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# Systems Engineering Management Training at Naval Air Systems Command

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**Abstract.** Within the past few years the Naval Air Systems Command (NAVAIR) has undergone several major changes including an engineering reorganization from a matrix organization to an Integrated Program Team/Competency Aligned (IPT/CAO) organization and a geographic relocation. These changes and others related to Acquisition Reform have had a major impact on the systems engineering organization within the command. To respond to these changes, NAVAIR has revamped its internal systems engineering training program. New classes have been identified and implemented. Additional training needs are also being addressed.

**Keywords:** Training, IPT, SE roles

## BACKGROUND

The Naval Air Systems Command (NAVAIR) is responsible for the acquisition of all aircraft weapon systems for the Navy. The performance of this mission rests on sound systems engineering management. For many years NAVAIR Systems Engineering has been organized around what was termed a "Class Desk". Each major aircraft platform or weapon had a program office, usually designated as a Program Manager Aircraft (PMA), responsible for managing the acquisition of that aircraft or weapon. Engineering support to the PMA came from a separate engineering organization. Within the engineering organization there were Class Desks assigned to every PMA. These positions were responsible for conducting the systems engineering tasks for the program, coordinating all engineering support to the program, and effectively acting as the chief engineer for the program. Specific duties of a Class Desk are defined in reference (a) and listed in Table 1.

- Develop and manage the systems engineering management plan
- Ensure that staffing and resources of IPT are appropriate for engineering effort
- Tailor system engineering processes and apply them throughout the program life cycle
- Maintain total system perspective
- Ensure integration of engineering specialties
- Establish internal IPT communications with engineering personnel
- Ensure documentation of engineering baseline
- Participate in all trade off decisions and maintain risk management process
- Establish and track technical performance measures and conduct design reviews
- Ensure airworthiness, service life, and systems safety
- Coordinate engineering efforts with fleet operators
- Ensure in-service engineering efforts are coordinated

Table 1: Class Desk Duties

A Class Desk Office for a program usually consists of a minimum of two people, a military officer and a civilian engineer. The military officer is usually an O-5 rank (Commander in the Navy) and the civilian is usually a GS-14 in the Civil Service. Larger programs required a larger class desk office and are staffed by additional military usually at the O-4 rank and additional civilians usually at the GS-13 level. It is common for major programs to have as many as 15-20 personnel assigned. The background and education of the personnel staffing these offices varied for the military and civilian personnel. The military personnel are usually pilots or Naval Flight Officers (NFO) and are typically arriving at NAVAIR from a recent fleet assignment. Although most of these officers had engineering degrees, it was

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typical of them to have not worked in an engineering assignment for several years prior to their arrival. The civilian personnel were all degreed engineers and typically had worked at NAVAIR in an engineering assignment for a minimum of 4-5 years prior to their assignment to a Class Desk. However, it was also typical that these engineers would not have a degree in Systems Engineering nor any formal training in the discipline of systems engineering. Prior to their assignment to a Class Desk they would have performed systems engineering management duties, but usually at the sub-system level. Any training or education that these engineers received in Systems Engineering Management was either on-the-job or from any voluntary after-hours graduate program that they may have elected.

### ORIGINAL TRAINING PROGRAM

For many years NAVAIR has maintained a career planning and development guide for all systems engineers (Reference (b)). This guide defined the systems engineering core skills and knowledge areas in which systems engineers were expected to be proficient. Table 2 lists the Core Skills and Knowledge Areas.

|                                                |                                                                                                                                                                                                   |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Knowledge of SE Discipline                     | <ul style="list-style-type: none"> <li>• SE Process</li> <li>• SE Management</li> <li>• Concurrent Eng.</li> <li>• Simulation</li> <li>• Support Sys Integ</li> </ul>                             |
| Knowledge of airborne weapon systems           | <ul style="list-style-type: none"> <li>• Naval aircraft systems</li> <li>• Air Vehicle Design</li> <li>• Operational Doctrine</li> <li>• Operational environment</li> </ul>                       |
| Knowledge of specialty engineering Disciplines | <ul style="list-style-type: none"> <li>• R&amp;M</li> <li>• E3</li> <li>• Survivability &amp; vulnerability</li> <li>• Manufacturing</li> <li>• System safety</li> <li>• Cost analysis</li> </ul> |
| Knowledge of program management                | <ul style="list-style-type: none"> <li>• Program management</li> <li>• Acquisition management</li> <li>• Acquisition policy</li> <li>• Risk management</li> </ul>                                 |
| Work performance skills                        | <ul style="list-style-type: none"> <li>• Oral &amp; written communication</li> <li>• Problem solving</li> </ul>                                                                                   |
| Knowledge of government                        | <ul style="list-style-type: none"> <li>• Naval command structure</li> <li>• Congressional ops</li> <li>• OSD/SECNAV ops</li> </ul>                                                                |

**Table 2: Core Skills and Knowledge Areas**

As a result of the varying background and skills that newly assigned people brought to the position, each person was expected to develop and execute an individual development plan (IDP) centered on the core skills and knowledge areas. In many cases it could take several years for individuals to become reasonably proficient in all areas. Due to the critical nature of these positions and the often short duration of an assignment (military officers were typically assigned for a tour of only 2-3 years), it was decided that training should consist of two phases. The first phase would be a mandatory orientation course to quickly ground people in some of the fundamentals. The second phase would be the more traditional development cycle centered on the IDP. Once the DAWIA (Defense Acquisition Workforce Improvement Act) became law, much of this formal training was provided by the Defense Acquisition University and was tied to formal certification for the three levels of the "Systems, Planning, Development, and Engineering" career field. Other training in this phase usually included courses from colleges and universities, on-the-job training, rotational assignments, and other developmental tasks. The problem for NAVAIR management became how to conduct the first phase of training, the quick orientation course. Suitable training of this type was deemed to be not available "off the shelf" although periodically NAVAIR contracted with Jim Lacy to conduct a "Systems Engineering Workshop". For reasons of cost and flexibility in scheduling the decision was made to develop and offer this training in-house. This training was to be mandatory for all new Class Desk personnel and was developed and taught by NAVAIR personnel. The scope and content of this program changed several times over a period of years. During the 1970's and 80's, the program was a one week, 40 hour course. The syllabus was built around the specific tasks that the Class Desk employee would be expected to perform and consisted of topics such as: configuration management, design reviews, risk analysis, etc. Material was very high level and oriented around practice vice theory. Instructors were drawn from the subject matter experts within the engineering organization. The problems perceived with this approach were that there was too much material in too little time (fire hose approach), and that personnel also needed some time to commence on-the-job training as soon as possible. Vacancies in Class Desk positions were often gapped and new arrivals were always being pressured to begin their duties as soon as possible. The training program was then revised to spread the material out over two weeks, with personnel attending this training for half a day and spending the rest of their time gaining familiarity

with their program and specific issues. This seemed to be an agreeable compromise, but the press of day-to-day business eventually resulted in changing this program in the 1990's to consist of only one half-day session offered once a month. Material was limited to what was considered the current "hot topic" in engineering. The sessions were no longer considered mandatory and attendance became sporadic.

No metrics were kept by the Command to measure the success of this training. However, qualitatively, NAVAIR Management was pleased with the initial efforts. The intent of the course was to turn people with limited systems engineering background into functioning systems engineering managers and for the most part it succeeded. As the course degraded to the eventual once per month offering the results were being questioned, but other issues soon put training on the back burner.

### CHANGE COMES TO NAVAIR

The period of the 1990's brought significant changes to the Department of Defense, including NAVAIR. Most of these changes occurred almost simultaneously, and all had an impact on the Class Desk Organization and subsequently on how personnel for this organization were trained for their role. These changes included: downsizing of the workforce; closing and consolidating facilities; reengineering of the NAVAIR organization; and Acquisition Reform. The workforce downsizing was a direct result of the fall of the Soviet Union and subsequent changes to the federal budget. The defense industry has always been noted for its cyclic nature, but this time it was not a normal "boom/bust" cycle. NAVAIR would lose over 40% of its workforce in about a 10-year time frame. Not only were personnel being eliminated, but infrastructure was also being eliminated through the BRAC (Base Realignment and Closure) Process. NAVAIR would shrink from operations at 19 sites to 11 sites. Workload would have to be redistributed, laboratories and industrial facilities relocated or closed. A management solution to the dramatic reduction in workforce and facilities was required that would maintain full functional capability of the organization with only a fraction of the previous assets. This solution was arrived at via a reengineering study of the Command. The study recommended that NAVAIR convert from a matrix style organization to an IPT/CAO (Integrated Program Team/Competency Aligned Organization). At the same time that this reorganization was being implemented, another BRAC decision resulted in the geographical relocation of NAVAIR Headquarters from retail office space in Northern Virginia to the

Patuxent River Naval Air Station in Southern Maryland. The final change to impact NAVAIR was Acquisition Reform which can probably be summarized as a wide sweeping effort by the Department of Defense to reduce costs by eliminating restrictive practices embodied in Military Specifications and processes and replacing them with commercial specifications and processes.

### IMPACT ON SYSTEMS ENGINEERING

The impact that these changes had on the NAVAIR Systems Engineering Organization can best be seen by comparing the organization prior to the 1990's with the current situation

**Prior Organization.** The Systems Engineering function was managed by the Class Desk Organization previously described. As part of the Engineering Organization of NAVAIR Headquarters, personnel assigned to the various class desks were located in offices in Northern Virginia. The organization was structured along functional lines so that the class desks from tactical aircraft were seated together in the same branch, and the same with rotary wing aircraft and others. This facilitated an easy exchange of lessons learned from program to program and aided in on-the-job training of newly appointed personnel. The Program Offices that they supported were located close by, usually the next building, as were most of the other engineering disciplines such as structures, aerodynamics, and so forth. Engineering tasks such as test and evaluation, research and development, and in-service engineering were typically performed at other sites around the country. The senior officer or engineer within the class desk had complete engineering responsibility for all activities within the assigned program. All engineering assets assigned to the program came through the Class Desk. All systems engineering tasks were performed or managed by the Class Desk. Systems Engineering Procedures were defined by Mil Specs and Standards such as MIL-STD-499. Daily supervision of personnel came from the Engineering organization and senior engineering management was kept closely apprised of technical issues and progress.

**Current Organization.** Today the Class Desk Officers and engineers are located within their specific Program Offices at Patuxent River and no longer sit with the rest of the engineering organization. Individuals are often assigned to a single IPT within the PMA as the systems engineer for that IPT. Occasionally they are assigned as the IPT Lead and the systems engineer for the team

comes from some other part of the NAVAIR engineering organization, or even other organizations such as Naval Surface Warfare Centers, Naval Research Center, or support contractors. Other elements of the NAVAIR engineering organization are located in other buildings at the Patuxent River site or at some of the remaining sites around the country such as China Lake. The Class Desk still has responsibility for all engineering activity on the program, but no longer heads a separate engineering entity within the program. Previously a "wiring diagram" of the engineering function was equivalent to the Class Desk Organization for that program. (Fig 1).

Insert Fig 1

Now, the engineering function was part of each IPT within a program and the Senior Class Desk Officer or Engineer was primarily responsible for cross-IPT coordination rather than direct involvement in individual projects (Fig 2).

Insert Fig 2

Another significant responsibility was to ensure uniform deployment of systems engineering processes across all IPT's. In the absence of MIL Specs and standards this presented a problem. Daily supervision of Class desk personnel on most matters was now the responsibility of the IPT Lead or the Program Manager.

**A New Way of Doing Business.** The combination of downsizing, reengineering, relocating, and throwing away the "cookbook" of MIL Specs could have resulted in chaos, but in fact has gone very well in the eye of NAVAIR and senior Navy Management. This success is achieved in part by adapting to the new paradigms and properly training our people in how to operate in this new environment. Our Class Desks now had to operate in entirely new modes. Among other things they have to develop ways to ensure that the IPT's didn't become "stovepiped" and that someone was taking a total systems engineering view across all teams to ensure that integration would be successful at the top level. They needed to communicate this picture and the processes to accomplish it in the absence of any established tools.

## PROVIDING THE TOOLS

Once the dust began to settle from all these changes and management began to see that the role of the Class Desk was evolving, it became apparent that two things would be needed immediately. First, existing

processes and policies needed to be documented in a fashion useable in the new environment. Secondly, our training program would have to be upgraded to deal with the issues mentioned above.

**Processes and Policies.** Previously, NAVAIR management was able to communicate engineering policies and processes through written documents (MIL Specs), and the informal communication that came through the on-site supervision and peer coordination that came with the physical collocation of the Class Desks. The solution that has been proposed to overcome this obstacle is two fold. First, a commercial systems engineering standard will be adopted. A NAVAIR working group is currently looking into the adoption of EIA-632 as the new standard. Secondly, all NAVAIR processes and policies that are not covered by commercial policies or processes are being documented in terms of instructions and handbooks. Hard copies are published and are also placed on a web site called "TEAM Toolkit" where anyone at NAVAIR can pull up information on any key process and see the what, how, and why in terms of text and flow charts.

**Training Program.** As the policy and process initiative progressed, it became obvious that merely establishing a new standard and documenting processes would be insufficient. Training would be a key part in making the new Class Desk structure work. As a first step, the old orientation course was resurrected and revamped. The course was structured to be offered over one week, with classes held seven hours per day for four consecutive days. The syllabus was modeled after the Core Skills and Knowledge Areas, but condensed to an overview of as many of the topics as possible without reaching the saturation level experienced before. Subject matter experts were identified and tasked with developing their training material on a purely voluntary basis. A course coordinator was identified to administer the preparation and offering of the course. An initial offering of the course was conducted with a small class to "shakedown" the material. Small adjustments were made based on feedback from the initial students and senior managers who audited the first class. Most of the changes involved deleting repetitive material and ensuring that the students were provided with adequate reference sources to delve further into specific issues on their own. The course is now offered on a regular basis. Attendance at the course is voluntary, but currently applications are running at or near capacity for training. Table 3 shows the current course content.

- Class Desk Roles & Responsibilities
- Acquisition Decision Milestones
- Budget
- Systems Engineering Role
- R&M
- Design Reviews
- Test & Evaluation
- Grounding Bulletins
- Engineering Investigations
- Technical Directives
- Software Management
- Cost Analysis
- System Safety
- Configuration Management
- Air Vehicle Engineering
- Airworthiness
- Acquisition Overview
- Current topics

**Table 3. Orientation Course Content**

The content strongly matches the original Core Skills and Knowledge Areas. Each segment typically runs for an hour. Presentation is done in a typical classroom environment using vugraph presentations. Most of the instructors have had no formal training in teaching skills, but are considered the premier subject matter expert within the command and rely on years of briefing skills to communicate their message. Typically NAVAIR measures the effectiveness of any training course through a student survey instrument at the completion of the course. These surveys are usually scored quantitatively based on student rankings of several parameters on a 1-4 scale. In the case of this course, a decision was made to only collect student qualitative comments. This type of input would still permit the Course Coordinator and the instructors to receive feedback which might lead to changes in that module, but in a less competitive atmosphere that often accompanies a numerical ranking of instructors.

#### **THE NEXT STEP**

The Orientation Course is only intended to be the first step in providing sufficient training for Class Desk personnel to operate in their new environment. The next problem to be tackled is the lack of a systems engineering standard. As mentioned

previously, a NAVAIR Working Group is evaluating the possibility of using EIA-632 as the replacement for MIL-STD-499. Whether EIA-632 or another standard is selected, it will be necessary to train our personnel on the new standard. Just as with the Orientation Course, decisions will have to be made such as: whether to offer the course using internal resources or to purchase commercial training; how to fit the training into the time demands placed on Class Desk personnel; and how this training will be complemented by other courses or on-the-job training. Even further into the future, the use of automated systems engineering tools is being considered to aid class desk engineers in performance of their duties. Training on these tools will have to be added to the Core Skill Areas.

**Summary.** The Naval Air Systems Command was able to successfully construct a training course using internal resources in a short period of time. Initial results show that the course is providing newly assigned personnel the knowledge and skills they need to operate in a rapidly changing environment. Further training resources will be required to supplement this course.

#### **REFERENCES**

- (a) Naval Aviation Systems TEAM, *Assistant Program Manager Systems Engineering Quick Reference Guide*, August 1996
- (b) Naval Aviation Systems TEAM, *Career Planning and Development Guide Systems Engineering Department*, June 1997

#### **BIOGRAPHY**

Mr. Rebel is the Assistant Program Executive Officer for Systems Engineering on the staff of the Program Executive Officer for Tactical Aircraft and is also the head of the Tactical Aircraft Systems Engineering Management Branch. Mr. Rebel holds a Bachelors degree in Aerospace Engineering from Penn State and a Masters in Aerospace Engineering from the University of Maryland. He has over 30 years experience with Naval Aviation and has held assignments as a flight test engineer, project engineer, and manager.