,000,000 and General Dynamics for \$28,000,000. This shows an apparent minimum investment of \$242,000,000 in order to effectively reduce the amount of manpower required by the Air Force.<sup>55</sup> In reality, the Mainstream GS and Bearing Point contracts are maximum value contracts with money to be paid per services rendered so could result in a substantially smaller investment.

## Survey

### Perception is Reality to the Hun<sup>56</sup>

Attitude and perception are crucial to successfully implementing CPI in an organization. CWO4 Johnson believes the key to this is selling the concept to the leadership first, without the buy in of squadron commanders and maintenance officers, CPI will fail.<sup>57</sup> Likewise, CDR Lucka's opinion on leadership buy in is that it "cannot come from the MMCO, but must have CO/XO/MO/OPSO level support and outcome goals driven by that level or higher (MAG/MAW) level Operators and Maintainers."<sup>58</sup> A formal survey of 21 respondents who currently work or have worked in F/A-18 organizational level maintenance was conducted with the specific goal of evaluating opinions on the value and relevance of CPI in the OMA. (Appendix A) The demographics of the respondents included Gunnery Sergeants through Lieutenant Colonels, maintenance officers and aviators who have served as maintenance officers and a range of experience from 2 months to 30 years. It is important to note that 15 of the 21 respondents are professional maintenance officers in the 6000 MOS series while the remaining 6 are F/A-18 pilots and Weapons Systems Officers (WSO). Additionally, current billets held by these respondents range from Maintenance Material Control Chiefs and Officers, Maintenance

Officers, Operations Officers, and a Squadron Commander. Another notable set of responses is regarding the level of training that these respondents have despite the widespread use of AIRSpeed in the IMA. Only 12 of the 21 respondents indicated that they have received any training and of those that have, the majority was in basic introduction courses in AIRSpeed, TOC, or LSS. The only respondent who indicated an actual belt certification was a Maintenance Material Control Officers who is white belt certified.

The overwhelming majority, 95 percent, of this small sample believes that Process Improvement can be utilized at the OMA for planned maintenance such as Phase inspections. Despite this seemingly positive perception, only 61 percent indicated a positive opinion of Process Improvement, 6 percent indicated a negative opinion and 22 percent were neutral in their attitude. One survey response summarized CPI as "as a good tool for making things better however, if everyone is not onboard it (will be) very difficult to use it successfully."<sup>59</sup> Interestingly, ten also indicated that Process Improvement could be used for unplanned maintenance while ten disagreed and do not believe it to be a useful tool. Unplanned maintenance consists of discrepancies that are noted by the aircrew or maintenance personnel and are not maintenance actions that were forecasted based on flight hours or known life cycles of parts that will need replacement. Arguably, certain Process Improvement theories have better application for certain processes than others. Lean for example may be applicable to the flight line or hangar while Six Sigma is not. Commander Doug Lucka, the E-2/C-2 Deputy Program Manager at Fleet Readiness Center Southwest North Island believes that with Process Improvement it is imperative to use "the right tool for the right job. Some things lend themselves to Lean and some to TOC. (Six Sigma) is also a great tool for solving complex problems, but you have to have data and good measurement systems."<sup>60</sup>

## Implementation

A major consideration with implementing CPI is the required amount of training in order for the process owners and users to understand and buy into the concept. It seems that the Marine Corps is constantly adding training requirements but never taking any away. This leads to just another "log on the fire" mentality which can potentially lead to poor attitudes to CPI training. Additionally, there needs to be a robust but reasonable training plan that is feasible to implement in a unit that is already taxed with Marine Corps and NAVAIR maintenance training requirements.

In addition to training in CPI, CDR Lucka believes that "critical thinking and change management/influencing skill sets" that he learned from being a test pilot were crucial to implementing CPI at the F/A-18 Depot.<sup>61</sup> While critical thinking is not something that the Marine Corps trains its young Marines or Officers to do, it is a tenet of Marine Corps Command and Staff College which many Maintenance Officers and Squadron Commanders have benefited from.

Where does the CPI training begin if the Marine Corps is serious about making this part of our culture and not just a fad similar to Total Quality Management that will pass with a future SECDEF? CDR Lucka believes that we can make this part of the way we do things but it will take a significant time commitment. He believes that "6 months for short term results that will not be self sustaining, 2-5 years to become embedded in our culture and be self sustaining, and 10-20 years to have it in the DNA like Toyota."<sup>62</sup> Training would begin at MOS schools in order to build the foundation and then continue similar to other training and qualifications once at the fleet squadron.

As stated previously, Lean can easily be applied at the OMA however under current Marine Corps HICVS mapping this will likely not be conducted unless NAVAIR mandates its application under NAVAIR AIRSpeed. Once again, this overly simple illustration of Lean applied to hangar and administrative spaces can be seen in figure (1). These apparently common sense tools are all too easy to apply and can result in significant time, cost and accident savings. As written, the MROC's designation of Aviation Material Life Cycle Management will most likely not identify hangar design or maintenance administration when mapping that value stream.

Another consideration for CPI at the OMA is to use Six Sigma and/or TOC to complete Phase Inspections. There are four Phase Inspections on the F/A-18 that correspond with Phase A through D and are conducted at periodic intervals in order at the OMA. Per the Technical Manual Phase Maintenance Requirement Cards, the total maintenance hours required to complete a Phase A is 23.6 assuming that there are no other issues identified during the inspections.<sup>63</sup> Recently, major unforeseen problems with the airframe such as heat damage and structural cracks have been identified during this process that can increase time in phase to several weeks. Regardless, these inspections are rarely, if ever, completed anywhere near 23.6 hours. In the survey, the primary reason for this is the additional incorporation of technical directives which are requirements from NAVAIR that must be completed on the aircraft and are usually done in conjunction with a Phase Inspection. However other delays that were noted indicated problems in logistical support, manpower, and equipment. One respondent noted that "During deployments, phases can be completed in two to three days and the quality of the product differs very little from the two weeks required during phases while at home."<sup>64</sup> Paradoxically, the procedures used while deployed remain the same however often the infrastructure available in austere locations is much less suited for aircraft maintenance. An



additional consideration is while deployed for contingency operations; squadrons receive the highest priority for parts and are often allowed to complete repairs that would normally be conducted by depot artisans. Additionally, maintenance crews will generally work consecutive twelve hours shifts for the entire deployment compared to eight to nine hour shifts at home base and the normal distractions which further promote lost time.

Unfortunately, attempts to apply CPI under Enterprise AIRSpeed have reportedly not seen much success. HS-10, the Navy H-60 Fleet Replacement Squadron (FRS) was the subject of CPI application for some of its scheduled maintenance events. CDR Lucka stated that "Some scheduled (maintenance) events have been completed here at HS-10. Has not sustained well. I am not convinced the Enterprise Airspeed Team has the right approach to doing this at the O level."<sup>65</sup> While CDR Lucka did not elaborate on the reasons that CPI applied to scheduled maintenance has not sustained it can be assumed that the culture and leadership support has a significant impact. Kirk Nicholas does elaborate on the CPI culture in the Navy despite having almost nine years of experience with AIRSpeed. "As you are seeing in the Navy side, there are disconnects between the AIRSpeed and Enterprise AIRSpeed . . . my understanding is they are right next door to each other and aren't sharing, good indicator that the culture issues haven't been resolved yet."<sup>66</sup> Conversely, CDR Lucka's experience is that "When and where management followed through with their words and commitment, and really turned over the process to the workforce, it has self sustained and continues to evolve."<sup>67</sup>

Due to the Marine culture of do more with less, an often-overlooked aspect of why maintenance takes longer than it should is manpower and infrastructure. It is not uncommon to see Phase Inspections occurring in hangars adjacent to a squadron's assigned hangar space. Likewise, due to limited hangar availability, an aircraft may begin Phase inside the hangar but

have to be moved several times during the course of the inspection in order to make room for other maintenance actions that require hangar space. The movement of the aircraft when not required for the inspection, and the movement of personnel, parts, and tools to other hangars is non-value added work. Conversely, the PMI line at North Island in concert with its Lean design has a place for everything. Aircraft undergo the same maintenance actions at the same spot in the hangar each time and the tools and support equipment are all in place where needed. While it is too late to rebuild our hangars in Beaufort and Miramar with CPI in mind, Marine Corps Air Station Iwakuni, Japan is a prime location for a "ground up" design. By 2014, Carrier Air Wing 5 along with its eight squadrons and over 4,000 personnel will relocate to new facilities being built aboard the air station. Additionally, the current hangars used for VMFA(AW)-242 and squadrons assigned to the Unit Deployment Program will be destroyed and rebuilt. By allocating a specific area in the hangar for phase inspections that has the necessary support equipment such as hydraulic generators, power carts, and stands as well as storage for tools, panels, fasteners, and parts, non-value added work can be eliminated.

The idea of adding infrastructure or storage racks to facilitate planned or unplanned maintenance leads to the question of whether or not CPI at this level is a deployable solution or not. Weight considerations are foremost when packing a squadron for any deployment and there is never an excess of available space. The proposed solution for this problem is to invest the money in redundant sets of gear for issue at MALS-12 in Iwakuni, Japan for squadrons that are deploying there. While it may not be feasible to deploy to combat zones or smaller deployments for training with this equipment, that should not be viewed as a reason to not implement this aspect of CPI.

While it is virtually impossible to train every Marine in the squadron to a Green Belt level, training needs to be conducted where it will have the greatest effect. Kirk Nicholson, the Marine Corps Business Enterprise Solution Specialist, points out the important distinction that “We won't train just to train; we will train with it tied to the transformation of the organization.”<sup>68</sup> The training requirements for squadron maintenance personnel are intensive as currently written, combine these with Marine Corps training requirements such as the rifle range, gas chamber, martial arts, etc and there is very little if any room for unnecessary training. However, the benefits of training specific billets and crews will far outweigh the cost. A key consideration is that for deploying fleet squadrons it is extremely difficult to permanently assign a crew to planned maintenance and keep that crew integrity for any considerable length of time unlike what can be accomplished at the FRS. CDR Lucka believes that “To implement a good Lean Phase process - you may want to do this (permanently assign a phase crew) – especially at FRS like (VMFAT) 101 where there is always 1 or more in phase. Deploying squadrons, maybe depending on (operational) tempo.”<sup>69</sup>

## **Conclusions**

In order to create a CPI culture within the Marine Corps like has been successfully accomplished in private industry, training and indoctrination needs to begin early. It is likewise important to continue to have an outside view of our processes to avoid the proverbial “self licking ice cream cone.” Kirk Nicholas emphasized that “Our focus will be on the training the civilians in Black Belt roles, due to cost and need to utilize over long periods of time. The uniform side is to transitory to apply the training in a spot long enough before they depart to make that cost effective, but we are training both military and civilian in Green Belt roles.”<sup>70</sup> The

civilian cadre that will be the CPI experts for the Marine Corps will provide a consistent and stable pool that is not subject to change of station orders every few years as Marines are. Developing a CPI culture will take years and can only be accomplished with buy in from senior leaders as well as those who will be hands on with CPI. To emphasize, CDR Lucka stated that in order to build this culture, it will take "6 months for short term results that will not be self sustaining. 2-5 years to become embedded in our culture and be self-sustaining, and 10-20 years to have it in the DNA like Toyota."<sup>71</sup>

As previously stated, the Air Force has invested potentially as much as 242 million dollars for CPI consultation, advisory and assistance, training and contractor support. According to the AFSO21 office, the Bearing Point contract "was established through our office allowing any (Air Force) unit/organization to write task orders and obligate money against for support."<sup>72</sup> Conversely, the Marine Corps is relying on executive identification of Strategic Value Streams such as the HICVS identified by the MROC to identify where CPI should be applied. This effectively negates the opportunity for the process owners to nominate smaller level projects for CPI, an area with high payoff for limited investment if used properly. Unfortunately, Mr. Nicholas points out that "In the case of the Navy, Army, and AF, they have big buckets to spend on, the Corps doesn't. Our annual investment in labor, consultants, and training is around \$4.5 mil."<sup>73</sup> In order to maximize CPI at the OMA, specifically the smaller maintenance processes, Marine Aviation Units will need to leverage NAVAIR AIRSpeed for expertise and financial support in the near term. Once a trained cadre of Black Belts and Master Black Belts has been established, the Marine Corps will have the internal capability to leverage this expertise with limited financial investment.

## Recommendations

The near term recommendations for the Marine Corps with regards to CPI are to develop and integrate a method for process owners and end users to nominate processes, and potential recommended solutions, to be targeted for CPI. At a minimum, this will help to foster the culture of CPI at all levels and further avoid the attitude of CPI being a passing fad that will change with the leadership. Ownership at lower levels will likewise increase the probability of success for projects and likely identify time and money saving processes that will go unnoticed at the higher echelons.

NAVAIR AIRSpeed needs to encompass OMA maintenance specifically and not rely solely on Enterprise AIRSpeed to improve processes at the OMA. Process owners and leaders at the OMA should be trained to the appropriate level to include Maintenance Officers and Commanding Officers. Until operational tempo dictates otherwise, Squadron and Group Commanders should be required to undergo CPI training on a case by case basis as the majority of F/A-18 squadrons and groups are not committed to the war. The current mandate that O-6/GS-15 level and above are required to attend CPI training does not take into consideration the significant challenges that a squadron commander and maintenance officer will face. CPI training targets at this level will further ease the implementation at the OMA and create the "buy in" required making the program palatable to the end user.

Finally, future military construction projects at all levels should be analyzed and designed with Lean in mind, much like the new layout of the PMI line at North Island. This should include not only design of the hangar floor to optimize tool storage and issue, aircraft placement, and support equipment but offices to include primarily Maintenance Administration, Maintenance Control, and the maintenance officer and chief.

<sup>1</sup> Deborah L. Clark, and Theodore J. Kaehler, *Evaluation of Organizational Self-assessment Tools and Methodologies to Measure Continuous Process Improvement for the Naval Aviation Enterprise* (Monterey, Naval Postgraduate School, 2006), 1.

<sup>2</sup> Gordon England, *DoD-Wide Continuous Process Improvement (CPI) / Lean Six Sigma (LSS)* (Washington D.C., 2007).

<sup>3</sup> Ibid.

<sup>4</sup> Ibid.

<sup>5</sup> Ibid.

<sup>6</sup> Donald Winter, *Transformation Through Lean Six Sigma* (Washington D.C., 2006).

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

<sup>9</sup> Ibid.

<sup>10</sup> Dr. William Edwards Deming was an American statistician, college professor, author, lecturer, and consultant. Deming is widely credited with improving production in the United States during World War II, although he is perhaps best known for his work in Japan. There, from 1950 onward he taught top management how to improve design (and thus service), product quality, testing and sales (the last through global markets) through various methods, including the application of statistical methods such as analysis of variance (ANOVA) and hypothesis testing. (Wikipedia.org)

<sup>11</sup> George, Michael L., Bill Kastle, and David Rowlands. *What is Lean Six Sigma* (New York: McGraw-Hill, 2003), 9.

<sup>12</sup> Robert Davis, *Framework for managing process improvement: A guide to enterprise integration* (Arlington: U.S. Dept. Of Defense, 1994), A-4.

<sup>13</sup> Ibid, A-2.

<sup>14</sup> David Nave, *How to Compare Six Sigma, Lean, and Theory of Constraints, A framework for choosing what's best for your organization*, [www.asq.org](http://www.asq.org), (accessed 5 December 2007).

<sup>15</sup> Taco Gilbert, "Leading Process Improvement." AFSSO21 Overview, Brig Gen Taco Gilbert (Washington DC, 1 May 2007).

<sup>16</sup> Don Roll, "An Introduction to 6S." Vital Enterprises - Homepage. [http://www.vitalentusa.com/learn/6s\\_article.php#intro](http://www.vitalentusa.com/learn/6s_article.php#intro) (accessed 21 January 2008).

<sup>17</sup> Ibid.

<sup>18</sup> Nave, *Compare SS, L, TOC*, 73.

<sup>19</sup> Ibid, 73.

<sup>20</sup> Ibid, 74.

<sup>21</sup> "Six Sigma Training", <http://www.isixsigma.com/library/content/c010225a.asp> (accessed 27 January 2008).

<sup>22</sup> Ibid.

<sup>23</sup> Charles Dunne, *Combat Readiness in Marine Corps Aviation: The Utility of the Theory of Constraints to Aviation Logistics* (Quantico, Marine Corps University, 2002), 14.

<sup>24</sup> Nave, *Compare SS, L, TOC*, 75.

<sup>25</sup> Dunne, *Combat Readiness*, 14.

<sup>26</sup> *Naval Aviation Vision 2020* (Washington, DC 2002).

<sup>27</sup> Ibid.

<sup>28</sup> Ibid.

<sup>29</sup> Steve Simpliciano, and Rob Willis, "AIRSpeed E2E Brief ." 3d MAW, HQMC(ASL) (San Diego, 7 December 2008).

<sup>30</sup> *Naval Aviation Vision 2020* (Washington, DC 2002).

<sup>31</sup> Clark, *Evaluation of Organizational Self-assessment Tools*, 3.

<sup>32</sup> Joel Eissinger, "MARADMIN - USMC Continuous Process Improvement (CPI) Implementation Policy." United States Marine Corps - Marines.mil,

<http://www.usmc.mil/maradmins/maradmin2000.nsf/37f49138fc3d9c00852569b9000af6b7/6232a594e091fc96852573ca003af66d?OpenDocument> (accessed 7 January 2008).

<sup>33</sup> Ibid.

<sup>34</sup> "Enterprise AIRSpeed." Commander, Naval Air Forces.

<http://www.cnaf.navy.mil/airspeed/main.asp?ItemID=703> (accessed 20 December 2008).

<sup>35</sup> Patrick Johnson, Interview by author. Personal. Quantico, VA (Telephone) (December 21, 2007).

<sup>36</sup> Ibid.

<sup>37</sup> Douglas Lucka, Interview by author. Personal. Quantico, VA (E-mail) (December 4, 2007).

<sup>38</sup> Simpliciano, *AIRSpeed E2E Brief*.

<sup>39</sup> Gilbert, *Leading Process Improvement*.

<sup>40</sup> Ibid.

<sup>41</sup> Adam Hebert, "AFSO21 Explained." *Air Force Magazine* (1 January 2008).

<sup>42</sup> Ibid.

<sup>43</sup> Ibid.

<sup>44</sup> Ibid.

<sup>45</sup> *DoD Lean Report To Congressional Defense Committees*.

<sup>46</sup> Ibid.

<sup>47</sup> Ibid.

<sup>48</sup> Gilbert, *Leading Process Improvement*.

<sup>49</sup> Robert Haverman, "Langley AFB 1 MXG F-15 Phase." Standard Work and 6S, AFSSO21 (Hampton, January 29, 2007).

<sup>50</sup> Simon Izaguirre, "VSA Aircraft Maintenance." 20th Fighter Wing, AFSSO21 (Columbia, January 5, 2007).

<sup>51</sup> Ibid.

<sup>52</sup> Nave, *Compare SS, L, TOC, 75*.

<sup>53</sup> Hebert, *AFSSO21 Explained*.

<sup>54</sup> Ibid.

<sup>55</sup> Michael Marx, "Six Sigma Blogs: Air Force Smart Operations for the 21st Century - AFSSO 21." Six Sigma Companies.com - The Six Sigma Scoop on the Fortune 500 and Global 500. [http://www.sixsigmacompanies.com/archive/air\\_force\\_smart\\_operations\\_for\\_the\\_21st\\_century\\_afso\\_21.html](http://www.sixsigmacompanies.com/archive/air_force_smart_operations_for_the_21st_century_afso_21.html) (accessed 15 January 2008).

<sup>56</sup> Wess Roberts, *Leadership Secrets of Attila the Hun* (New York: Warner Books, 1990).

<sup>57</sup> Johnson, Interview.

<sup>58</sup> Lucka, Interview.

<sup>59</sup> Survey.

<sup>60</sup> Lucka, Interview.

<sup>61</sup> Ibid.

<sup>62</sup> Ibid.

<sup>63</sup> "Technical Manual Phased Maintenance Requirements Cards Navy Model F/A-18C and F/A-18D" (November, 2005).

<sup>64</sup> Survey.

<sup>65</sup> Lucka, Interview.

<sup>66</sup> Kirk Nicholas, Interview by author. Personal. Quantico, VA (E-mail) (6 February 2008).

<sup>67</sup> Lucka, Interview.

<sup>68</sup> Kirk, Interview.

<sup>69</sup> Lucka, Interview.

<sup>70</sup> Kirk, Interview.

<sup>71</sup> Lucka, Interview.

<sup>72</sup> Joseph Heilhecker, Interviewed by author. Personal. Quantico, VA (E-mail) (January 2008).

<sup>73</sup> Ibid.



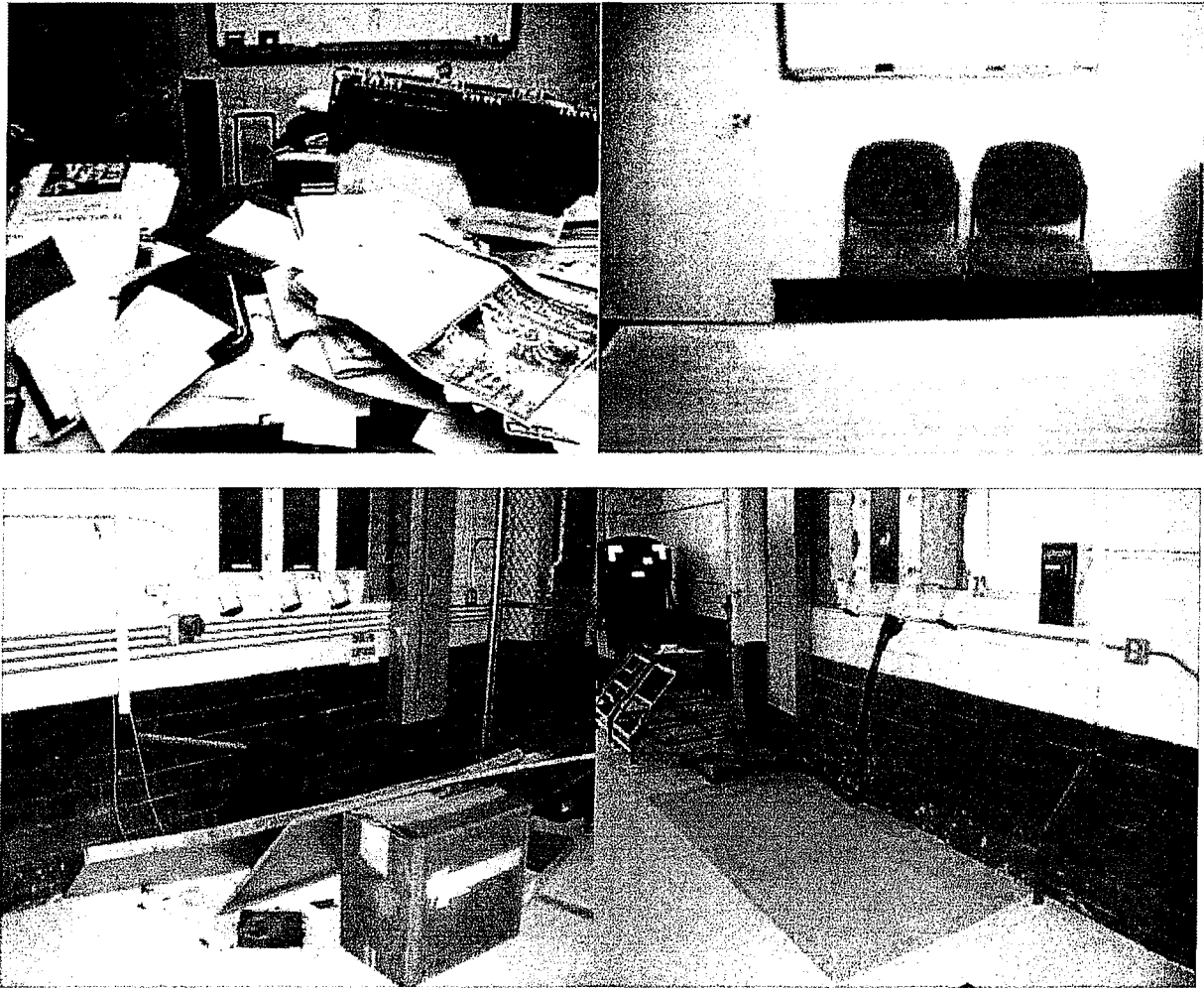


Figure 1

## *Appendix A*

1. What is your current rank?
2. What is your MOS designator? e.g. 6002, 7523, 7525, etc
3. What is your current job? e.g. MO, AMO, MMCO, MMCC
4. What is the length of your total maintenance experience?
5. Have you attended the Maintenance Officer Course in Pensacola or the DETMO five day course?
6. If you are an officer, do you have prior enlisted maintenance experience?
7. Have you ever heard of Process Improvement? e.g. AIRSpeed, Lean Six Sigma, Theory of Constraints.
8. Do you have any training in Process Improvement?
9. What is your overall opinion of Process Improvement?
10. Based on your experience, do you think that Process Improvement can be utilized at the squadron level to improve the efficiency of planned maintenance such as Phase Inspections?
11. Based on your experience, do you think that Process Improvement can be utilized at the squadron level to improve the efficiency of unplanned maintenance?
12. Is it feasible to assign Marines (trained in Process Improvement) to a phase crew for 6-12 months?
13. Is a two-week Process Improvement indoctrination course for your SNCO's feasible? Explain.
14. Is a two-day Process Improvement indoctrination course for your junior Marines feasible?

15. Please indicate what are your top "time killers" with phase inspections.
16. In your opinion, are the requirement cards as prescribed in the A1-F18AE-MRC-300 organized effectively?
17. In your opinion, does your squadron possess the needed infrastructure to accomplish phase inspections? e.g. tool/part storage, hangar space etc.

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