THE IRIS STRATEGY FOR FOCUSED SPECIFICATION DEVELOPMENT

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ABSTRACT

The principles and approaches for designing system acquisition documentation are changing. Due to re-engineering, downsizing and acquisition reform, the desire to create more efficient processes is becoming reality, including the development of acquisition documentation. This paper discusses a streamlined approach to specification development in procuring a training system. It must be noted that these initiatives are still being developed and matured and this represents the current intent. This paper will explore some of the tenets of acquisition reform as it applies to specification development and address the desire for performance based requirement specifications. In addition, this paper will address the move toward joint service guidance and present a strategy geared toward developing a training system specification. As with any approach, there are challenges which must be addressed in order to achieve a successful product. This paper will discuss how to overcome some of these challenges in a streamlined acquisition environment using Joint Primary Aircraft Training System (JPATS) Ground Based Training System (GBTS) as an example.

BACKGROUND

Requirements definition and requirements stability have been and remain major challenges in the development of training systems. Training system specifications have failed to mitigate the problem and have frequently aggravated it (Hoog 1986). Furthermore, there has been a noticeable lack of systems engineering in the specification development process. In many cases, individuals who developed requirements mindlessly incorporated numerous requirements from past programs without questions or significant higher-level reviews, or they tried to design the system. Use of a test matrix to indicate the type of verification (e.g. inspection, analysis, demonstration and test), rather than a test paragraph based on performance requirements often led to testing based on contractor developed procedures, not the specification itself. Opinion rather than training requirements often determined acceptability of a system.

Requirements definition for training systems has evolved in parallel with use of and expectations of training systems. Flight simulator use became significant in the early to mid 1970’s. In the 70's, the main cost driver for training simulators was hardware. The specifications focused on hardware and described design and construction exhaustively. The system specifications referenced many separate military standards and specifications and directed methodology details down to the level of how to tape wire terminal ends, in some cases. In many cases, program teams incorporated specifications and standards they thought were applicable without considering the impact or in many cases, even reading them. Except for these standards, the teams thoroughly understood the technology and tended to design the system in the specifications. They also wanted to ensure that contractors did everything they promised and often placed complete proposals on contract. This led to a “band-aid” approach - put a fix (“band-aid”) in for each problem encountered in a recent program.

The fuel crisis in the mid to late 70's increased emphasis on flight simulator use and accelerated simulator technology advancement. In addition, commercial hardware was being used more extensively in simulators. Recognition of the fact that simulators operated in benign environments led to less emphasis on military specifications and standards. But references to them did not decrease in proportion nor was there an increase in the understanding of the effects of applying them. As more programs were started, teams were not so well versed in technology and there was a great tendency to copy previous specifications. In lieu of putting proposals on contract, important features of contractor designs were incorporated into the specifications.

In the 80's and early 90's, the main cost driver for training devices changed from hardware to software. This reduced the focus on highly detailed hardware specifications and allowed for greater use of off-the-shelf components. Specification content re-focused on software requirements. Software requirements, “use Ada” (or Fortran in the early 80s), “provide a percentage of spare capacity and use a sound software process”, were often expressed in multiple pages of extraneous detail. Use of contractor logistics support eliminated the remaining need for hardware designed to military specifications and standards. Again, references to military specifications were reduced but not in proportion to the change in technology.

During the 80's, Military Airlift Command (MAC), contractors, and even the Simulator System Program Office (SPO) (Doty and Kottmann 1984), (Hussar 1983) began to encourage contractor innovation and commercial practice, based on the success of the KC-10 Aircrew Training System (ATS) with American Airlines. The ATS defines the training requirements and a contractor develops training devices and instruction to guarantee a certain student throughput and cost per student. Use of Federal Aviation Administration (FAA) requirements for simulators was encouraged. This created new requirements problems. Instructional requirements such as "train instrument procedures, instrument takeoff, instrument cross check, and precision and non-precision approaches”(Lethert and Martin 1993) are subjective. They cannot be measured in an unambiguous manner. FAA requirements were mixed with simulator requirements left over from previous programs.

At the present time, the JPATS GBTS program represents a culmination of many of these trends. The JPATS GBTS consists of several types of simulators, courses of instruction and a computer network to manage and schedule all training known as the Training Integration Management System (TIMS). It is procured from Raytheon Aircraft Company as an integral part of the JPATS program. Raytheon is building the aircraft and is currently selecting a contractor to build the GBTS. In developing JPATS requirements, the program office is dealing with many of the issues discussed in the previous paragraphs as well as trying to develop requirements for a sub-system, the TIMS, with which the training community has little experience. This is also being done in the age of Acquisition Reform.

DEVELOPING A SUCCESSFUL SPECIFICATION, USING THE IRIS STRATEGY

It is essential that the requirements be well understood by all parties in a training system acquisition. Developing specifications for training systems is not easy. There are no universally accepted rules. Experienced personnel must integrate the requirements into an overall acquisition strategy. This means that the necessary commitment of resources to fully define the top level requirements is essential. This paper proposes a concept by which specifications can be developed; it is called the IRIS (I-Identify requirements, R-Recognize constraints and opportunities, I-Integrate expectations, S-Say what you mean) strategy. Although not explicitly used on any program it represents many of the concepts used on the JPATS GBTS. The IRIS strategy is illustrated in figure 1.

Figure 1 represents a logical as opposed to temporal process. Requirements definition and specification development do not end at contract award. They are iterative and conducted at all levels, thus, continue throughout the life of the program. Multiple blocks occur in parallel, and as design decisions are made further requirements must be defined. For example, once we conclude we need simulators to train our pilots, we must determine the simulator characteristics.

Identification of performance requirements (IRIS)

The first step in the IRIS strategy is identifying the requirements of the system. It is very important that these requirements be identified in performance terms (move a ten ton load across a 1/4 mile wide river) as opposed to design terms (build a bridge to support a ten ton load). Performance based requirements allow the contractor developing the system to innovate thus reducing either costs or development schedules. Performance requirements do not become outdated as technology changes - only their implementation does.

Identification of requirements begins with the user's identification of the need for a training system using a Mission Need Statement (MNS) or similar document. Once this is identified, a key step is the training system requirements analysis.

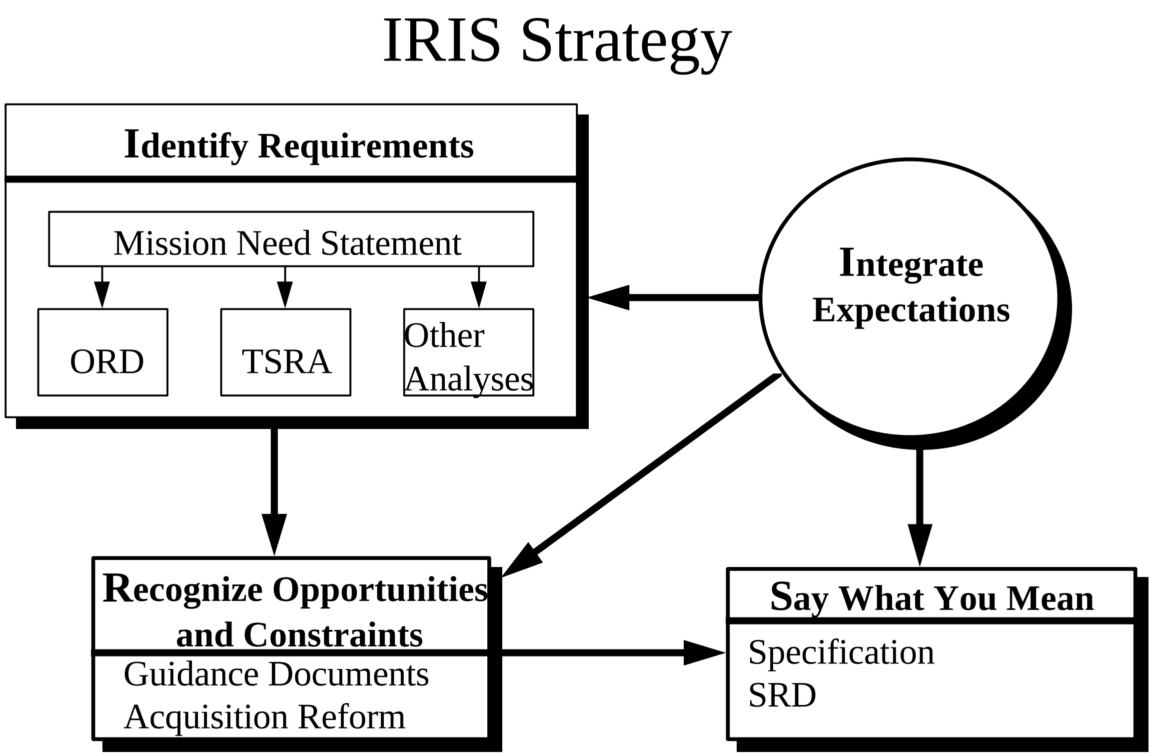

Figure 1. IRIS Strategy

Training System Requirements Analysis (TSRA) The Training System Requirements Analysis (TSRA) is a systematic process designed to define the components, interrelationships, and requirements of a training system. This is a critical step in the acquisition process. The user and SPO, and usually a contractor, work together to analyze system and training requirements and develop training objectives and test criteria. The TSRA begins by defining the mission tasks and defining entry level and exit level skills and knowledge needed by the student population in question. It also identifies training objectives and strategies for instruction, including both media and methods, needed to meet the objectives. The TSRA culminates with a comprehensive study of the baseline system, including system deficiencies, and recommends solutions. Concept and configuration decisions and rationale from the trade studies are detailed.

Other Analyses Some other programs may have unique requirements which require special analyses. For example JPATS includes a Training Integration Management System. The system will manage and schedule all undergraduate flying training. In order to have a better understanding how flight training management is handled, an analysis of the processes, people and systems used to manage flying training was conducted. Two different models were developed using object-oriented methodology. First, a physical model of the system was developed to capture the reality of today's flying training management. This analysis includes a description of how flying training is managed today. It includes all the inefficiencies and redundancies that are currently in place today. The second analysis, using a logical model, was conducted to focus on what the training management system needed to do in order to minimize and overcome system limitations identified in the physical model. And more specifically, the logical model, presents the requirements for a more efficient training management system. These two studies formed the foundation for the training management system requirements.

Operational Requirements Document (ORD) The ORD is generated by the using agency utilizing the results of these analyses. As shown in figure 1 it will often be generated while the TSRA and other analyses are on- going. It may also change during the program. Once completed the ORD defines the training system the program office must procure. The ORD is the overall governing document which drives the generation of the specifications. The ORD is also the basis for operational testing of the system. ORDs should state broad and general operational requirements in performance terms.

Challenges in identification of requirements Distinguishing performance requirements from design requirements is not always easy. As programs to procure training systems begin, it is important to estimate the cost. Training system costs are based on an implementation, not performance. The estimators will typically assume some design, e.g. a training system consists of simulators, courses, and a system to manage training. There will also be assumptions about the characteristics of each item. Results of the TSRA is the basis that can be used to identify the characteristics for the cost estimate. Once estimates are made, it is not necessary to include all estimating assumptions in the requirements. The estimate establishes a probable scenario. The contractor building the system should not be constrained by the basis of this estimate.

It is also a fallacy to think that we can achieve totally pure performance requirements. We think in design terms and often fear that true performance requirements won't adequately result in our need being met. Some compromises may be necessary. In the JPATS ground based training system there is a user need for instructors to quickly and efficiently enter the student results at the end of a training flight. Our first iteration required a personal digital assistant (PDA) with a battery life of 6 hours, handwriting recognition capability, etc. We had specified a solution. As we reviewed this requirement, some team members felt that a qualitative statement would not adequately describe the requirement, but a PDA might not be feasible or cost effective. Our solution was to leave the method to the contractor but to state that a PDA should be considered. Our user wanted several additional requirements if a PDA was used. This was a compromise solution and not a true performance requirement.

Recognize Constraints and Opportunities (IRIS)

Constraints and opportunities play a major role in the development of training specifications.

Acquisition Reform There have been hundreds of specific acquisition reform initiatives. Some of these initiatives focus on the move from government oversight to insight and increased dependence on contractor processes rather than military specifications and standards. The goal is for the government to define only necessary requirements and for the contractor to implement these requirements in a manner consistent with their standard commercial practices and processes. The revised DoDI 5000.1 requires the generation of performance specifications, encourages the use of commercial standards, and requires a waiver for use of military specifications and standards.

Under acquisition reform initiatives the Air Force does not write a detailed Statement of Work (SOW). This may preclude defining the processes used in developing the specifications. Instead, the government provides a broad Statement of Objectives (SOO) and lets the contractor write the Statement of Work. A bilateral agreement is accomplished which includes an Integrated Master Plan (IMP) which defines entry and exit criteria. It is believed that the details can be worked out with the contractor in the source selection process but this is yet to be proven for a training system acquisition.

DoD Regulation 5000.2-R, Part 2, Program Definition contains the mandatory procedures for translating broadly stated mission needs into a more sharply defined set of performance specifications. However, using agencies have often been uncomfortable with such direction. They fear they will lose control of the product. This fear has some basis in fact. We previously discussed the difficulties in developing true performance requirements. The USAF/USN JPATS program had an ORD which started with many "how to" type of requirements. Most of these items have been converted to performance based specifications which ultimately has driven the ORD to more closely match a performance based document. This is a sensitive situation when the user has a clear "picture" of what he "really wants" and the acquisition community is trying to obtain what he “really needs” without constraining the contractors innovation. Currently much compromise is necessary. Additional guidance for implementation of acquisition reform in the aviation sector is planned for release this year.

Opportunities The Instructional System Development (ISD) process defined by AFM 36-2234 is a valuable tool in defining and updating training requirements. "In 1992, the Air Training Command and Aeronautical Systems Center joined forces to establish a new direction for the Instructional Systems Development (ISD) process"(Golas et al 1992). The revision included advances that had been made in the area of cognitive psychology, instructional design, learning theory and human factors. The revised ISD model stressed the importance of quality and feedback throughout. This change emphasized the need for performance requirements to be the basis for the development.

At the Aeronautical Systems Center (ASC) we recognized a need to document the steps with respect to management of the ISD process. The "scrolls" (given their name for the size of the charts), tracked the ISD process from the concept exploration phase of acquisition through a long range support. Not only did this internal working guide document ASC's management approach, but provided 'just in time' training to engineers and identified the major areas of concern within courseware development. A form of the "scrolls" subsequently became Volume 3 of AFH 36-2235.

The major challenge here is to achieve comprehensive acceptance of the output by all parties concerned. People tend to reject systematic analysis in favor of their own biases based on past experiences. They want to incorporate lessons from past programs they have learned whether or not they are applicable. All of these are valid concerns. But integrating them into a logical product is difficult. We must learn to trust our processes once they've been demonstrated to work.

Guide Specifications Guide Specifications were developed to provide tools to aid government and industry to prepare development specifications for weapon systems. These documents provided guidance on how to apply proven methodologies and processes in development programs. Guide specifications can:

a. Provide examples of good requirements.

b. Standardize language and terminology to enhance the understanding of all parties.

c. Provide a logical structure to ensure requirements are adequate and consistent.

Originally the AF Guide Specifications addressed flight simulators and maintenance simulator products in the area of training. In the early 1990's an additional training system document was developed that addressed complete training systems as well as specific devices. Efforts are currently underway to develop a joint service guide specification for training systems. This document will include some of the more recent acquisition reform initiatives such as incremental verification requirements and increased reliance on contractor processes. Key portions should be tied to the IMP.

Guide specifications have not been widely accepted for use in training systems. Program offices must become stakeholders of the guide specifications if they are to be applied effectively. There must be a systematic exchange between the "program doers" and the specification authors to continuously improve these documents.

Integrate Expectations (IRIS)

Expectations must be managed during the training system development process lest they linger unresolved and become detrimental to the program. This is accomplished by integrating expectations into requirements or directly into the product or by modifying expectations to meet the characteristics of the product. As long as we are considering expectations, and not requirements, any of these approaches is valid.

An expectation is "a requirement that is not really a requirement." Program managers, engineers and the end users, have ideas of what the final product should look like. (Expectations are often design requirements which have been converted to performance requirements.) Some ideas can become mindsets that will never shift until the day of delivery when an engineering change proposal is issued changing the system requirement. All requirements will not and should not be identified at the start of a program. In order to integrate expectations lower level requirements definition can be deferred as long as there are provisions for complete requirements definition as they are necessary for detailed design. This is where a strong systems engineering process is vital to the success of a program.

The Integrated Product Team (IPT) concept has existed for many years, although the IPT practice is still in its infancy in many organizations. The IPT is a management philosophy which provides a framework for working within a dynamic environment. A key aspect of this management philosophy is the creation of cross functional teams that are formed for the specific purpose of delivering a product or managing a process. It selects the right mix of people and disciplines, skill levels and ensures the supplier and customer are both involved.

IPTs are ideal vehicles to integrate expectations. They provide a framework to discuss the design and requirements and review prototypes. As a result of these discussions these requirements, both lower level requirements and design details, are defined. For example, cost trade off can be discussed informally and alternative ideas can be discussed. As a result many expectations will be modified while others will be incorporated into sub-tier requirements.

The IPT process can be complemented with a prototype phase which refines the definition of the component which is being prototyped. This tool, not only facilitates the design of the system component but can also provide the end user with some confidence in the design by conceptually "seeing" what the designer is thinking about. Developing a prototype is a good way to see what types of design are available to meet the requirements. JPATS is planning prototypes to refine TIMS and courseware requirements.

IPT approaches have long been common in developing training system requirements. (Although the IPT name was not used). Hoog (1986) recognized that the main goal was to form a close knit team between the Air Force and contractor. The IPT approach is incorporated into the JPATS GBTS program. A system specification will be finalized when the GBTS contract change is awarded. Lower level specifications for simulators, courses, the TIMS and supporting elements will be developed and placed on contract as the program progresses. The user must sign up to the expanded requirements baseline prior to the commencement of each subsequent program phase (Hoog 1986).

Again there are challenges. The IPT philosophy is highly dependent on the working relationships of the parties involved. If the IPT is not effective, the required product won't happen. There is a trade off between finalizing sub-tier specifications and making the contractor responsible for all changes to sub-tier specifications until Functional Configuration Audit (FCA). The latter is encouraged by acquisition reform's Clear Accountability In Design (CAID) initiatives. The balance must be determined on a case by case basis.

Say what you mean (IRS)

Once requirements are identified, they must be expressed in a form suitable for contracting purposes. On many programs this begins with a System Requirements Document (SRD). The SRD specification concept began prior to acquisition reform. It is very similar to acquisition reform's SOO and SOW. The SRD in the Request for Proposal (RFP) should include complete top level performance requirements. The contractor turns the SRD into a specification adding more detail. In the JPATS program the SRD was developed based on TSRA results and preliminary ORD requirements. If a single contractor does both the requirements analysis and builds the system the SRD might be produced right after the Mission Need Statement.

In our nominal approach, industry proposals should include a complete top level specification that fleshes out the SRD requirements based on the proposed implementation by the specific contractor. If necessary to control risk, selected lower level specifications may be required. These specifications then become the contractual performance requirements. The specification should include statement of the performance requirements themselves and the means to verify the requirements. Guide specifications can be used as an aid in developing and evaluating both the SRD and specifications.

The set of requirements should be minimal, but complete. Only essential needs of the user and essential constraints on the training system design should be identified. Contractors implementing the system should have maximum flexibility to design a system. If requirements are minimized, flexibility will be increased. For example, the JPATS Training System Requirements Analysis identified the need for three types of flight simulators. Each device had identical requirements to the other except for visual systems The first approach was a specification that required the devices be built from identical components except the visual systems. After review, we realized that since all other requirements for the devices were identical, we could levy the common requirements and let the contractor choose how to meet them.

The set of requirements must be consistent. JPATS GBTS defines the number of simulators, their operating hours, the number of classrooms and computer based training terminals, and their operating hours. It also specifies the student load per base per year and the baseline course syllabus. Potential inconsistencies must be further evaluated.

Requirements should not include extraneous information to "help" the contractor. If this information can be derived from the stated requirements or if it can be obtained from other sources, it should not be stated in a contractual document. The implementing contractor should have the responsibility (and authority) to obtain this information.

It is very important that requirements are expressed in a manner such that all parties understand clearly and identically what is meant. English expression often tends toward ambiguity. Authors write to produce smooth flowing, interesting to read documents. Specification authors may try to capture all related concepts in one place. A good specification is boring. A computer programming language is an example. Syntax should be rigid. Any statement in a top-level paragraph should apply all subparagraphs. Similar requirements should be expressed in similar language. A standard set of terminology should be used. Requirements are the minimum the system must do, not everything it can do. Martin and Lethert (1993) expand on this concept in some detail. Some other examples:

a. Saying "the system shall be designed to do" or "the system shall be capable of doing" is looking for misinterpretation. The statement "the system shall do" eliminates any misinterpretation.

b. Stating the same requirements in multiple places frequently leads to multiple interpretations.

c. Using more than one name for the same item can create misinterpretations.

d. When diagrams are used, they include design details. It is not necessary to specify on the diagram - may not be consistent.

e. Use of "and/or" leads to difficulties in meaning.

f. The phrase "include, but not be limited to" sounds lawyer-like but really means that in addition to items listed, the contractor must include more. The term "include" should be sufficient.

CONCLUSIONS

Creating a training system specification can be made easier by applying the IRIS strategy. IRIS provides the foundation and guidance needed to define requirements and develop a training system specification.

While these principles are simple they are neither universally accepted or enforced by government or contractor managers. Specifications are often not carefully reviewed. Managers concentrate on acquisition strategy or cost and schedules. SRD and specifications do not get the attention they deserve.

Identification of performance requirements must be done formally and systematically. Agencies must devote the necessary time and resources to this activity. A structured review process should trace requirements to the analyses performed rather than merely consolidate inputs from various groups. We must ensure that requirements are expressed in performance terms; but we must also realize that some compromises may be necessary.

In the past, government procurements have imposed many restrictions on contractor flexibility. Allowing the contractor to utilize their own proven processes and practices will most likely provide benefits to cost, performance and schedule. The IRIS strategy addresses the identification of requirements with an emphasis on a new approach to acquisition. This new approach includes the recognition of constraints and opportunities, the incorporation of expectations and the 'say what you mean' idea applied to the training system specification development.

BIOGRAPHIES

John F. Lethert is the JPATS Chief Engineer in the Flight Training System Program Office at Wright Patterson AFB, Ohio. Mr. Lethert has almost 30 years experience in DoD acquisition, most of which was spent in the area of simulation and training. He spent seven years as chief engineer for the F-16 Weapon Systems Trainers and has also worked as chief engineer for the TACIT Rainbow and Seek Spinner Unmanned Autonomous Air Vehicles and worked on the Advanced Tactical Fighter program. He is a registered professional engineer and a graduate of Defense Systems Management College and a lieutenant colonel (retired) in the US Air Force Reserve.

Jacqueline S. Townsend is a training systems engineer in the Flight Training System Program Office at Wright Patterson AFB, Ohio. For the past 4 years she has provided technical support on the JPATS GBTS program in the areas of training management systems, UFT training, and training system requirements analysis. Her experience in programs such as the F-16, T-1A, F-22, C-17, SOF ATS, JSTARS, USAFE LATS and JPATS have allowed her to concentrate on training system acquisition as well as evaluation techniques for contractor developed training materials. She holds a B.S. and M.S. in Systems Engineering from Wright State University in Dayton, Ohio.

Thomas W. Hoog is currently the branch chief for the Training and Support Systems Branch in the Engineering Directorate at ASC. He has held numerous positions and spent the last 28 years supporting various Air Force training system programs, including development of technical and management processes used in training system programs. He has also held positions with special topic teams such as the recently completed Non Government Standards Integrated Product Team.

Joseph N. Galletti is the JPATS GBTS Lead System Engineer in the Flight Training System Program Office at Wright Patterson AFB, Ohio. His past positions include Integrated Product Team leader/lead engineer for the Air Mobility Command Simulator Aerodynamic Upgrade Effort, involving development of new aerial refueling simulator acceptance criteria and the flight testing of seven aircraft. Previously lead engineer on the following systems: F-15E Weapon System Trainer, F-16 Air Defense Fighter, C-5/C-141 Aerial Refueling Part Task Trainer, and the EF-111 A Operational Flight Trainer. He holds a B.S. in Aerospace Engineering from the State University of

New York (SUNY) at Buffalo and is a member of the 1996 I/ITSEC Research and Development Subcommittee.

2Lt Jeffrey P. DeJoannis currently supports the Air Mobility Command Simulator Upgrade Program Integrated Product Team in the Training System Program Office at Wright Patterson AFB. His past experience includes flight testing and aircrew training device aerodynamics upgrades on the KC-10, KC-135, C-17, C-141 and C-5 programs. He has also worked in industry as a research and development engineer prior to entering the USAF He holds a B.S. in Aeronautical and Astronautical Engineering from Purdue University.

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