NASA TM- 85908

NASA Technical Memorandum 85908

NASA-TM-85908 19840023042

Software Control and System Configuration Management: A Systems-Wide Approach

Kevin L. Petersen and Christobal Flores, Jr.

August 1984

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Kevin L. Petersen and Christobal Flores, Jr.
NASA Ames Research Center, Dryden Flight Research Facility, Edwards, California 93523

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N84-31112 #

SUMMARY

A comprehensive software control and system configuration management process for flight-critical digital control systems of advanced aircraft has been developed and refined to ensure efficient flight system development and safe flight operations. Because of the highly complex interactions among the hardware, software, and system elements of state-of-the-art digital flight control system designs, a systems-wide approach to configuration control and management has been used. Specific procedures are implemented to govern discrepancy reporting and reconciliation, software and hardware change control, system verification and validation testing, and formal documentation requirements. An active and knowledgeable configuration control board reviews and approves all flight system configuration modifications and revalidation tests. This report includes examples of configuration management forms and a description of the tracking process which ensures accurate and consistent records. This flexible process has proved effective during the development and flight testing of several research aircraft and remotely piloted research vehicles with digital flight control systems that ranged from relatively simple to highly complex, integrated mechanizations.

INTRODUCTION

The complex and integrated nature of the flight-critical digital control systems of advanced aircraft necessitates a rigorous software control and system configuration management process to ensure efficient flight system development and safe flight operations. Over the past 10 years, the Dryden Flight Research Facility of NASA Ames Research Center has developed and refined a comprehensive configuration management process, which has been applied to several research aircraft and remotely piloted research vehicles with digital flight control systems that ranged from relatively simple to complex and highly integrated mechanizations. This flexible process has proved effective for the F-8 digital fly-by-wire (DFBW) and the highly integrated advanced fighter technology integration (AFTI) F-16 research aircraft, as well as the 3/8-scale F-15 spin research vehicle (SRV), the highly maneuverable aircraft technology (HiMAT), and the drones for aerostructural testing (DAST) remotely piloted research vehicles.

Various methods and approaches for software control and system configuration management have been used successfully, and many have been published in the literature. All systems have some unique and dominant characteristics; advanced aircraft flight control systems are no exception. Because of the highly complex interactions among the hardware, software, and system elements of a state-of-the-art digital flight control system design, a systems-wide configuration control and management process is necessary. Experience with the development of various advanced flight systems has shown that use of separate hardware and software configuration control procedures is ineffective for highly integrated flight systems in that many of the difficult design, development, and testing issues involve interactions between hardware and software systems.

This paper describes the process and procedures of a highly successful and efficient software control and system configuration management technique for advanced aircraft digital flight control systems. Experience with several advanced vehicle systems is described, and specific examples are given to illustrate the implementation process.

NOMENCLATURE

AFTI	advanced fighter technology integration
CCR	configuration change request
DAST	drones for aerostructural testing
DFBW	digital fly-by-wire
DR	discrepancy report
HiMAT	highly maneuverable aircraft technology
PC	program change
RAV	remotely augmented vehicle
SRV	spin research vehicle
STR	system test report
WO	work order

SYSTEM DEVELOPMENT PHASES

The proper application of a successful software control and system configuration management process requires a thorough understanding of the various phases required for development of an advanced system. The primary phases for development of an integrated digital flight control system for an advanced aircraft are definition of requirements, design, production, and ground and flight test (fig. 1). Recognizing that all these phases are likely to require interactive development over the lifespan of a complex system is critical in the implementation of a configuration management process.

The definition of requirements typically begins with specification of the broad mission requirements and culminates with a conceptual design of the system. The conceptual design is presented in a comprehensive system specification document which describes the overall system characteristics, including the functional requirements of the hardware and software. Other requirements defined in this phase include the equipment and facilities required for system testing, the staffing plan, and the documentation procedures.

The generation of detailed specification documents outlining specific system hardware and software requirements is an initial step of the design phase. These documents must satisfy the requirements of the comprehensive system specification document. During the design phase, the overall plan for software control and system configuration management is defined, and specific procedures and responsibilities are established. A series of specification and design reviews is essential for the efficient evolution of the system development.

After the critical design review is the software and hardware production phase, which requires the mechanization of various tools and facilities. Generally, the hardware and software elements of a complex system are initially tested independently using specialized stand-alone equipment and facilities. After functional verification tests, the software and hardware elements are integrated for final ground testing, overall system validation, and flight qualification tests. A flight readiness review is conducted prior to flight test evaluations to assess the results of the various ground tests and the flight readiness of the vehicle and flight systems.

To properly manage these phases of development, an overall software control and system configuration management process is needed to provide consistent treatment of software and hardware elements. This process is designed to include both the software and hardware elements of advanced integrated systems and accommodates the inherent iterative nature of advanced digital flight control system development. The concept of a systems-wide approach to configuration control and management (which means that the same process is used for both software and hardware system elements) is a primary contributor to the successful application of this process on a number of highly complex aircraft systems.

PROCESS DESCRIPTION

The primary purpose of the software control and system configuration management process for flight-critical digital flight control systems is to provide a method for efficient flight system development and a procedure for assuring safe flight operations. The process is designed to control system configuration changes by managing the primary system development phases described previously, and to resolve discrepancies uncovered during system testing. In addition, the configuration control process prescribes stringent test and documentation requirements and provides for visibility of changes across all involved engineering disciplines through formal review procedures.

The overall software control and systems configuration management process (fig. 2) can be divided into four phases, analogous to those of the system development process. Requirements for configuration changes arise from new software or hardware system requirements or from discrepancies noted during system analysis or test. An important element of this change-in-requirements phase is the documenting and reporting of system discrepancies. All system development personnel are responsible for documenting and reporting all discrepancies, software or otherwise, found during system operation and test. A standardized form for discrepancy reporting aids the documentation and tracking process. When the discrepancy is discovered, the anomalous behavior and the system software and hardware test configuration are documented in detail. The cause of the discrepancy and the required fix are usually determined at a later time; a method of working around the problem or a temporary fix may be incorporated if necessary to continue testing.

After the change requirements are defined, analyses are undertaken to define and then design the required software or hardware modifications. For changes required as a result of a system discrepancy, the cause and required fix are indicated on the discrepancy report form. A configuration change request form is prepared for any change required. Before being implemented, each system hardware or software change must be reviewed and approved by the configuration control board which includes software, hardware, systems, operations, and management personnel. This board provides the forum for disciplinary and flight test engineers to discuss the changes and

their impacts, identify test or retest requirements, and determine the effects of the changes on operational procedures or system performance. The configuration control board approves, returns for further analysis, or rejects the specific hardware and software changes requested and then formally documents the action taken. If a system hardware modification is required, a work order form is prepared to provide a detailed description of the modification. If a system software modification is required, a program change notice is prepared to describe the specific change and the reason for and impact of the change.

The primary function of the software control and system configuration management process during the production phase is to assure that proper procedures are followed in the implementation of the approved changes and that requirements for updated documentation are met. A hardware drawing is updated, and after fabrication, the modification is inspected for quality assurance and compliance with the work order. The software manufacturing process is highly dependent on the specific computer equipment and software development tools and varies greatly from system to system. An important element common to all software production processes is the requirement for adherence to formal written procedures detailing specific sequences in the manufacturing process as well as for updating the formal software documentation.

The configuration management process has an integral function in the testing that follows the incorporation of any change. Procedures that govern verification and validation test requirements are implemented for both software and hardware modifications. Written system verification and validation test reports are required for all system elements and for all system changes. The verification test for a hardware change includes the visual inspection and continuity check which determines that a hardware item is constructed and wired in accordance with the drawing. Hardware validation involves a series of systems functional tests which are performed to qualify the design and its implementation. Software verification is the testing process that formally assures that the software is coded in accordance with its design specification. The software validation step assures that the specified software change accomplishes the desired objective within acceptable limits and operates correctly in the operating environment of the total system. The system validation testing often uncovers system discrepancies resulting from the integration of the hardware and software. Adherence to an established written policy concerning software reverification and system revalidation testing after a software change is required. The documented test results are reviewed by the configuration control board for adequacy and completeness before the modified hardware or software is released for pre-flight checks and flight testing of the system.

The configuration control board plays a vital role in a successful software control and system configuration management process. The board assures that a coordinated closed-loop process exists at all system development stages by controlling system configuration changes arising from new requirements or discrepancy reconciliations and by reviewing implementation details and test results. An active and knowledgeable configuration control board greatly enhances the efficiency of complex and integrated system developments by maintaining the essential common thread of knowledge and experience.

Documentation

An essential part of the software control and system configuration management process is a comprehensive and consistent method for documenting developmental changes. The primary goal of this documentation is to provide communication and

therefore visibility of changes across all involved engineering disciplines. The documentation generated during the validation and test phases of the system development process provides the means by which conformance to the overall mission requirements is tracked and controlled. The material generated for the various design and readiness reviews is also a valuable documentation element.

A method for "checks and balances" is provided on the forms used for system configuration control documentation and tracking (fig. 3). Closing the loop on the change control process is essential in the development of a complex flight system. To assure that changes are tracked, tested, and documented properly, the discrepancy report, configuration change request, program change, work order, and system test report forms are cross-referenced. Each form has a unique identification number to aid this cross-referencing process. Examples of the forms used are included in the appendix.

The closing action section on the discrepancy report form provides space for recording the configuration change request, program change, and work order numbers identifying the implemented change. The configuration change request form cross-references all the other forms and is the primary form used for assuring that the change has been implemented and documented properly. The program change form used for software changes references the discrepancy report and configuration change request numbers. In addition, specific software release identification and documentation updates are referenced on this form. The work order form includes a reference to the discrepancy report if the change is the result of a system discrepancy and also provides for documentation of the quality assurance inspection. Hardware drawing updates are generally attached to the work order form. The system test report forms are used for documenting all formal system testing and the retesting required after system changes. For tests resulting from the implementation of system changes, the program change or work order number is referenced.

Status and Tracking

An advanced flight system development program commonly has a large number of discrepancies, changes, and tests in various stages of resolution, design or analysis, and accomplishment, respectively. An efficient method of tracking progress and generating status information is required for overall project management and scheduling purposes. Manual recordkeeping and documentation control may be adequate for simpler system development projects, but becomes cumbersome and ineffective on larger, more complex projects.

An automated method for maintaining tracking and status information for complex flight system configuration modifications has been developed using a microprocessor-based computer system. Standard data-base management software is used to create files containing all pertinent information required to track system configuration status. The computer system is used to store, update, and retrieve information pertaining to the status of discrepancy reports, configuration change requests, program changes, work orders, and system verification/validation test reports. Hardware and software documentation updates are also tracked. Various sorting and indexing methods are used to generate hard-copy status reports in a variety of formats. This automated system has proved to be an accurate and efficient tool in the overall software control and system configuration management process.

APPLICATION EXPERIENCE

The process for software control and system configuration management has been applied to several research aircraft and remotely piloted research vehicle programs, including the F-8 DFBW, AFTI/F-16, HiMAT, F-15 SRV, and DAST. All these vehicles have integrated digital flight control systems; the mechanization complexity varies greatly. The key elements of the process were adapted for specific application on each of these programs, demonstrating the flexibility of the overall concept. The point at which the formal configuration control process begins varies from program to program but generally starts when the baseline system configuration has matured to the point of allowing efficient formal testing without undue restrictions or operational difficulties. The software control and system configuration management methods described in the previous section represent the current status of a continually evolving process; experiences from each program contribute refinements and enhance both the overall approach and specific procedures. The process, as detailed in figure 2, is certainly not envisioned to be directly applicable for all programs; however, it has provided a basic framework from which useful configuration control and management procedures have been developed.

The configuration control process used on the highly complex AFTI/F-16 aircraft was largely based on these concepts. Over 100 flights were accomplished and 13 major software releases were developed and qualified for the AFTI/F-16 digital flight control systems during the first year of flight testing. More than 330 discrepancy reports were processed during the development and flight test activity, and over 95 software program changes were implemented. Specific details of the configuration control process used on the AFTI/F-16 aircraft program are contained in reference 1. The following sections outline application experience on the F-8 DFBW and HiMAT research programs; the experiences with the F-15 SRV and DAST programs were similar.

F-8 DFBW Program

The F-8 DFBW research aircraft was first flown in 1972 with a simplex, full-authority digital flight control system using ultrareliable system hardware from the Apollo spacecraft program and a triply-redundant analog backup system. The first flight of the second phase of the F-8 DFBW program, which occurred in 1976, used a triply redundant, full-authority digital flight control system for primary control and a triplex analog backup system. The flight qualification and validation experience gained on the F-8 DFBW flight program is described in reference 2. The commitment to remove the aircraft's mechanical control system before the initial flight test forced the development of a comprehensive set of qualification procedures, including a process for software control and system configuration management. This early process, which stressed rigorous testing procedures and formal documentation, provided the basis for the current process.

The triply redundant primary flight control system of the F-8 DFBW was designed as a flexible research testbed, and has allowed many flight control and system research experiments to be investigated in flight. In over 6 years of active flight testing and nearly 150 flights, a total of 40 software releases have been qualified and used in ground and flight tests. The software control and system configuration management system has been used successfully to track over 500 discrepancy reports and to process more than 320 program changes to the onboard flight-critical software.

The F-8 DFBW aircraft also has the capability to use a remotely augmented vehicle (RAV) flight test technique for investigating advanced control law concepts in a cost-effective manner. The RAV concept (ref. 3) uses a ground-based, FORTRAN-programmable digital computer for control law computations and up and down telemetry links to allow complete closed-loop control. The technique was designed to provide the flexibility and versatility necessary to investigate advanced or highly speculative control concepts in flight. The onboard flight software treats the simplex RAV interface and mechanization as another flight control mode and contains the necessary validity checks required to maintain overall system integrity.

The RAV ground computer system and software configurations were developed and managed using the same process as was used for the onboard software and flight systems. The system testing approach was modified slightly to account for the less critical nature of the RAV ground systems and software. The systems-wide approach to software control and systems configuration management made the accommodation of the additional RAV software and system hardware elements a relatively easy task. The process thus demonstrated its inherent flexibility to accommodate and manage complex system hardware and software elements that might be added to an advanced aircraft flight system after the initial development phase.

HiMAT Program

The HiMAT program was conceived to demonstrate advanced technology concepts through flight tests of scaled aircraft using a remote piloting technique. Advanced composite structures, aeroelastic tailoring, a digital integrated propulsion control system, reduced static stability, and a microprocessor-based digital fly-by-wire control system are all elements of the HiMAT program. Closed-loop primary flight control is performed from a ground-based cockpit, using a digital computer and up and down telemetry links. A backup flight control system for emergency operation resides in an onboard computer. The onboard systems, which are designed to provide fail-safe or better capabilities, use two microcomputers, dual uplink receiver/decoders, and redundant hydraulic actuation and power systems.

The HiMAT system development and flight qualification was a complex, highly integrated task (ref. 4). Four independent flight-control digital computers, all with different software programs, were required to meet the research program objectives. The two ground-based computers were programmed in FORTRAN, and the two onboard computers were programmed in assembly language. The software development facilities, verification tools, and ground support equipment used for system validation testing were specific to each computer system. The various computer hardware and software elements were quite diverse, yet the overall flight system functions were highly integrated. A coordinated and consistent software and system development process was essential in the qualification and flight test activities.

In over 4 years of development and ground and flight test activities, 30 software releases were generated for the 2 onboard computers, 24 software releases for the primary ground computer, and 11 software releases for the other ground computer. Nearly 500 discrepancy reports were written and resolved, over 320 work orders were processed for flight system hardware modifications, and over 480 program changes were incorporated in the various software elements. In general, the HiMAT program used the outlined discrepancy reporting, software change, and system verification/validation test procedures quite rigorously. However, the system hardware modification process was tailored to respond to the many unique and dynamic requirements of the HiMAT flight system development. In particular, many of the system hardware

changes did not require the review and approval of the configuration control board; the cognizant systems engineer authorized the modifications directly. Any major flight control system hardware modifications and those of an integrated-systems nature were processed according to the established procedures for overall system configuration management. As an illustration of the iterative nature of an advanced system development project, the system development history of the HiMAT program is summarized in figure 4.

The software control and system configuration management process proved to be an effective and efficient method to track, document, and manage this advanced aircraft system development activity. The capability of this process to accurately and efficiently manage the development of a highly integrated flight system containing multiple, diverse subsystems with an overall systems-wide approach was again demonstrated.

CONCLUDING REMARKS

An effective software control and system configuration management process for flight-critical digital control systems of advanced aircraft has been described and illustrated. The process has been successfully applied to a number of programs involving research aircraft and remotely piloted research vehicles with advanced flight control systems. Key factors to be considered in the development of a software control and system configuration management process that works include:

1. The highly complex interactions among the hardware, software, and system elements of a state-of-the-art digital flight control system design require that a systems-wide approach be used for configuration control and management.

2. Application experience has shown that maintenance of separate hardware and software configuration control procedures is ineffective for highly integrated flight systems in that many of the difficult design, development, and testing issues involve interactions between hardware and software systems.

3. The implementation of a configuration management process must account for the fact that all the primary system development phases are likely to require iterative development over the lifespan of a complex flight system.

The primary purpose of the software control and system configuration management process for flight-critical digital control systems is to provide a method for efficient system development and a process for assuring safe flight operations. The principal elements of the process include: (1) procedures for reporting, tracking, and reconciling all system hardware and software discrepancies; (2) a structured process for identifying, reviewing, and implementing system hardware and software configuration changes; (3) rigorous system verification and validation test procedures; (4) accurate and consistent documentation requirements; and (5) an active and knowledgeable configuration control board to review and approve all system configuration modifications.

The effectiveness and flexibility of this software control and system configuration management process has been demonstrated in use on several advanced flight system development programs of varying complexity and diverse configurations.

APPENDIX - CONFIGURATION MANAGEMENT FORMS

This appendix includes examples of typical forms used in the systems configuration management documentation and tracking process: Discrepancy Report, Configuration Change Request, Work Order, Program Change, and System Test Report.

DISCREPANCY REPORT (DR)

–REPORT GROUND-BASED OR AIRBORNE PROBLEM WITH HARDWARE, SOFTWARE, OR ASSOCIATED OPERATION.
–SEE PROCESS SPECIFICATION 00-7 FOR DETAILS

(1) DR NO:	(2) SITE	(3) ASSIGNED TO:	(4) CRITICALITY:

PART A – AIRCRAFT/FACILITY PORTION OF DR

(5) ACFT/FACILITY:	(6) ACFT SER NO:	(7) FLT NO:	(8)

(9) DISCREPANCY – List ALL symptoms: | (10) MO/DY/YR | (11) FLT/OP HRS | (12) FW STATUS | (13) SIGNATURE/ORG/SITE

FAILURE 1ST SUSPECT

(14) FINDINGS OF DETAILED FAILURE ANALYSIS – Root Causes: | (15) MO/DY/YR | (16) FLT/OP HRS | (17) FW STATUS | (18) SIGNATURE/ORG/SITE

FAILURE CAUSE FOUND – Details Listed Above

(19) CORRECTIVE & CLOSING ACTIONS: | (20) PCN'S, CCR'S WO'S, etc. | (21) MO/DY/YR | (22) FLT/OP HRS | (23) FW STATUS | (24) SIGNATURE/ORG/SITE

ACFT/FACILITY CLOSEOUT ACTION COMPLETE

(25) ACFT/FACILITY CLOSEOUT SIGNATURE:	(26) MO/DY/YR:	(27)	(28) ACFT/FACILITY CLOSEOUT SIGNATURE	(29) MO/DY/YR	(30)

PART B – ☐ SUB-ASSY PORTION OF DR. USE FOR HARDWARE OR SOFTWARE. USE 1 PART B FOR EACH MAJOR OR LOWER ASSY

(31) ITEM WUC:	(32) ITEM NAME:	(33) ITEM PART NO:	(34) ITEM SER NO:

(35) DISCREPANCY – List ALL symptoms not previously listed: | (36) MO/DY/YR | (37) OP HRS/CYC | (38) FW STATUS | (39) SIGNATURE/ORG/SITE

FAILURE 1ST SUSPECT

(40) FINDINGS OF DETAILED FAILURE ANALYSIS – List findings not previously listed: | (41) MO/DY/YR | (42) OP HRS/CYC | (43) FW STATUS | (44) SIGNATURE/ORG/SITE

FAILURE CAUSE FOUND – DETAILS LISTED ABOVE

(45) CORRECTIVE & CLOSING ACTIONS NOT PREVIOUSLY LISTED: | (46) PCN'S, CCR'S, WO'S, etc. | (47) MO/DY/YR | (48) OP HRS/CYC | (49) FW STATUS | (50) SIGNATURE/ORG/SITE

ITEM CLOSEOUT ACTION COMPLETE

(51) ITEM CLOSEOUT SIGNATURE:	(52) MO/DY/YR:	(53)	(54) ITEM CLOSEOUT SIGNATURE:	(55) MO/DY/YR:	(56)

CONFIGURATION CHANGE REQUEST

			CCR NO.
PROJECT	INITIATOR	ORGANIZATION	DATE
PROJECT TEAM REP.	D.R. NO. (REF.)	W.O. NO. (REF.)	P.C. NO. (REF.)

REQUEST:

EVALUATION AND ASSESSMENT

APPROVE ☐	DISAPPROVE ☐	RETURN FOR ANALYSIS ☐
FOR RELEASE	CCB OFFICIAL	DATE

SIG _____ DATE _____ SIG _____ DATE _____

REMARKS

STR NO.

Work Order

(1) DATE OF REQUEST:	(2) WORK ORDER NUMBER:	(3) SUB-TASK:	
(4) DATE REQUIRED:	(5) STARTED:	(6) COMPLETED:	(7) INSP:
(8) ORIGINATOR: TELEPHONE:	(9) TO:		
(10) PROJECT:	(11) ATTACHMENTS: NO ___ YES ___ If YES, list each attachment at BOTTOM of WORK ORDER		
(12) APPROVALS: (a) signature title date	(c) signature title date		
(b) signature title	(d) signature title date		

(13) ITEM No.	(14) DESCRIPTION OF WORK	(15) DATE	(16) TECH.	(17) INSP.
	LIST ATTACHMENTS ORIGINATOR			

PROGRAM CHANGE
SOFTWARE CHANGE CONTROL

REQUEST	NOTICE	IF REQUEST, DATE DOCUMENTATION UPDATED SIG: DATE:	PC NO.

TITLE	DATE

CHANGE TO REL.	S/N	ORIGINATOR/ORG.

DR NO	MODULES/SUB ROUTINES CHANGED	CCR NO. (REF.)

SPECIFICATION REV. NO	VERIFICATION AND VALIDATION COMPLETE: SIG: _____ DATE: _____

DESCRIPTION OF CHANGE

REASON FOR CHANGE

IMPACT ANALYSIS

MEMORY	TIMING	MODULES

REMARKS

SIG: _____ DATE: _____

SYSTEM TEST REPORT

TITLE			NUMBER	DATE
ORIGINATOR/ORG	RELEASE		SYSTEM CONFIGURATION	

OBJECTIVE

CONT'D ON PAGE_____

TEST SETUP

SIG: DATE:

CONT'D ON PAGE_____

SUMMARY RESULTS

SIG: DATE:

CONT'D ON PAGE_____

CONCLUSIONS

SIG: DATE:

CONT'D ON PAGE_____

RETEST REQUIRED	YES	NO	DR ISSUED	DATE	NO.

REMARKS

SIG: DATE:

W.O. NO. (REF.)	PC NO. (REF)

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4. Petersen, Kevin L. Flight Control Systems Development of Highly Maneuverable Aircraft Technology (HiMAT) Vehicle. AIAA Paper 79-1789, Aug. 1979.

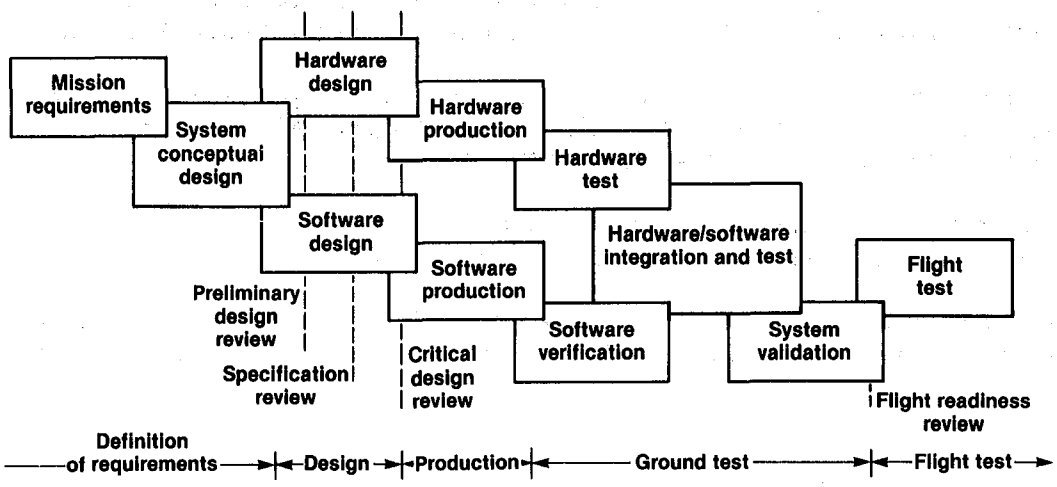


Figure 1. System development phases.

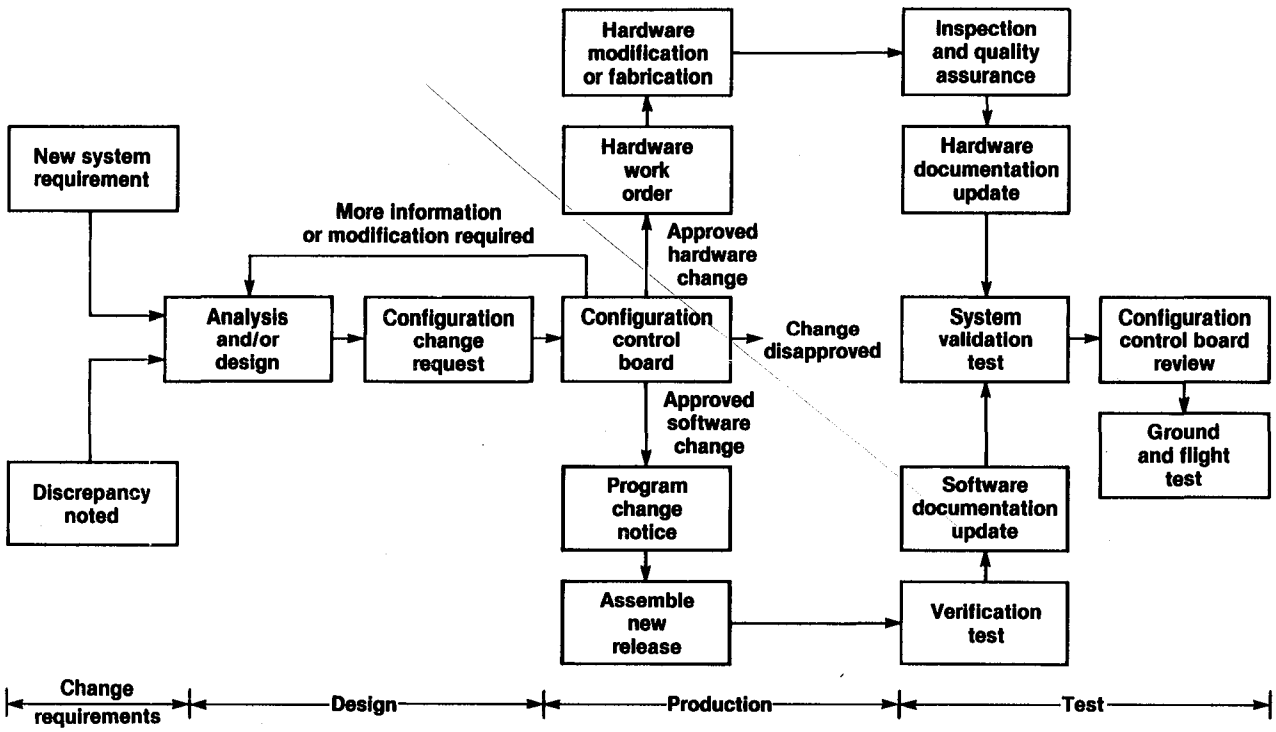


Figure 2. Software control and system configuration management process.

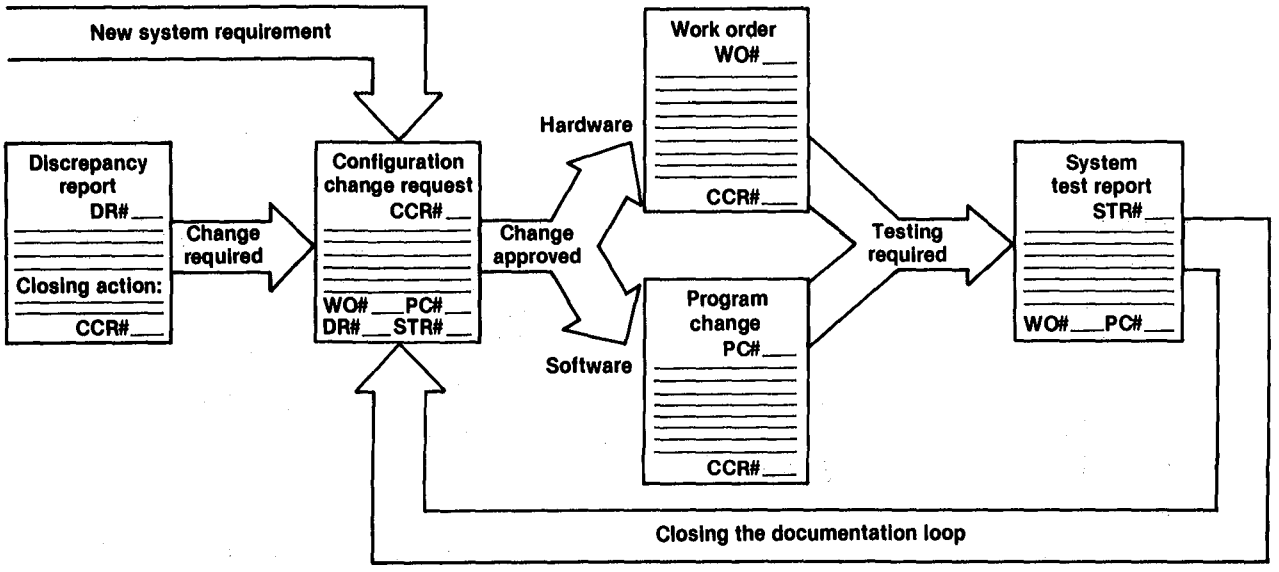
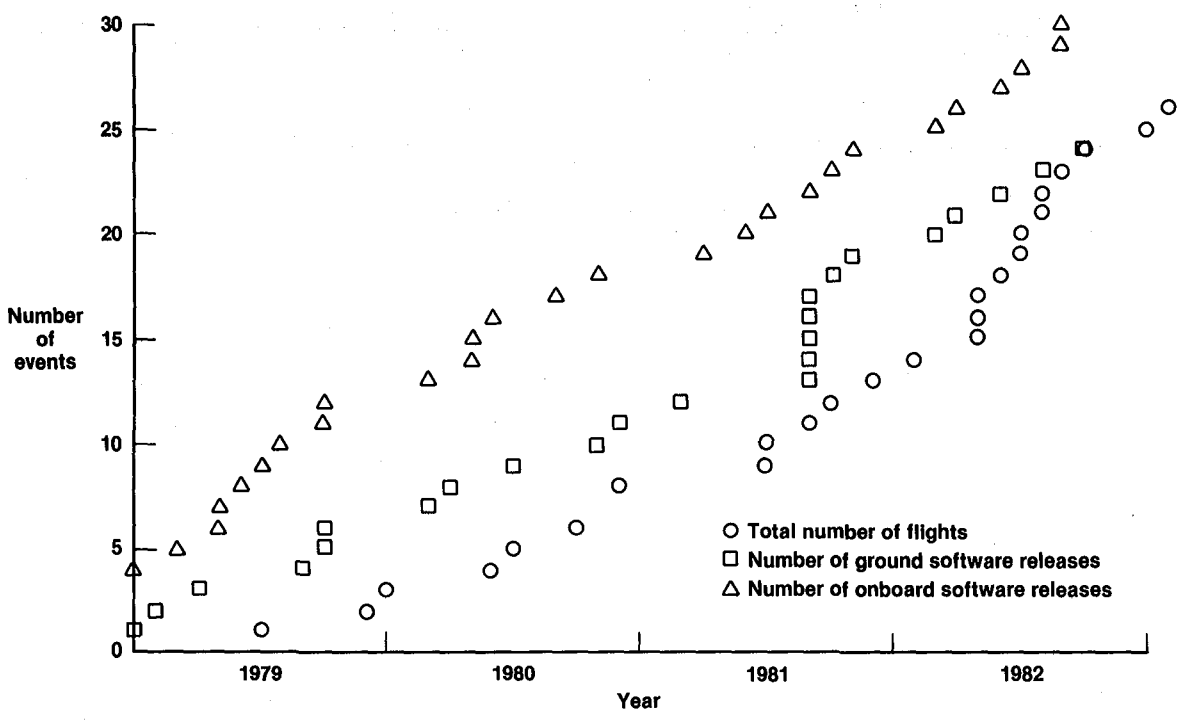
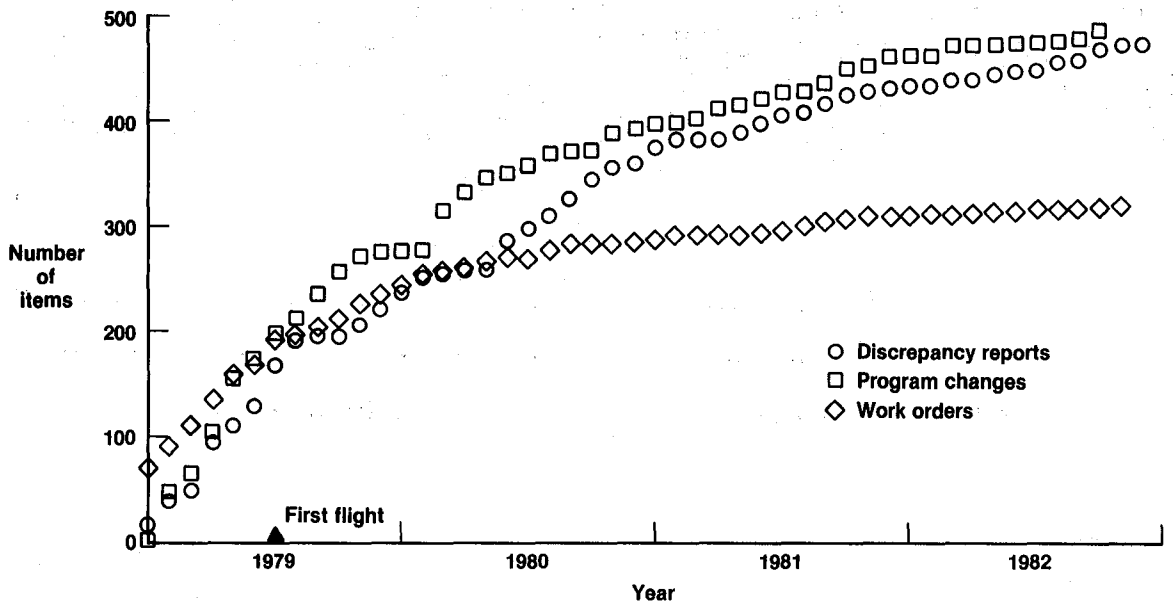


Figure 3. Documentation flow and tracking process.



(a) Flights and software releases.

Figure 4. HiMAT system development history.



(b) Discrepancy reports, program changes, and work orders.

Figure 4. Concluded.

1. Report No. NASA TM-85908	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Software Control and System Configuration Management: A Systems-Wide Approach		5. Report Date August 1984 6. Performing Organization Code
7. Author(s) Kevin L. Petersen and Christobal Flores, Jr.		8. Performing Organization Report No. H-1256 10. Work Unit No.
9. Performing Organization Name and Address NASA Ames Research Center Dryden Flight Research Facility P.O. Box 273 Edwards, California 93523		11. Contract or Grant No. 13. Type of Report and Period Covered Technical Memorandum
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code RTOP 505-34-01

15. Supplementary Notes

This report is a revised version of an IEEE/AIAA paper presented at the IEEE/AIAA 5th Digital Avionics Systems Conference, Seattle, Washington, Oct. 31 - Nov. 3, 1983. It includes examples of configuration management forms.

16. Abstract

A comprehensive software control and system configuration management process for flight-critical digital control systems of advanced aircraft has been developed and refined to ensure efficient flight system development and safe flight operations. Because of the highly complex interactions among the hardware, software, and system elements of state-of-the-art digital flight control system designs, a systems-wide approach to configuration control and management has been used. Specific procedures are implemented to govern discrepancy reporting and reconciliation, software and hardware change control, system verification and validation testing, and formal documentation requirements. An active and knowledgeable configuration control board reviews and approves all flight system configuration modifications and revalidation tests. This report includes examples of configuration management forms and a description of the tracking process which ensures accurate and consistent records. This flexible process has proved effective during the development and flight testing of several research aircraft and remotely piloted research vehicles with digital flight control systems that ranged from relatively simple to highly complex, integrated mechanizations.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Configuration management Software change control	Unclassified-Unlimited STAR cataegory 05

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	19	A02

For sale by the National Technical Information Service, Springfield, Virginia 22161.

The testing and acquisition process for the AN/ARN-101 avionics system for navigation and weapons delivery on the F/RF-4 fighter are outlined. System specifications included digital navigation, weapon delivery and reconnaissance capabilities, an integrated Loran-inertial guidance system, all-altitude visual/blind bombing capability, and integration with optical, radar, IR and laser sensors. The ARN-101 comprises 14 line replaceable units, e.g., a digital computer, signal-data converter, Loran receiver, and a digital inertial measurement unit. The system also interfaces with the Pave Tack external IR sensor laser ranger/designator pod for target identification/acquisition. New specifications were introduced after a fly-off identified a suitable system. Four stages of hardware and software test and evaluation became necessary for updates and validation. The entire process took over a half decade. Delays are attributed to modifications being separately managed. ¤ A84-44455 #

Retrofit of older military aircraft with new electronic systems challenges EMI control engineers MESSER, L. A. AA(Teledyne Ryan Electronics, San Diego, CA) SEP. 1983 7 PAGES 5 REFS. EMC Technology (ISSN 0278-4270), vol. 2, July-Sept. 1983, p. 41, 42, 44 (4 ff.).

Some typical examples of problems encountered in maintaining electromagnetic compatibility (EMC) between digital and analog electronic equipment while retrofitting older military aircraft are discussed. Consideration is given to the difficulties of electronic retrofits with older unique wiring systems without incurring substantial cost penalties. Several solutions to the problem of limited wires are discussed, including not sending analog signals from a voltage source over a link which uses a common ground wire and reserving a pair of wires for analog signals. Several misconceptions concerning the retrofitted wiring system of digital microprocessors for managing ground velocity sensor data, aircraft heading, altitude and search data, and weapons pointing data for older special purpose aircraft are discussed. ¤ A84-44691

Software control and system configuration management: A systems-wide approach National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif. National Aeronautics and Space Administration. Ames Research Center, Moffett Field, 21-06) NOV. 1982 21 PAGES AD-P003553 AVAIL-NTIS HC A25/MF A01

The USAFR-developed GPU Chip Set has been utilized by Tracor to implement both USAF and Navy Standard 16-Bit Airborne Computer Architectures. Both configurations are currently being delivered into DOD full-scale development programs. Leadless Hermetic Chip Carrier packaging has facilitated implementation of both architectures on single 41/2 x 5 substrates. The CMOS and CMOS/SOS implementations of the GPU Chip Set have allowed both CPU implementations to use less than 3 watts of power each. Recent efforts by Tracor for USAF have included the definition of a next-generation GPU Chip Set that will retain the application-proven architecture of the current chip set while offering the added cost advantages of transportability across ISO-CMOS and CMOS/SOS processes and across numerous semiconductor manufacturers using a newly-defined set of common design rules. The Enhanced GPU Chip Set will increase speed by an approximate factor of 3 while significantly reducing chip counts and costs of standard CPU implementations. ¤ N84-31157 #

MIL-STD-1750A as a spaceborne instruction set architecture Aerospace Corp., Los Angeles, Calif. CONSTANT, R. N. FLEMING, R. C. GARCIA, E. M. LUBOFSKY, M. OBELL, D. R. In ASD Proc. Papers of the 2nd AFSC Avionics Standardization Conf., Vol. 1 p 479-491 (SEE N84-31121 21-06) NOV. 1982 13 PAGES AD-P003554 AVAIL-NTIS HC A25/MF A01

A study was undertaken to examine the issues involved in establishing instruction set architecture (ISA) standards for computers used in embedded spaceborne applications on Air Force Space Division projects. The specific areas addressed were: (1) Space Division requirements and ISA tradeoffs, (2) comparisons of military standard and commercial spaceborne ISAs, (3) an LSI implementation study, and (4) an LSI cost study. The bottom line of the study is that the MIL-STD-1750A ISA addresses the onboard processing needs of all present and near term Space Division projects as well as many of those on far term projects. In addition, the development of space qualified 1750A computers should be a low risk project with relatively modest costs once the efforts currently sponsored by other agencies are successfully completed. ¤ N84-31158 #

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LANTIRN software development has successfully demonstrated the practicality of language and architecture standardization. Savings in schedule and resources directly resulted from the transportability of code. While there were (and still are) challenges to standardization, LANTIRN has proven its effectiveness on large, complex, state-of-the-art systems. ¤ N84-31188 #

Development of a digital air data computer using modern microprocessors, hybrid circuits, and pressure sensors with frequency output *Final Report, Dec. 1982* Nord-Micro Elektronic Feinmechanik G.m.b.H., Frankfort (West Germany). WALDMANN, D. Bonn Bundesministerium fuer Forschung und Technologie MAY 1984 119 PAGES REFS. In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie BMFT-FB-W-84-018 ISSN-0340-7608 AVAIL- NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 25

The development of an air data computer according to the standard ARINC 706 for the Airbus A 310 is reviewed. Features, mechanical construction, and software structure of the computer are described. The built-in test capability and the high reliability are discussed. ¤ N84-31208 #

BRESEX: On board supervision, basic architecture and preliminary aspects for payload and space shuttle interface Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). BERGANINI, E. W. DEPAULA, A. R., JR. MARTINS, R. C. D. O. JUL. 1984 23 PAGES Presented at the NASA/INPE Conf. on Brazilian Remote Sensing Experiment - BRESEX, Sao Jose dos Campos, Brazil, 13-14 Mar. 1984 Sponsored by NASA NASA-CR-173673 NAS 1.26:173673 INPE-3200-PRE/562 AVAIL- NTIS HC A02/MF A01

Data relative to the on board supervision subsystem are presented which were considered in a conference between INPE and NASA personnel, with the purpose of initiating a joint effort leading to the implementation of the Brazilian remote sensing experiment - (BRESEX). The BRESEX should consist, basically, of a multispectral camera for Earth observation, to be tested in a future space shuttle flight. ¤ N84-31271*#

Some management initiatives to improve embedded commercial computer and training device life cycle support Veda, Inc., should be kept out of the direct loop of simulation. The following blocks make up the simulation. The thermal model block is a classical heat transfer program. It is a non-steady state program. The quasistatic block deals with problems associated with rigid body control of reflector segments. The steady state block assembles data into equations of motion and dynamics. A differential raytrace is obtained to establish a change in wave aberrations. The observation scene is described. The focal plane module converts the photon intensity impinging on it into electron streams or into permanent film records. ¤ N84-32317*#

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