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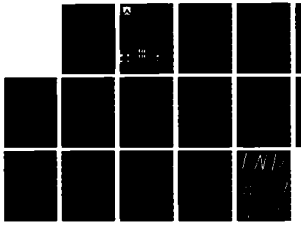

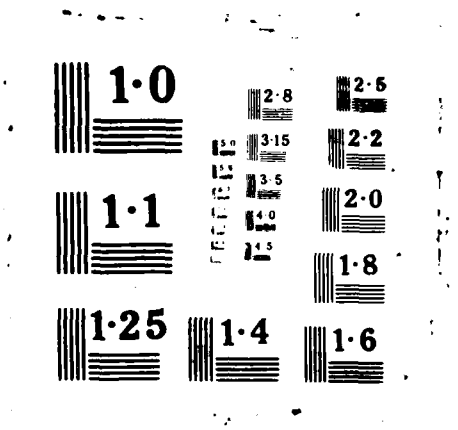
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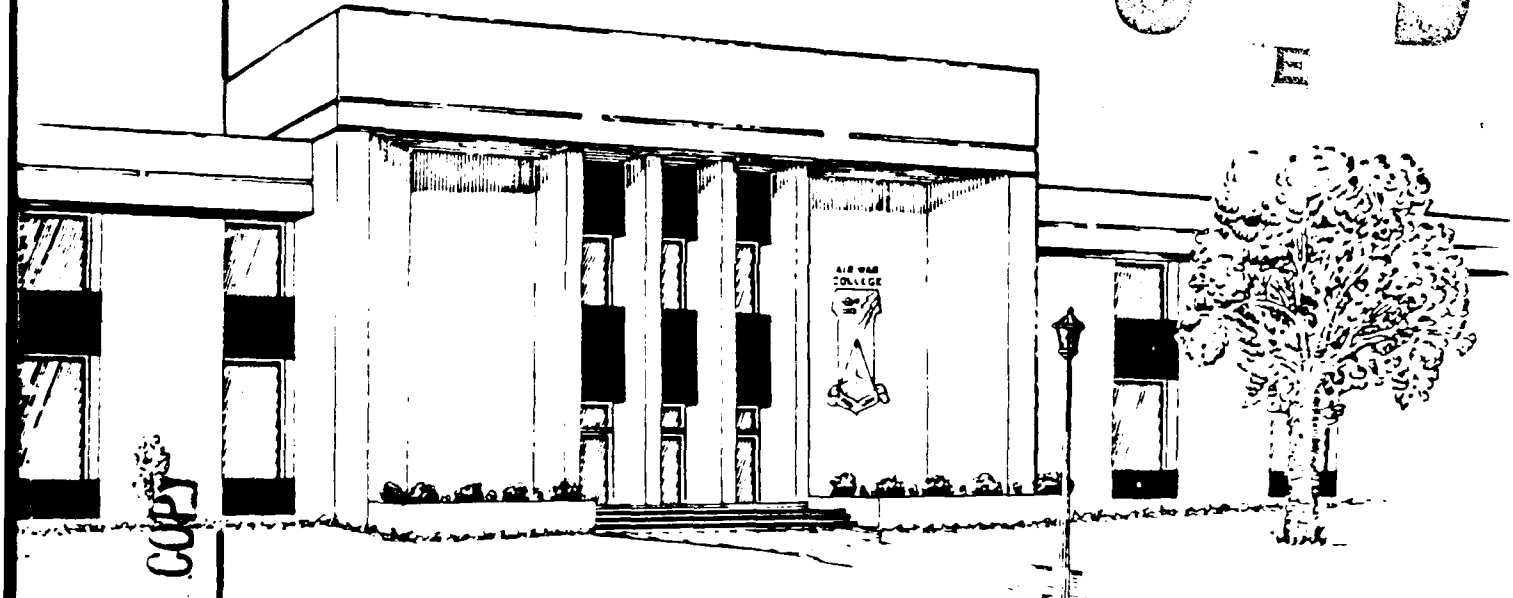
AIR WAR COLLEGE

RESEARCH REPORT

No. AU-AWC-86-125

THE ROLE OF THE OPERATIONAL COMMAND IN ACQUIRING C^3 SYSTEMS

By COLONEL WAH LEONG



AIR UNIVERSITY
UNITED STATES AIR FORCE
MAXWELL AIR FORCE BASE, ALABAMA

AIR WAR COLLEGE
AIR UNIVERSITY

The Role of the Operational Command in Acquiring C3 Systems

by
Wah Leong

Colonel, USAF

A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

FULFILLMENT OF THE RESEARCH

REQUIREMENT

RESEARCH ADVISOR: Lt. Colonel Donald Bishop

MAXWELL AIR FORCE BASE, ALABAMA

MAY 1986

DISCLAIMER-ABSTAINER

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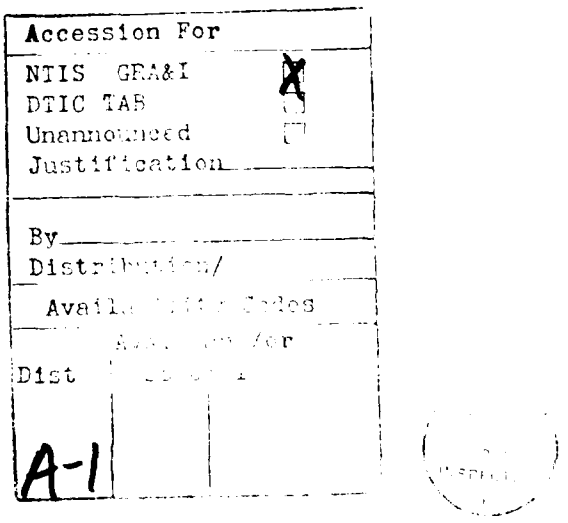

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AIR WAR COLLEGE RESEARCH REPORT ABSTRACT

TITLE: The Role of The Operational Command in Acquiring C3 Systems

AUTHOR: F. Wah. Leong, Colonel, USAF

The Air force has not been successful in acquiring Communication Command and Control (C3) systems. The failure of the acquisition to NORAD Cheyenne Mountain Complex Improvement Program (427M) is one of the notable failures discussed briefly. This paper describes some characteristics of C3 systems that necessarily link the user or operation command to the success of C3 acquisitions. Then the specific role of the operational command in C3 acquisition is discussed with hope of showing the user how he can structure his command to acquire C3 systems.

BIOGRAPHICAL SKETCH

Colonel F. Wah Leong (MA in Mathematics, University of Missouri) has worked computer systems and C3 systems acquisitions most of his 21 years in the Air Force. He was the Aerospace Defense Command's technical representative for the acquisition of the ground communication segment for the Defense Support Program. In 1968 he headed up a mission analysis effort to define space surveillance systems requirements for the late 1970s. As a captain, he was the user project officer for the design, development, and implementation of a computer security system for the computer system that served the Air Staff and the Office of the Secretary of Defense. He was assigned to the Air Staff in 1977 to staff the approval of data automation requirements for electronic warfare systems, avionics support systems, and intelligence systems in the Air Force. When he transferred to the Directorate of Command and Control and Telecommunications in the Pentagon he was responsible for the planning and programming of funds for the strategic command and control systems in the Air Force. In 1981 Colonel Leong was assigned as the Deputy Director of Architecture in the System Integration Office under CINCNORAD. After a year in the job, Colonel Leong spent the next three years acquiring computer systems to replace the existing NORAD command and control system. Colonel Leong is a graduate of the Air War College Class of 1986.

INTRODUCTION

In September, 1979 the North American Aerospace Defense Command (NORAD) Cheyenne Mountain Complex Improvement Program (427M) achieved equivalent operational capability (EOC). The term EOC was uniquely coined for Program 427 to indicate that the new system achieved a level of operational capability equal to the capability of the systems being replaced. Thus, Program 427M which could not meet the specified user requirements, was more than three years behind schedule, had doubled in cost to more than $200M, and had more than 2000 errors in its software achieved operational status. There is little debate on whether or not the 427M acquisition was a failure. To make matters even worse, two significant events occurred within nine months after the EOC date which seriously questioned the sufficiency of the technical requirements identified for the 427M System. These two events were the NORAD false alarm incidents that took place in November 1979 and June 1980.

The acquisition of this complex communications, command and control (C3) system has been studied in the most minute detail. Studies on the 427M System were accomplished by Air Force Systems Command's Electronic Systems Division, Air Force Inspector General, General Accounting Office, DOD Blue Ribbon Panel with industry experts, Congress, Joint Chiefs of Staff, and numerous technical consultant companies. My object is not to reiterate all that has been said by these studies. My purpose is to use the acquisition of the 427M System and its follow-on replacements to describe how the

user or operational command for a C3 system should structure itself to successfully acquire these kinds of systems. First, I will define what a C3 system is and will describe how the nature of C3 systems requires extraordinary user or operational command involvement. Then I will rely on my overall C3 acquisition experience and my specific experience with the acquisition of 427M System and its replacement programs to describe the role of the user or operational command in acquiring C3 systems. Not all of the suggestions and ideas presented here were implemented at NORAD/Space Command so they are not necessarily tried and proven. One has to accept these ideas for face value since no one organization has fully implemented this approach and carried it to a successful conclusion. However, with the absolute vacuum within the technical literature about the role of the user or operational command for C3 acquisitions, I believe this kind of discussion is sorely needed.

CHAPTER II

Defining C3 Systems

The Armed Forces Communications and Electronics Association (AFCEA) Command and Control System Acquisition Study defined command and control systems as systems which augment the decision processes of operational military commanders and their staffs, including those which constitute weapon/platform control systems as well as intelligence information/exploitation and management/force planning and control aids. (1) I would only add communications to the definition of command and control systems because these systems must receive the data they process and assimilate it through some media of communication and similarly they must communicate with the commander and his staff to provide the information he needs to make his decisions. In short, communications, command and control (C3) systems directly support decisions by operational military commanders. The NORAD command and control system which encompasses the 427M systems and other subsystems within Cheyenne Mountain Complex is a C3 System. A second example of a C3 System is the Data System Modernization Program which supports the on-orbit control of satellites for the Air Force. On the other hand, automated management information systems processing financial, personnel, or logistical information are not C3 systems. The common thread is, and should be, that the C3 systems must provide direct information to augment commander

decisions on operational military issues. More often than not, C3 systems must obtain, process and dissiminate the information for the operational commander in a timely fashion. Timely means within seconds and minutes as opposed to hours and days. It is this time line requirement that ususally separates C3 systems from management information systems.

CHAPTER III

Nature of C3 Systems

When one researches the technical literature on C3 System acquisition and system acquisition in general, he finds no common solution or recommended approach to acquiring C3 systems successfully. Unfortunately, this paper does not propose to have found the magical answer to the problems confronting C3 system acquisition. What I did find in my research was a general confirmation of the importance of user involvement to the success of C3 system acquisitions. In his Air War College paper, then Colonel James Cassity, in describing the system acquisition process, stated that the requirements of the operating command can be met when it (the operating command) acts as a full partner in the acquisition process, assisting in developing the request for proposal, selecting the source, and in all phases of design and development.(2) Although Colonel Cassity meant for this partnership to apply to the acquisition of weapons systems in general, I claim that the unique nature of C3 Systems demands a total commitment of involvement by the user or the operational command.

To substantiate this claim, I will describe these characteristics of C3 systems that require the total participation of the user in the acquisition of these systems. These characteristics are: C3 system requirements are constantly changing; C3 systems must interface with other systems; and C3 systems support wartime operational

missions. In his article on the C3 acquisition process Robert Dean stated that C3 systems are intrinsically evolutionary, partly because they must operate in a constantly, but not always predictably, changing environment, and because they must support human decision making, a process that cannot be completely specified a priori.(3) An excellent example of this changing environment is the threat that the 427M program had to counter during eight years of development and the last seven years as an operational system. In the early 1970s the atmospheric bombers and intercontinental ballistic missiles constituted the major threat to the defense of the North American continent. By the mid-1970s the atmospheric threat practically evaporated and the predominant threat was the sea launched ballistic missiles and intercontinental ballistic missiles. During the late 1970s, and early 1980s, the emphasis on the 427M system turned to the space threat and support of space operations with the space shuttle. Now the emphasis has turned full circle to the atmospheric defense arena where we must counter the effect of bombers launching cruise missiles. While the threat evolved the fundamental requirements also changed from being able to detect a massive attack on the U.S. to being able to detect limited nuclear attacks with the highest degree of certainty. This changing environment provides some insight as to why the 427M system was only able to satisfy the capabilities of existing systems after eight years of development. It is difficult to hit a moving target when

one has to develop and modify over 11 million lines of codes that make the 427M system function. From these comments one can also understand why only the user who best understands the changing environment should be the one to work continuously with the developer to properly change requirements and to establish priorities as required. But even the user cannot predict the changing requirement.

C3 System must also evolve to support the human decision-making process because we know so little of this complex process. One way to minimize the changes here is for the user to analyze the details of his decision-making process to identify necessary and sufficient conditions for determining a course of action. Unfortunately, this kind of work is usually foreign to personnel in a user or operational command. The other way to minimize the changes is to specify in our requirements the type of flexibility that readily permits the C3 system to accommodate the latest desire to see this kind of information in a new and different format. Only the user or operational command can do any meaningful work in the decision-making process as it applies to the user's system and mission. For anyone else to do this results in an academic exercise of little utility. This is not to say that the user cannot get help to do such analysis work, but he must be the prime mover in any effort to insure what is done is applicable to the real world situation.

The second characteristic is that C3 systems are generally sub-systems of larger complex systems and must by

necessity interface to many other systems or sub-systems. The problem that arises from this particular characteristic is that C3 systems become very complex systems to build because of the vast number of interfaces to other systems. Furthermore, usually the user of the system has little or no control over the systems he must interface to. That is to say that a system to be interfaced to your C3 system may be owned by a different major command or even a different service where the C3 user has absolutely no technical responsibility or mission authority for affecting interface requirements to the system. Consequently, one could be building a specific interface to system A, but before you get the system operational, System A modifys its interface to external systems and now you cannot interconnect with System A with the new change. The question becomes who changes their interfaces? One can begin to understand this problem when you deal with systems such as the 427M that must interface to literally hundreds of other systems. As the 427M became operational in the early 1980s, there were over 120 different technical interfaces to the 427M system in the NORAD Cheyenne Mountain Complex. We only formally recognized that the 427M system was a sub-system of the overall Tactical Warning and Attack Assessment System in the fall of 1980 after the Air Force Inspector General performed a management review of the Air Force organizational structure and units tasked with the mission of defending the North American continent for aerospace attack. The review also recognized the need to identify a technical system

manager for the total Tactical Warning and Attack Assessment System whose authority could transcend service and joint agency boundaries. The manager was given the techinical responsibility for integrating the sub-systems into the whole. What was key here was that the 427M user or operational command was given the system integration role. The integrator for C3 systems must be the organization that is most knowledgeable with the system and has the most to gain by effectively employing the system. Most often this is indeed the user or the operational command. The role of the system integrator is to make certain the sub-systems work together when they are interconnected. When the user accomplishes this job he will simplify and limit the number of technical interfaces within a total system. After this is done -- and it takes literally years to do -- the C3 system and its replacements will become easier to develop and to maintain.

The initial comment a user or operational command makes when one suggests that they become the system integrator for a C3 system is that operators do not have the technical expertise to do the integration job. They then try to convince the developer to take over the integration task. Well, I am strongly convinced that the developer does not have the motivation to perform the integrator function which by necessity does not end when the C3 system becomes operational. Under my concept, the system integrator exists for the life of the system to insure that all proposed changes do not adversely affect the total system. The lack

of technical capability can be overcome by the operational command. But this takes time and a complete commitment on the kind of people the user needs to hire and reward when they have proven themselves. When a user has had the opportunity to be the technical system integrator for a C3 system, that system becomes more manageable to acquire a replacement for and the replacement system will be more effectively operated.

The third characteristic is that one must understand that C3 systems must function in a wartime environment This means that the care and feeding of a C3 system is more critical than the care and feeding for non-wartime systems. It is easy to look at the parts of a C3 system and come to the conclusion that since C3 systems are composed of computers, communication lines, graphic devices and software, they are just complex management information systems. Nothing could be further from the truth and nothing can get us into more trouble if we continue to let such thoughts and complacency guide our actions and acquisition policy. It is not sufficient that a C3 system works correctly in a non-hostile environment. A C3 system must be designed to function in a wartime situation when other systems and communication lines do not work. It may be forced to operate in a degraded mode. For example, can the software run on less than the optimum number of processors? I claim that only the user or operational command can fully understand the impact of a C3 system not working in a wartime environment. Consequently, the user

must be the one asking the tough questions on whether a specific requirement will cause the system not to function properly in a wartime environment. Furthermore, the user is the right person for insuring that the C3 system functions in wartime because he is the one that suffers the consequences if the system should fail. C3 systems are more than force multipliers. The 427M system must provide CINCNORAD the information necessary to give adequate and unambiguous warning information to the National Command Authorities. If the warning is not timely or if it is incorrect, the failure could result in the destruction of our country as we know it today.

In summary, only C3 system users can understand and articulate the changing requirements for these systems, can manage and integrate the system within the overall system, and can insure that the C3 system works in a wartime environment. This is precisely why the user or operational command must be a full partner and totally involved with the developer in acquiring C3 systems. Little is written about how the user or operational commands should acquire C3 systems. What I hope to impart to those commands involved in acquisition is some ideas on how they can prepare themselves to acquire new C3 systems.

CHAPTER IV

ROLE OF THE USER OR OPERATIONAL COMMAND

A. User's Perspective

As the user or operational command participate in an acquisition of a C3 system, it is essential that each individual representing the user understands what his fundamental objective is. By the same token, the user needs to understand what really drives the representatives of the developing command. Let's first address the developer. Developing organizations are usually organized under entities called system program offices or SPOs which are headed up by a program manager. The program manager will generally be competing against other program managers in the functional organization he is in. Because each program is totally different, the primary evaluation tool that is used to evaluate the performance of these program managers is schedule and cost. The program manager wants to know whether the project is on schedule and within the projected cost. Certainly, the developer or program manager wants the contractor to satisfy the technical specifications and support requirements, but rest assured that when cost and schedule are threatened, requirements become secondary. This type of motivation is not necessarily wrong, but it is real. What is important about the developer's perspective is that the user understand that his perspective should provide the counter-balance to the acquisition partnership. The user's primary perspective should be to insure that the system works to support the wartime mission. While this

seems obvious, the user representatives do not fully support this perspective. The reason for this misunderstanding is because no one evaluates the user representatives on the basis of whether the C3 system works. When the C3 system does not work properly or meet the specifications, the user blames the developer or the contractor. One might say that you cannot expect the user to be responsible for the work of a contractor they had no control over. While this may be very true, who is really going to be concerned about the system working if the user doesn't? Clearly the contractor wants the system to work, but his primary motivation is to make money. The user representatives must be held accountable for identifying problems with the system as it is being developed and not just discover the problem as it is being tested in the operational environment. Before we can successfully acquire C3 systems, the user has to undertake the responsibility of making certain the system works well enough to do the mission.

B. Organizing and Manning to Acquire C3 Systems

Most operational commands use their existing Deputy Chief of Staff (DCS) structure to support the acquisition of C3 systems. Various members of the functional staff participate in the acquisition process. For example, the DCS Plans people usually provide an interface to the system program office for the commmand, but their concern with the acquisition is with the program schedule and cost because planning and funding is what the DCS Plans does for a

command. Representatives from the DCS Operations are concerned about the operational concept for this new C3 system. But because the staff is consumed by the current operational staff problems, acquisition takes a back seat with a Lieutenant assigned the job on a part-time basis. Similarly the DCS Logistics representative insures the logistic support plans are properly implemented, but often this function is done on a part-time basis. Who ever heard of a person in an operational command getting promoted early because he did a good job in acquiring a C3 system? Well, it just doesn't happen. By the same token, no one in an operational command gets fired if the C3 system doesn't work. One might say that "so what if the operational command is not organized to acquire systems". "That's System Command's job." Well, this is where I strongly disagree. I believe that the user is not organized to acquire systems, but I don't believe that the user can leave the job to the developer. If the user wants to successfully acquire C3 systems, he has to organize to do just that. The development community has learned that you cannot acquire systems without dedicating effort to that task. The user can learn from these lessons. An independent organization within the operational command is needed to do the acquisition tasks for the user. This organization should not have any of the other staff functions and should be able to communicate directly across Deputy Chief of Staff lines in order to obtain coordination on system requirements, specifications, and modifications. The acquisition unit

will represent the interest of the various functional staff elements, but now you have someone in the operational command who is solely responsible for the acquisition of a C3 system for the user. Usually, a command is involved with multiple system acquisitions. Each C3 system that is being acquired should have a mini system program office manned with personnnel with a variety of technical and operational background. These should include personnel with computer acquisition expertise, including both hardware- and software-development expertise, computer graphics technology, C3 system acquisition experience, communication engineering experience, electronic maintenance experience, and operational experience with the C3 system. Finally, stability of the personnel assigned is absolutely imperative. This means at least three years on station for people working the C3 acquisition. Key leadership positions should have back-up personnel in training that are obtaining the specific experience to replace the leaders as they are reassigned, sometimes unexpectedly. Good people are the key to working acquisitions successfully.

C. Requirements Development

Most major operational commands wait until they have to replace a C3 system before they begin the requirement definition process to replace their existing system. By this time they are too late to do the analysis needed to properly describe what they want. There is no question that as I discussed earlier, the changing environment and supporting

the decision-making process make the determination of technical requirements for C3 systems a difficult task. But it is just as important to know that the operational commands do not do a good job in developing C3 requirements. Getting "behind the eight ball" is only part of the problem. Usually the operational command does not have sufficient numbers of people with the blend of technical and operational experience to adequately define the requirements. Furthermore, the process of developing requirements within an operational command staff always leads to a system conceived by committee. There should be a strong competent element within the staff that can consider the imputs from the staff, but in the end makes the determination as how the system should work. The user should first begin the requirements development process soon after the critical design review of the new C3 system that will be replacing the current system. Thus, once we understand what will be operational in the next three to five years, we should begin the effort to replace it. The first step is to formulate the conceptual definition of the follow-on replacement systems. The user needs to examine the technology as what is being fielded now and within the next ten years that could be applied to a future C3 system. He should look at projections of the threat to understand what the system must counter. And finally, he must look at the long-term strategy trends that will dictate how the future system will be expected to function in the future environment. The operational command can and should obtain

assistance in the conceptual definition process. For example, Space Command hosted technology panels where we invited members of industry and academia to discuss technology solution to specific requirements. However, the operational command needs to guard against the tendency of letting the technologist do all the work. It is too easy for the operators to let the technicians take charge of these kinds of tasks.

Once the user is able to develop the conceptional definition of the follow-on system, the next step is the concept of operations. The user needs to understand if he can do the mission with this new conceptual C3 system. Operational concepts for C3 systems are much more difficult to develop than for weapon systems. As a consequence, we often do not formulate these concepts until after C3 systems are implemented. The development of the operational concept may result in changes to the conceptual definition of the system. This iterative process is to be encouraged, but the changes should be formally done and all the rationale for recommending changes to the system definition must be documented to provide a record of why decisions were made. This record provides the continuity of management as key individuals are replaced during the process. When we decide the follow-on system can be operated and supported to perform the mission, the user needs to develop the initial drafts of the technical specification that will be provided to the developer. Specification development is usually reserved for the developer, but I believe that preliminary

specifications development by the user crystallizes early in the requirements development process is what is wanted. When the user can perform these tasks: conceptual definition, operational concept, and preliminary specifications, he becomes a sophisticated user who knows what he wants. This kind of preparation will not eliminate changes to C3 systems, but it will assist the developer in understanding what the end product should be and how to achieve it.

D. Integration and Implementation

Integration is defined as the process of making sub-systems work as an overall system. Because C3 systems are sub-systems of an overall system and because these C3 systems must interface with numerous other systems to accomplish their missions. The role of the integrator becomes essential to the successful acquisition of a C3 system. If the user or operational command is responsible for the operations of the total overall system, then he should be the system integrator. The user may get extensive support from various contractors, but he alone must be singularly responsible for integrating the sub-systems. The best individual to be the system integrator is the person who heads up the dedicated acquisition agency within the operational command. This integrator should manage the acquisition of all systems for a user and have sole responsibility for defining interface requirements to all user systems. He also is the focal point within the command

who works interface requirements to systems that are external to the operational command. An essential on-going function of the system integrator is to establish standard interface requirements for user C3 and weapon systems and to enforce these standard interfaces in the non-standard systems over time. The development and maintenance of standards is a difficult and time consuming effort that must be accomplished by the user because the developer will not be around long enough to perform this function. The integration must be kept separate from the developing function because of the potential conflict. Two developers cannot easily resolve the technical interface problems that may exist between them. But an integrator can view he problem as a third party and enforce the resolution decision.

The system integrator may also find it necessary to develop a technical architecture for his overall system to provide a technical road-map of how the overall system will look and operate in the future. The architecture becomes useful only if it is a formal document that must be complied with and can only be changed after a thorough evaluation process. The architecture in effect, provides a way to control the overall system and prohibits incompatible and non-standard major changes to the individual sub-systems. When you establish controls on the overall system that contain a C3 system, you greatly enhance your efforts to successfully acquire the replacement C3 systems.

Implementation of a C3 system requires significant

support of the user. The reason for this is fairly basic. Few, if any, weapons systems are changed out as they are operating. But on the other hand, that is exactly what is done with most C3 systems. For example, the operational command must operate the existing C3 system in parallel with the new C3 system in order to insure that the new system can assume the operational mission. This is no small feat. Facility requirements must support two operating systems and one must have the operators and maintainers to handle both systems simultaneously. In addition to careful planning and programming for the additional resources and personnel, a separate test development and training facility is an absolute requirement for one-of-a-kind C3 systems. This facility permits a C3 system to be implemented in an off-line environment that evaluates the operational environment. This test facility would allow the integration process to be tested prior to actual implementation. The facility also serves as a development/test bed for both software and hardware changes to the operational system during its system's life. Space Command has been operating an Off-Site Test Facility for its 427M System since 1981 and has just built a Test Development and Training Center for the four major C3 systems which will replace various portions of th 427M System. The benefits for such a test facility have been justified totally. As you may have guessed, the test facility must be managed by the user.

E. Costing C3 systems

Earlier we discussed the problems the user or operational command had in planning and programming for C3 Systems. Invariably, the operational command realizes it needs a replacement system long before it can properly fund and develop the system. When the user finally gets to the point when they decide to program funds for the replacement system, the amount to be programmed is no better than a rough estimate. Years later when the developing community performs an independent cost estimate for the new system, the new cost estimate will exceed the original estimate by several orders of magnitude and now the user is in the position of settling for less of a system or give up some other programmed system. Consequently, in addition to defining the requirements earlier, operational commands need to establish a capability to cost C3 systems. This means expending manpower and resources to maintain expertise in C3 system cost analysis. One does not acquire this expertise overnight so the user must understand the importance of this capability and invest in it up front.

CHAPTER V

CONCLUSION

The user or operational command can no longer afford the luxury of approaching C3 system acquisition in a casual manner. The user must make the total commitment in dedicating the resources to participate fully in the planning, programming, development and implementation of C3 systems. I believe that the most important message to communicate is that the user must not become the developer even though he may possess much of the expertise and employ many of the techniques of the developer. The operational command must undertake its share of responsibility to insure the C3 system works to support the wartime mission.

FOOTNOTES

1. Norman Waks, "Inherent Conflicts in C2 Systems Acquisition," Signal, 37:83-93, May 1983, p 93.

2. Colonel James S. Cassity, Jr. Systems Acquisition Management, Air University, Air War College Research Report, Maxwell AFB, Alabama, 1979.

3. Robert B. Doan, "The Evolving Nature of the C3 Systems Acquisition Process," Concepts, 5:177-190, Autumn 1982.

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