AD-A128 499 PLANNING AND SCHEDULING AT ASD - A REVIEW AND PRELIMINARY ASSESSMENT(U) AERONAUTICAL SYSTEMS DIV WRIGHT-PATTERSON AFB OH H E DAVIS DEC 80 1/1

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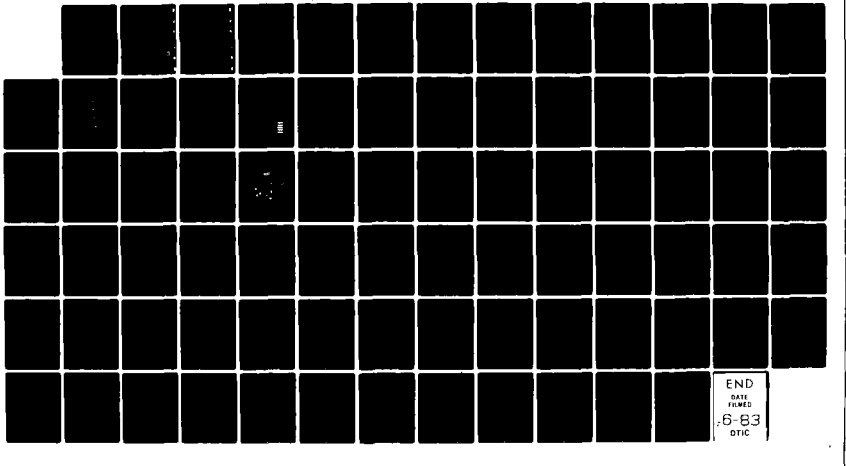

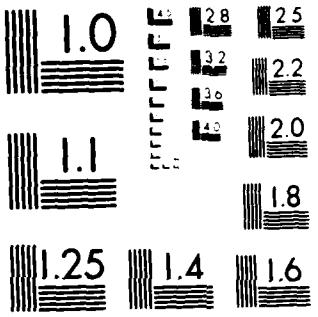

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This report was developed to assist the Aeronautical Systems Division (ASD) in the planning and scheduling tasks of program management. The following areas are examined:

a. Planning and Scheduling (P&S) definition: What is the scope of planning and scheduling techniques at ASD?

(See reverse)

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b. Planning and Scheduling environment at ASD: What are the proper roles for planning and scheduling in an ASD program as compared to a typical industry program?

c. Current ASD P&S areas: How do the roles of the Independent schedule assessment, The Vanguard system, and an Automated Management System (AMS) relate to the P&S function at ASD?

d. ASD P&S related organizations: Which organizations are currently doing tasks related to planning and scheduling, and what are some alternatives for improved integration and coordination of the P&S functions?

ASD RESERVE PROJECT REPORT 78-25

PLANNING AND SCHEDULING AT ASD - A REVIEW AND PRELIMINARY ASSESSMENT

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December 1980

Prepared for

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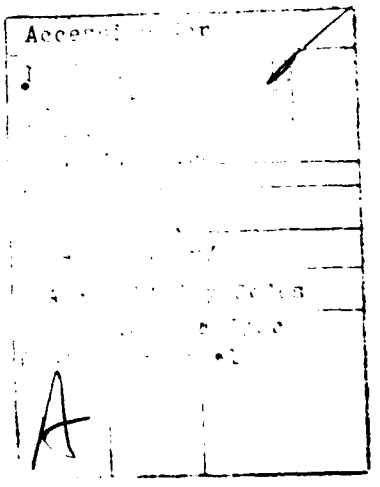

Project Report Summary

In July 1978 an ASD reserve project was authorized under the title of "Initial Identification of Project Schedule Elements, Variables, and Influences for Parametric Scheduling." This project was to be done in conjunction with the AFSC/ASD Initiative 16 for the development of an ASD independent schedule assessment concept.

However, after reviewing the data collected, and considering the potential for parametric scheduling use at ASD, it was determined that the greatest current opportunity existed for assisting ASD in the planning and scheduling tasks of program management.

1. Planning and Scheduling definition: What is the scope of Planning and Scheduling techniques at ASD?

2. Planning and Scheduling (P&S) environment at ASD: What are the proper roles for planning and scheduling in an ASD program as compared to a typical industry program?

3. Current ASD P&S areas: How do the roles of the Independent Schedule Assessment, the Vanguard System, and an automated management information system fit into the P&S function at ASD?

4. ASD P&S related organizations: What organizations are currently doing tasks related to planning and scheduling and what are some alternatives for improved integration and coordination of the P&S functions?

5. Questions for Planning and Scheduling Enhancement.

The answers to these questions should aid ASD in an analysis of its program control functions.

Unlike the cost area, where there are certain recognized organizations who will speak out with some degree of authority to protect cost/budget integrity, planning and scheduling does not seem to have such a centralized and influential advocate. For example, the Air Force Comptroller Office provides the guidance and assistance in the cost area. This provides stability of organization and personnel in the cost control function. Most of the planning and scheduling personnel in a SPO program management office are usually qualified military personnel who are somewhat transient, and their expertise is lost after they leave that program office.

The function of planning and scheduling has not had a primary organizational proponent at ASD and, therefore, its role is heavily influenced by the other functions and organizations to which it is related. It is most usually seen as adjunct to the cost control function. Most of the material reviewed in this report will deal with it in that context.

ASD, of course, operates within Department of Defense policies and procedures. This report briefly surveys the three major sub-functions in the planning and scheduling area: (a) the initial planning effort which precedes the letting of the contract, (b) the contractors planning, scheduling, and reporting systems, and (c) the USAF schedule surveillance and reporting requirements.

Also reviewed are three areas of interest which are currently influencing the future of planning and scheduling at ASD. They are the (1) Independent Schedule Assessment Program (AFSC Regulation 800-35), dated 31 January 1979, produced by AFSC Initiative 16-2, (2) the AFSC initiative project Vanguard, and (3) the ASD Automated Management Systems program now being developed by the ASD/ACP organization.

Planning and scheduling is being done primarily by the Deputy for Development Planning (ASD/XR), the various SPO Program Control organizations, and the Contract Management Division (CMD). They are supported in this function by the Controller (ASD/AC) organizations, the Program Costs Directorate, Cost Analysis Directorate, and the Deputy for Contracting and Manufacturing. These organizations and their relationship to the planning and scheduling function will be reviewed.

At the close of this report the planning and scheduling related organizations are asked certain questions basic to that discipline. They are proposed for self-testing of the function. Responses received will be used in making constructive recommendations for the overall integration and coordination of planning and scheduling at ASD.

The questions asked that are common to all organizations are:

1. Do the top managers and staff of each of these organizations have readily available the current schedule dates and schedule status of the major milestones of the program which are included in their operational responsibility?

2. How compatible are the planning and scheduling policies and procedures among these organizations?

3. Is any one officer at ASD reviewing, even at a summary level, the quality of the planning and scheduling support that is necessary including the CMD/AFPRO support?

Ten other questions are asked of applicable organizations.

ASD has a good opportunity at this particular time to assess its planning and scheduling operation and make meaningful improvements to such functions as the "Independent Schedule Assessment," "Vanguard," and "Automated Management System." In the spirit of this recommendation, this report concludes with the beginning of a follow-on reserve project which will review questions raised with ASD managers, and prepare specific recommendations for planning and scheduling enhancement in the above three functions.

Planning and scheduling is, of course, time management. Time is not only money, but for the Air Force it is also national security. If this study can contribute to greater savings and earlier performance, its contribution should be meaningful.

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Introduction

In December 1977 a Headquarters AFSC study group convened at ASD to review how the division does its business. One of the initiatives which resulted from this review was known as Initiative 16. The description of this initiative was as follows:

> "Objective is to define/improve schedule assessment processes so that 'realism of program schedule achievement' is more accurately evaluated. Task is to develop a standardized method for verifying the accuracy of program schedules being priced by independent cost assessment (ICA) teams. Anticipated output of this study is a draft guide for the conduct of independent schedule assessments which are compatible with and related to independent cost assessments." (1)

In response to this initiative, team committees were established at ASD and CMD to consider the AFSC recommendations. Inquiry was made through the Air Force Business Research Management Center at Wright-Patterson Air Force Base, Ohio, to utilize ASD reserve officers and their military and civilian professional experience in related fields of this initiative.

The task of this project started out in July of 1978 to provide assistance to the Initiative 16 effort. This included an initial review of typical program schedule documentation, discussion with some program staff members, and the application of extensive professional experience concern in the elements, variables, and influencing factors which would provide initial material.

On 31 January 1979, as a result of the ASD Initiative 16 teamwork, AFSC Regulation 800-39 was issued entitled the Independent Schedule Assessment Program. Also, a draft guide was prepared for Hq AFSC review and follow-on.

As the Initiative 16 effort was reflected in the Independent Schedule Assessment (ISA) Regulation and draft guide, a new question became apparent. This was the question concerning the scope of actual implementation of an ISA in the current ASD program management environment. There was another planning and scheduling endeavor which was already in effect within ASD known as Vanguard. The purpose of the Vanguard project was:

> "to provide integrated program planning for explanatory, advanced, and engineering development. Plans will be developed to describe activities for each mission area and will provide three perspectives--mission area, mission force element, and functional. Plans will, in general, include a base line based on analysis and assessments." (2)

Another significant development for planning and scheduling has been the implementation of an automated management system. The Director of Program Control (ACP) was given this responsibility which is described as:

"Design, development, test, and implementation of automated management system for use in all aspects of acquisition program management at all levels in ASD up through Commander, ASD, level. Integration of boldly developed systems with systems directed by higher headquarters and further wide definition of authority throughout ASD." (14)

In Figure O-1 the relative role of the systems which relate to planning and scheduling are illustrated. Vanguard identifies the Master Plan for AFSC. Contract schedule requirements which specify detail contractor support requirements through the CMD/AFPRO or direct to the SPO. The ASD management systems for the Program Control functions should assist in the necessary interface and interflow for program data between contract and AFSC as well as providing all levels of ASD management mid-level planning and analysis capability. These scheduling requirements, Initiative 16, ISA, the data management system, and Vanguard offered a new and significant opportunity to the ASD program management including the specific organizations discussed in detail in Section IV.

Reserve Project Background

In July 1978 an ASD reserve project was authorized under the title of "Initial Identification of Project Schedule Elements, Variables, and Influences for Parametric Scheduling." This project was to be done in conjunction with the AFSC/ASD Initiative 16 for the development of an ASD independent schedule assessment concept.

The ASD reserve project effort, being limited to one person, was only able to track this effort and benefit from the collection of related data at ASD (Wright-Patterson) and CMD (Kirtland AFB). The initial goal of this project was to look at a specific approach to schedule assessment through parametric scheduling. This form of scheduling uses historical data from technical quantifications compared to their related schedule durations to predict project schedules or to assess schedules that have been proposed.

However, after reviewing the data collected, and considering the potential for parametric scheduling use at ASD, it was determined that the greatest current opportunity existed for assisting ASD in the planning and scheduling tasks of program management.

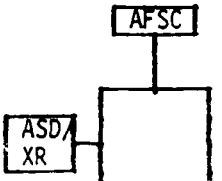
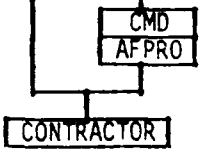
As a result this project has been designed to provide an evaluation of the function of Planning and Scheduling at ASD and will be the focus of this report. The primary questions which will be answered by this report are:

1. Planning and Scheduling definition: What is the scope of Planning and Scheduling techniques at ASD?

2. Planning and Scheduling (P&S) environment at ASD: What are the proper roles for planning and scheduling in an ASD program as compared to a typical industry program?

FIGURE O-1

PLANNING AND SCHEDULING HIERARCHY

LEVEL	SYSTEM	LEAD ORGANIZATION
MASTER PLANNING	VANGUARD	
MID-LEVEL DATA FLOW AND PLANNING AND ANALYSIS	ASD PROGRAM CONTROL MANAGEMENT SYSTEMS	
CONTRACTOR DATA CONTROL	CONTRACT SCHEDULING REQUIREMENTS	

3. Current ASD P&S areas: How do the roles of the Independent Schedule Assessment, the Vanguard system, and an automated management information system fit into the P&S function at ASD?

4. ASD P&S related organizations: What organizations are currently doing tasks related to planning and scheduling and what are some alternatives for improved integration and coordination of the P&S functions?

5. Questions for Planning and Scheduling Enhancement.

The answers to these questions should aid ASD in an analysis of its program control functions.

Current ASD Planning and Scheduling Update

The changing systems environment at ASD makes any type of report of limited long range value. It is necessary to add to this report some recent developments, which will not be referenced in the balance of the report.

ASD 1980 reorganizations seemed to have given new highlight[illegible]o the Program Control function. The Comptrollers Program Control Dir[illegible]orate FFR (ACP) has matrix staffing responsibilities for all the system d[illegible]ies and their related Program Control directorates. FFR is also respons[illegible]e for training Program Control people, but also providing standard ma[illegible]nent systems. SMART-D is referred to in this report elsewhere, but [illegible]FOCEM on overall system. INFOCEM is being replaced with BASIS, about [illegible] little data is now available. BASIS, like INFOCEM, includes CPM capabi[illegible]ty (Critical Path network concept).

The increasing role of FFR Program Control in providing planning and scheduling systems and program control training is giving added emphasis to this function at ASD.

I. PLANNING AND SCHEDULING DEFINITION

Planning and Scheduling (P&S) is a management function related to the planning of a job in task sequence and determining the applicable resources, time durations and subsequent schedule dates. This function will then include the collection of data required to determine the amount of progress achieved, resources remaining, work remaining including changes, and any evaluations or assessments of what the current information says about planned schedule achievement.

Schedules are subject to many variables. Some of these variables are as follows:

a. A schedule is based upon the management of time, which can be a very personal characteristic. Time management will vary greatly depending on how the workers and management understand the task, how they are motivated, and how fast they can function, mentally and physically.

b. Schedules, unlike costs, cannot usually be tied as easily to some current market value. While the market conditions are continually seen clearly in costs, the schedule variations which are affected by such conditions are harder to identify.

c. Every company and organization has a different management "personality." That personality is affected by its previous ways of doing business as well as the preferences of its current management and their policies and procedures. This affects such areas as resource allocation and cost to schedule trade-offs.

d. Competitive constraints will sometimes limit schedule alternatives. Under these pressures, it may be hard for management to remain realistic in their schedule decisions. It is often too easy to set aside schedule considerations for short term relief or benefit.

The development of schedules must take these subjective and sometimes intangible variables into account when any kind of schedule assessment is made.

In the Air Force's situation, part of the problem is the assignment of a project to many organizations and mission interests. Unlike the cost area, where there are certain recognized organizations who will speak out with some degree of authority to protect cost/budget integrity, planning, and scheduling does not seem to have such a centralized and influential advocate. For example, the Air Force Comptroller Office provides the guidance and assistance in the cost area. This provides stability of organization and personnel in the cost control function. Most of the planning and scheduling personnel in a SPO program management office are usually qualified military personnel who are somewhat transient and their expertise is lost after they leave that program office.

Finally, planning and scheduling is a field where there are many real and self-appointed experts, and many of these are strong advocates of their own position. This, coupled with the sensitivity of schedules to project management, causes real problems when there is not a single voice heard clearly on the subject minimizing unnecessary debate and uncertain direction and redirection.

II. THE PLANNING AND SCHEDULING ENVIRONMENT AT ASD

The function of planning and scheduling (P&S) has not had a single organizational proponent at ASD and, therefore, its role is heavily influenced by the other functions and organizations to which it is related. It is most usually seen as adjunct to the cost control function. Most all of the material reviewed in this report will deal with it in that context.

ASD, of course, operates within Department of Defense policies and procedures. There are three major sub-functions in the planning and scheduling area: (a) the initial planning effort which precedes the letting of the contract, (b) the contractors planning, scheduling, and reporting systems, and (c) the USAF schedule surveillance and reporting requirements. The various DOD requirements for planning and scheduling have been identified as follows:

> "Application of standard reporting requirements to new programs is accomplished on a selective basis. Program managers are encouraged to tailor reports to meet their needs and suit the peculiar characteristics of their program. Tailoring normally means reducing requirements rather than adding additional reporting elements, and it is DOD policy to hold reporting requirements to the minimum essential to support program management needs.
>
> The Contract Funds Status Report (CFSR) has the lowest threshold for application. The CFSR is applicable to contracts over $500,000 in value. The Cost/Schedule Status Report (C/SSR) and portions of the Contractor Cost Data Reporting system (CCDR) are also applicable to contracts over $2 million. On selected contracts within major programs, the Cost Performance Report (CPR) replaces the C/SSR, additional elements of CCDR are required, and the contractors' systems must meet the Cost/Schedule Control Systems Criteria (C/SCSC)." (3)

Figure II-1 illustrates these relationships.

The official DOD policy documents which address performance measurement systems requirements and associated performance reporting are DOD Instructions 7000.2 and 7000.10. This brochure and similar materials on the subject of cost/schedule performance measurement can be obtained directly from the Directorate for Major Acquisition Management Systems, OSD (Comptroller), The Pentagon, Washington, D.C. 20301.

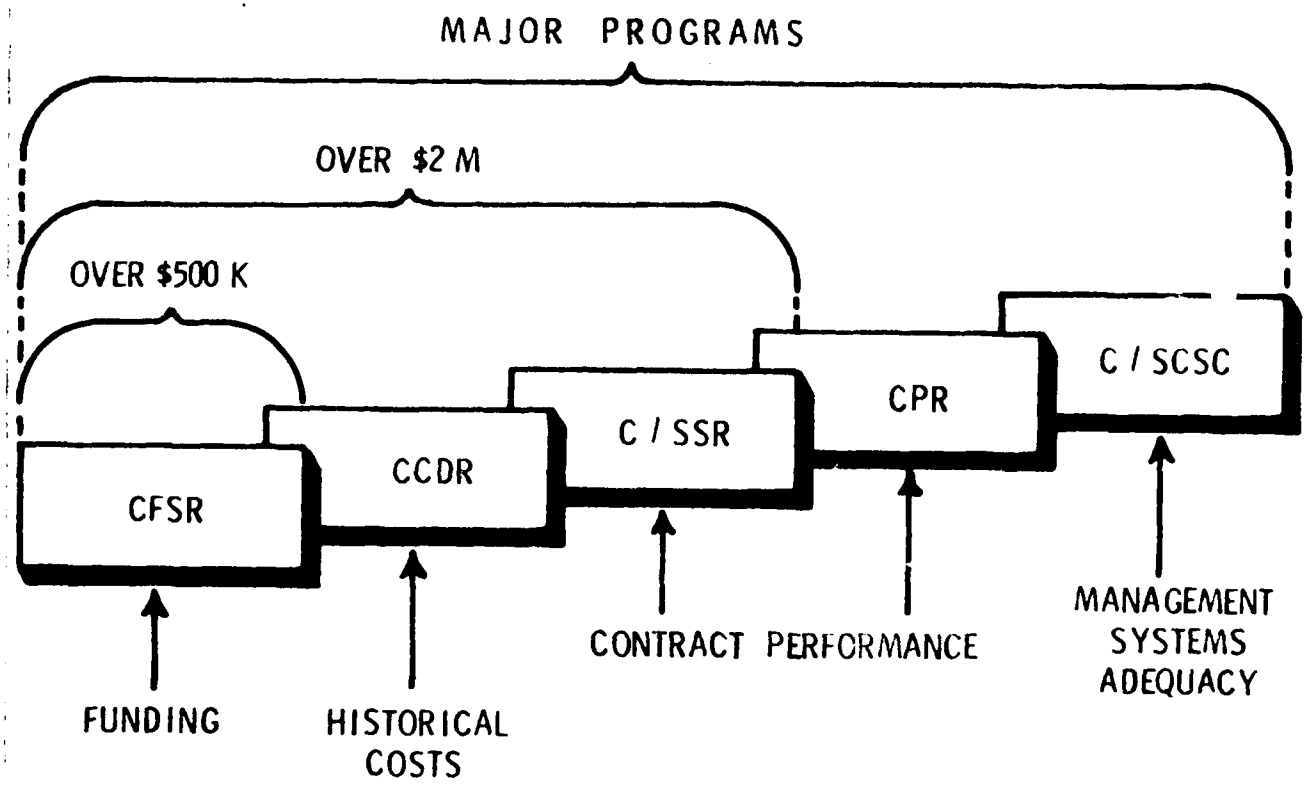
These reporting specifications do not preclude the preparation of other contracts scheduling requirements by the SPO who may request more direct involvement in the contractor systems management. With the increase of fixed price controls most contract scheduling requirements have been difficult to implement.

Assistant Secretary of Defense Schedule & Cost Measurement Requests

The office of Assistant Secretary of Defense has established the following requirements for schedule and cost performance measurement:

FIGURE II-1

REQUIREMENTS APPLICABILITY



"As a minimum, a good performance report must be able to answer the question, 'Where are we now?' in a clear, unequivocal manner. Unfortunately, many cost and schedule reports currently in use cannot adequately answer this question due to a lack of integration of cost and schedule data. Integration of cost and schedule information is required to eliminate much of the subjectivity with which the cost performance is determined. To illustrate this point, consider the manager who has to work with a report which compares actual costs to budgets and a separate report planned versus actual schedule status. If the project is right on budget, but is behind schedule, it is probably overrunning. Quantifying the cost attributable to the schedule deviation can be virtually impossible or, at best, highly subjective. If, however, budgets are related directly to schedule increments of work, much of the subjectivity can be eliminated. An objective report of work accomplishment will then provide a basis for determining meaningful cost performance. Overall schedule performance can also be viewed in dollar terms by simply comparng budgets for completed work to budgets for scheduled work.

The best place to measure accomplishment is at the level where work is performed. Simple summaries by organizational unit or work breakdown structure elements can provide upper-level managers with information which is aggregated in a meaningful form to facilitate management by exception and keeps the amount of information reported to higher levels to a minimum.

The management system which produces these reports must be reasonably well disciplined to be effective. Arbitrary transfers of budget from one task to another, for example, can destroy the significance of reported values.

The Cost/Schedule Control Systems Criteria (C/SCSC) of DODI 7000.2 set forth many of the characteristics and disciplines required of an effective performance measurement system. These criteria do not impose any specific management technique or methodology, but represent basic principles applicable to most management systems. Failure to meet a criterion generally indicates a weakness in a cost/schedule control system. While compliance with the C/SCSC is mandatory on major defense programs, the criteria also provide a useful checklist for evaluating programs of any size." (4) (Special attention should be given this last sentence and it will be noted again)

DOD policies and directives have specified that to have a good measurement one must also have good definition. The following requirements have been identified accordingly:

A. Define the Work. A thorough definition of all aspects of the contractual effort is essential to the establishment of a good performance measurement plan. Work identification can be facilitated by using a product or work breakdown structure to progressively

identify each element of the item to be produced as well as the activities required to accomplish the effort. While such a breakdown or product explosion is commonly used in manufacturing, it is usually more difficult to establish in engineering where the tendency is to describe the effort in broad general terms, identifying only near-term effort in detail. This lack of work definition can easily lead to downstream surprises on projects which appear to be doing well simply because it is virtually impossible to determine resources required for ill-defined work.

B. Schedule Activities. Scheduling is an important and integral part of the overall planning effort as the scheduling process forces people to quantify their effort in discrete terms and to place tasks in proper relationship to each other. Since outside schedule constraints may be dictated by contractual delivery dates, facility limitations or other external factors, the planning/scheduling functions are usually iterative in nature in order to provide for accomplishment of all required tasks within the specified time frames.

C. Allocate Resources. Once the contractual effort is defined and scheduled to the maximum possible extent, resources for accomplishing the work must be established, usually through the internal budgeting process. While scheduling is an iterative process in order to arrange for all the work within prescribed time limits, budgeting is also an iterative process in order to provide for accomplishing the work within pre-determined funding limits. In the case of company funded work, management establishes cost targets which form the basis for the internal budget. For contractual effort, the negotiated contract cost usually serves as the target and the point of departure for the budget. In order to measure contract cost performance, it is important that internal budgets sum to the contract target cost so that the relative value of completed work can be determined." (4)

See Figure II-2

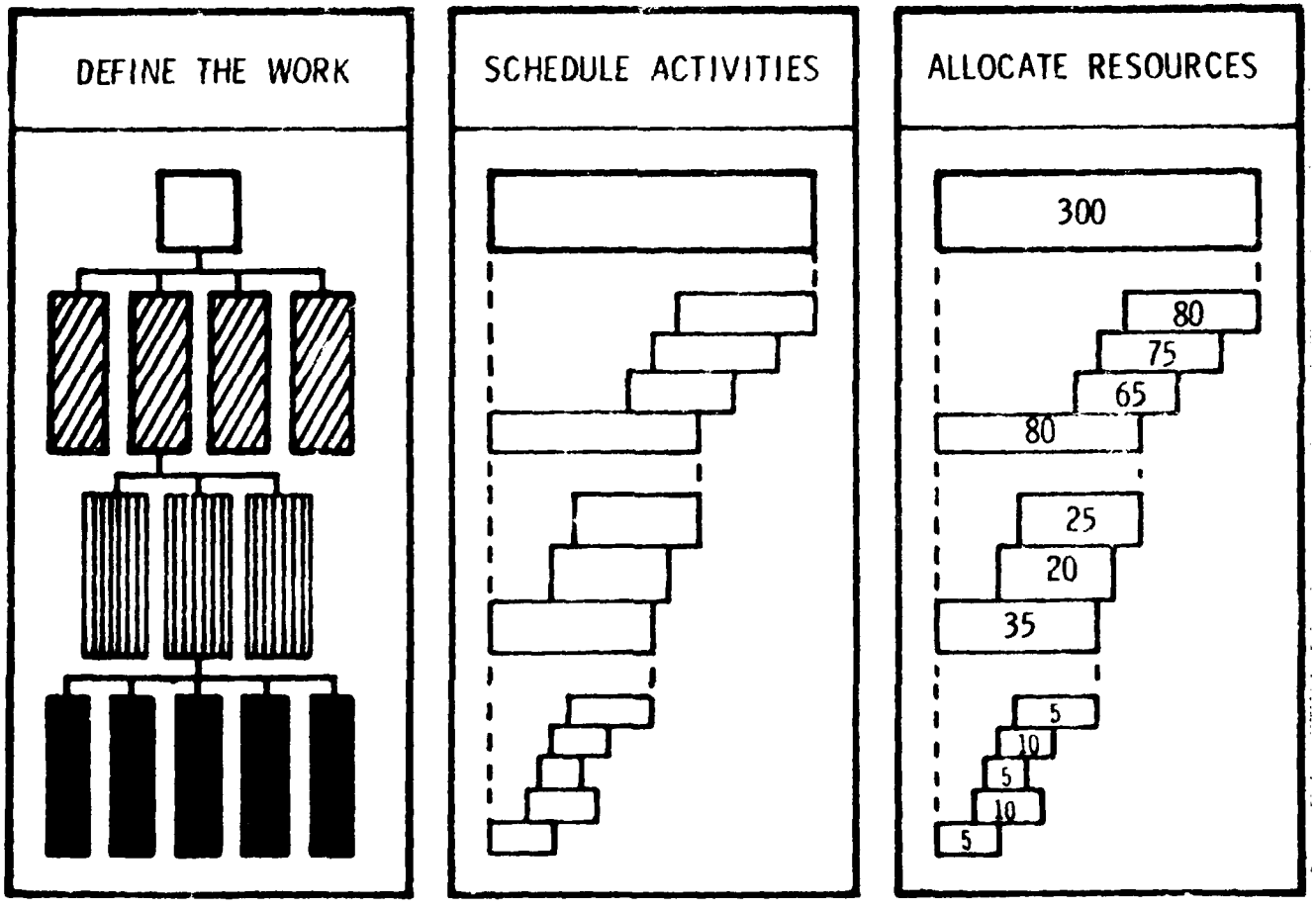
The preceeding remarks partially explain the environment which DOD would expect ASD, and CMD, to be working within. SPO management emphasis should be seeking to achieve these ideals in program management.

ASD Program Influence Factors

One of the Initiative 16 Team reports included this outline of factors which impact a typical ASD program. These factors in turn influence schedule and cost control.

FIGURE II-2

WORK-BUDGET-SCHEDULE INTEGRATION



Factors that impact on the Development of Program Schedule and Network at ASD. (1)

I. GROUPINGS	FACTORS
A. Program (Example)	Typical Aircraft Production Rate
B. Program Control Point	1. First Hardware Delivery 2. Maximum Production Rate Achieved 3. Initial Operating Capability (IOC) 4. Program Management Responsibility Transfer (PMRT)
C. Event/Activities	1. Release of Mission Element Need Statement (MENS) 2. Program Authority Received 3. Program Strategy Established 4. Work Breakdown Structure Prepared 5. Program Decision 6. Release of RFP 7. Start of Source Selection 8. Contract Award 9. Reviews and Audits 10. Test Programs
D. Physical/Performance Factors	1. Primary Factors: a. Thrust b. Velocity c. Attitude d. Acceleration e. Range f. Weaponry/Payload (useful load) g. Operating Characteristics Factors h. Advance Development Factor i. System Complexity Factor 2. Secondary Factors: a. Size b. Weight c. Number of Engines d. Maximum Surface Temperature e. Availability of Facilities
E. Correlated Events that could impact Program Schedule (Activities or factors that may not be totally controllable by the SPO or contractor)	May Not Be Totally Controllable a. Funding b. Requirements redirection c. Program priority d. Economic conditions e. GFE vs CFE

II. GROUPING	SCHEDULE INFLUENCE FACTORS
A. Engineering Design	1. System Complexity 2. State-of-Art Extension 3. Management Control/Integration 4. Contract or Design Experience 5. Procurement Strategy 6. Software Development 7. Configuration Contol & Stability
B. Prototype Fabrication	1. Related Manufacturing Experience 2. Manpower/Skills 3. Materials Availability 4. New M & P Technology 5. Project Management 6. Number Critical Subcontractors 7. Subcontractor Performance 8. Government Furnished Equipment Support 9. Contractor Facilities & Equipment 10. Drawing Release 11. Integration Requirements 12. Subsystem Qualification Tests
C. Production First Article	1. Related Manufacturing Experience 2. Manpower/Skills 3. Design Stability 4. Procurement Strategy 5. Contract Facilities & Equipment 6. Acceleration to Rate Requirements 7. Number of Critical Subcontractors 8. Subcontractor Performance 9. Government Furnished Equipment Support 10. Integration Requirements 11. Drawing Release 12. Project Management 13. Contractor Management Systems 14. System Qualification Test
D. Model Test and Evaluation	1. Test and Facility Availability 2. Test Support Software 3. Model Fabrication 4. State-of-Art Extension
E. Gun and Ammo Qualification Tests	1. Test Facility Availability 2. Data Reduction/Evaluation 3. Number Test Events 4. Failure Analysis

(1)

ASD Schedule Constraints

Schedule constraints from both the contractor and the SPO can have a significant impact on the contractor's ability to successfully meet the program schedule. Through effective management the milestones are established and resources allocated which lead to successful completion of the

project. However, there are several factors which will impact schedules and are beyond the capability of the SPO or contractor to directly influence. Schedule constraints, therefore, are divided into two categories: Controllable - those factors that the contractor or SPO can have a direct impact on and uncontrollable or those factors which neither the contractor or the SPO can directly impact.

A. Controllable - SPO management and administrative milestones. The program manager and his subordinates must establish milestones which are measureable and meaningful. Little is accomplished if milestones are established which cannot be accurately measured against a completed activity. Since milestones are by definition a management check point, the measurability and meaningfulness of the milestones are an all important factor. Little is gained if the milestone lacks a significant meaning or the ability to be measured. The milestones should include significant program management milestones such as completion of the program reviews. This helps to assure that adequate time exists for advanced planning and preparation leading to the review. The major administrative milestones must also be factors into the overall schedule. This will assure that when the timing of each major milestone is firmly established that the administrative leadtimes have been considered. In addition, without identification of the administrative milestones, times spans, often consuming several months preceding and following a milestone may not have a check point for controlling the program. One such milestone is the release of the RFP which culminates months of effort preparing the statement of work, the model contract, and instructions to offerors. The RFP release is then followed by months of contractor effort preparing a response.

B. Uncontrollable - Successful completion of the events and activities identified above may be influenced by factors some of which may not be totally controllable by the SPO or contractor. The factors are:

1. Funding. Deviations from the original planned funding profile may result in variations in the schedule. Funding cuts will extend the schedule and an increase may result in compression of the schedule.

2. Requirements Redirection. A change in the perceived need or funding levels may require the addition or deletion of some requirements. Depending on the stage of development or production a change in schedule might be required to accommodate the change.

3. Program Priority. The priority of the program may have a significant influence on the schedule. A low priority program will be more susceptible to budget cuts. In addition, a low priority program may have difficulty obtaining adequate range time for the test program. Either budget cuts or lack of range time will delay the development schedule and may result in concurrent development and production or a slip of the production start date." (1)

In order to handle these factors and manage the performance of their programs, one project office, ASD/AE, identified an extensive number of reviews that are required.

Cost/Schedule Control Systems Criteria

Some major programs are required to use the Cost/Schedule Control Systems Criteria (C/SCSC) in following DOD Instruction 7000.2. C/SCSC is a good example of Planning and Scheduling (P&S) criteria whether the system is used or not. A review of the background statement included is an important part of the P&S environment required for ASD SPO management activities. The following is an excerpt from AFSCP/AFLCP 173-5 dated 1 October 1976.

"1-2. Background.

a. Management Needs. A fundamental responsibility in the acquisition and modification of major weapon/support systems is to ensure that visibility of contractors' progress is sufficient to indicate reliably the results being obtained. In carrying out this responsibility in selected contracts within applicable Defense programs, DOD receives and reviews cost and schedule performance data. To be meaningful these data must: (1) portray budgets allocated overtime to specific contract tasks; (2) indicate work progress; (3) properly relate cost, schedule, and technical accomplishment; (4) be valid, timely, and auditable; and (5) supply DOD managers with a practical level of summarization. Such data should be derived from the same internal management control systems as used by the contractor to manage his contract effort.

b. Criteria Concept. It is recognized that no single common set of management control systems will meet every DOD and contractor management data need for performance measurement. Due to variations in organizations, products, and working relationships, it is not feasible to prescribe a universal system for cost and schedule controls. DOD has adopted an approach which simply defines the criteria that contractors' management control systems must meet. The criteria provide the basis for determining whether contractor management control systems are acceptable.

(1) The responsibility for developing and applying the specific procedures for complying with these criteria is vested in the contractor, but the specific management control systems he proposes are subject to DOD acceptance. In instances where the contractor's systems do not meet the criteria, necessary adjustments to achieve compliance will be required.

(2) By applying criteria, rather than specific DOD prescribed management control systems, contractors have the latitude and flexibility for meeting their unique management needs. This approach allows contractors to use existing management control systems or other systems of their choice, provided they meet the criteria.

(3) When the solicitation document (request for proposal, request for quotation, and the like) specifies application of the criteria, an element in the evaluation of proposals will be the prospective contractor's proposed systems for planning and controlling contract performance. The prospective contractor will describe the systems to be used in sufficient detail to permit their evaluation for compliance with the criteria.

(4) If awarded the contract, the contractor will be required to have a comprehensive description of the management control systems and demonstrate to a Government C/SCSC review team their effective application in planning and controlling the work under the contract. DOD relies on the contractor's systems when they are accepted and does not superimpose duplicative planning and control systems.

(5) Contractors having systems previously accepted are encouraged to maintain the essential elements and disciplines of the systems, if they intend to remain in the competitive environment for future defense contracts involving large acquisition programs." (6)

The C/SCSC did not seek to impose any particular system upon a contractor, but rather define the characteristics of what their control and reporting should include. This is explained in the additional 173-5 excerpt:

"3-5. Analysis. The C/SCSC do not require the submission of data or reports from the contractor to the Government. The criteria only set forth characteristics which contractors' systems must possess, and specify the type of data which should be derived from the systems." (6)

Also the schedule management requirements are further illustrated by this continuing excerpt from the same analysis section.

"c. Data Analyses. Comparisons of Budgeted Cost for Work Scheduled (BCWS) with Budgeted Cost for Work Performed (BCWP) relate work completed to work scheduled during a given period of time. While this provides a valuable indication of schedule status, in terms of dollars worth of work accomplished, it may not clearly indicate whether or not scheduled milestones are being met since some work may have been performed out of sequence. A formal time-phased scheduling system must therefore provide the means of determining the status of specific activities and milestones." (6)

A Checklist for Program Control

When the C/SCSC procedure is applied, the contractor is evaluated with the following questions being asked. These questions are also excerpts from 173-5 and indicate the kind of detail concern ASD program management should have for schedule control. The questions are from a checklist which is used in a contractor review.

"1. Schedule the authorized work in a manner which describes the sequence of work and identifies the significant task inter-dependencies required to meet the development, production, and delivery requirements of the contract.

a. Does the scheduling system contain: (Prepare exhibit showing traceability from contract task level to work package schedules.)

(1) A master program schedule?

(2) Intermediate schedules as required which provide a logical sequence from the master schedule to the cost account level?

(3) Detailed schedules which support cost account and work package start and completion dates/events?

b. Are significant decision points, constraints, and interfaces identified as key milestones?

c. Does the scheduling system provide for the identification of work progress against technical and other milestones, and also provide for forecasts of completion dates of scheduled work?

d. Are work packages formally scheduled in terms of physical accomplishment by calendar dates (Gregorian, Julian, or manufacturing day)?

2. Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure output.

a. Are meaningful indicators identified for use in measuring the status of cost and schedule performance? (Provide representative samples.)

b. Does the contractor's system identify work accomplishment against the schedule plan? (Provide representative examples.)

c. Are current work performance indicators and goals relatable to original goals as modified by contractual changes, replanning, and reprogramming actions? (Provide exhibit showing incorporation of changes to original indicators and goals.)

3. Establish and maintain a time-phased budget baseline at the cost account level against which contract performance can be measured. Initial budgets established for this purpose will be based on the negotiated target cost. Any other amount used for performance measurement purposes must be formally recognized by both the contractor and the government. (6)

4. To the extent the authorized work can be identified in discrete, short-span work packages, establish budgets for this work in terms of dollars, hours, or other measurable units. Where the entire cost account cannot be subdivided into detailed work packages, identify the far term effort in larger planning packages for budget and scheduling purposes:

a. Do work packages reflect the actual way in which the work will be done and are they meaningful product or management-oriented subdivision of a higher level element of work? (Provide representative sample.)

b. Are detailed work packages planned as far in advance as practicable?

c. Is work progressively subdivided into detailed work packages as requirements are defined?

d. Is future work which cannot be planned in detail subdivided to the extent practicable for budgeting and schedule purposes. (Provide sample.)

e. Are work packages reasonably short in time duration or do they have adequate objective indicators/milestones to minimize the in-process work evaluation?

f. Do work packages consist of discrete tasks which are adequately described? (Provide representative sample.)

g. Can the contractor substantiate work package and planning package budgets?

h. Are budgets or value assigned to work packages and planning packages in terms of dollars, hours, or other measurable units?

i. Are work packages assigned to performing organizations? (6)

5. Identify on a monthly basis significant differences between planned and actual schedule accomplishment together with the reasons.

a. Does the scheduling system identify in a timely manner the status of work? (Provide representative examples.)

b. Does the contractor use objective results, design reviews, and tests to track schedule performance? (Provide examples.)" (6)

This checklist would be of value for evaluating every project control system as applicable.

III. CURRENT ASD PLANNING AND SCHEDULING AREAS

There are three areas of interest which are currently influencing the future of planning and scheduling at ASD. They are the (1) Independent Schedule Assessment Program (AFSC Regulation 800-35, dated 31 January 1979, produced by AFSC Initiative 16-2, (2) the AFSC initiative project Vanguard, and (3) the ASD Automated Management Systems program now being developed by the ASD/ACP organization.

THE INDEPENDENT SCHEDULE ASSESSMENT

The Independent Schedule Assessment (ISA) program regulation resulting from the AFSC Initiative 16 effort is just being activated at ASD.

A copy of the regulation is included as Figure III-1. A draft guide for implementation of the ISA was prepared by the Initiative 16 team. The draft had not been approved for issue as this report was prepared, but excerpts of its contents will be used because it not only explains the thought process behind the ISA authorship, but also includes the results of a good deal of research.

The purpose of and an introduction to the ISA according to one of these excerpts are as follows:

PURPOSE

> Independent Schedule Assessments (ISAs) are intended to provide an assessment, by a team of "experts" from outside the program office of the realism of the projected program schedules. ISAs normally are conducted at major AFSARC/DSARC milestones. They are conducted in conjunction with and integrated into Independent Cost Analysis (ICAs). In special cases, an ISA may be conducted without being, for that occasion, a part of an ICA. The results of an ISA shall provide Air Force acquisition management with visibility and understanding of the origin and basis of the schedule estimate, significant factors influencing or constraining the projected schedule, and the risks involved in successful achievement of the projected schedule. The report of the ISA team should include recommended actions which would reduce schedule risks and enhance the probability of successful schedule achievement.

INTRODUCTION

> An ISA is essentially a three-step process, data collection, analysis/evaluation, and documentation. Data can be collected from three general sources: the program office, the contractor and historical records on similar programs. Prior to collecting data at the contractor's facility, the team should develop guidelines for data collection and notify contractor of the specific information desired. Data collection should emphasize how the schedule estimate was developed,

FIGURE III-1

DEPARTMENT OF THE AIR FORCE
Headquarters Air Force Systems Command
Andrews Air Force Base, DC 20334

AFSC REGULATION 800-35
31 January 1979

Acquisition Management

INDEPENDENT SCHEDULE ASSESSMENT PROGRAM

This regulation prescribes policies, assigns responsibilities, and establishes procedures for conducting and documenting Independent Schedule Assessments (ISA) for acquisition programs.

1. **Policy:**

a. An ISA is an independent assessment of the reasonableness of the system program office (SPO) master integrated program schedule.

b. An ISA will be conducted for acquisition programs before each AFSARC/DSARC milestone and as otherwise directed by HQ AFSC.

c. The ISA team chief and team membership will be comprised of personnel external to the responsible SPO.

d. The ISA is considered to be part of the Independent Cost Analysis (ICA) (AFR 173-11). Include ISA documentation as an annex to the ICA documentation.

2. **Responsibilities.**

a. HQ AFSC:

(1) HQ AFSC/AC will provide overall management of the ISA program.

(2) Other DCSs will support HQ AFSC/AC in conducting and reporting on ISA.

b. AFSC Product Divisions:

(1) Ensure ISAs are conducted as directed by HQ AFSC.

(2) Unless otherwise directed by HQ AFSC, the Comptroller will appoint the ISA team chief.

(3) Ensure that the PO provides the ISA team the master integrated program schedule, consistent with the program which will be presented for AFSARC/DSARC decision, and necessary technical supporting data.

c. ISA Team Chiefs:

(1) Select team membership appropriate to the scope and nature of the specific ISA to be conducted.

(2) Prepare an ISA plan for incorporation into the ICA plan.

(3) Conduct the ISA. Furnish the ICA team with the findings and results.

(4) Define and discuss ISA results with the *program manager and product division commander* as part of the ICA briefing cycle.

3. **Assessment Composition:**

a. An ISA will address that portion of the acquisition program covered at the AFSARC/DSARC major milestone, evaluating general schedule risk and identifying the critical path. In addition, the assessment will identify the specific pacing or critical schedule events and show program schedule variations to include low-, medium-, and high-risk schedules. As part of the above low-, medium-, and high-risk schedule identification and assessment, the ISA will evaluate alternate production rates, if applicable to the particular AFSARC/DSARC milestone.

b. The ISA will assess substantiating data on the projected master integrated program schedule. This would include identifying and understanding the origin and derivation of the schedule estimate, methodology used to develop the schedule estimate, constraints influencing the estimate, and relevant history or experience that would provide indicators for future schedule expectations.

c. Documentation will consist of detailed briefing charts and an accompanying script which *presents* ISA results as shown in attachment 1.

OFFICIAL

ALTON D. SLAY, General, USAF
Commander

JAMES L. WYATT, JR., Lt Col, USAF
Director of Administration

1 Attachment
Independent Schedule Assessment
Documentation Format

No. of Printed Pages: 2
OPR: ACC (Captain Williams)
Approved by: Brig Gen Spangrud
Editor: Mr. Mazulewicz
Distribution: F

AFSC — Andrews AFB Md 1979

INDEPENDENT SCHEDULE ASSESSMENT DOCUMENTATION FORMAT

1. **Purpose of Assessment**
   a. Purpose
   b. Objectives to be obtained

2. **Systems Description**
   a. Physical, technical, and performance characteristics
   b. Parameters required for assessment effort
   c. System concepts, plans, etc.

3. **Background and Scope**
   a. ISA direction
   b. Milestones covered
   c. Current program acquisition strategy

4. **Assumptions and Limitations**
   a. Ground rules
   b. Study limitations
   c. Other constraints

5. **Schedule Assessment Procedures**
   a. Data sources
   b. Models used
   c. Depth of assessment
   d. Risk and uncertainty
   e. Other

6. **Summary results**
   a. ISA results
   b. Comparisons with direction, PO schedules, previous ISAs, etc.

7. **Conclusions**
   a. Reasonableness of existing schedules
   b. Suggestions

Attachments:
A. Detailed Assessment
B. Risk and Sensitivity
C. References
D. ISA Review Checklist

what is the extent of substantiating data for time span estimates at both master and subtier functional schedule estimates, what are the uncertainties in the estimates and what contingencies were included to accommodate them, and what are the dependent and independent elements in the schedule estimate. Upon completion of the data collection, the final determination of the analytical approach to be taken must be made. If the approach is predetermined, it is assumed that all the necessary data exists. Therefore, unless advanced planning prescribes an approach and input data, the analytical approach will be dependent upon the quality and quantity of available data. It is highly desirable to require contractors, either by proposal instructions or by contract statement of work to provide schedule networks, production plans, and substantiating data in contemplation of ISAs at AFSARC/DSARC milestones. Typically, several approaches can be used to analyze schedules. These include: probablistic analysis of time estimated networked events, critical path network, estimates based on established time estimating relationships (parametric analysis) and detailed grass roots or built up subtier schedules can be used alone or in combination.

Documentation of the assessment will consist of a summary report, briefing charts and accompanying script which present the results of the ISA. The briefing should highlight the projected schedule in terms of key milestones such as authority to proceed, PDR, CDR, first flight, and major functional activities such as design, tooling fabrication, assembly and test. Identified schedule constraints and risk assessment shall be presented for each functional activity. Applicable experience to date should be used as supporting data for schedule projection. The analytical method used shall be described in detail. The assessment should result in a quantitative or qualitative probability of schedule achievement. (10)

As the ISA is initiated at ASD, it should provide some meaningful new assistance in understanding the current status of ASD programs. It should also provide a basis for a realistic analysis of its future performance and its potential for completion of schedule. It would be assisted by an ASD management data collection and sorting system and should provide good statusing assistance to project Vanguard.

Other Initiative 16 Team reports are summarized in Appendix 3 and 4 and is an excellent source for general P&S function review.

PROJECT VANGUARD

Project Vanguard was also an AFSC planning initiative. The following are excerpts from the contents of a letter issued by ASD/XR in May 1979 to provide for data collection for the project. (2)

1. The purpose of Vanguard is to provide integrated program planning for exploratory, advanced, and engineering development. Plans will be developed to describe activities for each mission area and will provide three perspectives: mission area, major force element, and functional. Plans will, in general, include a base line and proposal for changes

to the base line based on analyses and assessments. The plan will be briefed to the AFSC Panels, Program Evaluation Group (PEG), and Council during the Program Objective Memorandum (POM) development cycle. The AFSC plan, when approved by the Commander, will be the final output and will be submitted to the Air Staff at the AFSC POM input.

2. Within the direction guidelines of AFSC/XR, ASD will be responsible for the development of analyses and plans associated with many of the mission, major force element, and functional areas of Vanguard.

3. A first major effort in the Vanguard process is data collection. A portion of the required data is available in established planning documents, such as the Five Year Defense Plan (FYDP). However, it is necessary to enlist Product and Laboratory organizations for their assistance in data collection because of the need for identifying and categorizing program elements to the project level and because of the unique perspective that these organizations can lend to the process.

4. The following information is required for each Program Element/Project:

a. Name of Program and Program Element/Project Number.

b. Vanguard Planning Areas (Appendix 2) (Identify the Mission/Submissions, Major Force Elements, and Functional Areas for which this program has application). If more than one area is applicable, list them from most to least important.

c. Replacement (Identify what system or subsystem this replaces and how; i.e., Class V Modification. In the subsystem area also identify the major systems it is to be put on or in, and whether there is a specific effort established to accomplish this integration.)

d. Major Area of Improvement (Identify only those areas where significant improvement is expected and estimate the improvement which could be realized. If more than one is given, list them from most to least important).

e. Funding by Fiscal Year (the funding should be given either to the end of the program or to 1995, whichever comes first. These funds should be divided into R&D and Production funds for Program Element/Project. The initial five years should correspond to the January 1979 FYDP submission).

f. Date of Milestones and Planned IOC (for technology and subsystem programs not requiring SDARCs give the equivalent) as follows:

Milestone	Equivalent
0	Concept Formulation Study Sheet
1	Validation/Demonstration Start
2	Full-Scale Engineering Development Start
3	Production Decisions
IOC	Initial Operational Capability
	Production Start and Stop

g. Quantity to be produced if known.

h. Purpose (briefly state the purpose of the system, subsystem or technology program)

i. Description (a brief description of the system, subsystem, or technology program)

j. Related Programs or Support Technology (identify other programs which are related to this program or which are required for this program to be successful; i.e., PE/task number, point of contact, office symbol, OPR, etc.). Indicate whether integration with these Programs are sufficiently planned for and funded.

k. Remarks (provide any other information which may be of assistance in this project).

Vanguard planning areas are provided as Appendix 5 to this report.

AUTOMATED MANAGEMENT DATA SYSTEM

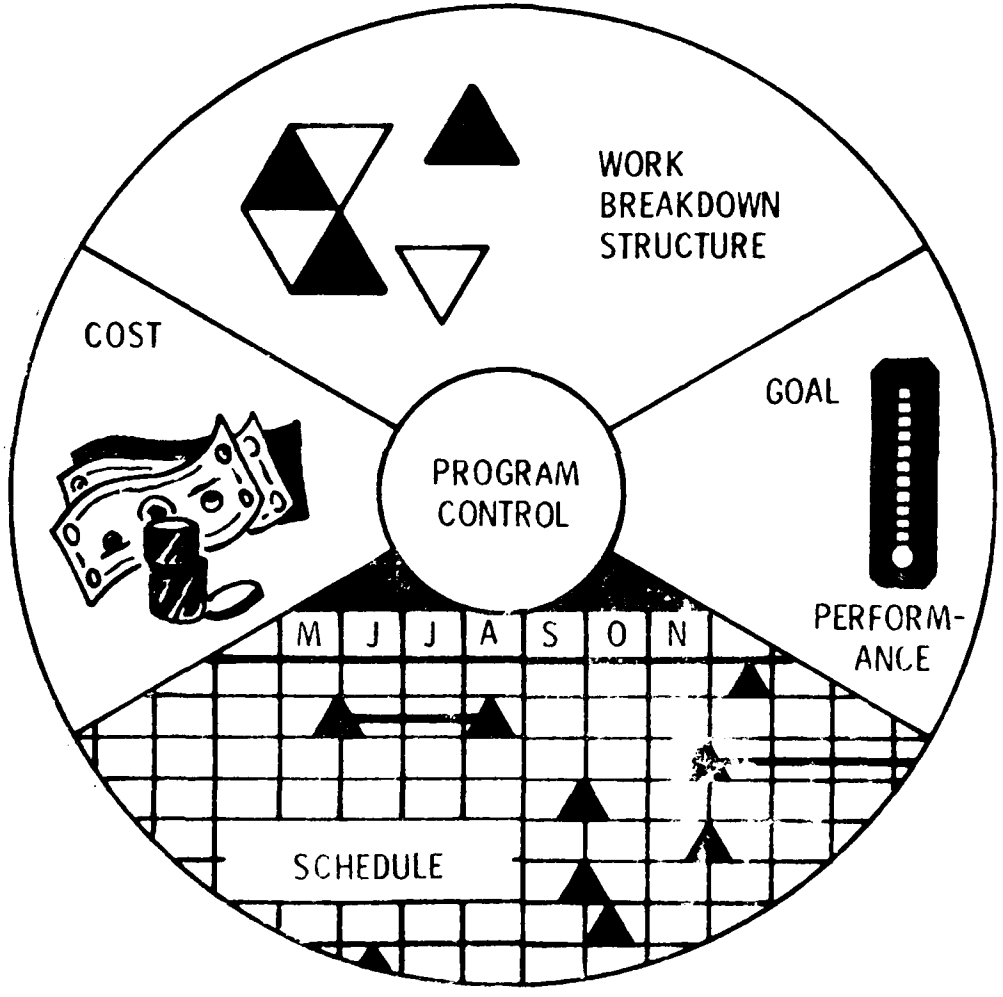
The need for an automated management data collection and sorting method to maintain the quantity of program detail status information required in a usable manner and on a timely basis has long been evident at ASD. ASD/AE developed such a system for its programs. The symbol on the cover of its Management Information System Guide well illustrates the goal of Program Control organizations in general and planning and scheduling as a participating function. (See Figure III-2)

In this guide AE describes the background for the system as follows.

> "The ASD/AE Management Information System (AEMIS) is an integrated management reporting system including a mechanized management data storage and retrieval system capable of providing recurring and special reports, in both hard copy and projected video form.
>
> The need for a computer-based system to provide corporate management information was recognized in early 1976 when the complex nature of the ASD/AE workload was investigated. This workload is large, diverse and highly dynamic. Summarization of corporate management data for this workload cannot be accomplished effectively by manual means. Development of the AEMIS Integrated Matrix Management Evaluation and Reporting System (IMMERSE) proceeded in areas appropriate for providing a valid corporate memory and reporting capability.
>
> The basic development concept employed was to design a computerized data bank containing input data from the various management functions

FIGURE III-2

AUTOMATED "MANAGEMENT INFORMATION SYSTEM GUIDE" ILLUSTRATION



supporting the AE program management efforts. The integration scheme is depicted in Figure III-3. The front face of the cube shows the types of input data envisioned for integration into the AE Management Information System. The top face of the cube represents the source of the input data and the side face depicts the various management levels capable of interrogating the system across the entire range of input data. This approach to system design enhances centralized control of a decentralized management effort normally associated with a multiprogram management organization. It also facilitates management information data retrieval from an almost infinite combination of data elements stored on each program." (11)

The following eighteen milestones were selected for their schedule tracking control.

Definitions of Key Milestones (11)

PROGRAM AUTHORITY RECEIVED
NEW START PROGRAM
PROGRAM STRATEGY ESTABLISHED
WORK BREAKDOWN STRUCTURE PREPARED
STATEMENT OF WORK PREPARED
RFP (Request for Proposal) RELEASED
START SOURCE SELECTION
CONTRACT AWARD
PDR (Preliminary Design Review) COMPLETED
CDR (Critical Design Review) COMPLETED
FIRST HARDWARE DELIVERED
  First prototype hardware (or software)
  For a pre-production contract this is the first pre-production model.
  For a production contract this is the first production model.
TEST PROGRAM COMPLETED
PROGRAM DECISION MADE
PCA (Physical Configuration Audit) HELD
MAX PRODUCTION RATE ACHIEVED
IOC (Initial Operational Capability)
PMRT (Program Management Responsibility Transfer)
PHYSICAL COMPLETION DATE

Additional information on the ASD/AE system is included in Appendix 1.

ASD-WIDE AUTOMATED MANAGEMENT INFORMATION SYSTEM

AFSC requested that this kind of system be developed on a broader scale and ASD/ACP began preparation for its ASD Automated Management Systems program. This program includes access to the many different types of ASD computer aided programs as a by-product of its need to collect data and sort it for program management.

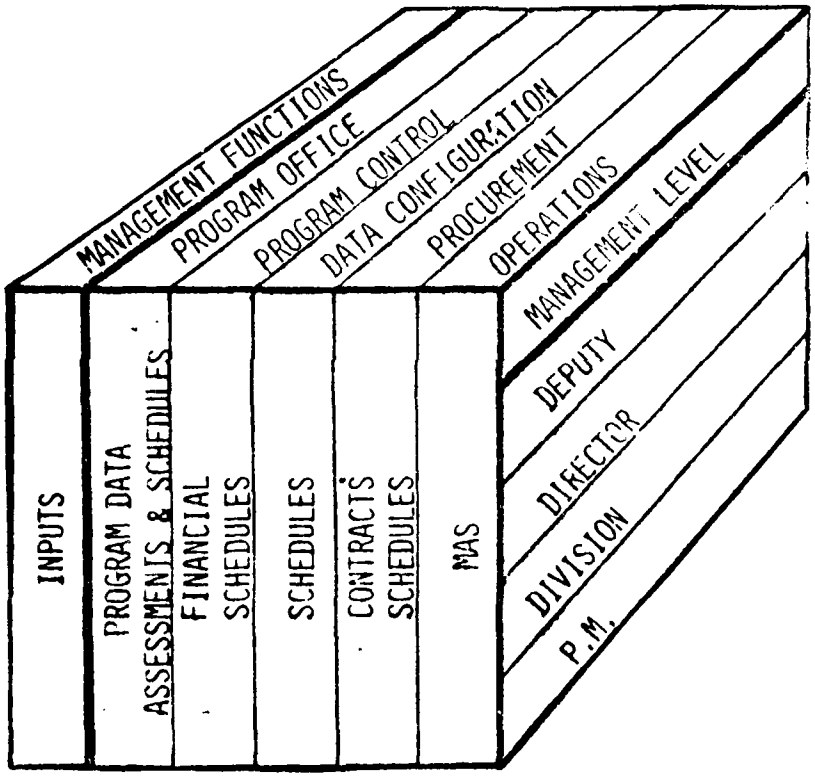
1. Studies - surveys, analyses, evaluations

2. Plans - program, procurement, implementation

3. Administrative Documentation - Projected automation requirements (PAR), data automation requirements (DAR), contract components, data base administration

FIGURE III-3

MANAGEMENT INFORMATION SYSTEM
DATA INTEGRATION



4. Program Control budgets, schedule and financial management, program documentation repository, access controls

5. Data Base administration - definition, access control, initialization

6. Procurement - buyer, contracting, source selection support

An interview with Col James Thompson of Program Control Directorate (ACP) in December 1979 indicated that ASD was adopting the "SMART" management information system technique used at Eglin AFB, Florida. At that time the new system had 60 current participants and 80 potential participants. Like any new system, constant encouraging was needed to obtain the data in a timely and complete manner but progress was steady. Automated viewgraphs, with the associated data, is one of the goals of the system and eventual use of desk mounted CRT's is hoped for in the future.

Excerpts from the Users Dictionary describe the essential aspects of SMART. These experts are provided in appendix 6.

IV. PLANNING AND SCHEDULING ORGANIZATION

Planning and scheduling as defined in section I is being primarily done by the Deputy for Development Planning (ASD/XR), the various SPO Program Control organizations, and the Contract Management Division (CMD). They are supported in this function by the Controller (ASD/AC) organizations, the Program Costs Directorate and the Cost Analysis Directorate and by the Deputy for Procurement and Manufacturing.

DEPUTY FOR DEVELOPMENT PLANNING (XR)

The Deputy for Development Planning (XR) is pulling the overall ASD mission plan together. XR supports AFSC Regulation 80-2, AFSC Plans and Programs, at ASD. Excerpts from this regulation describe the planning and scheduling type of functions included in this assignment. (13)

> This regulation establishes policy and assigns specific functions and responsibilities in AFSC for development planning activities and the AFSC Program Plan.
>
> 1. Policy:
>
> a. To implement the AFSC mission of advancing technology and acquiring systems and equipment needed by the United States Air Force requires planning which is divided into three categories.
>
> (1) Development planning is the process of recognizing and synthesizing the future needs of the Air Force and reconciling those needs with available technology.
>
> (2) Technology planning is the process of establishing the broad framework for the technology base programs. This planning includes establishing near and long term technology planning objectives that are responsive to Air Force capability needs.
>
> (3) Engineering development and production planning is the process of mapping out programs through full-scale development and production. It develops the time-phased costs and schedules for achieving the delivery of operational systems, subsystems, and equipment to the major commands (AFR 800-2).
>
> b. The AFSC Program Plan is the integration of development, technology, and engineering development and production planning activities into a logical ordering and flow of programs from the inception of ideas and technical options to production systems and equipment in the Air Force inventory.
>
> (1) The AFSC Program Plan is developed from USAF and OSD guidance, with the President's budget as a baseline, and forms the basis of the formal submission of the command in the Program Objectives Memorandum (POM) process.

(2) The AFSC Program Plan requires the development of a number of member plans to provide perspectives necessary for presentation and evaluation of the aggregate of programs. Mission area plans are prepared for each Air Force mission area such as strategic offense, strategic defense, tactical air-to-ground, and others. Major force element plans (such as for fighter force, missile force, and bomber force) address systems, supporting subsystems and armament that have enough homogeneity to accomplish a number of mission area tasks. Functional plans have functional or technical homogeneity and address subsystems or systems, technologies, and concepts that are common to two or more force elements, mission area tasks, or mission areas.

THE SPO, PROGRAM CONTROL ORGANIZATION

The next two primary planning and scheduling functions are the SPO program control organizations and CMD. The SPO Director of Program Control has the bulk of active program planning and scheduling along with the contractor coordination and data support function of CMD. The functions of CMD are described in some detail further on. The responsibility of the SPO Director of Program Control is excerpted from Functional Mission Statement (CPC 31, dated 76 March 79) issued by the Comptroller (AC).

PROGRAM CONTROL FUNCTIONAL MISSION STATEMENT

PURPOSE: The purpose of this policy letter is to provide an overall definition of the functions and responsibilities of SPO Program Control organizations. The functions and responsibilities listed in this policy letter represent a minimum level of performance that must be met by all Program Control organizations. Those organizations desiring to expand the scope of their responsibilities beyond those listed herein will do so through the publication of a SPO Operating Instruction (OI) covering those differences. All such OI's will be coordinated through ASD/AC.

The Director of Program Control for each organization at ASD is responsible to the System Program Director and his staff for all financial and resource management functions on assigned programs. These functions include:

Planning - This process consists of describing and assigning tasks so that all participants will mutually understand who is responsible for each acquisition action. Tasks include:

1. Integrating all plans into a Program Management Plan. Requires writing, editing, compiling, coordinating, distributing and updating of the plan with the assistance of other SPO and ASD staff activities.

2. Preparing and issuing Joint Agreements, Memos of Understanding, and other formal arrangements with other participants in the acquisition process.

3. Reviewing and analyzing the PMD and the AFSC Form 56 to identify the action needed to carry out the direction.

4. Maintaining the official documentation file for the SPO.

Scheduling - Develops and maintains a Master Schedule which incorporates all of the sub-schedules that are needed to fulfill the requirements of the Program Management Plan. These sub-schedules include, but are not limited to the following:

1. Manpower loading as related to various milestones.

2. WBS - Relate interfaces to key milestones.

3. Update schedules - report deviations from plan with impact and recommended solutions.

Forecasting - Looking downstream to see where a program is going and proposing alternatives to accommodate threat or hasten progress. The tasks include:

1. Develop and continually update the data base needed to make accurate projections.

2. Determine the validity of the data.

3. Know the assumptions upon which a forecast is based.

4. Test the forecast by determining the probability of the occurrence of events happening as scheduled.

5. Identify potential problems and develop alternative plans to accommodate these problems should they occur.

6. Project Program progress. (14)

THE COMPTROLLERS TWO SUPPORT FUNCTIONS

In the support area the comptroller has two organizations, ACP and ACC. ACC's activity in the Independent Schedule Assessment (ISA) is described in Section III. ACP is responsible for the automated management information system and assists the SPO Directors of Program Control in their mission in certain areas. An excerpt from Position Description ACP-09530 updated copy indicate some of the functions of ACP.

DUTIES AND RESPONSIBILITIES OF PROGRAM CONTROL DIRECTORATE

Type of Work Supervised

1. Formulation of top level policy and procedures for the management of the Comptroller matrix organization. This organization consists of over

350 personnel collocated in all ASD program offices. It covers the functional areas of financial management, cost analysis, program analysis, and all clerical areas.

2. Balancing the assigned matrix workforce against the requirements of the various ASD system program offices in order to insure an equitable balance of personnel, in numbers, functional skills, and levels of experience in each organization consistent with the relative priority of each program and with its position in the acquisition life cycle.

3. Design, development, test, and implementation of automated management systems for use in all aspects of acquisition program management at all levels in ASD up through Commander, ASD level. Integration of locally developed systems with systems directed by higher headquarters. Chair ASD Automated Management Working Group, and serve as secretariat for ASD Automated Management Steering Group which is chaired by the Comptroller, ASD. Integration of diverse requirements of separate ASD SPO's and staff agencies into a unified ASD automation program for approval by the Commander, ASD.

4. Management of the ASD Manhour Accounting System (MAS) throughout ASD and all analysis of MAS information. Production of special studies and analyses of MAS data for ASD managers at all levels including Commander, ASD.

5. Conduct workload surveys of ASD organizations to determine detailed personnel requirements in program control functional areas. (15)

THE DEPUTY FOR PROCUREMENT AND MANUFACTURING (PP)

The role of the Deputy for Procurement and Manufacturing (PP) is well established in ASD. It includes procurement specialists who are knowledgeable to procurement lead times and contractor/vendor delivery capability. It also includes manufacturing specialists who are fully qualified to assess production lead times and production plan feasibilities. These personnel are essential to SPO planning and scheduling capability.

CONTRACT MANAGEMENT DIVISION

Although the Contract Management Division is a separate division from ASD it is an integral part of the planning and scheduling function for ASD programs. The following excerpts from a CMD briefing explain their function. (3)

AFCMD Headquarters Functions

1. Ensure effective implementation of contract management policies and procedures throughout the command.
2. Promote and facilitate necessary coordination between the various plant representative and test site offices.
3. Ensure effective response by field units to requirements laid on by system program offices and higher headquarters.
4. Evaluate Air Force and DOD procurement policies and procedures in the light of field experience and recommend changes needed to improve in-plant aspects of weapon system procurement.

5. The Headquarters directorates and staff offices also accomplish a number of operational functions. These include production readiness reviews, "should cost" studies, surveys of contractor management systems and procurement methods, price analyses of contractor proposals, default terminations, flight operations standardization and evaluation, reviews on contractor's inventions and patent activities, reviews and analyses of contractor insurance programs, and management of communications security.
6. New ideas and projects for improving contract management, which have been assigned major command emphasis.

The CMD Mission is to "help the System Program Director bring his program in on target and to see that the contractors under AFCMD cognizance live up to their contractual promises." The arms of AFCMD which are in direct contact with the contractor are the AFPRO's (Air Force Plant Representative Office). The AFPRO/SPO relationship and his functions are described as follows:

AFPRO/SPO Relationship

The AFPRO SPO relationship is one wherein the AFPRO is a member of a team whose efforts, in support of the SPO are planned, organized, and coordinated between the Air Force Plant Representative and the System Program Director to expeditiously, effectively, and economically complete the SPO's acquisition program.

As with all other organizations participating in the acquisition program, the AFPRO/SPO relationship is a "two way street" and reciprocity is essential:

a. The SPD must insure the participating AFPR is constantly aware of his program from all viewpoints which affect the contract and any changes in the support to be provided by the AFPRO.

b. The appropriate AFPR must insure that the SPD is constantly informed of the contractor's performance to the terms of the contract and of any problems that may impact the support to be provided by the AFPRO.

During the process of establishing the requirements to be negotiated with the AFPR for his particular program, the SPD must consider that each AFPRO has several contracts (sometimes as many as several hundred) assigned from AFSC, AFLC, Army, Navy and NASA. Many programs have a "tailored" set of instructions to be performed by the AFPRO; e.g., not all assigned contracts require performance of all AFCMD functions nor are the functions common to all contracts performed in the same manner. Further, the SPO and AFPRO are each responsible for various aspects of the contract. Therefore, the SPD and associated AFPR must get together to determine those functions that can be most effectively and efficiently performed in-plant by the AFPRO and to "carve out" those that can best be performed within the SPO.

The procedures to be followed and specific tasks required of the AFPRO, including associated delegations, limitations, schedules, and processes necessary to establish and maintain clear lines of communications between the SPO and AFPRO, are formally documented and agreed to in a Memorandum of Agreement (MOA).

MEMORANDUM OF AGREEMENT (MOA)

Normal contract administration service support functions are listed in Armed Services Procurement Regulation (ASPR) 1-406. The MOA is used by AFCMD to clarify support requirements, delete unnecessary functions, or specify additional functions, over and above those listed in the ASPR, to be performed by an AFPRO for a SPO or other buying activity. The agreement stipulates the functions to be performed, including delegations of authority to perform those functions and the procedures for incorporation required changes in applicable contracts.

A clear, understandable MOA facilitates provision of contract management support to the program offices by reducing the total decision-making time, assuring compliance with contractual requirements (cost, schedule, performance), and closely integrating the DOD-industry team's effort to cope with program variations.

TYPICAL AFPRO FUNCTIONS

ENGINEERING

1. Provide in-plant engineering support to systems program offices and other buying activities.
2. Assure the contractor has acceptable engineering management systems and that he follows those systems.
3. Help assure complete contractor understanding of contractor specification requirements.
4. Evaluate the engineering aspects of contractor's proposals.

MANUFACTURING OPERATIONS

1. Evaluate the contractor's production planning and manufacturing capability.
2. Evaluate and act on contractor need for manufacturing resources.
3. Check the contractor's manufacturing operations day-to-day.
4. Track and report on status of contractor deliveries.
5. Evaluate the contractor's traffic management system.
6. Evaluate the contractor's packaging management system.

ESTIMATING FUNCTIONAL SIMILARITIES

The elements of estimating have many things in common with planning, scheduling, and cost. The same data collected by estimators is required to identify engineerinng and production functions, and material and other resources required to develop the schedule. Master's Thesis by Major (USAF) Edwin M. Lewis and Eugene D. Pearson on "The Air Force Cost Estimating Process: The Agencies Involved and Estimating Techniques Used" has been added as Appendix 2.

V. QUESTIONS FOR PLANNING & SCHEDULING ENHANCEMENT

The planning and scheduling related organizations can always improve their effectiveness by asking itself certain questions basic to that discipline. Some of these questions follow. They are proposed for self-testing of the function. When responses are received, they will be used to make constructive recommendations for the overall integration and coordination of planning and scheduling at ASD.

Questions that are common to all organizations should be these:

1. Do the top managers and staff of each of these organizations have readily available the current schedule dates and schedule status of the major milestones of the program which are included in their operational responsibility? It is not possible for managers to give proper priority and direction to his portion of a program if he is not aware of the the same schedule information which higher command must have. Common major milestone reports must be available to the operating and supporting organizations.

2. How compatible are the planning and scheduling policies and procedures among these organizations? Lack of commonality in data gathering, sorting, and evaluating techniques can lead to serious inconsistencies in data as it is reported to higher command. Unless definite ground rules exist for the definition of activities, milestones, status and variance reports, they will have different meanings even if they look alike on the surface.

3. Is any one officer at ASD reviewing, even at a summary level, the quality of the planning and scheduling support that is necessary including the CMD/AFPRO support? It does not have to utilize all of the ASD Program Control methods as some contractors use, but it should at least request the assistance of a few people, on a regular basis, to look at what is happening and highlighting problem areas with recommended solutions.

Questions for some organizations:

1. How does the methodology used in developing Vanguard relate to other efforts at program integration at ASD? Duplication of effort and redefinition of data categories and symbols can cause added confusion when follow-up maintenance is done either on Vanguard or on its possible successors. Since the Vanguard methodology has been directed by higher command, existing ASD practices may need to be revised or the differences clearly explained in applicable reports.

2. What is the relationship of new program plans to the master plan for ASD's portion of the USAF mission, and the ongoing programs, or how capable ASD is in relating what is happening on the ongoing programs (status and schedule forecasts) to the work it is doing on new programs and the master mission plan?

3. As automated management systems are becoming operational, will the using and supporting organizations have adequately resolved the differences which always exist in manual system or unique automated systems, so that data compatibility will exist in the central system? The job of initiating and assuring the heavy negotiation necessary to assure the necessary agreements, or command arbitration, will be a large one and should be given equal priority to that of developing the automated system itself.

4. What impact will the implementation of the Independent Schedule Assessment Program have on the existing data collection and evaluation systems? As large amounts of data gathering and processing continues to become more practical, the demand for an integrated master plan such as Vanguard, will increase and the desire for implementation of the ISA, at greater and greater levels of detail, will increase. The maintenance of Vanguard will require a large amount of data on a regular and dependable basis. Are the cost collection channels which provide data to the cost centers to the comptroller organization able to provide the same quality of schedule status data? At the contractor level cost and schedule data is sometimes incompatible and cost usually has the advantage. The ground rules for validating and evaluating schedule data is in some ways different than for cost data.

5. Is the level of quality for schedule data received from the contractor and CMD data processing systems, believed to be satisfactory? Inconsistency and inadequacy should be immediately addressed.

6. Are the areas currently being measured for schedule performance adequate to forecast potential schedule trouble at a reasonable level of accuracy? If schedule surprises are more the rule than the exception, then definite improvement should be expected in the data reporting requirements.

7. Do the personnel responsible for evaluation and guiding the program planning and scheduling function have adequate experience and training in this field? A program manager must have people who can recognize trends in schedule slippage, in adequate or incomplete data, and evaluate the contractor's compliance with the reporting system such as C/SCSC, with which he is supposed to be complying in the planning and scheduling area.

8. Does the program completion milestones on my programs have the same degree of validity as the bottom-line in the cost area? The cost area traditionally receives more attention. The schedule evaluation can be equally important, particularly for national security, compared to the dollar evaluation.

9. Are the Work Packages defined by the contractor adequate for accurate tracking and validation of completion? There can be a tendency to allow these basic elements of a good schedule to become vague, which will cause the completion percentage progress report to be equally vague. The contractor should do things according to his best and proven method, but it must provide the Air Force with usable data.

10. Do the answers to the questions answered by the other organizations reflect back on the way CMD has been collecting and reporting the program data and what can be done about it? Perhaps some of the answers will be due to a lack of understanding on how the data can be used, but data quality appears to be primarily the responsibility of CMD with the contractor.

These questions reflect on the kind of role these organizations should be playing in the planning and scheduling area. It is important to try to pull the right answers to these questions together and make recommendations for improvement. This effort should not be just a one-time effort but is a function that the staff of ASD should be doing on a regular basis to maintain program schedule integrity.

VI. CONCLUSIONS

The motivation for the Initiative 16 on "Independent Schedule Assessment" and the Vanguard AFSC initiative surely includes a concern for the adequacy of the planning and scheduling function in AFSC and ASD.

At the beginning of this report, five questions were raised as being partially answerable by this report. A summary of those answers, which are detailed by the contents of the report itself, are as follows:

1. A definition of planning and scheduling and the key variables that significantly effect its operation are discussed in detail in Section I.

2. The proper role for planning and scheduling will become more clear as responses to this report are gathered and follow-on reports are prepared. Certainly the heart of the answer is for the P&S functions to carry out to the fullest degree possible the spirit and letter of the quoted official documents in this report.

3. The integration and coordination of the Independent Schedule Assessment, project Vanguard, and an automated management information system into the planning and scheduling activites is one of the objectives of this report by exposing them and interrelating them to each other and other P&S policies, activities and related organizations.

4. The role of organizations in planning and scheduling at ASD is dealt with in Section IV. However, an expansion on coordinations of these roles will be dealt with in follow-on reports based upon responses to this report and the more current environment that will exist when this follow-on report is prepared. The roles of P&S related organizations have been changing rapidly and this report hopefully will continue a positive trend in this area.

Questions concerning the planning and scheduling enhancement opportunities at ASD have been documented in Section V.

ASD has a good opportunity at this particular time to assess its planning and scheduling operation and the implementation of such functions as the "Independent Schedule Assessment," "Vanguard," and an "Automated Management System" could make meaningful improvements. In the spirit of this recommendation, this report concludes with an outline of a follow-on reserve project which will accomplish the following tasks:

1. Perform a survey of the applicable organizations to determine their answers to the types of questions asked in Section V.

2. Discuss with the responsible organizations possible ways in which the ISA, Vanguard, and AMS could be integrated.

3. Prepare specific recommendations for improving the ASD planning and scheduling operation.

Planning and scheduling is of course time management. Time is not only money, but for the Air Force it is also national security. If this study can contribute to greater savings and earlier performance, its contribution should be meaningful.

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APPENDIX 1

ASD/AE MANAGEMENT SYSTEM EXAMPLE

This excerpt from AEOI 10-1, dated 31 August 1978, illustrates the level of attention and the importance of the quality of the evaluation procedure and the material reviewed.

ASD/AE REVIEWS

a. ASD/AE Corporate Review Group (CRG): A senior management review group that assures proper management attention, consistent with available resources, is given to all ASD/AE work efforts.

Membership is as follows:

ASD/AE Deputy - Chairman
ASD/AE Assistant Deputy
ASD/AE Technical Director
ASD/AE Assistant Deputy for Programs
ASD/AEP Director
ASD/AEK Director
ASD/AEC Director
ASD/AEQ Director

NOTE: The secretariat for all formal reviews by the CRB will be provided by ASD/AEP.

b. ASD/AE Briefing Review Board (BRB):

(1) A senior management review group that assures proper management attention is provided to insure professional, accurate and relevant briefings to:

(a) The ASD Council

(b) A General Officer Panel/Study Group

(c) A General Officer/Equivalent Grade Civilian

(d) Four-Letter Symbol Air Staff Elements

(e) Three-Letter Symbol HQ AFSC Staff Elements

(2) Membership is as follows:

ASD/AE Assistant Deputy -Chairman
ASD/AE Technical Director
ASD/AE Assistant Deputy for Programs
ASD/AEP Director
ASD/AEK Director
ASD/AEC Director
ASD/AEQ Director

NOTE: The secretariat for all formal reviews by the BRB will be provided by the three-letter symbol office making the presentation.

c. Command Assessment Review (CAR): This review is set forth in AFSCR 800-1 and AFSCR 800-23. Such reviews will be presented to the BRB, CRG, and ASD Council.

d. New Start: A program/project for which appropriate direction has tasked ASD/AE to initiate either a new program or to add new work to an on-going program.

e. New Start Review (NSR): This review assesses the applicability of a new start work effort to the overall mission of ASD/AE. In addition, the availability of presently assigned manpower, future forecast, and ASD/AE available resources to carry out the new work effort are reviewed. This review is conducted by the ASD/AE three-letter symbol SPO gaining the new work effort and presented to the ASD/AE CRG. The results of this NSR is an ASD/AE decision to proceed or not proceed with the proposed new work effort.

f. Initial Program Review (IPR): This review examines management and business approaches to an approved new start effort. This review is conducted by the cognizant ASD/AE three-letter symbol SPO and, if directed by the NSR, presented to the ASD/AE CRG. The purpose of this review is for the three-letter symbol SPO to present the results of their previously conducted Business Strategy Meetings, cost trade-offs (if applicable) and other refined program strategy aspects since the time of the NSR. The cognizant SPO should have by now selected alternatives for the successful conduct of their NSR assigned program, identified performance, cost and schedule baselines, and be prepared to commit to measurement thresholds.

g. Three-Letter Symbol Organization Program Review (TOPR): This review is conducted to maintain SPO management cognizance of the status of each ongoing work effort.

h. Management Assessment Review (MAR): This review is conducted to provide information concerning the status and details of existing/potential problems relative to established cost, schedule, technical performance baselines, and other assessment criteria.

i. Program Management Review (PMR): This review provides visibility into program problem areas and the attendant course of action for solution. In addition, topics of special interest are presented.

j. ASD/AE Special Program Reviews (AE-SPR): This review provides detailed status of ongoing efforts considered to be of major importance. Such reviews are scheduled at the direction of ASD/AE.

k. ASD/AE Functional Management Review (AE-FMR): This review provides an overview of all ASD/AE business and a summary of resource allocations to ASD/AE. This review is conducted at ASD/AE direction not less than quarterly and immediately preceding the ASD FMR." (5)

In order to properly prepare for these reviews, the following list of charts are prepared for command review briefings, as required. A quick review of these titles alone indicate that over half of them are affected by schedule/cost factors.

ASD/AE Program Review Charts

Prog Data Sheet Chart
History Chart
Prog Doc/Review Level Chart
Cost Risk Chart
Prog Funding Allocations Chart
Proc Actions Schedule Chart
Schedule Risk Chart
System Performance Chart
Prog Control Chart
Life Cycle Cost Chart
Logistics Chart
System Safety Chart
Config Mgt Chart
Govt Furnished Matls/ Facilities Chart
Source Selection Procedures Chart
Alternate Proc Approach Chart
Should Cost Chart
Personnel Resources Chart
Prog Direction Summary Chart
Development Funds Chart
Production Funds Chart
Prog Major Milestone Schedule Chart
Prog Schedule (AFSC Fm 103) Chart
Threat Status Chart
Tech Risk/Risk Reduction Chart
Design to Cost Chart
Integrated Logistics Plng Chart
Rel/Maintain Chart
Value Engrg Chart
Item Test Summary Chart
Prod Readiness Review Chart
Negotiation Authority Chart
Contract Type Chart
PMRT Chart

This is an example of how one of the ASD SPO's has responded to the planning and scheduling obligation. Others have used difference methods.

APPENDIX 2

ESTIMATING FUNCTIONAL SIMILARITIES

In order to address the area of planning in the early phase of a program the following excerpt from a Master's Thesis by Maj (USAF) Edwin M. Lewis and Eugene D. Pearson on "The Air Force Cost Estimating Process is Provided."

"Aeronautical Systems Division. ASD SPOs generate cost estimates in all four phases of the weapon system acquisition cycle. Within ASD, the Directorate of Cost Analysis, Advanced Systems Division (ASD/ACCX) is responsible for generating the cost estimates in the conceptual phase. The SPOs, which are formed toward the end of the conceptual phase, use the estimates generated by ASD/ACCX as their own estimate for that phase. The SPO personnel generate their own estimates in the remaining phases. 'ASD/ACCX does the initial phase estimating.' Therefore, ASD/ACCX is considered by ASD personnel to be the SPO for the major portion of the conceptual phase. They work on pre-ROC studies and conduct studies to meet the ROC after it is developed.

The amount of data available for use by the estimators influenced the type of technique used to a great extent. Personnel from one SPO emphasized this, claiming 'The technique used is driven by the amount and type of data available.' The ASD SPO estimators use parametric estimating techniques in the conceptual and validation phases. The RCA PRICE model is used for estimating electronic equipment. CERs, expert opinion, and analogies are relied upon quite heavily for generation cost estimates in both of these phases. An attempt is made to correlate design parameters to historical cost data from other programs and arrive at the estimated cost of the new weapon system. In the full scale development phase, the estimators use some parametric techniques, but begin to rely on engineering techniques. They are able to use detailed engineering, statistical (grass roots), marginal analysis and trend analysis techniques. Prototype weapon systems have been developed and produced, yielding a much greater data base to work with. The estimators also have the work break down packages from the Cost/Schedule Control Systems Criteria (C/SCSC) available for the weapon system they are working on. This added data base allows the estimator to use the engineering techniques. In the production phase, actual production data is available. Historical standard time/cost by task and historical trends are used to generate the cost estimates during this phase (47).

Cost estimates are generated by the ASD SPOs for a variety of reasons, the primary ones being for program advocacy to the AFSARC and DSARC and for budget preparation. Cost estimates are also used for program control and adjustment, 'what if' contingency reviews, and in support of source selection and contract negotiations. In the conceptual and validation phases, the cost estimates are used in making comparisons

between the different weapon systems under consideration. The cost estimates give the decision makers at the Air Staff and DOD a gross idea of the costs involved to achieve a certain capability.

In summary, the ASD SPOs validate the model in all areas except technique used. The ASD SPOs make cost estimates in the conceptual, validation, full scale development, and production phases of the weapon system acquisition cycle. The amount of data available for generating cost estimates grows from very little (vague) to extensive, production data (historical). The quality and quantity of data grows as the weapon system progresses through the cycle while the risk and the time over which estimates are required to be valid decreases. The SPOs make estimates for two major reasons--program advocacy and budget generation. In the area of techniques used, the ASD SPOs use parametric estimating techniques to generate cost estimates in the conceptual and validation phases. They use research and development and engineering techniques in the full scale development phase, and standards techniques in the production phase. The type of technique used is dependent upon the amount of data available. The individual estimator chooses which technique he will use based upon his interpretation of the amount of data available." (7)

APPENDIX 3

INITIATIVE 16 TEAM MEMBER ASSESSMENT

This section includes a copy of an Initiative 16 Team member report prepared after his interviews of some ASD SPOs. This report is of course only one man's opinion. But it may offer some good clues as to some current strengths and weaknesses in ASD in the planning and scheduling area. It was written in June of 1978 by Lt John R. McNally of ASD.

"SUBJECT: Command Initiative 16, Improve the Quality of Program Schedules.

1. I have completed the review of ASD program offices with regards to what methods are used for schedule assessment. Since ASD has representation from both AC and PM, my efforts centered on the ASD manufacturing community. However, I did interview some program managers and the F-16 focal point for schedules in Program Control (ASD/YPPP).

2. During my interviews, all personnel stated that there was no formal method presently being used to analyze schedules. In most offices, Program Control receives scheduling inputs from the functional areas to establish the master schedule, however, there is no further analysis of the schedule. Except for the people in ASD/YP, the personnel interviewed were not aware of which office within Program Control was responsible for schedule analysis. In ASD/AE the individual program managers were responsible for the schedule. They rely on experience and do not perform a formal schedule analysis. The primary reasons given for lack of schedule analysis at ASD were:

a. The schedule was established by the PMD and it is easier in most cases to live with it than to try to change it and possibly end up further behind schedule.

b. In the case of the F-16, the schedule was established in a large part by State Department agreements and cannot be changed.

c. The experience with a particular contractor does not warrant a detailed analysis when the contractor says he can meet a schedule.

3. Experience with a contractor and system, knowledge of the product and judgement were three qualities that those interviewed believed were essential for analyzing schedules and unless an individual had considerable knowledge and experience he could not evaluate schedule realism. The experience of an individual will dictate whether or not program leadtimes, e.g. procurement, were realistic and sufficiently addressed. Since there was no formal method used for schedule analysis, the majority of people relied heavily on the contractor's schedule as well as their own experience. Manufacturing in some instances used the Line of Balance technique. However, they

also generally relied on the contractor's schedule except for the long lead items which were more thoroughly analyzed.

4. During the interview the people were questioned concerning what factors would be necessary to address if a formal methodology could be developed.

Some stated that a formal method was impractical due to the variations in programs. Others favored a checklist type of approach which would still rely on an individuals experience. Those who did feel it could be achieved recommended that in addition to performance factors that the Air Force experience with a particular contractor, the contractor's experience and long lead items some how be recognized. These items should then be tied into cost and program phase.

5. Following are my conclusions as a result of the survey:

a. No formal method is being used at ASD to analyze master program schedules.

b. Experience is essential to schedule analysis and the individuals experience will dictate whether or not a schedule is realistic.

c. Manufacturing approaches a formal analysis by using the Line of Balance technique, but they still rely heavily on contractor inputs.

d. Attitudes are divergent on the practicality of establishing a formal schedule analysis methodology.

APPENDIX 4

INITIATIVE 16 TEAM AFPRO REPORT

When the Initiative 16 team did a survey of the AFPRO's concerning whether they performed schedule assessments the following results were reported.

SUMMARY OF AFPRO RESPONSES
TO
INITIATIVE #16 QUESTIONS ON CURRENT METHODOLOGY USED

1. Does the AFPRO have a structured program schedule assessment technique/methodology?

The AFPROs do not have a structured technique/methodology except for the standard systems required on contract as C/SCSC, Line of Balance, etc. Our personnel evaluate contractor provided data and supporting rationale to determine whether near term schedule can be achieved. When the AFPROs are requested to review contractor plans during early acquisition phase by Pre-Award Survey and Manufacturing Management/ Production Capability Review, time restrictions inhibit detailed analyses of overall program milestone schedules.

2. Is the schedule assessment methodology documented?

No, not in the context of a methodology for assessing achievability and accuracy of overall program milestones.

3. What individual (or office) is most knowledgeable of the application of the schedule assessment methodology?

Data is available at HQ AFCMD/PD for whoever desires the information.

4. How is the schedule assessment information applied or used (Source selection, PAS, MM/PC, CMR, etc.).

The information is provided to the buying activity for the above reviews.

5. What offices (AFPRO internal, AFCMD, SPO, etc.) use the schedule assessment information?

The AFPRO functional offices use the information and it is also provided to the SPO for visibility of schedule achievement.

6. How is the schedule assessment data generated (i.e., parametrics, grass roots, analogy, modeling, etc.)

Generally, contractor generates data by grass roots method or analogy comparison with prior completed systems. AFPRO personnel analyze the contractor's back-up data to assess whether planned milestones are achievable.

7. Does the nature of the program/project (conceptual, validation, FSD, production) impact the application of the schedule assessment methodology or the accuracy of its output?

Yes, there is more accuracy in the schedule assessment data as the program/project nears the end of the acquisition life cycle.

8. Is the schedule assessment methodology appropriate for near-term schedule analysis vs DSARC milestone schedule analysis or both?

Our capabilities are directed more to near-term schedule assessment of contract tasks and end item deliveries rather than overall program milestones. This is within the purview of program office responsibility.

9. What is the primary deficiency in present program schedule assessment techniques/methodologies being used by the AFPRO?

a. Evaluators must be more knowledgeable of contractor operations and management systems. Better training courses are needed in this area.

b. Resources aren't available to maintain and update historical data.

c. Real time information is needed.

10. What techniques do contractors use to evaluate a subcontractor's projected schedules?

Contractors use Pre-Award Surveys to evaluate a subcontractor's capability to meet schedules. They also rely on their past experiences with known subcontractors. (1)

AFPRO REPORTS RELATED TO P&S

The AFCMD/AFPRO uses many methods to accomplish his mission. Three of them are the Production Plan, the Production Progress Report, and the Production Analysis Report. These reports are described as follows:

1. Production Plan - The Production Plan permits evaluation of make-or-buy proposals and manufacturing capability, in conjunction with the contractor's planning to support the development/production/testing efforts associated with a proposed program. This is applied primarily in the Definition Phase on complete systems and GFAE equipment/subsystem programs.

General Procedures:

A production plan shall be prepared portraying methods and concepts for employing facilities, tooling, and manpower resources of the contractor and subcontractors. It reflects all time-phased production actions required to produce, test, inspect, and deliver acceptable contractual end items on schedules and at minimum cost.

Production Planning

a. Delivery Schedule. Depict the proposed delivery schedule for all end items to be produced to support the proposed program, to include test articles and operational end items.

b. Manufacturing Leadtime. Depict the relationship of time-phased milestones for in-plant and subcontracted effort from contract go-ahead to delivery of the first end item. Manufacturing leadtime to meet the initial production block release quantity and the total schedule will be depicted to indicate those items which require prebuy funding release or a specified contract go-ahead date, in order to meet the proposed delivery schedule.

c. Master Phasing Chart. Provide a Master Phasing Chart depicting milestones for each element that controls time phasing of the total program to meet the projected schedule. This chart should include major elements such as contract awarded research/development testing, materials procurement, tooling, facilities, GFAE deliveries, fabrication, subassembly, assembly, production testing, and delivery of end items.

d. Production Control. Provide an explanation of the existing or proposed production control system. Details of the system should be outlined to ensure that the planned program can be accomplished. The relationship between configuration control, quality control, and production control will be explained. The plan to consolidate related data in an Integrated Records System will be provided.

e. Manufacturing Plan. Provide a manufacturing plan utilizing a goes-into chart, tree chart, or equivalent to portray the planned process of manufacturer and assembly in terms of key plan operations or assembly points showing their total and individual leadtimes, from procurement of raw material to delivery of the end item (i.e., one management tool that may be used to portray and measure a manufacturing plan in the "Line of Balance" method or technique.)

f. Experience:

(1) Provide a listing of types of items or systems produced within the past five years that are comparable in size/complexity to the items specified in the acquisition phase work statement.

(2) Provide in chart form contractor past performance within the past five years to include (a) number and type of contract, (b) item description, (c) quantity, (d) total dollar amount, (e) percentage of underrun, (f) percentage of overrun, (g) percentage of on-time delivery (monthly-rate), and (h) contractor's ability to meet technical requirements.

2. Production Progress Report - For providing production status, identification of production deficiencies, or delinquencies, incipient problem areas, and other significant facts relating to the qualitative and timely delivery of contract items to the Government. Applicable for inclusion in any contract requiring status reporting on contract line items.

3. Production Analysis Report - This is used to (a) graphically portray the progress made in the fabrication, procurement, and assembly of end items and major subassemblies; (b) show deficiencies and overages of raw materials, parts, and subassemblies; (c) depict the status of manufacturing operation necessary to fulfillment of the contract; and (d) identify sources of difficulty or delays in production before the trouble becomes acute.

This normally applied during the acquisition phase.

Preparation Instructions

1. The contractor shall prepare a production analysis report setting forth:

a. Schedule and Delivery of End Items consisting of:

(1) A graphic chart of the end item contract delivery schedule, in quantities, by month, for items on contract. In addition, another line will show the end item cumulative net position through the current month and a forecast of acceptance for the next 6 months, by month. Whenever the forecast deviates from the contract schedule, a minus sign (-) shall indicate "behind schedule" and plus sign (+), "ahead of schedule."

(2) A bar chart, depicting the cumulative number of end items that have been accepted.

b. Stock Position and Balance Line. All figures will be expressed in terms of end-item sets. The line of balance will show the status required for each of the control points as of the date of observation. It will show the level of material, parts of major assemblies needed to support on-schedule production. The actual status will be plotted for each control point. The height of the bar for each control point is determined by cumulative receipts as of the date of observation. This cumulative quantity will always be expressed in sets. The item will not be counted unless complete in every detail.

c. Production Plan. The contractor will prepare a flow diagram which represents the respective leadtimes of each of the established production control points schematically depicting the entire production operation. These control points, which represent homogeneous groups of materials, components, and major assembly or fabrication operations required in the manufacture of a system or major component of a system, will be numbered in sequence from left to right. The leadtimes for these points will be shown graphically against a time scale at the bottom of the chart. All time phasing will be expressed in leadtime prior to final acceptance of the end item. Management may include as much detail as desired. However, it is desirable to avoid unnecessary detail and include only the most important steps in the production plan.

2. A narrative statement will accompany the Production Analysis Report and contain data on each shortage or problem reported on the Production Analysis Report, in the following outline:

a. A brief statement as to the difficulty being encountered on all items below the line of balance.

b. Action taken to alleviate the problem. A statement as to the corrective action being taken with forecast "get well" dates.

c. Forecast recovery date. Any other pertinent information of the problem which the contractor thinks should be brought to the attention of management. (9)

APPENDIX 5

VANGUARD PLANNING AREAS

A. MISSION/SUB-MISSION

1. Strategic Offense

2. Strategic Defense

   a. Atmospheric Surveillance and Warning
   b. Atmospheric Threat Engagement
   c. Ballistic Missile Defense
   d. Space Defense
   e. Anti-Satellite

3. Counter Air

   a. Command and Control Countermeasures
   b. Offensive
   c. Defensive

4. Air to Surface

   a. Defense Suppression
   b. Fixed Targets
   c. Non-Fixed Targets

5. Airlift

   a. Intertheater
   b. Intratheater
   c. Support

6. Recc/Intel

   a. Reconnaissance
   b. Surveillance
   c. Correlation/Fusion

7. C3

   a. Strategic
   b. Tactical
   c. Support

B. MAJOR FORCE ELEMENTS

1. Strategic Offensive Aircraft

2. Fighter/Fighter Bombers

3. ICBM

In Figure A5-1 is shown an example of a Vanguard illustrated chart. The comparison to a summary level CPM bar-graph is evident. With the associated back-up and the ability to maintain that back-up with an ISA and automated management data collection and sorting system, the capacity for an integrated ASD planning and scheduling system significantly improves.

C. FUNCTIONAL

1. Propulsion
2. Avionics
3. RPV-Drones
4. EW
5. Conventional Armaments and Missiles
6. Nuclear Munitions
7. Space
8. Computer Resources

MAJOR AREA OF IMPROVEMENT

Operational Readiness
Sortie Generation Rate
Reliability
Maintainability
Weather
Target Acquisition
Navigation
Survivability
- Ground
- Air

Payload-Range
Accuracy
Weapon Effects
Cost
- RDT&E
- Production
- Operation & Support

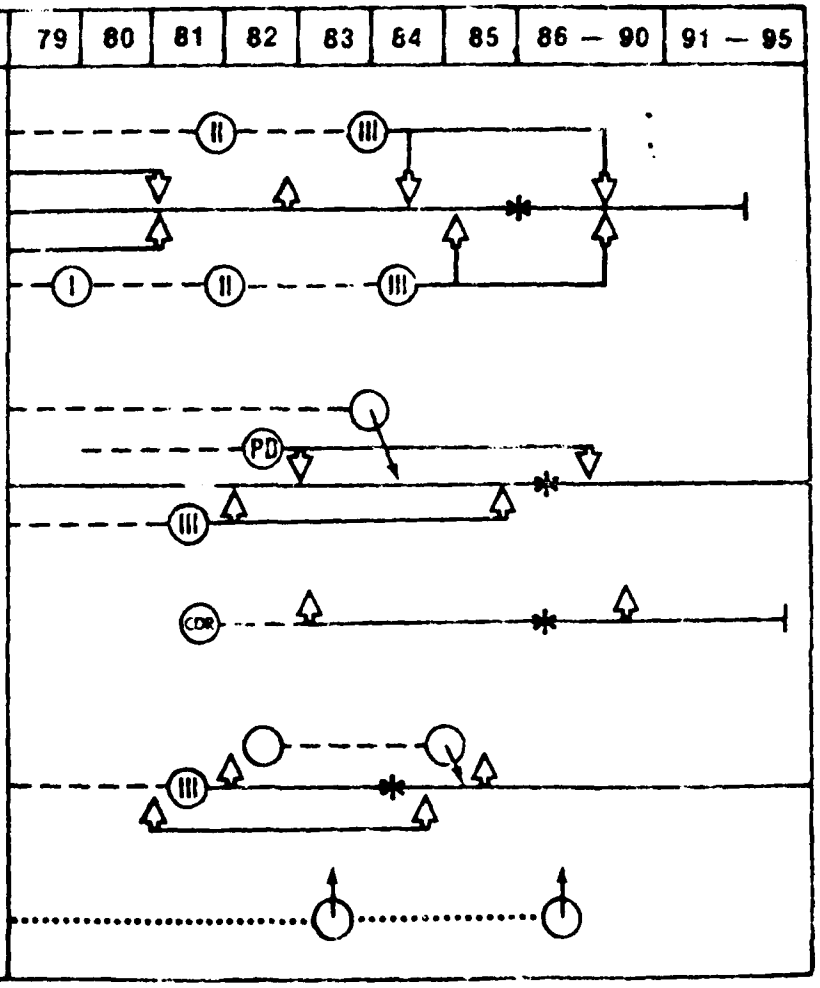
Flexibility
Frequency Coverage
Response Time
Energy
Productivity
Weight Reduction
Safety
Product Improvement
Endurance
Other

FIGURE A5-1

BASELINE PLAN

SUB-MISSION A

PROGRAM/PE	TOTAL $(M)	QTY
SYSTEM A		
SUBSYSTEM A 27xxx	1200	8000
SUBSYSTEM B 27xxx	65	1250
SUBSYSTEM C 27xxx	63	115
SUBSYSTEM D 27xxx	26	115
PROGRAM A 63xxx	9.5	250
SYSTEM B		
PROGRAM B 64xxx	48	N/A
PROGRAM C 64xxx	25	70
PROGRAM D 64xxx	450	35
PROGRAM E 64xxx	540	35
SYSTEM C		
PROGRAM F 64xxx	90	3000
SYSTEM D		
PROGRAM G 63xxx	65	N/A
SUBSYSTEM E 27xxx	900	40
PROGRAM H 64xxx	95	40
TECHNOLOGY BASE 62xxx	38	N/A



APPENDIX 6

"SMART" USERS DIRECTORY

Summary Management Assessment Review Trends (SMART)
Program Data Base

1. Introduction. The automated Product Division portion of the Command Management Information System (CMIS) is a macroscopic management tool used by the Hq AFSC Command Section, Hq AFSC staff level, Product Division Command level, and at all lower management levels to provide corporate information on programs for which AFSC Product Divisions are responsible. The system is called SMART-D and fulfills Level 2 and Level 3 CMIS requirements. Access to the unclassified portions of the data base by HQ AFSC personnel is unlimited. Access by Product Division personnel is limited to information on their respective Product Divisions. This information is, however, FOR OFFICIAL USE ONLY and is not releasable to non-Air Force personnel such as contractors. Updates will be made as indicated in the instructions that follow. NO CLASSIFIED INFORMATION will be entered in this system.

2. General. The Summary Management Assessment Review Trends (SMART) program information file is a comprehensive data base of information at the program level. This Users Directory describes the items in the data base, describes the source to be used for obtaining the required information, and establishes the number of characters permitted in each data field. (12)

The data elements to be included in SMART are as follows:

Status
Short Title
Program Element
Project
Task
Program Manager
Product Division
Organization
Gaining Organization
Long Title
Phone number
Air Force Precedence Rating
Acquisition Life Cycle
Requirement (Operational capability)
Program Management Directive
AFSC Form 56 Direction
Description
AFSC Systems Staff Officer
SYSTO Office Symbol
Assessment Codes, "N" - Not Applicable, "S" - Satisfactory, "U" - Unsatisfactory, and "-" not evaluated, are used in the following areas of concern:

1. System/Technical Performance (STP)
2. Funding (FUND)
3. Cost Performance (COST)

4. Schedule (SCH)
5. Controls (CONT)
6. Manning (MAN)
7. Logistics (LOG)
8. Operations and Training (OPT)
9. Testing (TEST)
10. Key Decisions (KDEC)
11. Program Direction (PDIR)
12. Integration-Interface (INT)
13. Threat Status Requirement (TSR)
14. Transfer/Program Management Responsibility Transfer (PMRT)
15. Design to Cost (DTC)
16. Baseline Status (BLS)

Over forty (40) different data categories are included in the program and about eighty (80) additional data categories are recognized.

When classified data and other modifications can be included, it is hoped that SMART can be a direct data source for Vanguard.

Before completing the SMART review, the following excerpt from the evaluation guide for program schedule status will be helpful for this reports completeness.

4. SCH = Schedule. Compare progress to date with the approved schedule or milestones. The impact of schedule variations on initial operational capability or need dates and upon costs must be considered. Various fields for major milestone dates are in the SMART data base. These fields are described in (23) through (67) below. The assessment of the schedule should be particularly sensitive to the status of the program in meeting the AFSC-directed baseline dates. Thresholds:

Satisfactory--Program has met or is predicted to meet all established program master schedule (milestone) dates.

Marginal--Program has failed or is expected to fail to meet milestone date(s). A plan has been devised wherein action can be taken under local authority to get back on schedule; or, flexibility within the program can absorb the slippage without impacting critical milestone dates such as the initial operational capability (IOC) date.

Unsatisfactory--Program cannot meet critical milestone dates on the master program schedule. The program slip cannot be remedied and the master schedule must be rebaselined. The program will not meet PMD/AFSC Form 56 directed dates.

This concludes the section on what is happening now as ASD related to planning and scheduling. The next section will deal with who is doing it and some questions about how.

APPENDIX 7

PLANNING AND SCHEDULING METHODOLOGIES

The following three planning and scheduling concepts have been used in industry for some time. Milestones techniques and bar charts are the oldest methods. Network techniques have come as a result of defense and space complex programs. Parametric scheduling interest has been increasing with the greater use of the computer and the collection of large data banks. These methods will be reviewed, beginning with the last one first. These reviews are a collection of excerpts from the Initiative 16 effort.

A. Parametric Techniques

A parameter is a physical or performance property whose value will define a particular characteristic of a system. A set of properly selected parameters will describe the system and its operating characteristics. An example is the maximum velocity at which an aircraft must travel which may be used to predict the spantimes required to achieve various schedule milestones. Physical and performance characteristics and the actual spantimes required to accomplish certain milestones are used in multiple regression analyses to develop equations that best fit the input data base.

This section presents physical and performance characteristics as potential data base candidates. It also defines each characteristic or parameter.

The evolution of an aerospace program may be started with a document called Statement of Requirements (SOR). This SOR is analyzed and mission objectives and/or requirements are formalized from which candidate concepts are synthesized and evaluated through Engineering trade studies. These trade studies evaluate performance versus cost, time to acquire, and risk in order to obtain a harmonious balance. The more desirable concepts are then evaluated at a lower level until a final best configuration is selected.

Physical and/or performance parameters for aircraft progra- are:

a. Thrust. This is the thrust required for an aircraft to perform its assigned mission. One of the difficulties of obtaining the required thrust is the amount of space allotted for the propulsion system, e.g., single vs multiple engines.

b. Velocity. This is the maximum velocity that the aircraft is expected to obtain in its operational environment. This is a measure of the combined efficiency of airframe and propulsion design and the airframe structural complexity.

c. Altitude. The altitude at which an aircraft will operate will, to a large degree, effect the aerodynamic design of the airframe and the required operating characteristics of the propulsion system.

d. Acceleration. This parameter combines the effects of thrust, aerodynamics, size, and weight. An aircraft's primary mission will dictate how fast an aircraft must be able to accelerate to a certain velocity.

e. Range. The unrefueled range of an aircraft is a measure of the engine and airframe efficiency and the size of the aircraft.

f. Weaponry/Payload (useful load). This parameter may dictate the structural efficiency of the airframe required to meet designated lead carrying and capability. To meet this factor, sophisticated materials and manufacturing may be required to obtain minimum aircraft weight while maintaining structural integrity.

g. Operating Characteristics Factor. This parameter considers the effect that operational requirements such as V/STOL, use of unimproved runways, and maneuverability characteristics have on development. These factors typically effect one subsystem more than the rest, e.g., unimproved runways may require a different landing gear system than if the aircraft was designed to operate exclusively from improved runways.

h. Advance Development Factor. This is a measure of the amount of advanced development required to meet stated performance requirements. This is especially critical in subsystems development, e.g., avionics or propulsion where these subsystems may be a pacing item. Often, off the shelf or modified off the shelf components and materials may be used in lieu of new developments. In such cases, the impact of this factor would be significantly reduced.

i. System Complexity Factor. The system complexity has two main segments, the structural complexity and subsystem integration complexity. The structure complexity factor is defined in the TER's report by Vought. The integration complexity is a measure of the difficulty in integrating the numerous subsystems to obtain the desired performance characteristics. The complexity of the system will not only effect the development cost and schedule, but also the production cost and schedule.

2. In addition to the nine primary parameters, there are four secondary parameters which effect development. These parameters combine with each other, the primary parameters or other design features to impact the development schedule. These parameters will typically have a direct impact on the development schedule when extremes are required. However, there will generally be a direct effect on the detailed design and production. The four parameters are:

a. Size. Generally, unless the size is extreme, e.g., C5A, it will not have a direct bearing on the development schedule. However, the size will effect both detailed design and manufacturing. As the size increases more time will be required for detailed design and drawings. The size will also influence production tooling and leadtime.

b. Weight. The weight of the aircraft is a function of size, material and other equipment necessary for the aircraft to perform its mission. If the size and weight are critical factors, then advanced materials and processes may be required. This in turn may impact the development and production schedule.

c. Number of engines. This parameter reflects the complexity of the propulsion system. The ability to use multiple engines may permit the use of existing engines in lieu of newly developed ones. However, as the number of engines used on an aircraft increase, so does the difficulty in getting the propulsion system to function like a unit rather than individual engines.

d. Maximum Surface Temperature. This parameter is a function of velocity and altitude. The surface temperature may be a critical factor when considering material, construction and process selection. The temperature will also influence the system design and consequently the design complexity.

3. One other factor which is not a characteristic of the system but may effect both development and production is the availability of facilities. This includes manufacturing, tests, and other essential development equipment. Facilities acquisition or construction often requires well over a year before it is ready for use. The need for additional facilities must be identified early enough to permit acquisition, otherwise development and production schedule difficullties are sure to arise.

PARAMETRIC -- STRENGTHS AND WEAKNESSES

1.	Validity	Good in Conceptual and development phases	May overlook important schedule constraints
2.	Reliability	Reliability is Quantifiable in statistical terms	Projects past errors
3.	Implementation	Proven techniques have been developed which facilities use	May require use of complex statistical technique
4.	Universality of project coverage	May be applied to a broad class of products	Requires Adjustments for comparability
5.	Sensitivity testing (simulation)	Ideally suited to testing and modeling	
6.	Forecasting	Able to forecast program schedules for R&D efforts	

Vought Missiles and Space Company (VMSC) has developed a parametric scheduling concept called Time Estimating Relationship (TER). The following material has been collected on their approach. Part of this description is from a report by LA McNally of ASD/PMDPM at Wright-Patterson AFB.

The objectives of TERs are based on the assumption that certain performance/physical parameters were linked, thru the cause/effect mechanism, with time required, and that the relationship--parameters and time, could be displayed in a mathematical framework to demonstrate the feasibility of developing time estimating relationships.

This approach includes the following steps:

a. Gather and assimilate data,

b. Evaluate possible parameters,

c. Use data in multiple regression analysis,

d. Review and analyze multiple regression results,

e. Select best parameters,

f. Select best equations.

The attached Figures A7-1 and A7-2 briefly illustrate: (1) the statistical technique for milestone date selection, and (2) how the statistical selected data compares to milestone dates selected by conventional methods.

A total of ten parameters were used by VMSC to develop the set of algorithms. Most of these parameters could be derived from the system specification at the end of the conceptual phase. These parameters are applicable only to aircraft or missile systems. The parameters are:

a. Empty weight,

b. Structure weight,

c. Useful load to structure weight ratio,

d. System weight to empty weight ratio,

e. Maximum velocity,

f. Thrust to weight ratio,

g. Number of engines,

h. Planform area,

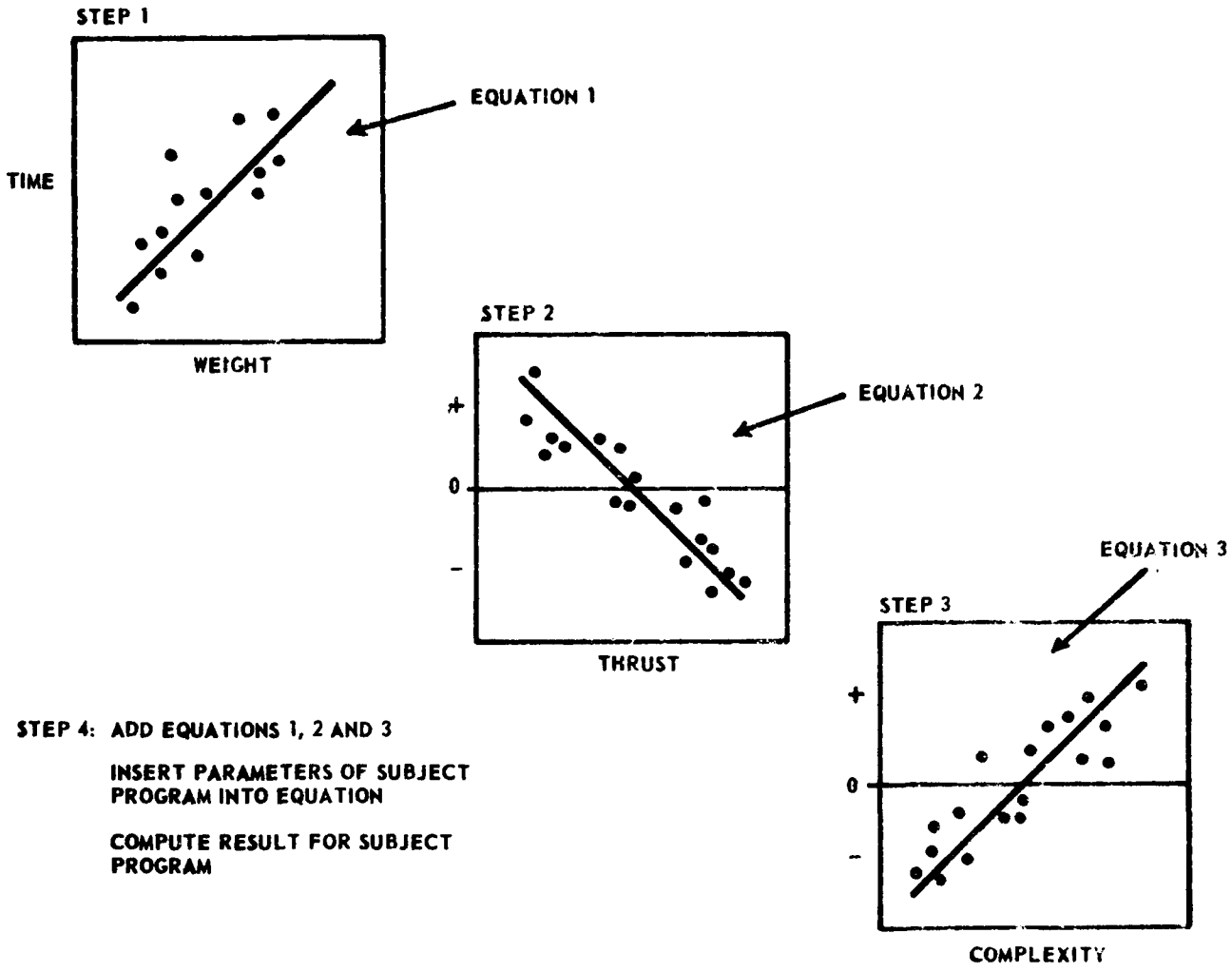
i. Structure complexity factor,

j. Maximum exposed surface temperature.

These parameters could not be applied to ground based systems/systems/subsystems nor could they be applied to airborne subsystems.

FIGURE A7-1

TER DEVELOPMENT - METHODOLOGY
MULTIPLE REGRESSION MECHANICS



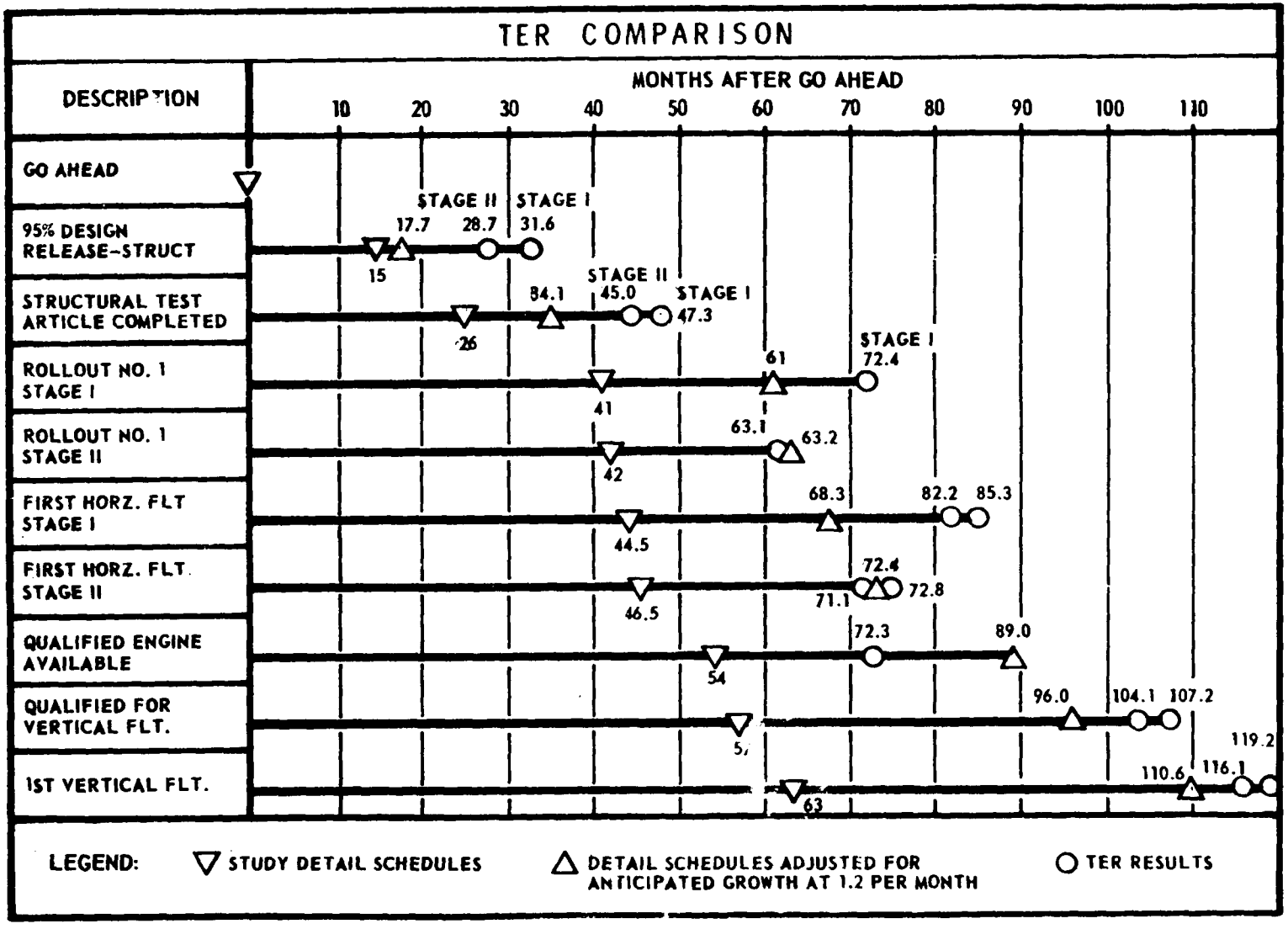
STEP 4: ADD EQUATIONS 1, 2 AND 3

INSERT PARAMETERS OF SUBJECT PROGRAM INTO EQUATION

COMPUTE RESULT FOR SUBJECT PROGRAM

FIGURE A7-2

SUMMARY MASTER SCHEDULE



This set of algorithms can be applied only to aircraft and missile systems starting with the initiation of the validation phase. The VMSC method is not applicable to the production phase of a program. In addition, this method does not consider quantity, unit cost, or production rates.

Although the VMSC method could prove to be valuable to analysis of schedules for the development phases of an aircraft or missile program, it has several deficiencies:

a. This method does not relate to program urgency or the contractor experience. Both these factors will have a definite bearing on how long it takes a contractor to perform the tasks required.

b. Another area that needs attention if these algorithms are to be applied as is to aircraft or missile systems is the data base. The data needs to be updated to reflect the more recent programs. The equations should be verified by testing them against systems not used in the original data base. The equations may then need to be refined.

c. The time durations between milestones are excessive. In order to provide the needed visibility, more milestones should be established.

d. Additional parameters are needed to be derived to establish schedules which will be through the production base.

If parametric scheduling is ever used, it must have an adequate data base. In a master thesis entitled, "The Air Force Cost Estimating Process: The Agencies Involved and Estimating Techniques Used," by Major Edwin M. Lewis and Major Eugene D. Pearson, the following excerpt deals with the question of data availability in the Air Force, including a major consideration of ASD. Even though the subject dealt with is estimating, the same problems would effect statistical scheduling.

Contractor Proposals Estimates.

The defense industry is composed of approximately 22,000 prime contractors and 100,000 subcontractors. These contractors are used throughout the weapon system acquisition process to support the Air Force efforts in designing and estimating the cost of new weapon systems as well as producing the weapon system. They provide technical, feasibility, and cost studies to the Air Force in the conceptual phase and cost proposals, budget estimates and cost performance reports in the conceptual, validation and full-scale development phases. Cost estimates of the program's progress and compliance with earlier estimates, in the form of cost performance reports, are provided in the production phase. These cost estimates are used by the appropriate SPO as a basis for their cost estimates and in tradeoff studies to determine which alternative system to develop to satisfy the operational requirement and/or which design to pursue.

Amount of Data Available

Professor Baker, in his doctoral dissertation, "Improving Cost Estimating and Analysis in DOD and NASA," identified Historical Data Problems as a major problem area for estimations. One question in a survey conducted for his dissertation requested information about the principle problems of cost estimating perceived by persons in the field. Twenty three percent of the 1353 individuals involved in making cost estimates indicated that problems related

to the amount of historical data available were the most important problems of cost estimating and analysis. AFSC responses to the survey indicated 26% (74 out of 285) felt that the data availability was the most important problem.

The problem grouped into the category of Historical Data Problems were:

1. data availability and collection problems,

2. lack of accurate, reliable, credible, valid, and current data,

3. lack of data base and/or computerized data bank,

4. insufficient data regarding installing and operating costs, and

5. insufficient data regarding recurring versus non-recurring costs.

Problems involving techniques, tools, methodology, and procedures were also identified as major problems of cost estimating by 26% of the respondents. The specific problems identified within this category all involved a lack of knowledge concerning how and when the various techniques, tools, methodology, and procedures should be used.

Captains Barga and Poch in their technical memorandum for the Air Force Aero-Propulsion Laboratory indicate that during the conceptual and validation phases of the acquisition process, there is often a lack of adequate, complete or firm system definitions. The specifications, drawings, and statements of work are not available in detail, because the decision of which alternative design to use has not yet been made. The weapon system design is still undergoing research and development. Because there is a lack of complete data and only historical data on analogous systems is available during the conceptual and validation phases, a parametric approach to cost estimating should be used. More information becomes available during the full-scale development and production phases. Additional data on system specification and performance requirements become available as the weapon system is better defined. More identification and prediction of the information not available is also possible during the full-scale development and production phases. For this reason, more accurate methods of estimating weapon systems costs can be used. A detailed engineering approach becomes possible during the full-scale development and production phases.

The amount or level of data available to make cost estimates, as described by Baker and Barga and Poch can be placed on a continuum ranging from little or no hard, factual data available to a highly detailed level of data. For the purpose of this research, the researchers have defined four categories of data levels. These levels are based on the activities taking place in the phase of the weapon system acquisition proces, i.e., as the system progresses through the acquisition process, it becomes better defined and moves from a paper concept to an actual item in the Air Force inventory. The four levels of data as defined by the researchers are:

1. VAGUE--In the conceptual phase, there is an almost complete absence of factual cost data on the specific system being worked. The new weapon system is basically a paper system and has not been defined beyond the stage of a requirement for a particular type of weapon system to meet a need. There is, however, specific data on other weapon systems available for use, but the relation to the new weapon system is questionable.

2. LIMITED--In the validation phase, the design of the system begins to take shape. More specific information is available on what the new system will be and what the specifications of the system are. Because this additional information is available, a better comparison to other, previous weapon systems can be made, giving the estimating agencies more, but still limited, data on which to base their estimates.

3. *DETAILED--In the full scale development phase,* the system is completely defined and the specifications finalized. Prototypes of the weapon system are developed for testing. It is in this phase, that the majority of detailed data for making cost estimates becomes available. Limited production figure from the prototype production are also available for use.

4. HISTORICAL--In the production phase the full production figures are available in the form of cost performance reports and other accounting reports. At this point, except for changes in the production schedule and future inflation rates, the actual cost of producing the weapon system is easily and accurately projected.

Techniques Used to Generate Cost Estimates

One of the cost estimating technique categories is the parametric category -- in this category the cost estimates come from relationships which can be developed between historical costs, system physical attributes and/or performance characteristics. The historical costs take into account system growth, engineering changes, program stretchouts and any other possible difficulties encountered in comparable programs. They have valuable application when:

a. Some performance/design parameters are known but detailed mechanization features are lacking.

b. Gross estimates are acceptable.

c. In the early stages of program development.

d. Quick reaction estimates are needed.

e. Used for cost/performance trade-off studies.

The cost estimating techniques which fit into this category include analogy, CER, expert opinion, list price, and parametric. There are also other approaches to statistical scheduling such as that done by Dr. R. L. Sielken, Jr. and Dr. H. O. Hartley of the Institute of Statistics at Texas A&M University. A copy of their university publication was acquired entitled, "A New Statistical Approach to Project Scheduling." If further interest is seen in this area, this material should be reviewed. The work was done under a grant from the Office of Naval Research, Contract N000014-68-A-0140, Project NR047-700.

B. Network Techniques

Networks utilize events and activities diagrams which show the direction of progress and major interdependencies between the activities. Networks can be structured to show the detail required by the various levels of Air Force or contractor management. Portions of major tasks can also be depicted by networks if that amount of detail is required. These techniques are designed for scheduling activities in development or one-of-a-kind operations. Neither technique is particularly well suited for repetitive operations.

1. Critical Path Method

The network concept of CPM is an excellent device for explicitly depicting significant interrelationships among events. Since time estimates lead to the determination of a critical path so that resources can be applied or reallocated to permit the schedule to be met. One criticism of CPM is that emphasis on the critical path activities may obscure the fact that other paths may be close to being critical and would become so with slight changes in values this problem could be overcome by ranking the paths according to the project time to complete. CPM does not provide the capability to effectively handle schedule uncertainties. The time estimate must represent the single best estimate of the time required. Uncertainty is not reflected in terms of range of times if the estimates are not accurate then the critical path may be incorrectly identified.

CPM TECHNIQUES--STRENGTHS AND WEAKNESSES

CRITERIA	STRENGTHS	WEAKNESSES
1. Validity		No formula is provided to estimate time to completion; consequently, the technique is as valid as the estimator. The margin of error is generally less in construction than in development.
2. Reliability		Numerous estimates in a large project, each with some reliability may lead to significant errors in judging project status.
3. Implementation		Relatively difficult to explain, especially if the various concepts of float are utilized.
4. Universality of project coverage	Very good for single-shot activities, such as construction or development projects.	Weak in the production phase of a weapon life cycle. The technique is not well adapted to scheduling production quantities
5. Sensitivity Testing (simulation)	Excellent for simulating alternative plans, especially when coupled with the time-cost aspect.	
6. Forecasting	Strongly oriented to forecasting ability to accomplish future events on schedule.	

2. Program Evaluation Review Technique (PERT)

PERT was formulated at approximately the same time as CPM. The same basic concepts of events, activities, and networks are used in both methods. The discussion of PERT will center on the areas of difference between the two methods.

The major difference is the treatment by PERT of schedule uncertainties. PERT uses three time estimates to arrive at the expected time. The first estimate is the optimistic time. This is the time in which the project could be completed more quickly only about 1% of the time. The second estimate is the most likely time (the mode) to complete the project. The third estimate is the pessimistic time, or the time in which a project would take longer to accomplish only about 1% of the time. The mean or the expected time is determined by summing the optimistic, the pessimistic and 4 times the most likely time. This sum is then divided by 6 to arrive at the expected time. The PERT time estimating offers some advantages over CPM. First, the estimators usually make more valid estimates if they can express the extent of their uncertainty. In addition, a range-of-time estimate will provide a more realistic and informative picture of the program than will a single point. Another advantage is that a single point estimate is likely to be the mode. The mean is considered to be more statistically representative of the distribution than the mode. The mean is based on all the information about the distribution rather than the single most frequent estimate. One criticism of PERT is that the three time estimates are too time consuming to develop and that in most cases the expected time estimates do not vary significantly from the single point estimate and therefore are not justified.

PERT TECHNIQUE--STRENGTHS AND WEAKNESSES

CRITERIA	STRENGTHS	WEAKNESSES
1. Validity	PERT, like CPM, is capable of depicting work sequence. The use of three time estimates should make it more valid than any other technique.	
2. Reliability		On the other hand, securing three time estimates for each activity requires more information which tends to introduce additional error.
3. Implementation		The complete PERT system is quite complex and therefore difficult to implement.
4. Universality of Project Coverage	Very strong in development phase.	Requires adaptation for application to production operations.

CRITERIA	STRENGTHS	WEAKNESSES
5. Sensitivity (simulation)	Since PERT is usually mechanized, it has good potential for simulating the impact of various resource allocations on the schedule, or the various ways of sequencing work.	
6. Forecasting	PERT is strongly oriented to forecasting the ability to accomplish future events on schedule.	

3. Line of Balance

The Line of Balance technique (LOB) was developed to improve scheduling and status reporting in an ongoing production process. It is a technique for assembling, selecting, interpreting and presenting in a graphic form the essential factors involved in a production process from raw materials to completion of the product against time. As a planning tool, it helps to integrate the flow of materials and components which go into the manufacture of end items in accordance with phased delivery requirements. The LOB identifies relationships between various elements of the manufacturing process and can be used to identify deficiencies in the availability of subcontract elements, materials, parts, and assemblies at selected control points along the production line.

The LOB technique uses four essential elements:

The objective

The program or manufacturing plan

Program process

The line of balance

The Objective. The first step in using the LOB technique is the establishment of the objective. The objective of a production process is to meet the required delivery schedule both for a specified period and cumulatively. The data used in the objective shows both planned (contract requirements) and actual deliveries. The chart portrayal of the objective is accomplished by using a simple graph which displays the cumulative delivery requirements against time. Actual deliveries are plotted on the same graph.

The Program. Charting of the program on the manufacturing plan is the second step in establishing the LOB. This comprises the stages in producers planning where key manufacturing operations or assembly points are identified.

CRITERIA	STRENGTHS	WEAKNESSES
1. Validity	Uncertainties surrounding completion times in production operations are minimal; consequently LOB affords management a sound technique for judging status of operations.	Uncertainties encountered in the development phase impair judgment on actual project status. The techniques for estimation of percent completion can lead to erroneous decisions concerning project development.
2. Reliability	Compares favorably with Gantt technique	
3. Implementation	Only slightly more difficult to comprehend and to implement than Gantt technique.	
4. Universality of project coverage	Capable of covering a system life cycle	Does not emphasize resource allocation directly.
5. Sensitivity testing (simulation)		No significant capability for simulating alternative courses of action.
6. Forecasting	Depicts status of project well in production stage and can forecast whether or not schedule will be met.	Offers no technique to handle uncertainty in development phase.

Figure A7-3 illustrates the Network concept and Figure A7-4 illustrates how the network can be done at different levels.

C. Milestone Techniques

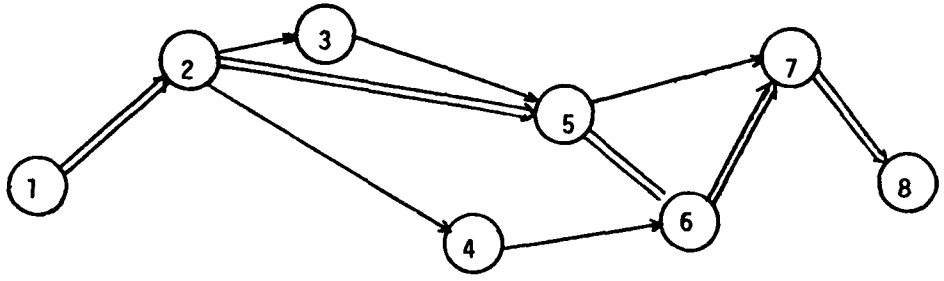
The Gantt technique was the first formal scheduling system to be used by management. The cornerstone of the technique is the Gantt chart, which is basically a bar chart showing planned and actual performance for those resources that management desires to control. In addition, major factors that create variance (i.e., overproduction or underproduction) are coded and depicted on the chart. The Gantt chart was designed for, and is most successfully applied to, highly repetitive production operations. Normally, it assumes that time standards are available for each operation and that the objective of management is to obtain "normal" output from each major resource employed, especially labor and machinery.

The milestone scheduling system is based largely on the same principles as the Gantt system but the technique of displaying project status differs. The milestone system is usually applied to development projects and is frequently used at several of the higher-management levels, for example, corporate, SPO, AFSC, and Hq USAF. A milestone represents an important event along the path to

FIGURE A7-3

DATA SURVEY SAMPLE NETWORK

The Figure below depicts hypothetical network of a highly compressed and simplified interpretation of activities



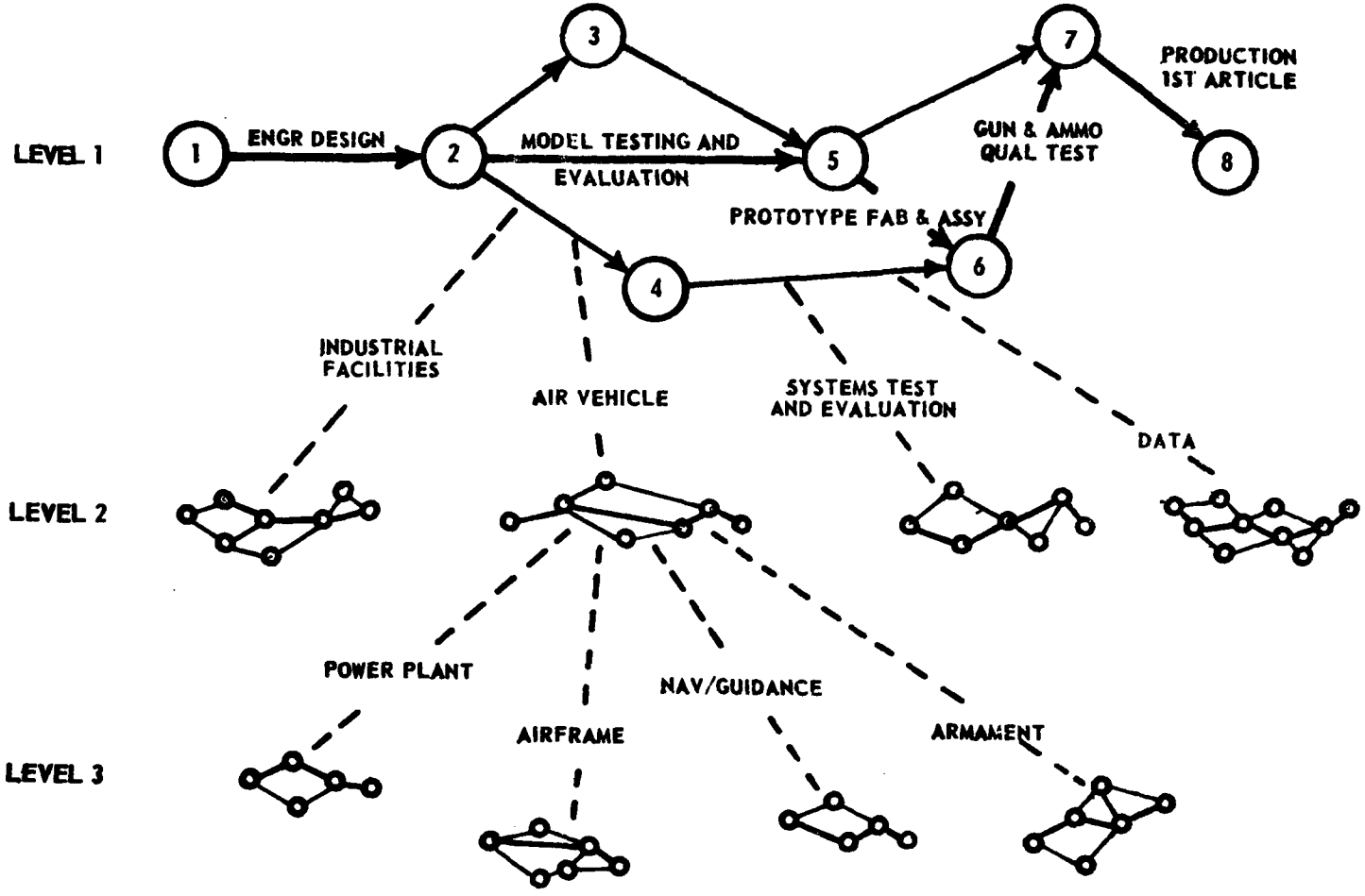
Activity

1-2	Engineering Design*
2-3	Detailed Planning and Data Reduction Requirements
2-4	Validating Material Specification
2-5	Model testing and Evaluation *
3-5	Data Reduction
4-6	Long Lead Materials
5-6	Prototype Fabrication and Assembly*
5-7	Structural Fatigue Tests
6-7	Gun and Ammo Qualification Tests*
7-8	Production of First Article*

*Critical Path Activities at level 1

FIGURE A7-4

NETWORK LEVELS



project completion. All milestones are not equally significant. The most significant are termed "major milestones" usually representing the completion of an important group of activities. In reality, of course, there are many gradations of importance.

MILESTONE

CRITERIA	STRENGTHS	WEAKNESSES
1. Validity	Good in production operations. Because of short time duration of each measured operation, only small errors in measurement are likely to occur.	No explicit technique for depicting interrelationships, which are especially important in development.
2. Reliability	Simplicity of system affords some reliability.	Frequently unreliable, especially in development stage, because judgment of estimator may change over time. Numerous estimates in a large project, each with some unreliability, may lead to errors in judging status.
3. Implementation	Easiest of all systems in some respects because it is well understood (System implies existence of time standards.)	Quite difficult to implement for the control of operations in development phase, where time standards do not ordinarily exist and must be developed.
4. Universality of Project coverage	Can comprehensively cover a given phase of a life cycle. Effective at the resource or input level of control.	Less useful in definition and development phases of life cycle.
5. Sensitivity Testing (simulation)		No significant capability.
6. Forecasting	In production operation, good technique to assess ability to meet schedule on a given activity if based on good time standards.	Weak in forecasting ability to meet schedule when interrelationships among activities are involved.

The list of 90 milestones were being considered by an ASD/SPO in order to adequately measure their schedule performance.

Figure A7-5 illustrates what can be done with an automated milestone status chart.

FIGURE A7-5

MASTER PROGRAM MANAGEMENT SCHEDULE
FOR
(PROGRAM TITLE)
(DOCNO)

PROGRAM MANAGER: (RANK) (NAME) (ORG) FINANCIAL MANAGER: (RANK) (NAME) (ORG)
PROGRAM ELEMENT: (PE) PROJECT NUMBER: (PROJNO)

TASK NUMBER: _____ MOD NUMBER: _____ FMS CASE: _____
CONTRACT NUMBER: _____ ACQ MODE: _____
TITLE: _____ PROJECT OFFICER: (RANK) (NAME) (ORG)
APPROPRIATION: (APPN)

MILESTONE KEY	MILESTONE DESCRIPTION	PRIOR YEARS YYMMDD	1979 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1980 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	OUT YEARS YYMMDD
01-01-00	NEW START APPROVED	780615																									
02-06-00	RFP		V																								
			+			+																					
02-10-00	SOURCE SELECTION						V																				
							+																				
02-21-00	CONTRACT DISTRIBUTION								X																		
									+																		
02-25-02	DELIVERY SCHEDULE								V	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	X	
									+	+	+	+															
02-26-02	PHYSICAL COMPLETION																										810210
05-21-00	PMRT									X																	
										+																	
05-22-00	RESIDUAL TASKS									V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	
										+																	

TASK NUMBER: _____ MOD NUMBER: _____ FMS CASE: _____
CONTRACT NUMBER: _____ ACQ MODE: _____
TITLE: _____ PROJECT OFFICER: (RANK) (NAME) ORG)
APPROPRIATION: (APPN)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LME