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Beyond AIRSpeed: How Organizational Modeling and Simulation Further Reduced Engine Maintenance Time

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Beyond AIR*Speed*: How Organizational Modeling and Simulation Further Reduced Engine Maintenance Time

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Abstract

Aircraft Intermediate Maintenance Division at Naval Air Station Lemoore achieved time and cost reductions using the NAVAIR Enterprise AIR*Speed* program of Lean, Six Sigma and Theory of Constraints, but could changes in organization structure or management practices provide further improvements?

Organizational simulation software was employed to test interventions that could reduce throughput time for the F414 aircraft engine. A baseline model was developed, and interventions were modeled and simulated. The simulated results indicated that paralleling some tasks could significantly decrease maintenance duration while maintaining quality. The intervention was implemented—saving 26 days per engine. Organizational modeling and simulation can identify and pre-test time and cost savings over and above techniques such as Lean and Six Sigma.

Key words: Organizational modeling, organizational simulation, Logistics, Lean, Six Sigma

Introduction

The Aircraft Intermediate Maintenance Division (AIMD) at Naval Air Station (NAS) Lemoore, CA, has worked aggressively to reduce engine maintenance time using the tools of the NAVAIR Enterprise AIR*Speed* (AIR*Speed*) program. AIR*Speed* is a system created by the Naval Aviation Readiness Integrated Improvement Program's (NAVRIIP) to enable cost-wise readiness across the naval aviation enterprise (Naval Air Forces Public Affairs Office, 2006). AIMD Lemoore has achieved time and cost reductions at the maintenance activity level using AIR*Speed's* prescribed tools of Theory of Constraints, Lean, and Six Sigma, but could further improvements be made by changing the organization structure or management practices?

In an effort to answer this research question, AIMD Lemoore teamed with the Naval Postgraduate School's (NPS) Graduate School of Business and Public Policy to explore organizational modeling as a method for identifying potential modifications to the organization which may improve AIMD performance. Specifically, AIMD leadership focused on improving F414 aircraft engine maintenance by decreasing engine throughput duration.

The objective of this effort was to provide the NAS Lemoore AIMD 400 Division, the Division responsible for F414 maintenance, with recommendations on how their organization may be restructured in order to decrease F414 maintenance cycle-time. To meet this objective, NPS developed an organizational model of the 400 Division which described their current F414 maintenance process. This model was then modified to characterize the impact of organizational changes on maintenance cycle-time.

This paper is organized into four sections. The first, a literature search, provides a basis for understanding organizational modeling in general as well as techniques specific to the

POWer software developed by Dr. Raymond E. Levitt's Virtual Design Team (VDT) research group at Stanford University and employed in this project. The second section discusses the methodology for conducting this study. The third section presents the results of the modeling effort. Finally, section four presents project conclusions, recommendations for restructuring the 400 Division, and recommendations for future research.

Computational Organizational Modeling

In the 21st Century, computational organizational modeling, a new predictive modeling technique, has come of age. It is a tool which has the potential to assess how changes to an organization may or may not benefit the organization's performance (Levitt, 2004). Computational organizational modeling as a tool for improving quality is different from many other quality-improvement techniques such as Lean, TOC, or Six Sigma in that it does not focus on the production process, but instead on the organizational structure that manages that production process, and the information flow through that organization necessary to execute the production process. It is based upon the understanding that by improving the quality of the organization and the flow of information through that organization, the quality of the organization's output can be improved.

The technique of organizational modeling is analogous to modeling employed in the natural sciences, such as finite element modeling (FEM) or computational fluid dynamics (CFD) modeling. FEM and CFD modeling both break down the larger structure being modeled into smaller elements, with each element having its own characteristics: e.g., modulus of elasticity, density, viscosity. With an understanding of how these elements interact, the overall effect of a force or moment on the larger structure can be assessed. Similarly, organizational modeling is accomplished by breaking down an organization into smaller elements such as tasks, people, and communication methods—each with their own characteristics, e.g., time required to accomplish a task, worker experience, communication clarity—and predicting how changes to an organization may affect each element and, subsequently, how those elements in turn affect the overall organizational performance (Levitt, 2004).

This detailed level of organizational characterization theoretically allows managers to design their organization in the same way that engineers design bridges. Organizational modeling allows managers to perform "what-if" analyses, evaluating, in a virtual environment, the effects of organizational constructs in order to identify the structure resulting in the best output. Gaining similar insight without the aid of a modeling tool would be prohibitive. Organizations could not withstand the dynamics of change after change simply to determine what works best and what does not.

The organizational model employed in this project is POWer, version 1.1.6. It was developed by Dr. Raymond Levitt as part of a suite of Virtual Design Team (VDT) simulations at Stanford University.

Virtual Design Team—POWer

POWer evolved from the Virtual Design Team simulations, which are based on macro-contingency theory and describe work in terms of information flow (Thomsen, Kunz, Levitt & Nass, 1998). POWer is based on the premise that no matter what business an organization is in, be it production of widgets, design of skyscrapers, or providing hotel rooms, one thing they all have in common is they must process information effectively to do their job well (Kunz, 1998).

Theoretical Basis for POWer

The concept that organizations can be modeled in terms of information flow is based on J.R. Galbraith's theory of information processing. According to Galbraith, information transfer and processing is dynamic. Due to the complexity of information and, many times, the sheer amount of it, there are often instances in which an individual is unable to process all of the information he is given because he does not have the skill or experience to make decisions quickly enough. As a result, an *exception* (as Galbraith defines it) is created. Exceptions are common in today's fast-paced world in which we are inundated with requests from e-mail, cell phones, black-berries, etc. In Galbraith's view, organizations are modeled primarily as hierarchies; it's through these hierarchies that exceptions are passed up the "chain of command" to be handled by more experienced individuals. Along with the hierarchical structure by which exceptions are passed, Galbraith notes there are also exchanges of information between individuals at equal levels in an organization. These information exchanges can also be used to handle exceptions, and are often more effective than those moving up the chain of command since they tend less to overload upper-level managers and create additional exceptions (Thomsen, Kunz, Levitt & Nass, 1998).

Methodology

The researchers visited the NAS Lemoore in order to conduct multiple interviews with 400 Division personnel. Information was collected to properly structure the 400 Division model in POWer and accurately characterize the properties of each software element. Through these exchanges, a baseline model was created that accurately characterized the operation of the 400 Division F414 maintenance process.

Modifications, also termed "interventions," were identified which have potential for decreasing F414 maintenance throughput. Each intervention was separately created by modifying the baseline model. Comparisons between these modified and baseline models were made to determine the utility of each intervention. Finally, a combined intervention model incorporating all individual interventions deemed beneficial was developed and compared to the baseline model.

Figure 1 presents the baseline model of the 400 Division. The slanted boxes at the top of the figure represent meetings. The human-shaped symbols represent positions within the division. The boxes in the center of the figure represent the primary F414 maintenance tasks, while the boxes in a vertical line on the left represent the off-core tasks. The remaining polygons represent milestones in the maintenance process.

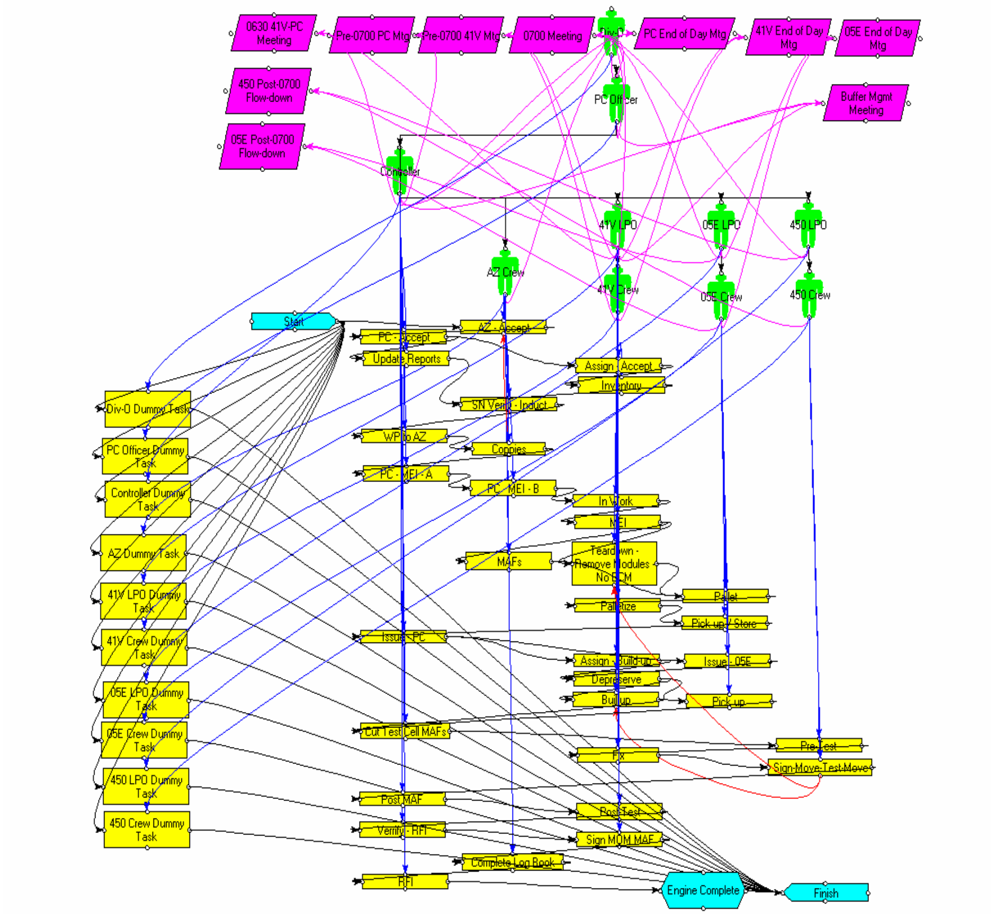

Figure 1. Organizational Model

The positions modeled were those that directly impacted F414 maintenance. Positions were modeled in terms of the number of personnel assigned, amount of time available to work F414 tasks, qualifications, skill levels, and experience. Since this engine was one of the six engines the division maintained, the time as allocated was 1/6 of the actual time available. In addition, off-core tasks described below were added to a positions' workload to occupy their time when not conducting F414 maintenance. Figure 2 presents the organizational structure.

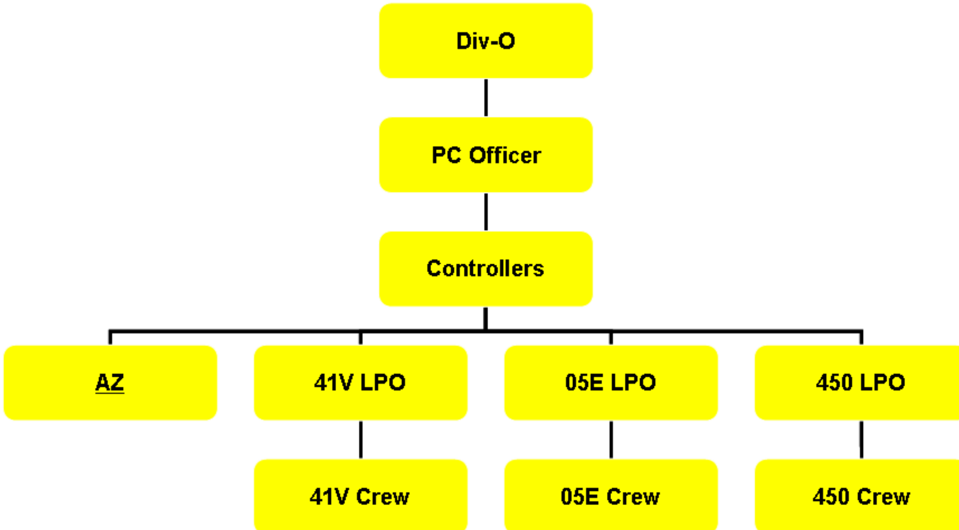

Figure 2. NAS Lemoore AIMD 400 Division Information Hierarchy

The terminology used in Figure 2 and throughout this report to reference individuals and groups is consistent with terminology used in the Navy's AIMD. For clarity, these terms are defined as follows:

Div-0: Division Officer

PC Officer: Production Control Officer

AZ: administrative personnel

41V: personnel who directly conduct F414 maintenance

05E: supply personnel dedicated to the division

450: personnel responsible for conducting final tests of the F414

LPO: Leading Petty Officer, responsible for the workcenter

Tasks were modeled in terms of duration, required skills, priority, and complexity. Modeled tasks are presented in Figure 3. The following is a general description of the F414 maintenance process.

After the engine is received, AZ personnel begin by comparing information in the engine logbook to information in two central databases, AEMS and SAME, which track engine parts and engine movement. Prior to maintenance action commencing on the engine, AZ personnel must resolve any discrepancies. Once completed, 41V personnel conduct a major engine inspection (MEI) followed by an engine teardown to determine which engine modules need replacing. Replacement modules are pulled from supply by 05E personnel. The engine is reassembled or "built-up" by 41V personnel, and then sent to the test cell, where 450 personnel run it through pre-defined profiles assessing operability. The engine is returned to the maintenance hanger where 41V personnel conduct a post-test inspection. At this point, AZ personnel complete paperwork; Controller personnel sign off the engine as ready for issue (RFI) to an operational squadron. Throughout this process, Controllers are directing the maintenance activities.

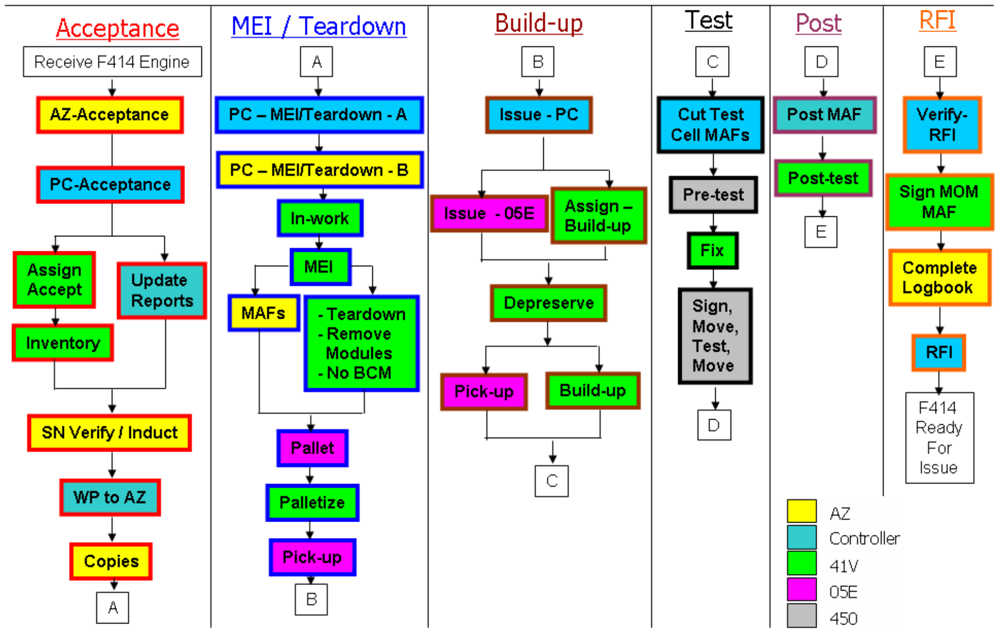

Figure 3. Work Breakdown Structure of the F414 Engine Maintenance Process

To ensure positions were continually occupied throughout the F414 maintenance process, as they would be in reality, off-core tasks were added to the model to simulate maintenance work being accomplished by personnel, other than maintenance of the single engine being modeled.

Meetings were modeled in terms of duration, who attended, priority and interval time between meetings. Meetings were a key method of reliably transferring information between personnel. In general, the division had a set of morning meetings and a set of afternoon meetings.

Rework was modeled as a percentage of work accomplished. Most F414 rework occurred at the test-cell phase of maintenance. The percentage of rework was based on 400 Division estimates.

Additional organizational characteristics modeled included the overall experience level of the division, the degree of centralized control, the degree of formality in transferring information (i.e., meetings versus hallway conversation), and the matrix strength or connectedness of personnel.

Model Validation Procedure

Once the model was constructed, the maintenance duration predicted by the model was compared to the actual time it should take to conduct engine maintenance. The actual time was calculated by summing the duration of all tasks occurring in series and the longest duration task of any grouping of tasks occurring in parallel. The smaller the difference was between these values, the higher the confidence in the model, and, hence, the predicted impacts of interventions.

Model Interventions

Once the model was determined to accurately depict the current organization, modifications or interventions were made to evaluate alternate organizational constructs which might reduce throughput duration. The following interventions to the baseline model were evaluated.

1. Parallel AZ Acceptance task with other maintenance tasks
2. Combine AZ and Controller positions
3. Combine 41V and 450 positions
4. Decrease organization's centralization
5. Add additional personnel to each position
6. Alter current meetings' duration and frequency
7. Combine meetings
8. Conduct a combined intervention

The current F414 maintenance process presented in Figure 3 shows a serial process initiated by the AZ Acceptance tasks.

Intervention 1: Considered the impact of conducting the AZ Acceptance tasks in parallel with all other maintenance tasks.

Intervention 2: Personnel assigned to the AZ and Controller positions are combined into a single position. This position is assigned the combination of tasks originally assigned to the separate positions. This intervention was evaluated in two sub-interventions, first without retraining individuals and then with retraining.

Intervention 3: The same as Intervention 2, with the work positions combined.

Intervention 4: One of the impacts of AIR*Speed* is to decrease the centralized control of an organization by pushing authority for decision-making to the lowest possible level. This fourth intervention assessed the impact of the division's further decreasing centralization.

Intervention 5: Assessed the impact of adding additional personnel to existing positions. Personnel were added separately to AZ, Controller, 41V Crew, 05E Crew, and 450 Crew positions while holding personnel at all other position constant.

Intervention 6: Considering maintenance tasks are well defined and the personnel are highly skilled, it's conceivable that that altering meeting duration and/or frequency may decrease F414 throughput duration. This intervention evaluated altering the duration and frequency of the 0700 morning meeting, the Division's primary coordination meeting.

Intervention 7: For the same rationale as intervention #6, this intervention evaluated the impact of combining all of the morning meetings while leaving the afternoon meetings separate.

It then evaluated the impact of separately combining all morning meetings and all afternoon meetings.

Intervention 8: Based on the results of the single interventions, a combined intervention was developed which included those interventions presented above that decreased the F414 maintenance throughput time.

Evaluating Interventions

Interventions were evaluated by comparing four metrics predicted by the baseline model to those predicted by the models with interventions. The first metric was project duration, the duration required to accomplish maintenance of a single F414. Duration was considered the most important metric. The second metric was position backlog, a measure of the number of days of work a position has yet to accomplish. It is analogous to the size of a person's in-box. A position with a high backlog poses a risk of increasing project duration and decreasing output quality. Position backlog is presented as a line graph of number of backlog days versus time. The third metric was cost. Although absolute cost was not a concern for this study, changes in costs resulting from interventions were. Of particular interest were interventions resulting in increases in costs associated with the major tasks of engine teardown, buildup, and testing. Cost was calculated by the simulation and output in both text and graphic. The fourth metric was functional risk, the risk that an engine has defects due to rework and the inability of personnel to handle problems. Qualitative comparisons of functional risk were made using output charts of the functional risk.

For any given intervention, the impact on each of the four metrics was categorized as positive, negative, or no impact and given a rating respectively. For example, a decrease in project duration resulting from an intervention would be considered positive, while an increase in cost or risk would be considered negative

Results

The Results section begins with a presentation of the baseline model validation results. The baseline model is followed by a summary of the results of the seven individual interventions and the combined intervention. Finally, there is a discussion of which interventions were implemented and their impact on F414 maintenance duration.

Baseline Model Evaluation

The actual time required to conduct F414 maintenance was calculated to be 21.77 days—compared to the baseline model prediction of 21.09 days. Since these two durations were within 3% of each other, there was high confidence that the baseline model was accurate.

Interventions—Summary of Results

Table 1 presents a summary of the intervention results. The first intervention, paralleling the AZ Acceptance Task, has the greatest benefit on decreasing F414 throughput duration. Other interventions that were beneficial included decreasing centralization, and separately combining the morning and afternoon meetings. The combined intervention, incorporating all of these beneficial interventions, resulted in a 35% decrease in F414 throughput duration with a slight decreasing in the backlog of most of the personnel. A detailed discussion of the analysis and results associated with Intervention 1 is presented in the following sub-section. All other interventions (including the combined intervention) were analyzed in the same manner.

Intervention	Project Duration	Backlog	Cost	Risk
1. Parallel AZ Acceptance	58.56 hour decrease	Decrease most positions	No significant impact	Increase in AZ Acceptance task risk
2a. Combine Controller & AZ positions without training	110 hour increase	Decrease controller & AZ, Increase for Div-O & PC	AZ Acceptance task work & rework cost increase by 205.6 & 11.72 respectively	Increase in AZ Acceptance task risk
2b. Combine Controller & AZ positions with training	56.7 hour increase	Decrease in Controller & AZ backlog. Increase for Div-O & PC	AZ Acceptance task work & rework cost increase by 140.1 & 18 respectively	Increase in AZ Acceptance task risk
3a. Combine 41V and 450 positions without training	132.6 hour increase	Slight decrease in 41V and 450 backlog	Increase costs: Buildup & rework—267.16 and 7.2, Test work, rework, and wait costs—1085, 61.5, 290.2	3/4 top risk areas assigned to combined 41V-450 vs 2/4 currently
3b. Combine 41V and 450 positions without training	67.6 hour increase	Slight decrease in 41V and 450 backlog	Increase costs: Buildup work – 267.15 & test work, rework, and wait costs – 303.4, 5.63, 93.41	3/4 top risk areas assigned to combined 41V-450 vs 2/4 currently
4. Decrease Centralization	4.4 hour decrease	No significant impact	Slight increase in Buildup task rework costs of 9.86	No significant impact
5a. Add AZ personnel	1.87 min saved / person	No data collected	No data collected	No significant impact
5b. Add Controller personnel	6.82 min lost / person	No data collected	No data collected	No significant impact
5c. Add 41V Crew personnel	0.91 min lost / person	No data collected	No data collected	No significant impact
5d. Add 05E Crew personnel	10.51 min saved / person	No data collected	No data collected	No significant impact
5e. Add 450 Crew personnel	4.42 min saved / person	No data collected	No data collected	No significant impact
6a. Vary 0700 meeting duration & frequency	6.56 hours saved due to less frequent meeting	No data collected	No data collected	No significant impact
6b. Vary 0630 meeting frequency	1.6 hours saved due to less frequent meetings	No data collected	No data collected	Slight increase in risk when increasing time between meetings
7a. Combine only morning meetings	No significant impact	No data collected	No data collected	No significant impact

7b. Separately combine morning and end of day meetings	7.28 hours saved by decreasing meeting frequency to every other day	No data collected	No data collected	No significant impact
8. Combined Interventions	58.96 hours saved	Decreases most positions. Increases 450 LPO	Buildup rework decreases by 26.3; Teardown rework increases by 10.49	No significant impact

Table 1. Simulation Results for Interventions by Duration, Backlog, Cost and Risk

Intervention 1, paralleling the acceptance task with maintenance, decreased project duration by 7 days from the base model prediction of 21.09 days to 13.77 days. The impact of this intervention on individual task durations and the overall duration are depicted in Figure 4. The dark bars represent the duration of the individual maintenance tasks—with the exception of the second through eleventh bars, which represent off-core tasks. The decrease in maintenance duration is the result of starting on-engine maintenance tasks at the same time as the AZ Acceptance task. In the current process (Figure 4 left chart), the 14-day AZ Acceptance task must be accomplished before any other tasks. This intervention (depicted in the right chart in Figure 4) allows the engine-maintenance-related tasks to begin at the same time as the AZ Acceptance task.

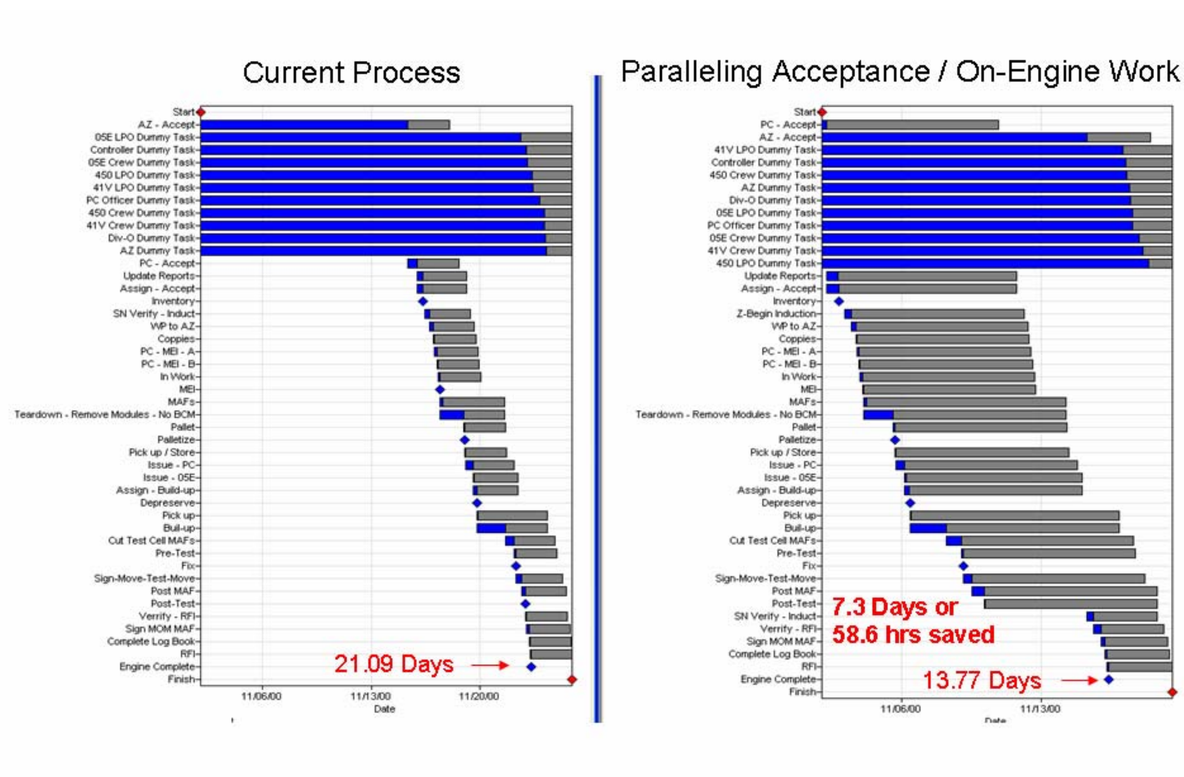

Figure 4. Comparison of Project Duration for Intervention 1

Figure 5 presents a comparison of the position backlog of the baseline model and the model employing the intervention. The comparison shows a slight decrease in position backlog resulting from Intervention 1.

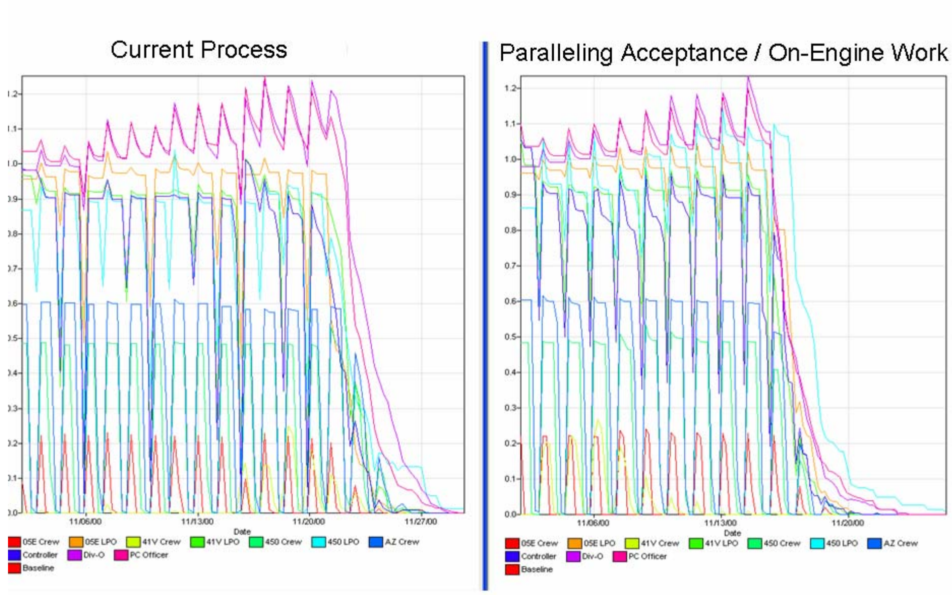

Figure 5. Comparison of Position Backlog for Intervention 1

Figure 6 presents a comparison between baseline model costs associated with the model employing the intervention. Figure 6 indicates no significant impact on cost.

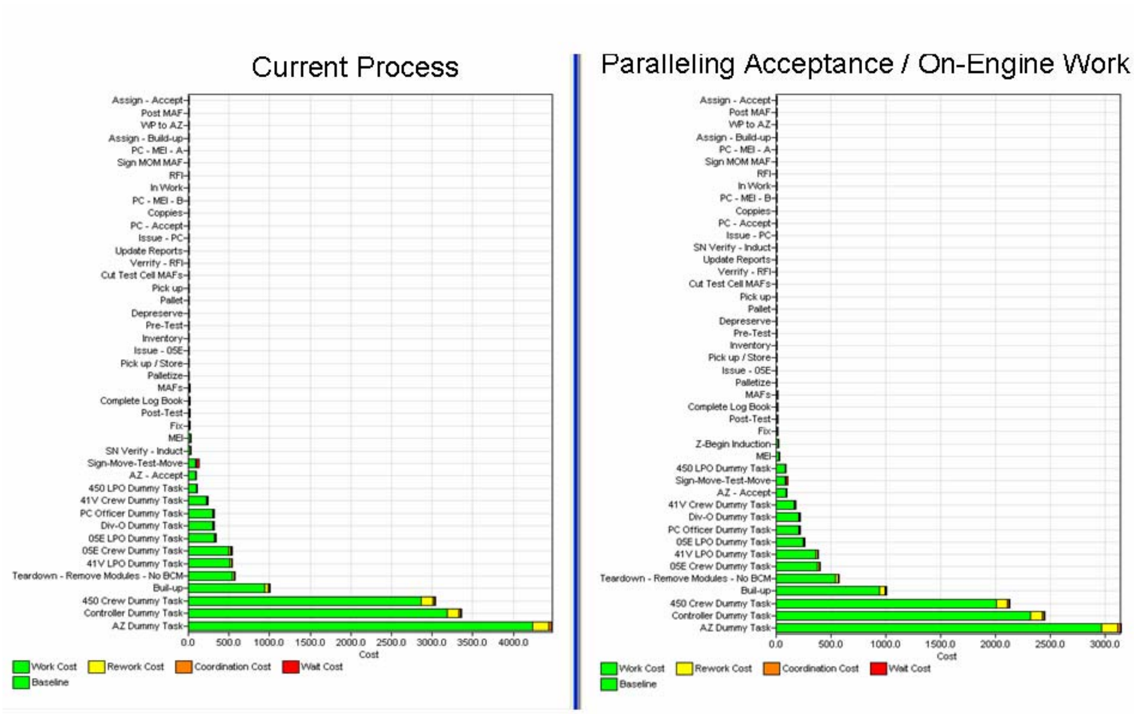

Figure 6. Comparison of Cost for Intervention 1

Figure 7 presents a comparison of the baseline model functional risk with the functional risk for the model implementing Intervention 1. This comparison indicates a slight risk increase for the AZ Acceptance task. This is not unexpected since this task is now being accomplished in conjunction with other tasks; hence, the time originally devoted by Controller personnel to assist AZ personnel in handling problems must now be devoted not only to AZ personnel, but to other personnel concurrently working engine-maintenance tasks.

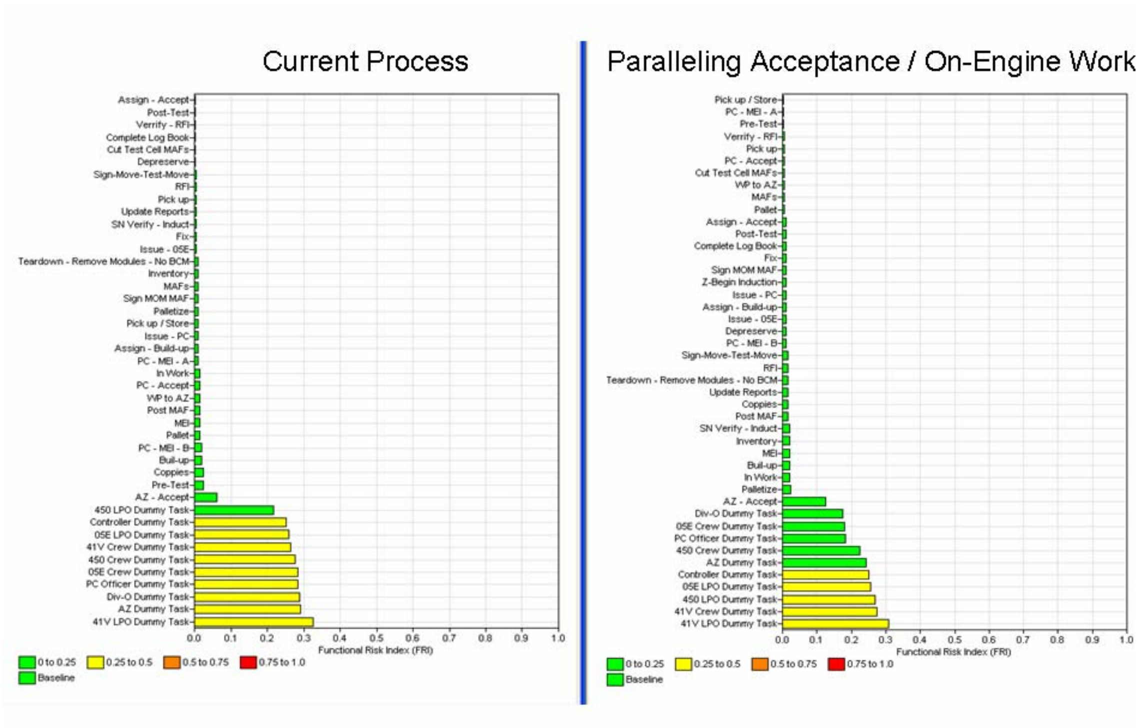

Figure 7. Comparison of Functional Risk for Intervention 1

The overall rating for Intervention 1 is presented in Table 1. This intervention was considered beneficial because it resulted in a significant decrease in project duration, a slight decrease in position backlog, no significant impact on cost, and only a slight increase in functional risk for a single task.

Intervention #8—Combined Intervention

The combined intervention included the following interventions, which were chosen for being the most beneficial:

Intervention #1—Paralleling the acceptance task

Intervention #4—Decreasing centralization from high to low

Intervention #6—Decreasing 0700 meeting frequency to every 2 days

Intervention #7—Separately combining morning & afternoon meetings

The impact of these combined interventions on project duration was a decrease from 21.09 days to 13.72 days. The backlog for most positions decreased with an increase in only one position, the 450 LPO. There was a slight increase in Teardown task rework cost from $26.44 to $36.93, and a slight decrease in the Buildup task rework cost from $48.43 to $22.13.

Overall, the changes in cost were not considered significant. Finally, there was no significant impact on functional risk.

Assessment of interventions

The results of this study lead to the conclusion that four of the seven interventions to the division considered in this study would be beneficial to reducing the throughput duration: paralleling the AZ Acceptance task, decreasing centralization, decreasing 0700 meeting frequency, and separately combining morning and afternoon meetings.

The greatest benefit to reducing the F414 throughput duration comes from paralleling the AZ Acceptance task. Although this intervention increases functional risk, this increase is minor relative to the decrease in throughput time by 7.21 days. There is also a consequent decrease in position backlog.

Decreasing centralization, a benefit realized through the implementation of AIR*Speed,* also has a positive impact on decreasing F414 throughput. This intervention resulted in a 4.4-hour decrease in duration.

By decreasing the 0700 meeting frequency from every day to every other day, F414 throughput duration decreases by 6.56 hours. This benefit is the result of a highly skilled workforce executing well-defined tasks, allowing personnel to spend more time working on engine maintenance and less time exchanging information in meetings.

By separately combining morning and afternoon meetings such that there is one morning meeting and one afternoon meeting that all personnel attend, F414 throughput duration decreases by 7.28 days. At the same time, there is also no increase in functional risk.

Unfortunately, benefits associated with combining these four interventions are not additive. This makes sense based on their interrelated nature. When combining interventions, the benefit to reducing F414 throughput duration is nonetheless significant in that there is a reduction of over 35% from the baseline case representing the current organization. In conjunction with this benefit, there is a decrease in backlog for all positions excluding one, the 450 LPO, and there is no adverse impact to cost or functional risk.

Two other interventions considered, combining the AZ and Controller positions and combining the 41V and 450 positions, resulted in increases in F414 throughput duration as well as increases in cost and risk, with the only predicted benefit being a decrease in position backlog for the combined positions. Clearly, these interventions are not beneficial.

Finally, the intervention associated with adding additional personnel did not affect F414 throughput duration, and had no impact on risk. Obviously, there would be no benefit to implementing this intervention.

Recommended Interventions

- NPS recommended the 400 Division implement the following interventions
- Decrease 0700 morning meeting frequency to every other day.

- Separately combine morning and end-of-day meetings
- Parallel the AZ Acceptance task

The first and each subsequent intervention recommendation should be implemented, followed by a period of evaluation. The priority order of these interventions is based on first implementing those interventions that can most easily be reversed. For example, conducting the 0700 meeting every other day is a relatively easy organizational change which should result in a decrease in F414 throughput duration. At the same time, it is an organization change that can be reversed if deemed necessary.

Impact of implementing interventions

The NAS Lemoore AIMD and 400 Division leadership had significant confidence in the results of this study, and chose to fully implement the recommendation to parallel the AZ acceptance task while partially implementing the recommendation to separately combine the morning and afternoon meetings. The impacts of these decisions were quickly realized and deemed successful. The following discussion presents three instances in which paralleling the AZ acceptance task significantly reduced F414 maintenance throughput time. Table 2 at the end of this section presents a summary of these results. Following this is a discussion of how partially combining 400 Division morning meetings improved organizational performance.

On 20 October, the 400 Division received F414 serial number 868472 from VFA106, NAS Oceana. On that same day, the engine-acceptance process commenced. During the acceptance process, SAME database problems were identified. Recall that the SAME database, described earlier in this paper, is an historical record of maintenance actions accomplished on each engine. Often, an engine is received by the 400 Division for which there are discrepancies between data contained in the SAME database and the engine log book. These SAME discrepancies were resolved on 7 November. Prior to implementing the intervention of paralleling the AZ acceptance process, teardown would not have started until after the SAME database problems were resolved on 7 November. By implementing this intervention, however, engine maintenance began on 23 October when personnel were available—saving 16 days, the difference between 23 October versus 7 November. (See Table 2.)

In the second observation, on 25 October, the 400 Division received F414 serial number 868083 from VFA-2. SAME database problems were identified on 26 October which were resolved on 13 November. By choosing to implement the intervention of paralleling the AZ acceptance process, maintenance on this engine commenced on 29 October versus waiting until 13 November, thus saving 16 days.

Finally, on 5 September, the 400 Division received F414 engine serial number 868265 from the USS Lincoln. On that same day, SAME database problems were identified which were eventually resolved on 16 October. A total of 46 days were saved in this case by paralleling the AZ acceptance process since maintenance on this engine started on 6 September. (See Table 2.)

Engine Serial Number	Engine Received	SAME Problem(s) Identified	SAME Problem(s) Resolved	Engine Maintenance Started	Days Saved
868472 VFA-106	20 Oct	20 Oct	7 Nov	23 Oct	16
868083 VFA-2	25 Oct	26 Oct 06	13 Nov	29 Oct	16
868265 USS Lincoln	5 Sep	5 Sep	16 Oct	6 Sep	46

Table 2. Summary of Intervention Results

Like the impacts presented in Table 2, the AIMD and 400 Division leadership's decision to combine certain aspects of their morning meetings also had a positive impact on decreasing the time required to conduct F414 maintenance. Specifically, LPO coordination efforts conducted at both the 0630 and 0700 meetings were combined. At the same time, the duration spent by each LPO in this combined meeting was decreased, allowing them to more quickly provide direction to their subordinates.

At the time of this article's writing, this intervention had just recently been implemented, and quantitative results of its impact were not yet available. Qualitatively, though, the Division Officer in charge of the 400 Division has identified a marked improvement in the amount of work being accomplished as a result of implementing this intervention. Prior to its implementation, upon his arrival to the office at 0630 each day, the Div-O would see a significant amount of coordination work being accomplished by LPO and PC personnel in preparation for the day's work. Following the combination of morning meetings, the Div-O arrives at work and now sees personnel working on the F414 engines. Information flow is being accomplished more smoothly, thus allowing coordination efforts to be accomplished more quickly; hence, more work is accomplished on a given day.

The AIMD and 400 Division leadership are pleased with the results of these interventions. Both quantitatively and qualitatively, their impacts have resulted in shorter F414 throughput time and improved organizational performance through better information flow.

Limitations and Future Research

This project only considered that portion of the AIMD 400 Division that accomplishes F414 maintenance. It considered only tasks associated with maintenance efforts starting from receipt of the engine to the point at which the engine is determined ready for issue (RFI). Although other maintenance work and collateral duties not directly associated with F414 maintenance were not directly modeled, generic, non-core tasks were modeled which required personnel to perform functions other than F414 maintenance. By doing so, limitations on 400 Division personnel's time to accomplish F414 maintenance were accurately characterized. The scope of this effort was further limited by modeling the maintenance of only a single engine, although total available time to accomplish tasks were correspondingly decreased to that available for a single engine.

Future research is needed to track AIMD performance post-implementation of selected interventions and to compare data to predicted performance. Other organizations within the NAS Lemoore AIMD (e.g., Airframe Division, Avionics Division, etc.) should also be separately modeled to identify potential organizational changes which may improve their processes. Consideration should then be given to integrating these separate models to develop a coherent AIMD model which would aid in identifying modifications to the larger organization, thus benefiting information flow. The model developed for this study could also be modified to represent engine maintenance divisions in other AIMD units across the Navy.

Conclusions

This study in applying organizational modeling to the NAS Lemoore AIMD identified several potential modifications or interventions to the 400 Division which could reduce F414 engine-maintenance throughput time. These interventions went beyond the process-improvement techniques implemented by the division under the AIR*Speed* program by focusing primarily on improving how and when the flow of information through the organization occurs.

Results have shown a savings between 16 and 46 days of maintenance time on each engine: an average of 26 days per engine. The Leadership also chose to partially implement the intervention of separately combining morning and afternoon meetings. Personnel now receive direction on required daily maintenance actions more quickly, which has increased the amount of work accomplished each day.

Organizational modeling provided key insights into improving the NAS Lemoore AIMD F414 maintenance process and allowed management to consider the likely impacts of alternatives on time, cost and quality prior to making these changes. The significant improvement in reducing F414 maintenance throughput time that resulted from this study affords high confidence in achieving future improvements in other Navy maintenance organizations via the tools and techniques of organizational modeling.

Organizational modeling has great potential for improving on outstanding process-improvement results the Navy has already achieved under the AIR*Speed* program.

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