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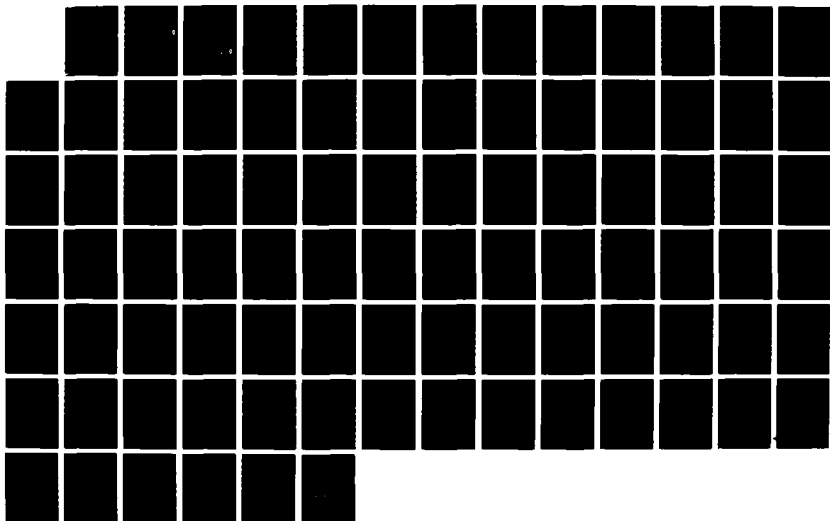
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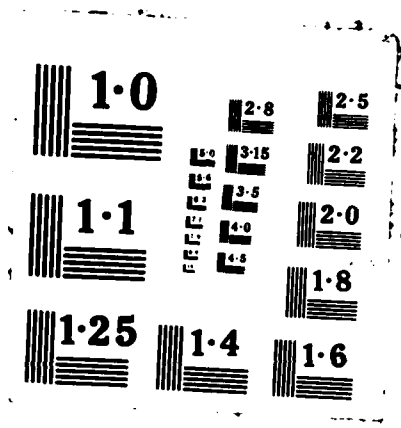
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THE STANDARD INERTIAL NAVIGATION UNIT
(STD INU) PROGRAM

THESIS

Thomas E. Rosensteel
Captain, USAF

AFIT/GSM/LSY/87D- 1

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AN EVALUATION OF PERCEPTIONS OF FORM, FIT, FUNCTION
(F3) STANDARDIZATION ON THE STANDARD INERTIAL
NAVIGATION UNIT (STD INU) PROGRAM

THESIS

Presented to the Faculty of the School of Systems and
Logistics of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Systems Management

Thomas E. Rosensteel, B.S.

Captain, USAF

December 1987

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Preface

The purpose of this study was to determine if the STD INU Standardization Acquisition community and the STD INU User Acquisition community both perceive the issues of Form, Fit, and Function (F3) standardization the same. The study surveyed and compared a subset of each of the two communities which work with the STD INU. The study addressed perceptions on how the F3 standardization approach affected the STD INU Program, perceptions on what the costs and benefits of F3 standardization are, and recommendations for change on the STD INU Program.

The Study showed the two groups disagree on whether F3 standardization: reduced acquisition and logistics support costs; increased mission availability; helped achieved the STD INU Program Management Directive objectives; and whether the benefits outweigh the costs. In general, the first group, the STD INU Standardization Acquisition community, perceived the benefits of F3 standardization were achieved, whereas, the second group, the STD INU User Acquisition community, were split on the issues.

In performing this study, I am deeply indebted to Mr. Milton Brickson and Mr Lou Salerno of the STD INU Program office for helping develop this research topic. I also wish to thank my thesis advisors, Lt Col Phillips and Lt Col Roland for their patience and cooperation in completing this work.

Thomas E. Rosensteel

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Abstract

The pupose of this study was to compare perceptions on Form, Fit, and Function (F3) standardization of the Avionics Standardization Acquisition community and the User Avionics Standardization Acquisition community. The study focussed on one specific program, the Standard Inertial Navigation Unit (STD INU) Program and the subset of the two acquisition communities which worked with the STD INU Program.

The study addressed perceptions on: the affect of F3 standardarization on acquisition costs, logistics support costs, mission availability, the inertial industrial base, new technology insertion, reliability, and achieving the Program Management Directive (PMD) objectives; the costs and benefits of F3 standardization and whether or not the benefits outweighed the costs; and whether or not the F3 standardization approach should be maintained on the current STD INU Program and be used on the next generation STD INU Program. Also, the study addressed recommendations for change on the standardization approach on the STD INU.

A survey of the two acquisition communities showed that their was a difference of opinion between the two groups. Analysis of the survey data showed the two groups disagreed on the affect of F3 standardization on acquisition costs, logistics support costs, mission

availability, achieving the PMD objectives and whether or not the benefits outweigh the costs of F3 standardization. In general, the STD INU Standardization Acquisition community perceived that the benefits of F3 standardization were achieved on the STD INU Program, whereas, the second group, the STD INU User Acquisition community were split on the issues.

The most often mentioned benefits were reduced logistics support costs, increased force readiness, and reduced acquisition costs. The most often mentioned costs were constant configuration changes, increased integration costs, and numerous aircraft interface requirements. About half the survey participants recommended standardizing at a lower level, ie. modular standardization, for both the Ring Laser Gyro and the next generation STD INU Programs.

AN EVALUATION OF PERCEPTIONS OF FORM, FIT, FUNCTION
(F3) STANDARDIZATION ON THE STANDARD INERTIAL
NAVIGATION UNIT (STD INU) PROGRAM

I. Introduction

Background

Standard avionics is any avionics equipment which is interchangeable between multiple aircraft types (8:1-1). An example of standard avionics is the AN/ASN-141 Standard Inertial Navigation Unit, which is used on the A-10, F-16C/D, and FB-111. One type of avionics standardization is form, fit, and function (F3) standardization. The F3 approach specifies only the form (shape), the fit (dimensions), and the function (for any specified input, a specific output or set of outputs). By specifying only the form, fit, and function, contractors can develop their own unique internal hardware and software designs which allows for interchangeability between multiple contractors' units in addition to interchangeability between multiple aircraft types (5:2-17). In 1976, the Standard Inertial Navigation Unit (STD INU) program was one of the first programs to implement the F3 avionics standardization policy (6).

The purpose of the STD INU program is to provide medium accuracy (0.8 NM/HR Circular Error Probable), form, fit, and function standard inertial navigation units as government furnished equipment for A-10, A-7, F-16, F/RF-4, F/EF/FB-111, C-130, C-17, and HH-53 aircraft. The A-10, F-16C/D, and FB-111 use the first generation STD INU, the

AN/ASN-141, Litton LN-39. The second generation Ring Laser Gyro (RLG) STD INU is planned for use on the A-7, F/RF-4, F/EF-111, C-130, C-17, F-16A/B, and HH-53 programs.

The STD INU program objectives, as outlined by Program Management Directive (PMD) 7033(4)/64201F/2258 are:

- a. Satisfy multiple aircraft inertial requirements with a standard performance specification.
- b. Lower acquisition costs.
- c. Reduce spares costs.
- d. Minimize investment in support equipment.
- e. Reduce training requirements.
- f. Increase reliability.
- g. Foster competition in the inertial industry.
- h. Eliminate vendor lock-in.
- i. Promote equipment interchangeability.
- j. Allow for insertion of new technology into the standard when it becomes cost competitive [10:2,3].

(These PMD objectives relate to the STD INU program and do not include objectives for the aircraft/INU integrations. The aircraft program objectives are covered in separate PMDs for each aircraft.) The form, fit, and function standardization approach was chosen to meet these PMD objectives for the STD INU (6).

F3 standardization offers the potential to reduce acquisition costs through acquiring larger quantities and increasing competition. Larger quantities are obtained by combining the requirements of multiple aircraft types. The Air Force is acquiring 1534 INUs (fiscal year 1985 through 1989) as a combined buy. The individual aircraft requirements are: C-130, 439; F-111, 139; F-4, 381; C-17, 43; HH-53, 21; A-7, 192; Army, 26; and spares,

293 (6). The cost savings are also increased by multiple competitions. The STD INU has had three production source selections: FY81, FY83, and FY85. During the second competitive source selection, the two competing systems, the LN-39 and Singer Kearfott's SKN-2416 were already in the Air Force's inventory and production contracts for additional units existed. Both Litton and Singer lowered their prices from their prices on the existing contracts for the competition. Singer lowered its unit price from \$162,000 to \$118,000 (27% savings) and Litton lowered its price from \$106,000 to \$85,000 (20% savings) (19). By not exercising the existing contract options and buying from the new contract, savings were realized. A program analysis done during the third source selection estimated the savings from competition was at least 18 percent (19).

F3 standardization also offers the potential to reduce costs by reducing logistics support costs. By sparing for multiple aircraft systems with one INU, the total spares requirement is reduced. Also, the cost of support equipment is reduced by having only one set of support equipment in lieu of having multiple support equipment for each aircraft's unique INU. Training requirements for maintenance is also reduced with one standard system (14:52). Further, the F3 approach which enables insertion of new technology (since the contractors' internal design

is not specified), offers the potential for increased reliability, which also reduces logistics support costs. The LN-39's Mean-Time-Between-Removal (MTBR) at the end of its five year warranty was approximately 625 hours (11). Insertion of Ring Laser Gyro technology into the STD INU program will increase reliability to approximately 2000 hours MTBR for fighter aircraft and 4000 hours for transport aircraft. These values for MTBR are contractually guaranteed by both Honeywell and Litton (1,2).

The F3 standardization approach fosters competition in the inertial industry and eliminates vendor lock-in by having multiple competitions and by not specifying the contractors' internal designs (5:2-17). As mentioned earlier, the STD INU program has had multiple competitions and will continue to do so as new technology, additional aircraft requirements, and new market conditions are identified. A 1983 study of the market for medium accuracy inertial navigation units revealed the following:

- a. One contractor, Litton had over 80% of the DOD high volume production of medium accuracy INUs.
- b. The three main competitors' (Singer, Honeywell and Delco) market shares were declining in the near future.
- c. There was a market dominance of medium accuracy INUs by Litton potentially leading to: a sole source environment, INU price escalation, and a weakened government negotiating position [18].

This study was briefed to the Air Force Systems Command Commander, General Skantze, who approved the program's

approach to increase competition in the DOD inertial market, namely to actively support the development and qualification of new technology INUs (ie. RLG technology). Following this briefing, three no-cost contracts for development and testing of RLGs systems were awarded to Honeywell, Litton, and Singer. Honeywell and Litton, who won the recent STD INU competition will share approximately (50% to 50%) the Air Force's medium accuracy INU requirements over the next few years. The Singer system is qualified as a standard system and will be eligible to compete in any future competitions (6).

The F3 approach also promotes equipment interchangeability not only between multiple aircraft types, but also between multiple contractors' designs. The F3 STD INU specification, SNU 84-1, strictly defines the interface requirements between the INUs and the aircrafts' systems (6). If the INUs are properly designed to the specification and the integrating contractors integrate the INUs in accordance with the specification, then any contractors' STD INU could be used on any aircraft type. This interchangeability increases the aircrafts' mission availability by having STD INUs available at practically any base world-wide (the C-130's alone will be stationed at approximately 60 bases world-wide) (17:6).

Although F3 standarization provides many benefits (lowered acquisition costs, lower support costs, increased

competition, equipment interchangeability), it has its costs too. By standardizing for multiple aircraft applications, the technical interface requirements become numerous. Each aircraft type has many unique interfaces, as well as some common interfaces. These interfaces include the aircrafts' mission computer, radar, weapons control system, LANTIRN, GPS, AHARS, TACAN, and other navigation aids. Many of the unique requirements are undiscovered or undetermined until system design, aircraft integration, and/or flight tests. These requirements not only cost the government in specification and design changes and modification to existing inventory, but also, add the costs of any reintegration or retest for any or all of the multiple aircraft types already using the STD INU. Further, as a standard, the STD INU is directed for use on new aircraft (eg. C-17), as well as new modification programs (eg. A-7). These programs which were not identified during the specification development process drive further changes causing the Air Force to incur the same costs as mentioned previously (design changes, reintegration, etc.). Compared to having a unique system for each aircraft type, any change to a standard causes the total cost of the change to multiply by approximately a factor of the number of aircraft types using the standard. A change to the STD INU required by one aircraft type could potentially cost all of the other users to incur additional costs (6).

Problem Statement

The first generation STD INU has been in production for seven years. It is currently in use on the A-10, F-16C/D, and FB-111. Both the F-16C/D and the FB-111 programs are still in their integration/flight test phases and multiple changes have been made in the past two years. These recent changes include correction of INU design deficiencies and incorporation of previously unidentified requirements. These recent INU changes have been software only (6).

The A-10, which is near completion of its INU modification program, has not been funded for testing and retesting of all the recent changes generated by the F-16 and FB-111 programs. Further, the F-16C/D and FB-111 were not funded to deal with the reintegration/retesting caused by the changes forced by the other aircraft program. In addition, these changes have caused schedule delays to both programs, further increasing the programs' costs (11).

To resolve the cost and schedule problems, the Director of Material Management at Sacramento Air Logistics Center, SM-ALC/MM requested the item management office, OC-ALC/MMIMI, to consider breaking the standardization of the LN-39. The SM-ALC proposal was to maintain hardware only standardization and allow each aircraft type to use a different software package (7). OC-ALC/MMIMI, the item

manager of the LN-39, who has total system responsibility for the LN-39 program, decided at this stage of the program (7 years in production, with no new users identified) not to break the standardization (6). The destandardization issue was raised again in a meeting at OC-ALC in Jun 87. Representatives from the LN-39 Item Management Office, the Standard INU Program Office, the ASD Avionics Control Directorate, the F-16C/D SPO, the A-10 SPM, the FB-111 SPM, and the using commands, TAC and SAC voted on the issue. The vote was 7 for maintaining the standardization and 6 for destandardizing the LN-39. The result of the meeting was again, a decision not to destandardize the LN-39 (6).

With the second generation STD INU, the Ring Laser Gyro STD INU, now beginning production and aircraft integration, similar problems of design changes due to previously undefined requirements are occurring. Due to these problems and the higher potential (two contractors and eight aircraft types for the RLG STD INUs versus only one contractor and three aircraft types for the LN-39) of additional changes and their associated costs, the STD INU Program Office needs to determine if F3 standardization should be broken for the RLG STD INUs. Further, they are developing the acquisition strategy for the next generation STD INU and need to determine what standardization approach to take (6).

Scope

This study will evaluate the perceptions of all those people directly involved with the STD INU program from both the Avionics Standardization Acquisition community and the User Avionics Standardization Acquisition community. The Avionics Standardization Acquisition community is defined as all organizations which either manage standard avionics programs or promote the use of standard avionics equipment through policy, guidance, or direction. The User Avionics Standardization Acquisition community is defined to be those organizations which are responsible for the integration of standard avionics equipment for use on weapons systems (e.g. the F-16 SPO, C-130 SPM). The groups studied in this effort are subsets of the two communities, specifically, the subsets that work with the STD INU Program. These two groups are labeled: the STD INU Standardization Acquisition community and the STD INU User Acquisition community. This study will determine if both groups agree or disagree on the major issues of F3 standardization. Further, this study will help define the perceived costs and benefits of F3 standardization.

Research Areas

Research Area 1. The F3 standardization approach meets the STD INU Program Management Directive (PMD) objectives.

Research Question 1. How do the two acquisition communities (the STD INU Standardization Acquisition

Acquisition community and the STD INU User Acquisition community) perceive F3 standardization has affected INU acquisition costs?

Research Question 2. How do the two acquisition communities perceive F3 standardization has affected logistics support costs?

Research Question 3. How do the two groups perceive F3 standardization has affected mission availability?

Research Question 4. How do the two groups perceive F3 standardization has affected the inertial industrial base?

Research Question 5. How do the two groups perceive F3 standardization has affected new technology insertion?

Research Question 6. How do the two groups perceive F3 standardization has affected INU reliability?

Research Question 7. Do the two groups perceive the STD INU PMD objectives were met as a direct result of the F3 standardization approach?

Research Area 2. The benefits of F3 standardization outweigh the costs of F3 standardization.

Research Question 8. Do the two acquisition communities perceive the benefits of F3 standardization to the Air Force outweigh the costs of F3 standardization to the Air Force?

Research Question 9. What do both groups perceive as the most significant benefits of F3 standardization?

Research Question 10. What do both groups perceive as the most significant costs of F3 standardization?

Research Area 3. F3 standardization should be continued for use on the Standard INU Ring Laser Gyro and the next generation STD INU Programs.

Research Question 11. Do the STD INU Standardization Acquisition community and the STD INU User Acquisition community recommend that F3 standardization should be maintained on the RLG STD INU Program?

Research Question 12. What changes do both groups recommend for the RLG STD INU Program?

Research Question 13. Do the two groups recommend the F3 standardization approach for the next generation STD INU?

Research Question 14. What changes do both groups recommend for the next generation STD INU Program?

Definitions

Avionics Equipment. "All the electronic and electromechanical systems and subsystems (hardware and software) installed in aircraft or attached to it" (8:1-1).

Standard Avionics. "Those pieces of common avionics equipment that perform a particular function for more than one system" (8:1-1).

Form, Fit and Function.

A standard which describes interfaces - mechanical, electrical, and environmental as well as the functions the equipment is to perform, but leaving the internal design and mechanization to the individual vendors [3:2-25].

Logistics Support Cost. "The cost of operation, maintenance, and follow-on logistics support of the end item and its associated support systems" (9:1-2).

II. Literature Review

Introduction

This chapter summarizes a review of recent literature on avionics standardization. A majority of the authors believe that standardization is a significant benefit to the military. There are problems; however, in implementing standardization and success in standardization programs to date has been limited. Both the Department of Defense (DOD) and the Air Force support standardization efforts.

Standardization

There are several standardization efforts being pursued by the DOD. Avionics standardization can be broken into three general categories: hardware; software; and system architecture (13:618). According to John Kidrell of the Naval Avionics Center, these categories can be further broken down,

Hardware can be broken into the areas of systems, subsystems, modules, and devices. The software area can be broken down into the selection of processor architecture, higher order language, algorithm, and support considerations. System architecture considerations include bus structure/interfaces, fault tolerant techniques, electrical interfaces, built-in test techniques, and the general area of packaging and thermal management [13:618].

All these areas are being pursued by the services (13:618).

Why are the services pursuing avionics standardization approaches? Development, procurement and, support costs for modern high technology aircraft are large. According

to the Government Accounting Office (GAO), the DOD will spend over \$50 Billion during 1984 through 1999 on avionics acquisitions (17:4). The Air Force alone is currently spending \$900 million a year on avionics acquisitions (16:36). With current budget constraints, an acquisition strategy is needed to reduced life-cycle costs.

"Standardization is seen as a way to reduce life-cycle costs while simultaneously enhancing interchangeability, interoperability, supportability, and force readiness" (17:4).

Standardization can reduce life-cycle costs through lowered acquisition costs and reduced logistics support costs. Standardization promotes competition and lowered acquisition costs can be realized from increased competition (16:57). A 1977 ARINC study of more than 40 avionics systems reprocurements showed savings of 20 to 69 percent on acquisition costs, with an average savings of 38 percent from competition (5:2-20). Life-cycle costs are also reduced by lower logistics support costs. Colonel Larimer, former Deputy for Avionics Control, stated,

When acquisition managers use the hardware, software, and architectural standards, the taxpayers achieve life-cycle cost savings accruing from common (or near common): spares; ground support equipment; software support tools; depot repair activities, equipment, etc.; training equipment, capabilities, etc.; and organic maintenance know-how [14:52].

Both Colonel Larimer and the GAO study also mention that standardization provides operational benefits

(increased force readiness) in addition to cost reductions (14:59,17:6). An example of enhanced force readiness was provided by the GAO report,

Since 1960, companies have sold more than 80 different air data computers to the services. Of these 28 are now obsolete, difficult to maintain, and scheduled for replacement. The Standard Central Air Data Computer (SCADC), a Joint Services Review Committee candidate, will have 1 set of support requirements to replace the current 28, alleviating traditional logistics burden. Further, SCADCs could reasonably expect to receive emergency service at any United States military (and perhaps allied) air base world wide [17:6].

Although standardization offers the potential for cost and operational benefits, not all avionics programs are suitable for standardization (4:1-1). Four general selection criteria are widely accepted by the research and development community for selection of candidate standardization programs. These criteria are:

- Technology - the technology must be mature.
- Architectural - the subsystem must perform identifiable, discrete, and separate functions.
- Applicability - the system specification must be broadly applicable to Air Force weapon system requirements.
- Economic - a sufficient market must exist for new systems within the period under consideration [4:2-1].

Core avionics are considered the most likely candidates for standardization because they are usually mature, stable, and low risk technically and because they meet with less resistance from the services than would mission-oriented and aircraft peculiar avionics (17:2). "Core avionics are defined as equipment which fulfill some common aircraft

requirement such as communications, enroute navigation, identification, radar altimeter, ..." (17:2).

Standardization in DOD

Standardization has been an issue in the DOD since 1952. In 1952, Congress passed the Defense Cataloging and Standardization Act requiring the DOD to establish the Defense Specification and Standardization Program. The program established the Defense Materiel Specifications and Standards Office (DMSSO), which is responsible for establishing DOD standardization policies, procedures, program guidance, and controls. The Act also required the creation of the Defense Materiel Standardization and Specifications Board, which meets twice a year to study standardization issues and advises the Secretary of Defense. Implementation and enforcement of the DOD policies is delegated to the individual services (17:1).

According to the GAO report, Congress has increased emphasis on avionics standardization in recent years. "In 1977, 1978, 1980, and 1983, the defense appropriations bills and hearings emphasized development and use of standard equipment" (17:1). In response to the congressional emphasis, the services established in 1980, the Joint Services Review Committee (JSRC) for Avionics Components and Subsystems. The JSRC is chartered to identify opportunities for standardization of avionics subsystems (17:2).

The JSRC initially identified 30 potential candidate avionics subsystems for standardization. Of these, they choose 5 programs to initially sponsor. Their January 1984 estimate of the savings from just these 5 programs was \$770 million (1983 dollars) (17:3,4). Two additional programs were selected in 1983 with a potential savings of an additional \$70 million (17:3).

"Interest in standard avionics was further increased in 1981 when the Deputy Secretary of Defense established the Acquisition Improvement Program ..." (17:2). Action 21 of that plan was an initiative to develop and use standard operation and support systems. Colonel Larimer believes that successful implementation of Action 21 will also help make progress in achieving other related Acquisition Improvement Program initiatives such as:

- Action 2 - Increase use of pre-planned product improvement.
- Action 4 - Increase program stability.
- Action 7 - Use economical production rates.
- Action 9 - Improve system support and readiness.
- Action 16 - Provide contractor incentives to improve reliability and support.
- Action 31 - Improve reliability and support.
- Action 32 - Increase competition [14:52].

Air Force Avionics Standardization Policies

Air Force Regulation 800-28 defines the Air Force's avionics acquisition policy. The regulation established strategies and tactics to achieve the objective of "providing cost effective, supportable avionics systems that help the Air Force accomplish its mission" (8:2-1).

The strategies related to standardization include:

- Maintaining a current knowledge of Air Force avionics requirements and deficiencies.
- Taking into account different mission requirements and maturing technology, control the proliferation of avionics systems as much as possible.
- Provide a way to communicate plans and decisions among the agencies involved in avionics [8:2-1].

The tactics related to standardization include:

- Develop a standard architecture with the objectives of maximizing the reusing or sharing of avionics systems and minimizing the cost of retrofit.
- Develop families of functional standards and apply these, if appropriate, to all avionics systems and subsystems.
- Regularly publish plans and guidance for Air Force wide dissemination and use. These documents will discuss the current avionics inventory and requirements, the projected force structure and requirements, the results of mission and functional area analysis and current avionics standards [8:2-1].

AFR 800-28 requires the designation of avionics standards for specific classes of equipment. Further, all new aircraft or modification programs must consider using these standards. In order to deviate from using one of these standards, the program must get a waiver from HQ USAF (8:3-2).

Responsibility for implementing standardization within the Air Force is spread accross all involved agencies. The responsibilities are:

- HQ USAF - review and approve proposed avionics standards; approve and disapprove waivers to the avionics standards.
- HQ AFSC - develop and apply avionics standards to all its development and acquisition programs.

- HQ AFLC - apply avionics standards, as much as possible, to all modification programs.
- ASD-AFALC/AX - Makes sure the use of common avionics equipment in all new aircraft systems is considered and act as the Air Force agent for identifying avionics standards and making sure they are used.
- Using and Operating Commands - Establish liaison with the Deputy for Avionics Control (ASD-AFALC/AX) to make sure that current avionics standards and architecture satisfy command requirements. Plan for the use of existing and future avionics standard items and plan avionics support based on the use of these standards [8:4-1].

Additional Air Force policy was discussed at the first AFSC Standardization Conference, 18 - 20 November 1980.

Colonel Teal in his opening presentation, stated that the Air Force's primary thrust in standardization is "to concentrate on interface standards rather than black box standards; to define the key architectural interfaces" (15:12). He further stated,

We are striving for the ability to insert new technology when it is ready, through field modifications when possible, and to achieve a level of modularity that allows functional subsystems to be upgraded with minimal impact to the rest of the weapon system [15:16].

Louis Urban's (ASD-AFALC/AX) presentation to the conference states that the Air Force is also trying to achieve "Rational Standardization." The principal objectives of "Rational Standardization" are to achieve cost savings and interoperability and also balance the needs of the users with what AFSC can produce and AFLC can support (16:78).

Form, Fit and Function Standardization

One of the standardization approaches selected by the

Air Force was Form, Fit, and Function (F3) standardization. The Air Force's decision in the mid-1970's to apply F3 standardization was based on attractive economic returns inferred from commercial practices. This approach departed significantly from previous government acquisition strategies (5:vii). The Air Force's F3 approach mirrors the commercial approach, but is not exactly the same. A 1977 ARINC study to help the Air Force develop the F3 strategy stated,

The resemblance of this military program to very successful practices that have evolved in the commercial air transport industry is strong; however, it is important to recognize the differences in the environment. Military avionics technology changes very rapidly ... lot sizes ordered in the two procurement environments ordinarily differ by an order of magnitude, and there are other more subtle differences. Thus there is justification in establishing a unique military F3 standardization approach [5:viii].

This unique military approach centers on 4 interrelated business practices:

- 1) the establishment of a single agency to consolidate requirements and procure avionics for the Air Force when an attractive market situation becomes apparent.
- 2) relaxation of the government role in configuration control so as to promote technological innovation with regard to reliability, maintainability and producibility.
- 3) establishment of a maintenance concept that provides for contractor support during the first few years of operations, which provides an incentive for such innovations and defers the acquisition of AGE until the equipment is matured.
- 4) articulation of an acquisition policy that provides for the periodic procurements rather than sole-source multi-year awards, thus sustaining competitive forces until all requirements have been met [5:vii].

This approach offers the potential of achieving several benefits including: interchangeability; promoting competition; maturing equipment design; reducing costly group "A" modification costs; and reducing training/ATE needs (16:57). The 1977 ARINC study states the most significant benefit is F3 standardization's ability to sustain competition. An F3 standardization interface specification allows multiple contractors to develop their own individual designs which can all meet a given Air Force requirement. "This approach has been found to place substantial competitive pressure on avionics suppliers in the commercial air transport industry" (5:2-17). As mentioned earlier, the ARINC study concluded that competition saves, on the average, 38 percent of acquisition costs.

Obstacles to Standardization

Although F3 standardization and other standardization approaches can provide significant benefits, efforts at large scale standardization have been greatly frustrated (4,5,10,14,17). "Acquisition managers often view standardization as an obstacle to be overcome in the pursuit of individual program goals" (14:52). Some of these obstacles include: cost and schedule risk; communication of requirements; level of standardization; difficulties in measuring benefits; funding difficulties and lack of high level management support (4,5,10,14,17).

Extra up-front work is often required to ensure multiple weapons systems' requirements are met. This extra work can affect the initial developer's program costs, schedules and technical performance. Although the extra up-front work will eventually payoff for follow-on users, the initial developer gains no immediate benefits (14:51).

"Communication of requirements between planners in the various organizations responsible for the development of equipment has not been reliable" (4:1-1). This communication is hampered by the numerous aircraft types (there are currently 151 type/model/series designations for Air Force aircraft). The design requirements for avionics equipment vary considerably from mission to mission. Further, requirements change frequently due to identification of new threats or scenarios (4:1-1).

A 1985 AFIT thesis by Captain Furr, studied perceptions on avionics standardization at Aeronautical Systems Division (ASD). Her study showed that avionics standardization has not been readily accepted by the acquisition community at ASD (12:53). One of her conclusions was that the level of standardization determines the degree of acceptability. "Subsystem standardization is associated with negative feelings, while architectural standardization, eg. MIL-STD-1553B, generally has been widely accepted" (12:38).

Another obstacle identified was the difficulty in measuring the benefits of standardization. Traditional life-cycle cost analyses have dealt with single aircraft programs. To measure the full benefits of standardization, the benefits need to be measured across all user aircrafts. "This is outside the scope of conventional LCC and perhaps cannot be accomplished in the traditional manner of DOD budgeting" (5:5-7).

The GAO's study of the JSRC standardization efforts, found two additional obstacles. The report states,

Based on our evaluation of JSRC efforts, avionics standardization is not occurring as rapidly as it could, primarily because of funding deficiencies, coupled with insufficient high level management commitment to implement stated policies [17:11].

They found the funding deficiencies resulted from:

- competition for funds against well-sponsored major weapon systems and more costly mission critical avionics programs
- JSRC programs typically provide benefits in the long run and lose out when competing for funds against programs which satisfy more immediate needs of service commanders [17:11,12].

Summary

In recent years, Congress, the Department of Defense, and the Air Force have increased their emphasis on avionics standardization. This is due to increasing costs and tightening budgets. Standardization is perceived as a means to get more for the money. Standardization offers the potential for reduced costs and increased force readiness. Although, the potential benefits are

significant, progress in implementing standardization has been sluggish. Many obstacles to standardization still must be overcome in order to reap the benefits standardization offers.

III. Research Methodology

Introduction

This chapter describes the research methodology used to evaluate the perceptions of Form, Fit, and Function (F3) standardization on the STD INU Program. The discussion includes a description of the population surveyed, the data collection method, the survey instrument, and the data analysis method. The general methodology is a survey of all individuals which work directly with the STD INU Program. The survey provides perceptions on the key issues of F3 standardization. A summary analysis of all responses to the research questions and an analysis of response variances is provided.

Population of Interest

The population of interest is all the individuals in Air Force acquisition organizations who work directly with the STD INU Program. The organizations included all the organizations which either manage one of the STD INU Programs (LN-39, RLG STD INU), manage the STD INU integration on a specific aircraft application, or provide policy, guidance, or direction on the STD INU Program. Tables 1. and 2. below lists the organizations and their relationship to the STD INU Program.

This population is further divided into two groups: the individuals from the STD INU Standardization Acquisition community and the individuals from the STD INU User

Acquisition community. The STD INU Standardization Acquisition community includes those organizations which either manage one of the STD INU programs or provide policy, guidance, or direction on the STD INU program. The STD INU User Acquisition community includes those organizations which are responsible for STD INU integration on each of the aircraft applications.

Table 1. Organizations Included in the STD INU Standardization Acquisition Community and Their Relationship to the STD INU Program

<u>Organization</u>	<u>Relationship to the STD INU Program</u>
ASD/AE	RLG STD INU Program
OC-ALC/MMI	LN-39 Program
AFWAL/AA	Next Generation INU
ASD/AX	AF Avionics Policy
AFSC/SDB	AFSC Guidance
AFLC LOC/CFV	AFLC Guidance
USAF/LEY	USAF Direction
SAF/AQP	SAF Direction

Table 2. Organizations Included in the STD INU User Acquisition Community and Their Relationship to the STD INU Program

<u>Organization</u>	<u>Relationship to the STD INU Program</u>
ASD/YP	F-16C/D Integration (LN-39)
ASD/AF	C-17 Integration (RLG)
SM-ALC/MMK	F/EF-111 (RLG) and FB-111 (LN-39) Integration
SM-ALC/MMS	A-10 Integration (LN-39)
OO-ALC/MMS	F-4 Integration (RLG)
WR-ALC/MMS	C-130 (RLG) and HH-53 (RLG) Integration

These organizations constitute a consensus of the acquisition organizations that are currently working with

the STD INU program (6). Within these organizations the population of interest are all the individuals who have worked with the STD INU program. Since not all the individuals in these organizations work on or with the STD INU program and the individuals are not necessarily the organizations' Chiefs or Directors, the perceptions of the actual population surveyed may not represent the view point of the organizations. However, the study is focusing on the F3 standardization approach on the STD INU Program and not F3 standardization or avionics standardization in general. Surveying the entire organization, including those individuals who are not familiar with the F3 standardization approach or the STD INU program would dilute any findings which may be beneficial to the STD INU program.

Data Collection Method

The method used was a survey of the above mentioned organizations. Survey questionnaires were mailed to each of the organizations by ASD/AEAA. Table 3. below lists the number of questionnaires sent to each organization. A total of 31 questionnaires were mailed. The quantity of surveys sent to each organization was dependent on the number of individuals in each organization who have/had worked with and were familiar with the STD INU Program. The intent was to survey the consensus of the population, although a 100 percent response rate was not anticipated

due to the participatory nature of the survey. To insure a high response rate, twenty six individuals were contacted by phone prior to mailing the surveys; all the individuals contacted agreed to participate in the survey.

Table 3. Number of Survey Questionnaires Sent to Each Organization

<u>Organization</u>	<u>Number of Surveys Sent</u>
ASD/AE	3
OC-ALC/MMI	4
AFWAL/AA	1
ASD/YP	2
ASD/AF	2
SM-ALC/MMK	3
SM-ALC/MMS	2
OO-ALC/MMS	1
WR-ALC/MMS	3
ASD/AX	3
AFSC/SDB	1
AFLC LOC/CFV	1
USAF/LEYY	2
SAF/AQPV	2

Survey Instrument

The survey instrument (Appendix) was developed for and approved by the ASD STD INU Program Office. The questionnaire was split into four sections. The first section included questions on demographic information on each survey participant. The demographic information collected included the survey participants' job title, rank, background/experience with avionics standardization programs, and background/experience with the STD INU Program.

The second part of the survey relates to the first research area, F3 standardization meets the STD INU Program

Management Directive (PMD) objectives. Each survey participant was asked to assess how well F3 standardization has affected the major issues covered by the PMD objectives. Further, the questionnaire asks about their perceptions on how well F3 standardization has met the PMD objectives.

The third section addressed the second research area, the benefits of F3 standardization outweigh the costs of F3 standardization. Each participant was asked what he or she believes are the most significant costs and benefits of F3 standardization. After looking at both the costs and benefits of F3 standardization, the survey participant was asked whether or not he or she believes the benefits of F3 standardization outweigh the costs of F3 standardization.

The final part of the survey related to the third research area, F3 standardization should be continued for use on the STD INU Program. The survey participants are asked if they believe the F3 standardization approach was the most effective standardization approach for the Ring Laser Gyro (RLG) STD INU Program and what changes they would recommend for the RLG Program. Finally, they are asked if they believe the F3 approach should be used on the next generation STD INU and what changes to the standardization approach they would recommend.

Data Analysis Methodology

Demographic Information. Summary statistics will be

provided on all of the demographic data. The ranks and number of participants in each rank will be listed. The number of avionics standardization programs each of the participants have worked with and the average number of programs will be provided. The number of years of experience with standard avionics programs of each participant will be listed and the average number of years computed. The number of years experience with the STD INU Program of each participant will be listed and the average computed. A qualitative evaluation of the demographic information will be provided to determine the quality of the data.

Research Questions. A summary analysis of the survey responses to the research questions will be conducted. The responses will be grouped by similar responses. Further, the responses will be categorized by the two acquisition communities to determine if the two communities agree on the research questions. The responses to questions 9, 10, 12, and 14 will not be categorized by the two groups. The other questions (questions 1 - 8, 11, and 13) will be used to show if there is a difference in opinion between the two groups on those questions. The responses to questions 9, 10, 12, and 14 will be used to make recommendations to improve the STD INU standardization approach.

Variance of Responses by Demographics. A summary analysis of the response variances by demographics will be

provided for each of the research questions where there was a significant difference (over forty percent difference) between the two groups. The responses will be summarized by rank, avionics standardization experience, and STD INU experience. Also, these variances will be compared with the demographic makeup of the two STD INU acquisition communities.

Summary

The general method of data collection is a survey of the population of the acquisition community that works with the STD INU Program. Summary statistics will be provided on the research questions and on the response variances by the demographic data. The data analysis from chapter 4 will be used to draw conclusions and findings in chapter 5.

IV. Data Analysis

Introduction

This chapter summarizes the results of the analysis of the survey data. The discussion includes results of the survey participation, summary of the demographic data, summary of the responses to the research questions, summary of response variances by demographic responses, and explanations for the differences in responses between the two communities.

Survey Participation

Of the 31 survey questionnaires mailed, 22 were returned through the mail. An additional 4 responses were received through telephone interviews, for a total of 26 responses. Using question 5. from the survey, the respondents were catagorized as either part of the STD INU Standardization Acquisition community or the STD INU User Acquisition community. Twelve of the responses were from the first group and fourteen from the second group.

Demographic Data

The demographic data was analyzed by group. The data summarized includes rank, number of years experience with standard avionics, number of standard avionics programs worked, and number of years experience with the Standard Inertial Naviagtion Unit (STD INU) Program (both the LN-39 and Ring Laser Gyro programs).

Rank. The total sample included 11 military and 15

civilians. The rank of the individuals ranged from first lieutenant to colonel and GS-11 to GM-13. The first group (STD INU Standardization Acquisition community) included 7 military and 5 civilians. The second group (STD INU User Acquisition community) included 4 military and 10 civilians. Table 4. summarizes the ranks of both groups.

Table 4. Ranks of the Survey Participants

Standardization Community

<u>Rank</u>	<u>Number</u>
Colonel	1
Lt Colonel	2
Major	1
Captain	3
GM/GS-13	2
GS-12	3

User Community

<u>Rank</u>	<u>Number</u>
Colonel	1
Major	1
Captain	1
1st Lieutenant	1
GM/GS-13	5
GS-12	2
GS-11	3

Years Experience with Avionics Standards. The first group averaged 4.18 years of experience with avionics standardization programs with a standard deviation of 2.03. Their experience ranged from 8 months to 8 years. The second group averaged 5.45 years with a standard deviation of 3.83. This group's experience ranged from 1 year to 15 years. Table 5. shows the number of years of experience

with avionics standardization along with number of standard avionics programs worked and the ranks of each individual.

Table 5. Experience With Avionics Standardization

<u>Rank</u>	<u>Years Associated With Standard Avionics</u>	<u>Number of Standard Avionics Programs</u>
<u>Standardization Community</u>		
Capt	3.5	4
Maj	1.0	2
GS-12	4.0	1
GS-13	5.0	8
Capt	5.5	4
Capt	0.67	10
Lt Col	3.0	4
GS-12	3.0	2
Lt Col	5.0	7
GS-12	8.0	6
GM-13	6.5	7
Col	5.0	10
<u>User Community</u>		
GS-11	3.5	1
GM-13	4.0	4
1Lt	3.5	2
Capt	2.0	1
GS-13	15.0	10
GM-13	5.0	1
GS-11	2.5	1
Col	4.0	2
GM-13	10.0	3
Maj	1.0	2
GS-11	0.75	2
GS-12	2.0	1
GM-13	9.0	5
GS-13	4.0	2

Number of Standard Avionics Programs Worked. As the above table shows the number of standard avionics programs worked ranged from just one to as many as 10 different standard avionics programs. In the first group, the average number of standard avionics programs worked was

5.42 with a standard deviation of 2.93. The average number of standard avionics programs worked in the second group was 2.64 with a standard deviation of 2.35.

Experience With the STD INU Program. Within the first group all 12 individuals had worked with the LN-39 Program and 10 worked with the RLG Program. The average number of years worked on the LN-39 in this group was 3.31 with a standard deviation of 1.38 and the average with the RLG Program was 2.67 with a standard deviation of 1.27. The second group averaged 3.88 years with the LN-39 with a standard deviation of 0.9. Their experience with the RLG averaged 2.45 years with a standard deviation of 1.26. Table 6. summarizes the survey participants experience with the STD INU Program.

Table 6. STD INU Experience

<u>LN-39/RLG</u>	<u>Years with LN-39/RLG</u>
<u>Standardization Community</u>	
yes / yes	2.5 / 2.0
yes / yes	1.0 / 1.0
yes / no	4.0 / 0.0
yes / yes	4.5 / 4.0
yes / yes	3.0 / 3.5
yes / yes	0.67 / 0.67
yes / no	3.0 / 0.0
yes / yes	3.0 / 3.0
yes / yes	5.0 / 4.0
yes / yes	5.0 / 3.0
yes / yes	5.0 / 1.5
yes / yes	4.0 / 4.0
<u>User Community</u>	
no / yes	4.0 / 3.5
yes / yes	4.0 / 3.5
yes / yes	3.5 / 2.0

Table 6. (Continued)

<u>LN-39/RLG</u>	<u>Years with LN-39/RLG</u>
yes / no	2.0 / 0.0
yes / yes	4.0 / 2.0
yes / no	5.0 / 0.0
yes / no	2.5 / 0.0
yes / no	4.0 / 0.0
no / yes	0.0 / 5.0
no / yes	0.0 / 0.83
yes / yes	0.75 / 0.75
no / yes	0.0 / 2.0
yes / yes	5.0 / 3.0
yes / no	4.0 / 0.0

Quality of the Data

The quality of the data is dependent on the experience of the survey participants. The most important consideration is experience with the STD INU Program since the research questions relate directly with F3 standardization and the STD INU Program (not avionics standardization in general). The experience on the STD INU Program ensures the survey participants are familiar with the standardization approach and the objectives of the STD INU Program. However, the avionics standardization experience is important, in that it gives a better perspective on standardization issues. The demographic data shows sufficient experience with both avionics standardization and the STD INU Program. Overall, the survey participants averaged 4.86 years of experience with standard avionics, 3.61 years with the LN-39, and 2.57 years with the RLG. Only four of the participants had less than 2 years of avionics standardization experience, one

however works with 10 different avionics standardization programs. Also, only four participants have less than 2 years working with the STD INU; however, two of the four work directly with the STD INU program and the other two work in standardization advocacy organizations (HQ USAF and HQ AFSC) and work with multiple standardization programs. Also 22 of the 26 participants work directly day-to-day with the STD INU Program, either in integration or management on the two INUs. The other four work in advocacy organizations (HQ USAF, HQ AFSC, AFLC LOC, ASD-AFALC/AX).

Research Questions

The responses to the research questions will be summarized by similar responses and categorized by the two STD INU acquisition communities. On questions 9, 10, 12, and 14 the responses will be summarized, but not categorized between the two groups.

Research Question 1. Eleven individuals (100 percent) from the STD INU Standardization Acquisition community perceived that F3 standardization reduced acquisition costs for the INU. One individual in this group did not respond to this issue. Seven (58.3 percent) from the STD INU User Acquisition community perceived that F3 standardization reduced INU acquisition costs and 5 believed it did not. Three individuals from this group did not respond to this issue. Although the majority of both groups perceived that

F3 Standardization reduced INU acquisition costs, there is a significant (over 40 percent difference) difference in proportions of the two groups that perceived F3 Standardization reduced INU acquisition costs.

Research Question 2. Ten individuals (90.9 percent) from the first group perceived F3 standardization reduces logistics support costs and one individual felt logistics support costs increased. Only four (38.5 percent) from the second group agreed that F3 standardization reduces logistics support costs and 9 from this group disagreed. Two individuals did not respond to this issue. Comparing the difference in proportions of individuals from the two groups that perceived F3 Standardization has reduced logistics support costs show the two groups do not agree on this issue.

Research Question 3. Eleven individuals (91.7 percent) of the first group perceived that F3 standardization has increased mission availability, with only one individual disagreeing. Only two (22.2 percent) from the second group agreed that F3 standardization has increased mission availability, with 7 survey participants disagreeing. Five of the participants did not respond to this issue. Again there was a significant difference of opinions between the two groups.

Research Question 4. Eight individuals (66.7 percent) from the first group perceived that F3 standardization has

helped maintain the inertial industrial base. Four individuals from the first group perceived that F3 standardization reduced the inertial industrial base. Only 3 (42 percent) of the second group agreed that F3 standardization has helped maintain the inertial industrial base, with 4 individuals disagreeing. Seven of the participants did not respond to this issue. Comparing the proportions of the two groups that perceived F3 Standardization helped maintained the inertial industrial base shows only a minor difference between the two groups.

Research Question 5. Eight (66.7 percent) from the first group perceived that F3 standardization has allowed for new technology insertion, with 4 individuals in this group disagreeing. Only four individuals (50 percent) from the second group agreed that F3 standardization has allowed for new technology insertion, with 4 from the second group disagreeing. Six of the respondents did not respond to this issue. The two groups do not differ greatly on this research question.

Research Question 6. Ten respondents (83.3 percent) from the first group perceived that F3 standardization increases reliability of the INU, with 2 individuals from this group disagreeing. Eight (61.5 percent) from the second group agreed that F3 standardization increases reliability of the INU with, 5 individuals disagreeing. Only one participant did not respond to this issue. The

proportions of both groups that perceived F3 Standardization increased INU reliability did not differ significantly.

Research Question 7. Eleven individuals (91.7 percent) from the first group perceived that F3 standardization has helped achieve the STD INU Program Management Directives (PMD) objectives, with one respondent disagreeing. Five respondents (41.7 percent) from the second group agreed that F3 standardization has helped achieve the STD INU PMD objectives, with seven from this group disagreeing. Two individuals did not respond to this issue. The significant difference in proportions of individuals that perceived F3 Standardization has helped achieve the PMD objectives between the two groups shows the two groups disagree in opinion.

Research Question 8. Ten respondents (83.3 percent) from the first group perceived that the benefits of F3 standardization to the Air Force outweighs the cost of F3 standardization to the Air Force, with 2 individuals disagreeing. Only three individuals (30 percent) from the second group perceived that the benefits outweigh the costs, with seven respondents in this group disagreeing. Four of participants did not respond to this issue. The significant difference in proportions of individuals that perceived that the benefits outweigh the costs indicates the two groups differ in opinion on this issue.

Research Question 11. Eight respondents (80 percent) from the first group believe F3 standardization should be maintained on the STD Ring Laser Gyro INU program, with 2 disagreeing. Six individuals (54.5 percent) from the second group agreed that F3 standardization should be maintained on the RLG program, with 5 disagreeing. Four of the participants did not respond on this issue. The difference in proportions on this question was not significant enough to state the two groups differ on this issue.

Research Question 13. Eight individuals (72.7 percent) from the first group recommended that F3 standardization be used on the next generation STD INU program, with 3 individuals disagreeing. Eight (51.7 percent) from the second group agreed that F3 Standardization should be used for the next generation STD INU, with six respondents in this group disagreeing. Only one of the participants did not respond on this issue. The difference in proportions between the two groups was not significant enough to infer the two groups differ on this issue.

Research Question 9. The respondents perceived that F3 standardization provides the following benefits: reduced acquisition costs; reduced logistics support costs; improved force readiness; improved reliability; future technology insertion; maintenance of the industrial base.

Table 7. below lists the benefits and the number of participants that listed the benefit.

Table 7. Benefits of F3 Standardization

<u>Benefits</u>	<u>Number of Participants</u>
Reduced Acquisition Costs	8
Reduced Logistics Costs	18
Interchangeability/Improved Readiness	10
Improved Reliability	3
New Technology Insertion	2
Maintenance of Industrial Base	1

Eight individuals mentioned reduced acquisition costs. One participant stated that comparable inertial systems were costing about twice the cost of the STD RLG INU. Another compared the costs of the new STD INUs (\$100 thousand) to the old F-15 IMU (\$150 thousand) and the F-16A/B INU (\$160 thousand). Two of the respondents stated acquisition costs were lowered through enhanced competition.

Eighteen of the respondents mention reduced logistics support costs as a significant benefit. Reasons for decreased logistics support costs include; fewer spares; less support equipment; less costly to train; fewer personnel required; and reduced proliferation.

Improved force readiness, interchangeability, interoperability was mentioned by 10 of the survey participants. Interchangeability, improved reliability, and a larger pool of spares were given as reasons for improved readiness.

Improved Reliability was mentioned by three individuals. One respondent stated, "Inertial systems in mid to late 70's got about 40/50 hrs MTBF - LN-39 getting 500-600 hrs - RLGs projected to 2000-4000 hrs." Another respondent mentioned new technology and better packaging as reasons for improved reliability.

Two of the respondents listed new technology insertion as a significant benefit. One participant stated,

F3 standardization has provided manufacturers with a large potential quantity of INUs to pursue, which makes the push for new technology stronger to find a competitive edge that could result in a big profit. Also, knowing the F3 requirements and limitations give direction to IR&D and new technology development.

Research Question 10. The significant costs/disbenefits of F3 standardization listed by the respondents include: constant configuration changes; increased integration costs; communications between users; numerous interface requirements; lowered reliability; and lack of high level advocacy. Table 8. summaries the costs/disbenefits.

Table 8. Costs/Disbenefits of F3 Standardization

<u>Costs/Disbenefits</u>	<u>Number of Respondents</u>
Constant Configuration Changes	13
Numerous Interface Requirements	6
Increased Integration Costs	3
Lowered Reliability	2
Communication Problems	2
Lack of High Level Advocacy	1

Constant configuration changes/unstable baseline was

the most often mentioned response by the survey participants. One respondent feels, "Nobody identified where or when to stop (costs, performance requirements), never ending cycle." Another stated that constant reconfigurations are required to solve aircraft peculiar problems. Still another stated, "The A-10 has suffered the worst on the LN-39. We have experienced numerous configuration changes, forced retrofits, and asset depletion by other users." Several of these respondents also mentioned that these changes impact their costs and schedule.

Of the respondents that listed numerous interface/technical requirements, one stated, "It may be that the INU is not an appropriate device for applying the standardization concept because of the interplay with so many different aircraft subsystems." Another responded, "Each application has specific operating/flight characteristics and in trying to keep everything standard, changes are made that impacts support for other users."

Another significant cost mentioned was decreased reliability. One respondent felt that reliability was reduced by including all the individual aircrafts' peculiar requirements.

Research Question 12. The changes recommended for the STD RLG INU Program include: modular standardization; better define the specification; delete aircraft peculiar

requirements; reprogrammable Operational Flight Programs; and destardize. Table 9. summarizes the recommended changes to the STD RLG INU Program.

Table 9. Recommended Changes to the STD RLG INU Program

<u>Recommendation</u>	<u>Number of Responses</u>
Modular Standardization	6
Delete A/C Peculiar Requirements	3
Better Define Specification	3
Reprogrammable OFP	3
Destandardize	1
Improved Management	1

Six participants felt that the RLG should standardize at a lower level, ie. modular standardization. One response was,

Standardize at a lower level (ie. at the inertial reference level, not the aircraft interface). This would allow the INU to integrate into a wider number of aircraft that have vastly different requirements (ie. simple enroute navigation, flight control, SAR motion compensation, cockpit displays, ...).

Similar to this recommendation was reprogrammable OFPs, this too is standardizing at a lower level. One respondent stated,

Probably at your present stage it would be prudent to de-standardize the software by use of EEPROMs on the memory card and then use memory reloader verifiers at the base level. This would still allow hardware interchangeability and allow more flexibility in suiting the INU to aircraft specific requirements.

Still another respondent felt that this approach also would facilitate a wider range of aircraft applications.

One respondent criticized the management of the

program by ASD. He feels, "The program bows to too many Gods such as technology insertion, multiple sourcing, the contractors and the whim of abstract avionics planners." He further stated that to correct the program's problems, they need better goals, better response time, and be more product oriented. Finally, there was one respondent that was adamant about total destandardization, "I recommend you de-standardize the INU program yesterday."

Although, there was no majority response to this question, three of the responses (modular standardization, delete A/C peculiar requirements, and reprogrammable OFFPs) are similar. Twelve of the respondents recommended standardizing at a lower level. Although on question 11, the majority of respondents in both groups believed that F3 Standardization should be maintained on the RLG Program, the responses from this question indicate that the F3 approach should be maintained at a lower level.

Research Question 14. Recommendations for the next generation STD INU Program included: modular standardization; reprogrammable OFF; destandardization; and better planning. Table 10 summarizes the recommendations for changes for the next generation STD INU Program.

The majority of respondents (11) felt that for the next generation INU, the program should be standardized at the Inertial Reference Assembly (IRA) (the gyros, accelerometer, and navigation electronics). By

standardizing at this level, unique aircraft requirements would stay on the aircraft interface side, so that when an aircraft's requirements change there should be no impacts to other users.

Table 10. Recommended Changes to the Next Generation STD INU Program

<u>Recommendation</u>	<u>Number of Responses</u>
Standardize at IRA	11
Reprogrammable OFP	2
Improved Planning	1
No Standardization	1

Standardizing the hardware only, with reprogrammable Operational Flight Programs (OFPs), would also lessen impact of changes to multiple users, according to two respondents. One stated, "Most modifications made to meet a particular weapon system requirements will be in the software."

Better upfront planning was recommended by two respondents. One survey participant stated,

I think they shouldn't arbitrarily define/decide on a standardization approach. The platform and requirements must be first defined. And then future applications must be identified for standardization. To arbitrarily identify a standard is an inefficient way to get a program started. All you'll do is fight the budget process and for advocacy the rest of the program's life. The key to standardization, in my opinion is to have Air Staff, AFSC, the SPO and the contractors all strong supporters - not to mention Congress as well. And that is a slow process and someone has to take the lead and be willing to fight.

Finally one felt the INU might be an inappropriate item to standardize. He states,

The INU does a great job for what it was intended (ie. navigation). The more we try to make an INU universal for everything using the 1553 MUX bus, the further we move from the INUs real capability. Moreover, the more we add to the INU in order to solve aircraft peculiar interface problems, the more restrictive the INU becomes especially with respect to memory capacity.

Analysis of Response Variance By Demographics

This section shows the variance of responses with respect to the demographic differences, ie. rank, avionics standardization experience, and experience with the STD INU Pprogram. Only the responses to the five research questions where there was a significant difference in proportions that agreed on that question is analyzed in this section.

Variance of Responses by Rank. Table 11. summarizes the variance of responses with respect to rank differences.

Table 11. Response Variance by Rank

<u>Rank</u>	<u>RQ 1 (A/D)</u>	<u>RQ 2 (A/D)</u>	<u>RQ 3 (A/D)</u>	<u>RQ 7 (A/D)</u>	<u>RQ 8 (A/D)</u>
Colonel	2/0	2/0	1/1	2/0	2/0
Lt Col	2/0	2/0	2/0	2/0	2/0
Major	1/1	1/1	1/0	1/1	1/1
Captain	4/0	3/1	3/1	3/1	3/1
1st Lt	1/0	1/0	0/0	1/0	0/0
GS/GM-13	4/2	4/3	3/3	3/3	3/4
GS-12	3/1	1/3	3/1	3/2	2/2
GS-11	1/1	1/1	0/2	1/1	1/0

In the table "RQ" denotes research question, "A" denotes the number of respondents that agreed on the issue, and "D" denotes the number of respondents that disagreed on the issue. The data shows there is little variance by rank on

the military or civilian side. In general, all the ranks of the military respondents agreed with the issues, whereas, the civilian respondents were split on the issues in all ranks. There is a difference; however, between the military and civilian responses. On research question 1, 10 of 11 (91 percent) military respondents agreed that F3 standardization reduced INU acquisition costs, whereas, 8 of 12 (67 percent) of the civilian respondents agreed. On question 2, 9 of 11 (82 percent) of the military agreed that F3 standardization decreased INU logistics support costs, versus, 6 of 13 (46 percent) of the civilians. On question 3, 7 of 9 (78 percent) military agreed that F3 standardization increased mission availability, versus, 6 of 12 (50 percent) of the civilians. On question 7, 9 of 11 (82 percent) military agreed that F3 standardization helped achieve the PMD objectives, versus 7 of 13 (54 percent) civilians. On question 8, 8 of 10 (80 percent) military agreed that the benefits of F3 standardization outweigh the costs of F3 standardization, whereas, 6 of 12 (50 percent) civilians agreed.

The majority of the STD INU Standardization Acquisition community (7 of 12) were military members. The majority of the STD INU User Acquisition community (10 of 14) were civilian employees. The variance of responses between the two communities agrees with the variance of responses between the military and civilian respondents. However,

within the two communities the civilians did not agree. In the STD INU Standardization Acquisition community the majority of civilians agreed with the issues in questions 1, 2, 3, 7, and 8, whereas, the majority of civilians in the User community disagreed. The large majority of civilians from the user community swayed the overall results for the civilian group, therefore, no real conclusions can be drawn between the civilian and military responses.

Table 12. Variance of Responses by Avionics Standardization Experience

<u>Experience</u>	<u>RQ 1</u> <u>(A/D)</u>	<u>RQ 2</u> <u>(A/D)</u>	<u>RQ 3</u> <u>(A/D)</u>	<u>RQ 7</u> <u>(A/D)</u>	<u>RQ 8</u> <u>(A/D)</u>
2 or less yrs	3/2	2/3	2/1	2/3	2/2
2 - 4 yrs	8/1	6/3	4/5	7/3	4/4
4 - 6 yrs	4/0	5/0	4/1	4/1	4/0
6 - 8 yrs	2/0	2/0	2/0	2/0	2/0
over 8 yrs	1/2	0/3	1/1	1/2	1/2

Variance of Responses by Avionics Standardization

Experience. Table 12. summarizes the variance of responses by years of avionics standardization experience. The data shows the least experienced (4 or less yrs) and the most experienced (over 8 yrs) had the majority of individuals that disagreed with the issues. On research question 1, 11 of 14 (79 percent) of the respondents with 4 or less years of avionics standardization experience agreed that F3 standardization decreased INU acquisition costs, versus, 7 of 9 (78 percent) of the respondents with over 4 years of avionics standardization experience. On question 2, 8 of

14 (57 percent) of the less experienced respondents agreed that F3 standardization decreased INU logistics support costs, whereas, 7 of 10 (70 percent) of the more experienced agreed. On question 3, 6 of 12 (50 percent) of the less experienced perceived that F3 standardization increased mission availability, versus, 7 of 9 (78 percent) of the more experienced respondents. On question 7, 9 of 15 (60 percent) of the less experienced respondents agreed that F3 standardization helped achieve the PMD objectives, versus, 7 of 10 (70 percent) of the more experienced. On question 8, 6 of 12 (50 percent) of the less experienced respondents agreed that the benefits of F3 standardization outweigh the costs of F3 standardization, whereas, 7 of 9 of the more experienced agreed.

The majority of the STD INU User Acquisition community (10 of 14) had 4 or less years of avionics standardization experience. The STD INU Standardization Acquisition community was split even between those with 4 or less years and those with over 4 years of avionics standardization experience (6 in each group). Both the STD INU User Acquisition community and the respondents with 4 or less years experience were more likely to disagree that F3 standardization decreased INU logistics support costs, therefore there appears to be no relationship between the difference in the two groups and the level of experience.

Variance of Responses by Number of Avionics

Standardization Programs Worked. The data shows the respondents that have worked with more than 4 avionics standardization programs were more likely to agree with the F3 standardization issues. Table 13. summarizes the variance of responses by number of avionics standardization programs worked.

Table 13. Variance of Responses by Number of Avionics Standardization Programs Worked

<u>Number of Programs</u>	<u>RQ 1 (A/D)</u>	<u>RQ 2 (A/D)</u>	<u>RQ 3 (A/D)</u>	<u>RQ 7 (A/D)</u>	<u>RQ 8 (A/D)</u>
1 - 2	7/3	5/6	3/6	6/5	4/5
3 - 4	4/1	4/1	3/1	3/2	2/3
5 - 6	2/0	1/1	2/0	2/0	2/0
7 - 8	3/0	3/0	3/0	3/0	3/0
over 8	2/1	2/1	2/1	2/1	2/1

On research question 1, 11 of 15 (73 percent) of the respondents that have worked with 4 or less avionics standardization programs agreed that F3 standardization decreased INU acquisition costs, whereas, 7 of 8 (88 percent) of the respondents that worked with over 4 avionics standardization programs agreed. On question 2, 9 of 16 (56 percent) of respondents that have worked with 4 or less programs agreed that F3 standardization reduced INU logistics support costs, versus, 6 of 8 (75 percent) of the respondents with more programs worked. On question 3, 6 of 13 (46 percent) of the respondents that worked with 4 or less programs agreed that F3 standardization increased mission availability, versus, 7 of 8 (88 percent) of the respondents that have worked with more programs. On

question 7, 9 of 14 (64 percent) of the respondents that have worked on less than 5 avionics standardization programs agreed that F3 standardization helped achieve the STD INU PMD objectives, whereas, 7 of 8 (88 percent) of the respondents that have worked on more than 4 avionics standardization programs agreed. On question 8, 6 of 14 (43 percent) of the respondents that worked with less than 5 programs agreed that the benefits of F3 standardization outweigh the cost of F3 standardization, versus, 7 of 8 (88 percent) of the respondents with more programs worked.

The majority of the STD INU User Acquisition community (12 of 14) worked with less than five avionics standardization programs. The STD INU Standardization Acquisition community was split between the two groups that have worked less than 5 and more than 4 avionics standardization programs (6 in each group). Both the STD INU User Acquisition community and the respondents with less than 5 standard avionics programs worked were more likely to disagree that F3 standardization helped achieve the STD INU PMD objectives. There appears to be a relationship between the perceptions on F3 Standardization and the number of Avionics standardization program. This could be possible due to a wider perspective on standardization efforts and the potential benefits they provide.

Variance of Responses by STD INU Experience. The data

shows the respondents that have worked with only one of the STD INU Programs (LN-39 or RLG only) were more likely to disagree with the F3 standardization issues. Table 14. summarizes the responses by STD INU experience.

Table 14. Variance of Responses by STD INU Experience

<u>STD INU Experience</u>	<u>RQ 1 (A/D)</u>	<u>RQ 2 (A/D)</u>	<u>RQ 3 (A/D)</u>	<u>RQ 7 (A/D)</u>	<u>RQ 8 (A/D)</u>
LN-39 only	6/0	4/3	2/5	4/2	2/5
RLG only	0/4	0/4	0/1	0/4	0/2
Both	12/1	11/2	11/2	12/2	11/2

On research question 1, 6 of 10 (60 percent) of the respondents that worked with only one of the STD INU Programs agreed that F3 standardization decreased INU acquisition costs, whereas, 12 of 13 (92 percent) of the respondents that worked with both programs agreed. On question 2, 4 of 11 (36 percent) of the respondents that worked with only one of the programs agreed that F3 standardization reduced INU logistics support costs, versus, 11 of 13 (85 percent) of the respondents that worked with both programs. On question 3, 2 of 8 (25 percent) of the respondents that worked with only one of the STD INU Programs agreed that F3 standardization increased mission availability, versus, 11 of 13 (85 percent) of the respondents that worked with both. On question 7, 4 of 10 (40 percent) of the respondents that worked with only one of the programs agreed that F3 standardization helped achieve the STD INU PMD objectives,

versus, 12 of 14 (86 percent) of the respondents that have worked with both. On question 8, 2 of 9 (22 percent) of the respondents that worked with only one of the STD INU Programs agreed that the benefits of F3 standardization outweigh the costs of F3 standardization, whereas, 11 of 13 (85 percent) of the respondents that have worked with both STD INU programs agreed.

The majority of the STD INU Standardization Acquisition community (10 of 12) worked with both STD INU Programs. The majority of the STD INU User Acquisition community (9 of 14) worked with only one of the two STD INU Programs. The variances between the two acquisition communities and between the two groups (worked only one of the STD INU Programs or worked both programs), in general, agree. Again, as with the last relationship (between the acquisition communities and the number of programs worked), there is a possible relationship due to a broader prospective of the potential F3 benefits from working both programs.

Table 15. Variance of Responses by Years of Experience With the STD INU Program

<u>STD INU Experience</u>	<u>RQ 1 (A/D)</u>	<u>RQ 2 (A/D)</u>	<u>RQ 3 (A/D)</u>	<u>RQ 7 (A/D)</u>	<u>RQ 8 (A/D)</u>
2 yrs or less	3/2	2/3	2/1	2/3	2/2
2 - 4 yrs	10/2	8/4	6/6	9/4	6/5
over 4 yrs	5/1	5/2	5/1	5/1	5/2

Variance of Responses by Years of Experience with the STD INU Program. The data shows that in general, the

respondents with more experience on the STD INU program were more likely to agree with the F3 standardization issues. On question 1, 3 of 5 (60 percent) of the respondents with two or less years STD INU experience; 10 of 12 (83 percent) of the respondents with 2 to 4 years of STD INU experience; and 5 of 6 (83 percent) of the respondents with over 4 years of STD INU experience agreed that F3 standardization reduced INU acquisition cost. On question 2, 2 of 5 (40 percent) of the first group; 8 of 12 (67 percent) of the second group; and 5 of 7 (71 percent) of the third group agreed that F3 standardization reduced INU logistics support costs. On question 3, 2 of 3 (67 percent) of the first group; 6 of 12 (50 percent) of the second group; and 5 of 6 (83 percent) of the third group agreed that F3 standardization increased mission availability. On question 7, 2 of 5 (40 percent) of the first group; 9 of 13 (69 percent); and 5 of 6 (83 percent) of the third group agreed that F3 standardization helped to achieve the STD INU PMD objectives. On question 8, 2 of 4 (50 percent) of the first group; 6 of 11 (55 percent) of the second group; and 5 of 7 (71 percent) of the third group agreed that the benefits of F3 standardization outweighs the costs of F3 standardization.

Both acquisition communities were equally divided by the three groups. The STD INU Standardization Acquisition community was divided: 3 with 2 of less years; 6 with 2 to

4 years; and 3 with over 4 years of experience with the STD INU Program. The STD INU User Acquisition community was divided: 3 with 2 or less years; 7 with 2 to 4 years; and 4 with over 4 years of experience on the STD INU Program. The data show no relationship between number of years experience on the STD INU Programs and the difference in responses between the two acquisition communities.

Explanation of Response Differences Between the Two Acquisition Communities

Research question 8 dealt with the costs and benefits of F3 standardization and questions 1 through 7 dealt with the PMD objectives. The PMD objectives are the benefits that the STD INU Program were trying to achieve. Since all 8 questions relate to the benefits of F3 standardization, there should be a strong relationship between the responses to question 8 and questions 1 - 7. Looking at the five questions where the two groups differed: between questions 1 and 8, 17 of the survey participants responded the same way on both issues (ie. they either perceived that F3 standardization decreased costs and the benefits outweighed the costs or the perceived that F3 standardization increased costs and that the costs outweighed the benefits); between questions 2 and 8, 19 responded the same way; between questions 3 and 8, 19 responded the same way; and between questions 7 and 8, 20 responded the same way. The data shows the majority of the STD INU Standardization

Acquisition community agreed that the benefits of F3 standardization outweighs the costs of F3 standardization and a majority agreed with the issue on questions 1, 2, 3, and 7. The majority of the STD INU User Acquisition community perceived that the costs outweighed the benefits and a majority disagreed with the issue on questions 2, 3, and 7. Therefore, one explanation of the differences between the two STD INU acquisition communities is that the STD INU User Acquisition community perceives that the benefits of F3 standardization are not being achieved, whereas, the STD INU Standardization Acquisition community perceives that the benefits are being achieved.

Another explanation is that the User community is more concerned with the particular aircraft performance objectives than the standardization objectives. Eleven of the 14 respondents in the STD INU User Acquisition community mentioned significant costs related to aircraft requirements and 9 respondents from this community mentioned reduced costs (either acquisition or logistics support costs or both) as the significant benefits of F3 standardization. In the STD INU Standardization Acquisition community, 9 of the 12 respondents mentioned significant costs/disbenefits related to aircraft requirements and 10 of the 12 respondents mentioned significant benefits related to reduced costs. This implies that the STD INU User Acquisition community

perceives that the aircraft requirements cost/disbenefit outweigh the reduced costs benefit and the STD INU Standardization Acquisition community perceives that the reduced costs benefits outweigh aircraft requirements cost/disbenefit.

Finally, from the analysis of the response variances, the data shows the respondents who were more familiar with the goals and objectives of avionics standardization and of the STD INU Program were more likely to agree with the issues raised in the research questions. A larger majority individuals with more years of avionics standardization experience, more avionics standardization programs worked, and those who worked both STD INU Programs agreed with the issues. A possible explanation for this, is the "more experienced" respondents had a wider perspective on the goals and objectives of avionics standardization. This also agrees with the last explanation that the Standardization community tended to respond favorably to the F3 standardization goals and objectives, whereas, the User community's responses were swayed by the aircrafts' goals and objectives.

Summary

The demographic data shows sufficient experience of the survey respondents, the average years of experience with the STD INU was over three years. Five of the research questions show differences in opinion between the

two acquisition communities: the affect of F3 standardization on INU acquisition cost (question 1); the affect of F3 standardization on INU logistics support costs (question 2); the affect of F3 standardization on mission availability (question 3); the affect of F3 standardization on achieving the STD INU PMD objectives (question 7); and on whether the benefits of F3 standardization outweigh the costs (question 8). The most often mentioned benefits of F3 standardization were reduced acquisition and logistics costs and improved force readiness. The most often mentioned disbenefits were the constant configuration changes and the numerous aircraft requirements. Many of the respondents recommended changing the STD INU's standardization approach, such as modular standardization and reprogrammable software. The data showed a strong relationship between question 8 and the other 4 questions where the two acquisition communities disagreed. In general, the majority of the STD INU Standardization Acquisition community agreed with the issues associated with research questions 1, 2, 3, 7, and 8 and the STD INU User Acquisition community disagreed with the issues associated with the same 5 questions.

V. Findings and Recommendations

Introduction

This chapter summarizes the findings from the data analysis in chapter 4, critiques the research methodology, makes some recommendations based on the literature review and data analysis and recommends areas for further research. In general, the two groups studied, the STD INU Standardization Acquisition Community and the STD INU User Acquisition Community differ in opinion on the success of F3 standardization on the Standard Inertial Navigation Unit (STD INU) Program. This study focused on just one standardization approach and one standard avionics program, using the perceptions of the Air Force acquisition personnel who worked directly with the STD INU Program.

Findings

The research questions were based on the premise that both groups perceive the issues of F3 Standardization the same way. Table 16. below summarizes the percentage of responses in both communities that were favorable on the F3 standardization issue. The data shows, five of research questions had significant differences (over 40 percent difference) between the two acquisition communities. Also, in the other five questions, the percentages are different, but the differences are not large enough to be significant due to the small sample size. This research shows that there is a relationship between the perceptions on F3

Standardization and which acquisition community you belong to.

Table 16. Summary of Research Question Responses

<u>Research Question</u>	<u>Standardization Community</u>	<u>User Community</u>
1	100	58.3
2	90.9	38.5
3	91.7	22.2
4	66.7	42.0
5	66.7	50.0
6	83.3	61.5
7	91.7	41.7
8	83.3	30.0
11	80.0	54.5
13	72.7	51.7

Further the data analysis showed the two communities differed due to their perceptions of whether the potential benefits of F3 Standardization were being achieved. The User community perceived the benefits were not being achieved and the costs of F3 Standardization outweighed the benefits. This negative bias of the User community is because the costs/disbenefits mentioned in the responses to research question 10 have a bigger negative impact to the aircraft programs than to the STD INU Program. The costs of the constant configuration changes and the increased integration effort are funded by the users, the constant configuration changes affect the aircraft integration and modification schedules, and the numerous interface requirements and lowered reliability affects the aircraft performance. The User community in general were more concerned about the aircraft program goals and objectives

while the Standardization community seemed more concerned about the standardization goals and objectives. Also, the differences in responses between the two communities can be attributed to the differences in experience and familiarity with F3 Standardization and avionics standardization and the goals and objectives of the standardization programs.

The benefits mentioned by the survey participants agree with the benefits found in the literature review. However, the literature fails to address some of the standardization problems identified in this research. The most significant problem that does not seem to have been addressed in the literature review is managing changes to a standard item. The survey responses indicates that on the STD INU Program, peculiar aircraft interface problems were solved by constantly changing the standard configuration. Nineteen of the 26 respondents mentioned costs/disbenefits associated with aircraft performance requirements. This issue must be resolved, on the RLG Program, since there are twice as many different user aircraft. If it is not, configuration control could become a nightmare.

Several methods to alleviate this problem were recommended by the survey participants. The two general methods were freeze the INU baseline (ie. force the changes on the aircraft side of the interface) or standardize to a lower level to exclude the multiple aircraft peculiar requirements. It may be too late to change the

standardization approach (ie. lower the level of standardization) on the STD RLG INU Program. If so, strict configuration management could determine the overall success of the program. For the next generation STD INU, different standardization approaches should be considered, along with F3 standardization. The majority of survey participants recommended F3 standardization be maintained, but at a lower level, thereby eliminating the problems with meeting multiple aircraft peculiar requirements.

Impact of the Research to the Air Force

The results of this study show that contrary to the current literature on the benefits of avionics standardization, the acquisition personnel associated with the STD INU are undecided on whether the benefits of F3 Standardization have been met on the STD INU Program. According to the literature review avionics standardization programs should be geared towards avionics equipment which perform common functions for multiple aircraft and do not perform unique aircraft requirements. In the case of the STD INU Program, the inertial navigation function is common to all the user aircraft, however, the INU was also used to meet many peculiar aircraft interfaces. The majority of survey participants recognized the potential for configuration change problems on the Ring Laser Gyro Program based on their knowledge of the configuration problems on the LN-39 Program. Lessons learned from the

LN-39 Program should be applied the the RLG and next generation STD INU Program to minimize configuration change problems and on other future avionics standardization programs. In particular, interface requirements should be completely defined upfront, standardization should be to the highest level excluding unique aircraft requirements, and once a standard baseline is established changes should be made only after a complete cost/benefit analysis across the entire user fleet.

Critique of the Research

Due to schedule constraints, several steps in this research were shortcutted. The biggest limitation of this study is the validity of the survey instrument. A pretest of the survey instrument would have provided more credibility to the data collected and the study.

The population defined was limited only to the individuals familiar with the the STD INU Program and may or may not represent the views of their organizations. Due to the limited population, generalizations can not be made accross the entire standardization acquisition communities and to all F3 standardization programs or avionics standardization programs. Further, the small number of respondents in the two communities required a larger proportional difference to confidently state that there is a significant difference since the difference of one response gives a large (approximately 10 percent)

percentage difference.

Recommendations for Further Research

This study showed there are differences in opinion on F3 standardization between the STD INU Standardization Acquisition community and the STD INU User Acquisition community. This study focussed on one specific standardization approach and one specific avionics standard program. Further research should be done on other standardization approaches and standard programs to determine if there is a difference of opinion between the standardization and user communities. A list of Air Force standardization programs, as well as points of contact, can be obtained from the Deputy for Avionics Control (ASD-AFALC/AX) at Wright-Patterson AFB OH. If there are significant differences between the two acquisition communities on standardization programs, further research should be done to determine the factors that cause the two acquisition communities to disagree and make recommendations to facilitate communication and cooperation between the two communities.

It appears the LN-39 is nearing a final configuration. Once the final configuration has stabilized, a study of the actual costs could be accomplished to determine if the Air Force really saved costs on this program. It should be noted that, this researcher initially intended to study these cost, but because of schedule constraints and

difficultly in getting actual cost data, that effort was dropped. Currently there is a Life Cycle Cost (LCC) model designed to measure life cycle cost for standardization programs, however, it does not include all costs, such as the costs of configuration changes. The LCC model is the STEP III model managed by the Deputy for Avionics Control.

Summary

This researcher concludes that the perceptions on the affects of F3 standardization on the STD INU Program is dependent on which STD INU Acquisition community an individual belongs to. Further, this research indicates that there is one significant problem (configuration changes forced by aircraft peculiar requirements) which does not seem to be being addressed. Lessons learned from the LN-39 Program, especially on configuration control problems, should be used on the Ring Laser Gyro and next generation STD INU and other standardization programs. The results of this study are limited due to the survey instrument validity, population validity, and population size.

Appendix: Survey Questionnaire

1. What is your current job title or position?
2. What is your rank/grade?
3. How long have you been involved with standard avionics programs?
4. How many standard avionics programs have you worked with, directly or indirectly?
5. What is your background/experience on the Standard Inertial Navigation Unit (STD INU) program?
6. Which of the STD INU programs are/were you involved with? (circle one or both)
 - a. LN-39 STD INU
 - b. Ring Laser Gyro (RLG) STD INU
7. How long have you been involved with the STD INU program?
 - a. How long with the LN-39?
 - b. How long with the RLGs?

The following section relates to the effectiveness of the Form, Fit and Function (F3) Standardization approach in meeting the STD INU Program Management Directive (PMD) objectives.

8. How has F3 standardization affected unit acquisition costs?

9. How has F3 standardization affected logistics support costs?

10. How has F3 standardization affected mission availability?

11. How has F3 standardization affected the inertial industrial base?

12. How has F3 standardization affected inertial navigation technology?

13. How has F3 standardization affected reliability?

14. Overall, how well do you believe the PMD objectives (reduced acquisition cost, reduced logistics support cost, increased reliability, promote interchangeability, maintain the inertial industrial base and allow for new technology insertion) were met and why?

The following section relates to the benefits and costs (disbenefits/problems) of F3 standardization.

15. What do you believe are the most significant benefits or advantages of F3 standardization and why?

16. What do you believe are the most significant disbenefits, costs, or problems of F3 standardization and why?

17. In your opinion do the benefits of F3 standardization outweigh the costs? Please explain.

The last section of this survey relates to the use of F3 standardization on the STD INU program.

18. Do you believe the F3 standardization approach was the most effective standardization approach for the STD INU program? (Yes or No)

19. IF YOU ANSWERED YES TO QUESTION 18, what changes, if any would you recommend and why? (go to question 21 next)

20. IF YOU ANSWERED NO TO QUESTION 18, would you recommend de-standardizing the Standard Ring Laser Gyro INU program at this stage in the program? If yes, how would you propose to de-standardize (standard hardware with reprogrammable software; standard SRUs/modules; de-standardize completely; etc.) and why?

21. For the next generation STD INU (Integrated Inertial Reference Assemblies (IIRA)) do you believe the F3 standardization approach should be used? (Yes or No)

22. IF YOU ANSWERED YES TO QUESTION 21, what changes, if any, would you recommend and why?

23. IF YOU ANSWERED NO TO QUESTION 21, what standardization approach would you recommend and why?

Thank you for your participation in this survey.

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Abstract: The purpose of this study was to compare perceptions on Form, Fit, and Function (F3) standardization of the Avionics Standardization Acquisition community and the User Avionics Standardization Acquisition community. The study focussed on one specific program, the Standard Inertial Navigation Unit (STD INU) Program and the subset of the two acquisition communities which worked with the STD INU Program.

The study addressed perceptions on: the affect of F3 standardization on acquisition costs, logistics support costs, mission availability, the inertial industrial base, new technology insertion, reliability, and achieving the Program Management Directive (PMD) objectives; the costs and benefits of F3 standardization and whether or not the benefits outweighed the costs, and whether or not the F3 standardization approach should be maintained on the current STD INU Program and be used on the next generation STD INU Program. Also, the study addressed recommendations for change on the standardization approach on the STD INU.

A survey of the two acquisition communities showed that there was a difference of opinion between the two groups. Analysis of the survey data showed the two groups disagreed on the affect of F3 standardization on acquisition costs, logistics support costs, mission availability, achieving the PMD objectives and whether or not the benefits outweigh the costs of F3 standardization. In general, the STD INU Standardization Acquisition community perceived that the benefits of F3 standardization were achieved on the STD INU Program, whereas, the second group, the STD INU User Acquisition community were split on the issues.

The most often mentioned benefits were reduced logistics support costs, increased force readiness, and reduced acquisition costs. The most often mentioned costs were constant configuration changes, increased integration costs, and numerous aircraft interface requirements. About half the survey participants recommended standardizing at a lower level, ie. modular standardization, for both the Ring Laser Gyro and the next generation STD INU Programs.

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