COMPUTER RESOURCES INTEGRATED SUPPORT PLAN, APPLIED IN TRAINING SYSTEMS ACQUISITION

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1. INTRODUCTION

The rapidly expanding application of programmable digital computer systems to the design of real-time crew training systems has amplified the complexity and impact of computer programs (software) in the world of training devices and simulators. Computer equipment and computer program systems implement math model descriptions of real-world performance and characteristics. In addition, computer programs implement environmental stimuli simulation, facilitate advanced instructional provisions, record and playback student performance and provide maintenance functions. As a result of these expanding applications of computer systems in simulators, the life-cycle effectiveness of a simulator is largely dependent upon the adaptability and flexibility of the computer system. The computer system must be configured with growth and supportability provisions to incorporate new operational requirements and incorporate changes in weapon system performance characteristics.

It has traditionally been assumed that changing "software" (i.e., the computer program system) is a simple matter. Although computer programs can be modified and new programs written to change system performance independent of hardware, very real and often unexpected complications, limitations and restrictions are encountered in the attempts to change and expand computer programs. Careful planning and the identification and specification of proper requirements can facilitate the potential flexibility inherent in computer programs as information processing elements of the system.

Within this context and awareness, a new planning concept has been formalized to address acquisition of computer resources in defense systems, including crew training systems. This plan was developed by an Air Force all-commands committee under the chairmanship of the author. The plan does not put forth original planning requirements, but rather formalizes a total integrated plan requiring participating command involvement. This concept is titled the Computer Resources Integrated Support Plan (CRISP). The term "computer resources" is intended to include the totality of computer equipment and computer programs, plus the related documentation, contractual services, personnel and supplies.

The CRISP concept was developed as part of an Air Force effort to establish new policy, direction and guidance for the acquisition management of computer resources in systems. This effort was stimulated, in part, by a weapon-system software-support study, initiated in December 1972, called Project PACER FLASH. This study specifically addressed aircrew trainer (simulators) software. The simulator software report is published as Volume IV of the PACER FLASH Final Report[1]. Following this report, an Air Force Regulation, AFR 800-14 (May 1974), was written directing early planning, user involvement, and integrated support for the system life cycle. Additionally, an Air Force Manual [1] was drafted to provide more detail guidance and procedures to implementing the policy and direction of the regulation. Chapter 3 of this manual addresses planning and includes the definition and discussion of the CRISP.

The objective of this paper is to define the computer resources integrated support plan and explain its purpose in the context of life cycle acquisition management.

The specific application of the CRISP to the acquisition of crew training devices will be described, including the elements of the plan, and participants in the process. Application of this plan to particular simulator acquisitions in various phases of the life cycle will be discussed to illustrate the concept. Finally, the impact and utility of this planning concept, in training system acquisitions, will be assessed and projected.

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1. This draft manual, AFM 800-XX (two draft revisions, 28 June 1974 and 15 October 1974), has since been restructured as Air Force Regulation 800-14, Volume II, "Acquisition and Support Procedures for Computer Resources in Systems," (see reference 2).

2. DEFINITION OF THE CRISP

The computer resources integrated support plan is intended to facilitate planning for life cycle support of computer resources in defense systems. This new Air Force concept is applied to those defense systems which have embedded computer equipment and computer program systems. Air Force defense systems include weapon system avionics, crew training simulators, automatic test equipment, command and control systems, and missiles and space systems. Ancillary support equipment such as avionics integration facilities are also included.

The CRISP is intended as an acquisition management tool to be accomplished as part of system acquisition planning. As it is applied to a particular system, the CRISP is initially formulated during the system definition phase to identify and define requirements to be incorporated in the development contract. Upon participating command approval, the CRISP is included in the system program management plan (PMP). To be most effective, it is essential that this plan be prepared prior to the preparation of system specifications and the development contract.

The term "integrated" in the acronym CRISP has a two-dimensional connotation. The inputs of all participating commands are integrated, and the computer subsystem and total system life cycle support planning is integrated. A basic purpose of the CRISP is to identify organizational relationships and responsibilities for the management and technical support of computer resources. To accomplish this objective, the CRISP is prepared by a Computer Resource Working Group (CRWG).

The CRWG will consist of representatives of the implementing, using and supporting commands. Initially, this group is chaired by a representative of the implementing command program office. The CRWG is responsible for preparation and periodic update of the CRISP. Since the CRISP is a life cycle plan, it remains active after the development phase and is maintained throughout the operational and support phases, with CRWG chairmanship assumed as mutually agreed by the using and supporting commands.

Preparation of a CRISP for a particular system acquisition requires consideration of the following items:

a. Designation of offices of primary responsibility for support of the computer resources and identification of communication channels among participating organizations.

b. Planning for the configuration management of computer equipment and computer programs including assignment of configuration control responsibilities for all phases of the acquisition life cycle. Configuration management planning for computer systems will reflect the operational and support concepts for the defense system.

c. Identification of documentation required to support each type of computer program, and the vehicle (data item description) planned to acquire the documentation.

d. Funding, scheduling, and system integration responsibilities.

e. Identification of personnel resources required for supporting computer equipment and programs, together with training requirements.

f. Identification of maintenance, test, and special computer programs required to support the computer equipment and operational computer programs, including planning to acquire these support programs.

g. Identification of computer equipment to facilitate computer program changes, including planning to acquire this equipment.

h. Verification and validation of computer programs and changes to these programs.

i. Plans and programs to establish and operate those facilities necessary to accomplish assigned computer program support responsibilities. Common and existing facilities shall be used where practical The magnitude and scope of computer program change activity over the life cycle should be estimated in planning these facilities.

j. Plans for computer system support manning considering in-house (organic) manning, contractor manning, or a combination of both.

k. Provisions for transfer of system management responsibility and system turnover, relative to the computer system.

Considering the items identified above in total, the "supportability" of a defense system activated with a programmable computer system is dependent upon two essential activities: (1) the proper definition of computer system requirements in the system contract, and (2) the planning and establishing of participating commands roles and responsibilities early in the acquisition life cycle.

The CRISP has been specifically endorsed by the commanders of Air Force Systems Command

and the Aeronautical Systems Division for application to defense systems and weapon systems including crew training simulators. This planning concept has been applied to the acquisition of crew training simulators on several programs in various phases of acquisition.

3. APPLICATION TO CREW TRAINING SYSTEMS

This history of concern for computer systems supportability in Air Force crew training simulators is well documented. MIL-STD-876, "Digital Computation Systems for Real-time Training Simulators," published 21 February 1967 and revised 8 July 1971, establishes requirements specifically concerned with maintenance, growth, spare and flexibility of the system to be readily modified. Data Item Description DI-H-3277, "Training Equipment Computer Program Documentation," issued December 1972 and modified several times since, is totally concerned with software supportability. As stated in the introduction, PACER FLASH included a study of simulator software supportability. The PACER FLASH simulator report, Volume IV, includes an outline of the software support plan prepared as an integral part of the Undergraduate Pilot Training-Instrument Flight Simulator (UPT-IFS) program management plan. This UPT-IFS software support plan is the basis from which the CRISP concept was derived.

Application of the CRISP to the simulator system acquisition process is tailored to recognize the following factors:

a. Training simulators are real-time operational systems.

b. Commercially available general-purpose digital computers are integrated and dedicated in the simulator system.

c. Standard commercially available assemblers and compilers have been successfully applied to computer program system development.

d. Assuming adequate availability, the computer system integral to the simulator can be used during nonoperational training periods to support the simulator, including preparation of changes to computer program systems.

e. The simulator is designed to a determinant base line identified by approved criteria defining the weapon system performance and characteristics.

f. The simulator system is basically a closed system in that it does not physically interface with the weapon system, but rather reflects weapon system performance.

g. Within the simulator system, small general-purpose computers are being dedicated to implement visual, radar, and instructor station cathode ray tube (CRT) display processing.

Air Force crew training simulator requirements are defined in performance/configuration specifications. These specifications are prepared by the simulator engineering office, and are included in the request for proposal and contract. The specification reflects engineering planning and definition of computer system requirements derived from analyses of operational and support requirements. Trade-offs are performed and alternative approaches compared to achieve required simulator system performance with minimal development risk. Computer system requirements are specified in terms of computer equipment performance and configuration characteristics, and computer program performance, organization, structure and language requirements.

The CRISP is applied, in this context, as an extension of the planning process to insure life cycle simulator computer system supportability. Supportability applies to both the simulator as a function of the computer system flexibility, and to the computer system.

A formal CRISP has been prepared during the definition phase of the A-XX Trainer, Flight Simulator (TFS)[3]. This early acquisition CRISP will be discussed, and quoted in part, to illustrate this concept as applied to training systems. The first step in the process was the formation of the Computer Resource Working Group (CRWG). All participating commands were invited to identify appropriate members for this working group. The A-XX TFS CRWG was established with the following command representation:

Command	Title
AFSC	Chairman, Computer Engineer
AFSC	Program Manager
AFSC	Lead Engineer
AFSC	Computation System Engineer
AFSC	Configuration Manager
AFSC	Equipment Specialist, Logistics
AFLC, Hq	Simulator Computer Resources Manager
AFLC	Logistics Officer/Computational Systems Management
AFLC	Logistics Engineer
TAC, Hq	Staff Simulator Superintendent

In addition to these initial CRWG members, the A-XX System Program Office and the newly formed Aeronautical Logistics Office were represented at the early CRISP meetings. Several disciplines and command offices are represented in this group. An initial CRISP was drafted by the CRWG with Section 1 identifying the members and Section 2 stating the purpose of the CRISP.

Section 3 of the A-XX TFS CRISP addresses operational requirements and trainer system level acquisition planning which are factors bearing on the computer system requirements and resources planning. Parts of Section 3 are quoted here to illustrate these factors:

"3. Trainer System Concepts and Assumptions. . . . The A-XX TFS development, operational and logistics requirements which impact the CRISP include the following:

3.1 The A-XX TFS will be initially acquired as a prototype production system. The A-XX TFS includes the following: cockpit, motion system, instructor station, computation system integral to the simulator, and limited visual system (i.e., night only). Present plans call for two A-XX TFS systems to be initially procured. These systems will be utilized operationally by TAC to support aircrew training in the Tactical Training Fighter Wing (TFTW) and transferred to AFLC for support.

3.2 Following procurement of the first two simulators, plans call for a possible follow-on acquisition of up to n additional instrument simulators. These simulators will each have a single cockpit capable of either integrated or independent operation. When in integrated mode, independently controlled simulators will be combined to form a two-cockpit full mission simulator (FMS) complex . . . . It is anticipated that wraparound type wide field of view (WFOV) visual systems will be added concurrent with simulator integration. . . .

3.3 If the follow-on full mission integrated simulators are acquired, the basic TFS portion (i.e., that required by the original TFS RFP) may be acquired from the original A-XX TFS contractor with the visual being developed under a competitive procurement.

3.4 Anticipation of the possible application of digital generated image (DGI) technology for visual image generation and processing, requires additional computer resources planning beyond the basic computational system. Computer resources planning for this visual subsystem is being accomplished as part of a current effort to develop an acquisition engineering concept and specification recognizing the off-the-shelf nature of this technology and subsystem availability.

3.5 The A-XX TFS will be defined via a Prime Item Development Specification(s) in accordance with MIL-STD-490. Part I specification(s) will include configuration item coverage of the computational system; i.e., with sections covering computer equipment, the computer program system (CPS), and computer resource supportability requirements. The CPS design base line will be controlled via Computer Program Configuration Item Product Specification.

3.6 Program management responsibility transfer planning for this trainer assumes that Air Force Systems Command responsibility for management and engineering including all configuration items will be transferred concurrently to Air Force Logistics Command.

3.7 The computer resources support for the A-XX TFS and A-XX FMS will be established at a single location which will be designated as the Development Engineering Prototype Site (DEPS). This site will be the single facility to prototype all changes to the aircrew training device.

3.8 Commonality between the F-XY and A-XX computational system equipment and program language in the aircrew training system will be investigated. The objective of this investigation will be to reduce life-cycle costs while recognizing acquisition management constraints.

3.9 Since the A-XX TFS and the A-XX FMS will be located at the same facility, the maximum practical use of common computer support resources will be considered. This may include the sharing of computer support peripherals between the A-XX TFS and the A-XX FMS systems."

The information identified in Section 3 provides necessary insight into the training simulator initial performance requirements, predicated expansion of training requirements, quantities to be acquired, and possible dedicated computer for digital generation of visual imagery. In addition, the system level specification approach, transfer of management responsibility, commonality with other TAC trainers and support concepts are identified.

Section 4 of the A-XX TFS CRISP addresses computer resources support planning. The major elements of this section are quoted here with additional discussion of details, where appropriate, following each quoted major element.

"4.1 The CPS consists of real-time operational programs and nonoperational system support programs including test and verification programs. The CPS will be identified at an appropriate level of the work breakdown

structure (WBS) to facilitate management attention and development cost visibility. Deliverable computer program media will be identified in the contract."

Organization of the CPS into major computer program areas, top-down design, functional modularity, and use of high-order language are planned under this element.

"4.2 The computer equipment required for this training system will be defined with performance characteristics to support both real-time simulation performance and life-cycle CPS supportability characteristics. Computer peripheral equipment including line printer, card reader and punch, key punch and magnetic storage devices will be acquired to facilitate changing the CPS and updating the source media and listings which document the CPS design. This support equipment configuration will be located at the DEPS.

4.3 . . . . Configuration Management (CM) will be established to identify, control and provide accounting for the CPS and changes to the system after development."

A milestone approach to successive identification and control of computer program modules, and base-line definitions is planned. An approach to configuration management of commercial computer equipment is identified. Control of changes to documentation is also planned under element 4.3.

"4.4 Data item descriptions covering computation system requirements including computer equipment and computer programs have been reviewed as part of the CRISP. Data items reviewed included those listed in the Department of Defense Authorized Data List (TD-3) volumes, those identified in the 28 June 1974 version of Air Force Manual 800-XX, and items employed on previous aircrew simulator and training equipment development programs. As a result of this review, the following categories and data items in the category are identified."

Five categories of planned use of data item descriptions are identified under this element of the CRISP which addresses computer resources documentation:

a. Two levels of computer system specifications are identified in the first category. A prime Item Development Specification (PIDS) covering training performance and configuration requirements including computer equipment, computer program system (CPS) and supportability requirements is incorporated into the request for proposals (RFP). A CPS product specification is required via DI-H-3277/M2. This product specification is successively developed and submitted with an incremental milestone build-up approach. Also included to facilitate comprehension of the CPS are a user's guide, computer programmer's notebook and computer vendor supplied programming manuals.

b. The second category of planned data item use is self-explanatory in the CRISP and therefore included in total.

"4.4.2 The following additional data items which are required for the total simulator system will be modified with additional wording to insure computational system coverage:

DI-A-3027	Data Accession List/Internal Data
DI-E-3128/M	Engineering Change Proposals (ECPs)
DI-E-3135/M	Characteristics Description
DI-E-3106/M	Specification Maintenance Document (Equipment/Munitions)
DI-M-3407/A	Technical Publications
DI-T-3714	Acceptance Test Procedures
DI-T-3718	Test Reports (General)
DI-E-3108	Configuration Management Plan (CMP)
DI-A-3023	Contract Work Breakdown Structure
DI-E-3118	Minutes of Formal Reviews, Inspections, and Audits
DI-E-3129	Request for Deviation/Waiver
DI-E-3133	Configuration Management Accounting Reports

The approach of modifying simulator 'system' data items rather than requiring separate computer system data items is being used to insure integrated coverage of development requirements which are integral in their design/development characteristics; i.e., the computation system equipment and computer programs are an integral real-time information processing subsystem of the simulator system. This approach is intended to facilitate management/engineering attention to the computation system without over-segmenting the computer system development."

c. The remaining three categories of planned data item use included those computer-related data items not required in the simulator contract because of redundant coverage. Several data items in this category were newly proposed items. Another category included those computer-related data items simply not required, with explanation as to why they are not required. The last category included two data items applicable to the total training system not requiring modification to insure computer resources coverage.

"4.5 The computer equipment and computer program development will be contracted as part of the trainer development contract. The computational system will be included at a level in the work breakdown structure to provide cost and management visibility. The schedule includes design reviews and management audits to insure visibility of computer program development progress."

This element of the CRISP is intended to plan for emphasis on the contractual/management aspects of computer software acquisition. The simulator contractor's approach to managing the development of the computer program system must be included in his management proposals and plans. These must be reviewed to insure proper emphasis is placed on software and that his approach provides visibility and traceability throughout the development phase.

"4.6 An Air Force team (TAC/AFLC) of CPS qualified personnel will be established at the DEPS. Training requirements for this team includes specific techniques of simulator engineering, simulator systems modeling, CPS implementation, and real-time programming in the selected computer language. Training requirements, including definition of knowledge and skills, number of personnel and qualification due dates, will be identified by TAC/AFLC to ATC. Provisions for contractor-conducted training will be required of both the computer and simulator contractors. Training, to include formal and practice with industry, will be complete prior to in-plant acceptance testing of the first simulator. ATC will provide follow-on training when required for activities responsible for software support. The contract will include a requirement for the contractor to identify skills required to support the computer program system."

Identification of training requirements and plans are essential to the timely development of personnel resources with the knowledge and skills required to effectively support the simulator and integral computer system. Computer system training requirements are, in part, a function of the simulator design. Note that training is planned to be complete prior to in-plant testing so that this (TAC/AFLC) support team can be active participants in the functional acceptance testing.

"4.7 ASD offices will be responsible for the management of the computation system and its support through development and deployment until transfer to AFLC, Ogden ALC. Following transfer, Ogden ALC will be responsible for the management of the computation system support. Ogden ALC and TAC will provide support of the CPS within the organic capability developed at the DEPS. All changes to the CPS base line will be prototyped and verified at this support site. Since Warner Robins supports the standard computer vendor supplied programs, changes to these will be initiated through that office."

These responsibilities are further definitized in revisions to the CRISP as the simulator program moves through successive phases. For example, the Undergraduate Pilot Training-Instrument Flight Simulator CRISP[4] identifies three specific phases with detailed tasks and responsibilities defined by command offices, and as a function of computer program and data base types.

"4.8 CPS verification will be performed as part of in-plant system acceptance testing of the first deliverable item. Verification requirements for the computational system will be identified in Section 4, Quality Assurance Provisions, of the PIDS. The verification requirements will be reflected in the Acceptance Test Procedures. Verification programs, acquired with the simulator, will be used as applicable during the CPS verification. Acceptance testing will be accomplished by a test team comprised of ASD, TAC, and AFLC representatives. The CPS product base-line specification will be verified for accuracy and completeness as part of the system PCA."

Following these initial plans, revisions to the CRISP will expand verification and validation planning to establish detail responsibilities and specific approaches to verify specified computer system "supportability" requirements. This is being accomplished as part of the F-XZ Simulator planning through activities of the CRWG.

"4.9 A DEPS will be established by Hq TAC/DR. This facility will include a complete operational trainer plus the computer resources identified in this plan.

4.10 The computer equipment and CPS will be considered ready for turnover when the computation system performance/configuration requirements of the PIDS have been verified by the Air Force DT&E team during the on-site acceptance tests. The computer equipment and CPS will be ready for transfer when the performance/configuration requirements, and the computer equipment and CPS Product Specifications have been verified. The product specifications for the computer equipment consist primarily of computer vendor written documentation.

4.11 A computer spare capacity and a growth capability will be specified in the computer equipment requirements section of the PIDS. Factors affecting the amount of spare and growth potential specified in the PIDS are:

a. Possible addition of a WFOV visual system on future production IFSs.

b. Possible integration of two cockpits into a full mission simulator.

c. Instructor station modification necessary to implement integration of two cockpits into a full mission simulator.

d. Predicted changes to the A-XX Weapon System.

Spare capacity will include processing time, input/output channel capacity, core memory and Random Access Memory (RMA) units. Growth capacity (add-on) will include processing capacity, input/output, core and RAM units. The spare and growth requirements shall be specified for each computer in the system."

It is recognized that this early acquisition A-XX TFS CRISP does not address all items identified for consideration in the Air Force Regulation 800-14, Volume II, Chapter 3. This plan, however, has accomplished a major objective of trainer life-cycle effectiveness in bringing together representatives of participating Air Force commands to establish responsibilities and communication channels and to initiate support planning. The critical requirement during the definition phase is to establish "supportability" requirements which must be incorporated into the trainer system and computer subsystem as an integral part of the development phase. A second important objective is served by this initial CRISP; i.e., recognition of the need to identify and develop qualified personnel to support the system, and to initiate these efforts early in the acquisition phase.

As the simulator progresses through the successive phases of the life cycle, the CRISP is revised and expanded to more exhaustively define simulator computer system support requirements. Participants, previously identified, become actively involved in the process of planning and accomplishing computer system supportability objectives. Operational, support and training commands participants contribute significantly with increased involvement and awareness. As a result, provisions for support are actively pursued and accomplished.

As previously mentioned, the UPT-IFS CRISP has recently been revised to more definitively identify command responsibilities and communication channels. This T-37 and T-38 trainer system CRISP reflects the contractor computer and simulator design progress in its latest revision. Detail planning for Air Force to efficiently assume support responsibility, following initial contractor support, is defined.

The potential impact of this planning concept applied to training simulators is significant. First, the CRWG will not only bring all the training equipment offices together, it will also provide a vehicle to insure that weapon system offices work more closely together with training equipment offices. In addition, the CRISP provides a vehicle to achieve commonality and standardization through master planning the computation system requirements and support approaches across several simulators. This potential can be realized through consistent command office representation on the Computer Resource Working Groups from one simulator acquisition to the next. Within the system acquisitions command and the logistics command, engineering and management offices have designated individuals to participate as regular members of each simulator training equipment CRWG.

In summary, the CRISP is proving a very effective tool in integrating the concerns of all participating commands and throughout the system life cycle, and serving to facilitate more effective life-cycle management and utility of crew training systems. Further use of the CRISP concept will serve to expand its utility and effectiveness to integrate planning between the weapon system and the simulator as well as across training simulators.

REFERENCES

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