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**THESIS**

**PROJECT ORION MICROCOMPUTER MANAGEMENT  
SYSTEM**

by

**Richard Boyd Darden**

**September 1988**

**Thesis Advisor:**

**Gerald L. Pauler**

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Project ORION Microcomputer Management System

by

Richard Boyd Darden  
Lieutenant Commander, United States Navy  
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Submitted in partial fulfillment of the  
requirements for the degree of

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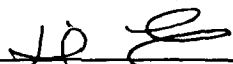
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## ABSTRACT

This thesis describes the development of a microcomputer project management system for the Space Systems Academic Group (SSAG) at the Naval Postgraduate School. The focus of the paper is on system requirements and implementation to manage Project ORION.

Project ORION is a high-technology mini-satellite venture under direction of the SSAG. It involves the design, procurement, fabrication and testing of the satellite in the planning, scheduling and controlling phases of project management.

Conclusions define key factors important in the implementation process such as organizational responsibilities, quantification of planning detail, personnel training and operating procedures.

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## DISCLAIMER

OPEN PLAN is a registered trademark of Welcom Software Technology Corp. dBASE III + is a registered trademark of Ashton-Tate, Inc. The use and/or recommendation of these or any other products as discussed in this thesis constitutes no endorsement by the U.S. Navy or by any other U.S. Government agency.

## TABLE OF CONTENTS

<b>I. INTRODUCTION.....</b>	<b>1</b>
A. BACKGROUND.....	1
B. PURPOSE.....	4
C. SCOPE.....	4
D. RESEARCH QUESTIONS.....	4
E. OVERVIEW OF STUDY.....	5
<b>II. NATURE OF THE PROBLEM .....</b>	<b>6</b>
A. PRIOR PROJECT MANAGEMENT .....	6
B. SSAG PROJECT ENVIRONMENT.....	6
<b>III. METHODOLOGY.....</b>	<b>8</b>
A. USER NEEDS ANALYSIS.....	8
B. REQUIREMENTS ANALYSIS.....	8
C. REVIEW OF COMMERCIAL SOFTWARE.....	8
<b>IV. REQUIREMENTS.....</b>	<b>9</b>
A. OBJECTIVES OF A PROJECT MANAGEMENT SYSTEM.....	9
B. USER REQUIREMENTS .....	9
<b>V. COMMERCIAL SOFTWARE REVIEW.....</b>	<b>11</b>
<b>VI. PROJECT MANAGEMENT .....</b>	<b>14</b>
A. PROJECT APPLICATION .....	14
B. COMPUTER-AIDED PLANNING AND SCHEDULING.....	14
C. INITIAL PLANNING.....	18
D. SCHEDULING THE PLAN.....	18
E. CONTROLLING THE PROJECT.....	19
F. PRODUCTIVITY/QUALITY IMPROVEMENTS .....	20

<b>VII. CONCLUSION .....</b>	<b>22</b>
<b>A. KEY FACTORS IN THE IMPLEMENTATION PROCESS.....</b>	<b>22</b>
<b>B. SUMMARY.....</b>	<b>26</b>
<b>APPENDIX A DEFINITION OF TERMS.....</b>	<b>27</b>
<b>APPENDIX B BASIC PROJECT MANAGEMENT.....</b>	<b>30</b>
<b>APPENDIX C REQUIREMENTS CHECKLIST.....</b>	<b>33</b>
<b>APPENDIX D LIST OF ACTIVITIES.....</b>	<b>35</b>
<b>APPENDIX E NETWORK DIAGRAM (INCL. TIME SCALE PLOT).....</b>	<b>39</b>
<b>APPENDIX F SORTED SCHEDULES FOR ACTIVITIES.....</b>	<b>42</b>
<b>LIST OF REFERENCES.....</b>	<b>54</b>
<b>SELECTED BIBLIOGRAPHY.....</b>	<b>55</b>
<b>INITIAL DISTRIBUTION LIST.....</b>	<b>57</b>

## I. INTRODUCTION

This study presents a management system for a high-technology mini-satellite venture using project management techniques with microcomputers. The rapid growth of microcomputer hardware and software technology within the past decade has provided a unique opportunity for improvement of communications, productivity, and responsiveness in the field of project management. It is now possible to use powerful planning and scheduling techniques with microcomputers in organizations responsible for the functional work on a project. This results in improved accuracy of the program planning data and stronger personal commitment on the part of users. [Ref. 1]

### A. BACKGROUND

Anyone who has witnessed a NASA space launch has observed the intricate and meticulous scheduling of tasks, built-in check points, and coordination that is necessary for a large high-technology effort. The accomplishment of such a massive undertaking requires not only technological skill but also managerial skill. Most of the techniques (i.e., network diagrams, PERT, CPM, etc.) used by present day Project Managers had their origins in military and space project environments. [Ref. 1]

Until the early 1980's Project Managers who sought computerized assistance for planning, scheduling and controlling tasks had no computer alternatives other than the use of mainframes and minicomputers. Presently, however, project management software has become widely available for the personal microcomputer. In the early stages, software designed for project management

was unsophisticated. [Ref. 2] Microcomputer project management software has now matured to a point at which it offers an elegant blend of large system performance, capacity, and versatility. It is capable of readily coping with the detailed management of multi-billion dollar projects.

At issue is the need for a control tool to keep pace with project progress, to provide early warning of unfavorable trends, and to support decision makers with meaningful information and simulations [Ref. 3] . While the next NASA launch may not be managed on a personal microcomputer, a scaled-down version of such a feat is now possible.

In assessing the process of implementing microcomputer technology in project management, it is instructive to reflect on the development of computerized program management tools over the past few decades. With the advent of mainframe computers and of higher level programming languages, more and more people became familiar with computers and aware of the enormous gains in productivity offered by the computer. Complex project planning and network calculations could then readily be performed by computer. With this capability came the growth of larger and larger networks, with more activities, resource allocations, listings, reports, etc. [Ref. 4] Unfortunately, using the full capabilities of computers for planning and scheduling tools demanded an expertise not readily obtained without the investment of considerable time and effort. Most project and functional managers, supervisors and technical and production staff were dissatisfied with such effort. The solution to this situation became available with the growth of separate computer-oriented planning, scheduling and control groups to provide this expertise. It was quite natural that these special groups would promote their technology and produce "bigger and better" planning tools which,

although more complex to use, could handle the largest programs imaginable.  
[Ref. 5]

If these massive, powerful computer programs were, in fact, the answer to all the Project Manager's planning and scheduling needs, then why did we see the continuation of hand drawn barcharts, informal networks, and the like in the field of project management [Ref. 6]?

The answer is obvious. That these available mainframe computer programs were so complex to run meant that project managers and functional groups did not use them on a daily basis. Turnaround time was too high. Thus, simple, understandable program planning and scheduling techniques continued to be used by the Project Manager and functional staff for their personal use. The massive mainframe computer programs tended to become a backup service not used directly by those making the day-to-day decisions, but used instead for monthly reports and for discussions with clients. This "double standard" in program management is eliminated by using microcomputers. Currently available hardware and software can be acquired cheaply, and, with minimal training, those directly responsible for the job can use powerful planning and scheduling tools. The charter for the Project Manager is to orchestrate this process to achieve an efficient computerized system that is internally consistent and coordinated for the benefit of the total program. Doing so adds another dimension to the Project Manager's role, and affects the charter and responsibility of the existing planning, scheduling and program control groups. The net result: a vast improvement in communications and in information accuracy and currency and, most important, a stronger personal commitment to the overall objectives of the program by those performing the jobs.

## **B. PURPOSE**

The purpose of this thesis is to provide a simple, integrated microcomputer system to fulfill requirements of Project ORION. Project ORION is a high-technology mini-satellite venture under direct coordination of the Space Systems Academic Group (SSAG) at the Naval Postgraduate School (NPS), Monterey, CA. The satellite has all the capabilities of most large satellites, including attitude control, propulsion, electrical power, telemetry, onboard microprocessor, data storage, and thermal control [Ref. 7]. One of the goals of the project is to demonstrate that a fully capable satellite can be built using currently available technology for less than 1.5 million dollars. Delivery of the unit for launch is currently estimated for mid-year 1991.

The group has selected and acquired a personal computer-based project management software package to assist in the planning, scheduling and control of the project. This software package must be used with existing hardware configurations within the group's facility.

## **C. SCOPE**

This study describes the application of microcomputer technology to the ongoing project involving design, procurement, fabrication and testing. Several microcomputer applications in the project management environment are discussed along with key factors found to be important in the implementation process. Conclusions include some general lessons from the actual case that will aid current and future use of microcomputers in project management.

## **D. RESEARCH QUESTIONS**

Three primary questions are:

- What key factors are important to the implementation process?

- What are general guidelines for use of microcomputers in the field of project management?
- What actual applications of microcomputers are required in this project management environment?

## **E. OVERVIEW OF STUDY**

The study's primary research includes a review of current literature on the subject of project management. Chapter II addresses the nature of the problem as provided by current operations within the SSAG and specifically, probes the project environment to determine factors that account for increasing reliance of organizations on project management techniques.

A definition of terms and a tutorial (Appendices A & B) on basic project management are provided on what project management is, what it employs and the benefits to be gained from its employment.

Chapter III discusses steps used in the research process to facilitate the selection and implementation process. Objectives and requirements identified from that method are presented in Chapter IV.

The software package is analyzed in Chapter V, while minimal configuration requirements are further delineated in Chapter VI, section B.

The specific project application is presented in Chapter VI. Key factors found to be important in the implementation process, along with a summary are provided in Chapter VII.

## II. NATURE OF THE PROBLEM

### A. PRIOR PROJECT MANAGEMENT

The Space Systems Academic Group (SSAG) had no microcomputer-based project management system prior to this study. Neither were there any well-defined procedures for project control and reporting.

Reporting/tracking mechanisms had been manual for projects in the past. The Project Manager simply issued a work unit package to cognizant departments. The work unit package contained major milestones/tasks for completion by a specified date. Depending on the Project Manager's own management style, the dates were monitored using strictly manual methods. When the Project Manager left during the course of the project, action items got lost and the project became "off track."

### B. SSAG PROJECT ENVIRONMENT

The SSAG uses a matrix form of organization as illustrated by the chart in Figure 2.1. A matrix organization is a network of intersections between a project team and the functional elements of an organization [Ref. 8]. It is based on the concept of pulling together technical and managerial talent into a team to operate within the limits of discipline or organizational lines. Matrix relationships are more complex than traditional functional relationships in which the relationships are mostly vertical with few cross-function aspects. Each department is primarily concerned with its own goals. The matrix organization changes these traditional patterns by creating new vertical, horizontal and diagonal relationships among its members. Communications becomes quite critical; thus tight project control and reporting is essential.

The department's goal orientation must also change due to matrix organization. Because the matrix form is midway between the project and the functional organization, departmental personnel must be concerned with project goals in addition to their functional goals. [Ref. 8]

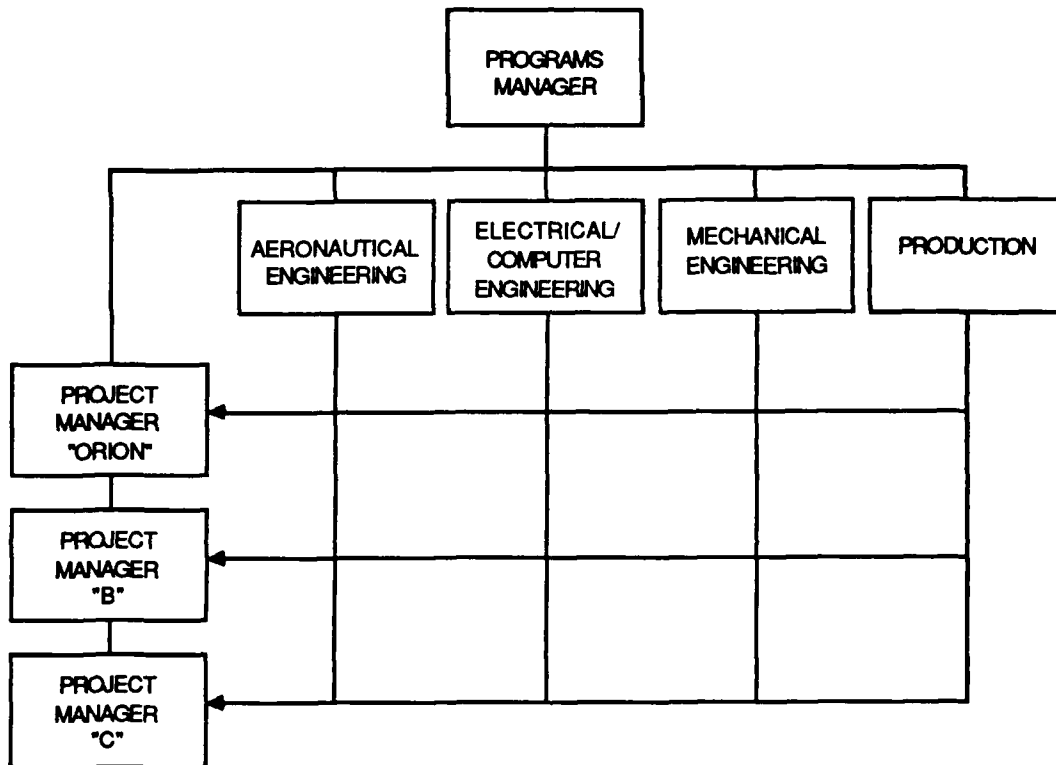


Figure 2.1 Matrix Management Organization

### **III. METHODOLOGY**

#### **A. USER NEEDS ANALYSIS**

Key personnel from the SSAG were selected early in the project life-cycle to determine what information requirements and/or capabilities they would like to see in a project management control system.

Responses from these personnel were summarized in a checklist format and reviewed at their level to validate the information.

#### **B. REQUIREMENTS ANALYSIS**

These checklist responses (Appendix C) were then analyzed. Items that were not felt to be necessary or essential were deleted and a comprehensive list of requirements, identified as the minimum necessary for project management, was used.

#### **C. REVIEW OF COMMERCIAL SOFTWARE**

Based on user needs and requirements, commercial project management software was reviewed and compared to the established requirements to select the most appropriate package. The selected package was OPEN PLAN. It was selected because it was readily available at nominal cost and met user requirements.

## **IV. REQUIREMENTS**

### **A. OBJECTIVES OF A PROJECT MANAGEMENT SYSTEM**

An overriding concern of most organizations is to increase overall effectiveness.

In order to define more specific objectives, it is necessary to interview user personnel familiar with the project. Results of these interviews were then used to describe the following objectives for Project ORION:

- Require minimal and logical inputs to the system. Easily operated.
- Deliver timely information to the appropriate manager. Situations requiring immediate attention can be controlled.
- Provide simultaneous horizontal and vertical dissemination of necessary information. Top management and operating departments will be adequately informed.
- Reduce reporting formats to meaningful facts for management use.

### **B. USER REQUIREMENTS**

Information was collected from interviews and checklist responses of the users. A comprehensive requirements list was created that would be useful by not being overly demanding on resources.

Minimal information requirements for the project management system are:

- Provide a means of establishing and tracking milestones, actual versus planned.
- Provide a method of allocating resources.
- Provide a means of indicating time/scheduling information.
- Provide a means to break the project up into tasks for tracking and reporting.
- Provide a means to easily update progress.

- Provide flexibility in report formats to allow managers to obtain information in a useful form.
- Ensure compatibility with existing equipment available to SSAG.

## V. COMMERCIAL SOFTWARE REVIEW

To help determine whether or not to use a formal automated tool to manage the project, the author reviewed a quick checklist of questions. This checklist is summarized in TABLE V-1 [Ref. 5] . If more than two boxes are checked, a project management system should be considered; if five or more are checked, the system is needed. In the case of Project ORION it was determined that a project management system was needed because the project was long and complex. Fifteen boxes were checked against the checklist.

Early in the initial planning stage for Project ORION the Project Manager reviewed several microcomputer-based software packages. While conducting his review he obtained a complete package of OPEN PLAN from WELCOM SOFTWARE TECHNOLOGY. This package was obtained at nominal cost for further evaluation.

In an attempt to keep costs down, the author reviewed the OPEN PLAN package first to determine if it met requirements. OPEN PLAN was evaluated using four categories for software selection criteria as suggested by Woodridge [Ref. 9] . These criteria address requirements in the area of features, technical and operational environment, implementation, and price of the package.

The four criteria with specific comments are:

- Features--The package should contain as many of the features described in chapter IV, section B as possible.
- Technical and Operational--Must be able to operate the package in the present environment.
  - Hardware Configuration--Must be capable of operating on equipment currently available.

**TABLE V-1**

**DO YOU NEED PROJECT MANAGEMENT SOFTWARE?**

- **Long Projects:**
  - Number of tasks greater than 25
  - Number of work days greater than 75
  - Number of elapsed days greater than 60
  - Budget greater than \$25,000.00
  - 3 or more workers
  - 2 or more resource types (people, machinery, and the like)
- **Complex Projects:**
  - Complex task-dependency structure
  - Work depends on delivery of equipment or other resources
  - Many milestones that need to be reported on
  - Two or more project locations
  - Two or more organizations participating
  - Multiple related projects with interdependencies on tasks/resources
  - Need to optimize projects--for example, resource leveling
- **Special Analysis Needed:**
  - Reports sequenced in various ways--for example, by date, by resource, by responsibility
  - Graphics--for example, Gantt, PERT, histograms, manpower loading charts
  - Special reports--cash flow projects, network analyses, project master plans, assignment work plans, and so on
  - Need to understand critical path and who has assignments on critical path
  - "What if" calculations to determine exposures and balance resources between two or more projects and to determine the effect of adding or deleting personnel on the project
- **Frequent updates/status needed:**
  - Weekly updates
  - Status reports/redrawn PERT or Gantt charts
  - Spontaneous questions on status of any task, milestone, resource
  - Desire more control over scheduling and cost control

- Higher Level Language--A higher level language must have been used to write the programs.
- Operating System--The package should be capable of operating under IBM PC DOS.
- Ease of Use--The package must require minimal manual inputs.
- Flexibility--Must be able to incorporate current procedures and reporting formats.
- Implementation and Maintenance
  - Immediate Availability--Package must be available for immediate delivery and implementation.
  - Supplier Reputation--Supplier must be responsive to user's problems.
  - Training and Documentation--Documentation should cover the system. Training should be minimal.
- Price--Package should be available to the user with no additional start-up costs.

OPEN PLAN was found favorable in each of the above four categories and, therefore, capable of meeting user requirements. Project ORION became the initial project application for microcomputer-based project management within the SSAG.

## **VI. PROJECT MANAGEMENT**

### **A. PROJECT APPLICATION**

The Naval Postgraduate School's (NPS) Project ORION involves the design and fabrication of a small experimental satellite. This program is being coordinated by the Space Systems Academic Group (SSAG) under the direction of Dr. Rudolf Panholzer with the support of nineteen faculty members. ORION is a small satellite mini-bus capable of providing autonomous operational support to a relatively independent payload weighing 50-100 pounds [Ref. 7] .

The primary objective of the ORION program is to enhance NPS students' education in various aspects of spacecraft design and applications. Research in support of the ORION project is provided by the students. The Project Manager is the key interface with departmental staff personnel responsible for the various phases of the project. TABLE VI-1 provides a summary of the current performance baseline for the project. Note that Figure 6.1 is a scaled drawing of the satellite. This figure shows key components.

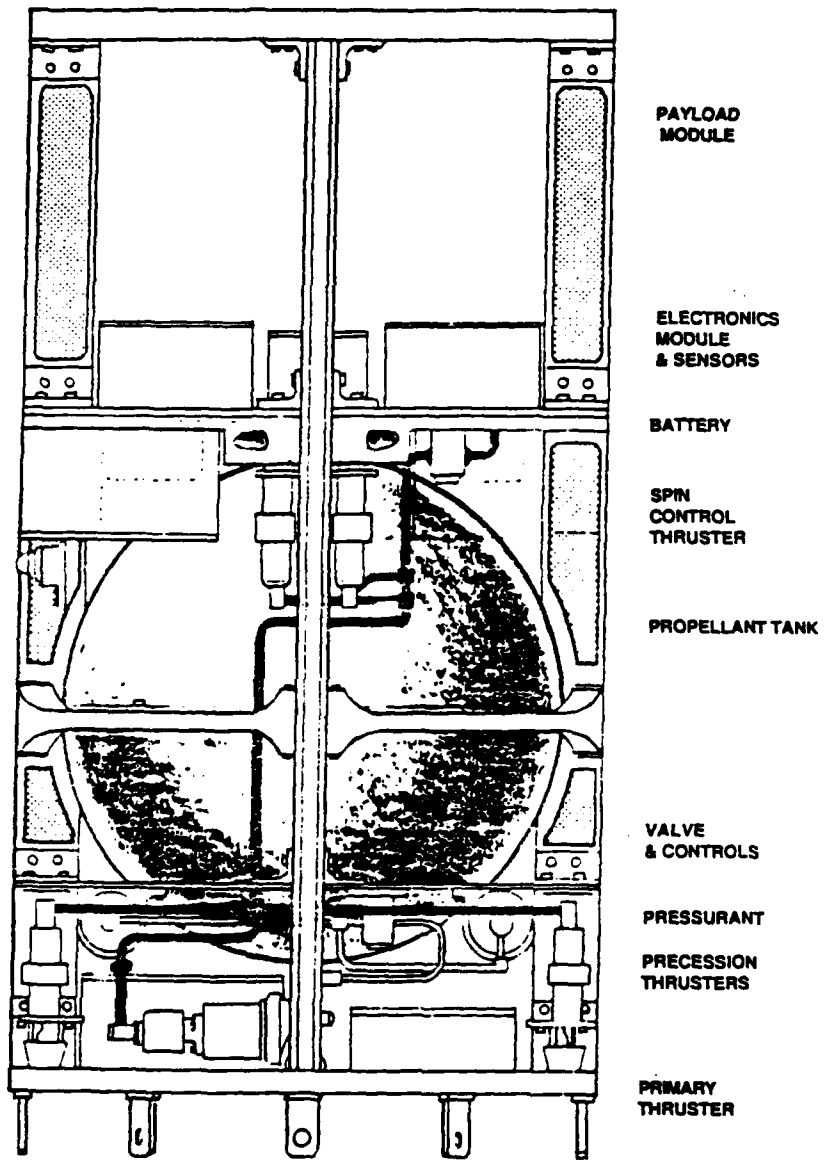
### **B. COMPUTER-AIDED PLANNING AND SCHEDULING**

Many computer programs (software packages) are available to do the scheduling calculations required using network planning techniques. The computer does not replace the planning, scheduling or controlling functions; nor does it replace the management decision-making process. The computer is used to produce a schedule and information in various report formats. These are used for analysis for decisions regarding alterations to the plan.

**TABLE VI-1 ORION PERFORMANCE BASELINE**  
**TABLE I**  
**PROJECT ORION SMALL, GENERAL PURPOSE LOW EARTH ORBIT**  
**SATELLITE BUS**

**SPECIFICATIONS:**

- Designed to support a wide variety of small payloads
- Simple, reliable and low cost design using proven components
- Provides economical access to space for small innovative payloads
- Total satellite weight approximately 270 pounds
  - 50 to 100 pounds of user payload
  - Four deployable booms
- Monopropellant hydrozine propulsion system
  - Total impulse of 15,720 lbf-sec; 12625 fps Delta-V
  - Circular orbits of 800 nautical miles (nm) and elliptic orbits to 2200 nm (from 135 nm)
- Silicon solar cell power system
  - 50 watts total; 15 watts average continuous power to payload
  - Redundant NiCad batteries; 150 watt-hour capacity
- Telemetry options include SGLS, VHF and S Band FM
- General purpose system microcomputer
  - 12 megabyte bubble memory data recorder based on NPS design
  - Data rates up to 2.0 megabytes per second
- Several launch options
  - Shuttle extended GAS cannister
  - Low cost ELV
- Flight unit to be delivered in 1990



**Figure 6.1 Mini-satellite Orion**

The Space Systems Academic Group selected WELCOM SOFTWARE TECHNOLOGY'S OPEN PLAN project management software package to assist in managing the project. OPEN PLAN is a graphically oriented, Critical Path Method (CPM) software package that uses a combination of CPM, Network Charts, Gantt Charts and cost schedules that allow the project manager to plan, schedule and control elements of the project. It uses dBASE III + to store data. It can handle:

[Ref. 10]

- Any number of projects
- Up to 32,750 activities per project
- Up to 8 calendars per project
- Up to 12 character node names (alphanumeric)
- Any number of predecessors per activity
- Up to 850 resources per project, 350 per activity

OPEN PLAN also has a report writer that uses an English-like command language enabling the user to write any report needed. The graphics supports time scaled plotting, color bar charts, histograms, stacked histograms, cost curves, logic plots, summary level schedules and progress curves. [Ref. 10]The package was installed along with dBASE III + on an IBM OS/2 PC. Both OPEN PLAN and dBASE III + are designed to cope with large volumes of data and sophisticated requirements in an open-ended manner. The open-ended nature of the OPEN PLAN package anticipates the continued rapid development of microcomputers and associated peripherals. OPEN PLAN system hardware and software requirements are:

[Ref. 10]

- Computer: IBM PC,XT,AT or 100% compatibles with hard disk
- Memory: 256K bytes minimum,512K recommended(640K for DOS 3)
- Hard Disk: 10M bytes or greater

- Operating System: PC DOS or MS DOS 2.0 or later
- Plotting: Hewlett Packard (HP-GL compatible devices), Nicolet Zeta, and Houston Instruments
- Software: dBASE III or dBASE III +

### **C. INITIAL PLANNING**

The goal of the planning function for Project ORION is to develop a network diagram showing the logical precedence relationship of all activities necessary to properly fabricate, test and ready the satellite for launch.

The first step involved a list of all activities necessary to meet these objectives. The Project Manager is responsible for preparing the list. The list of activities contained 35 specific tasks. See Appendix D. This list shows a description of each task and assigns each task with an alphanumeric activity identifier. A network diagram was developed by the Project Manager and his assistant from the list of activities. The network diagram is included in Appendix E. Note that activities are shown in the sequence of their logical relationship. A time scale plot is also included in Appendix E. This plot shows the activities plotted against a calendar which represents the duration of the entire project.

### **D. SCHEDULING THE PLAN**

Once the network diagram was drawn, the initial planning function was complete. The scheduling function began with the Project Manager estimating the expected duration of each of the activities in the network.

The network diagram, showing all the activities with their estimated durations, provided more information for planning and scheduling than the conventional bar chart technique. This is because network diagrams show the interrelationships of activities. The bar chart treats each activity independently of other activities. In

addition to estimates of the duration for each activity and the scheduled dates for the network start events, the scheduled finish date for completion of the project objective was estimated.

Upon completion of the above, the earliest finish date, latest finish date, and float (slack) for each activity were calculated by computer.

The network logic and all the data were input into the computer using OPEN PLAN. The program checked for errors in the input data and network logic. If the input data were free of errors, the computer made the proper calculations and report.

The program allows the schedule to be sorted in numerous ways. The most useful reports are those which sort the schedule for activities in the following three ways:

- Major sort by latest finish date, subsort by float;
- Major sort by responsibility code, first level subsort by latest finish date, second level subsort by float; and
- Major sort by float, subsort by latest finish date.

The schedules are included in Appendix F. Note that each sort keys on specific fields giving the user different ways to view the project activity data.

## **E. CONTROLLING THE PROJECT**

Once the initial plan and schedule had been developed, a system was developed for controlling the project to keep it on schedule. This system includes regular meetings at which schedule reports are discussed, new information is considered, and decisions regarding replanning are made. The Project Manager and representatives of the various departments attend these meetings. At these meetings, data regarding the actual completion dates of activities, actual dates of

network start events, any changes in activity durations or scheduled dates, and the addition, deletion, or rearrangement of activities are reported. Initial schedules are analyzed to find the most critical areas in the project and to make sure that work is being performed on the critical activities rather than on activities with large amounts of positive slack. The computer reports or schedules point out the areas where slippages occurred and are expected to occur in the schedule. Based on this information, the Project Manager and responsibility groups are able to make necessary planning decisions to bring the project back on schedule. Reasons for slippage are also discussed. The primary reasons are: material not being delivered on time and engineering changes made on equipment already installed or manufactured. Finally, the status of all activities that are in-progress and that are expected to be completed by the next meeting are discussed.

The data generated at these meetings are input to OPEN PLAN for an updated set of schedule reports which are issued to cognizant personnel. As familiarity is gained by the staff, more and more uses will be found for the daily functioning of the project. Communications should be improved and administratively necessary functions will be performed more efficiently.

## **F. PRODUCTIVITY/QUALITY IMPROVEMENTS**

Productivity is the measure of how well a system functions, usually expressed as a ratio of outputs to inputs. Precise measures of productivity are difficult to obtain and productivity figures remain only approximations. Automating the planning, scheduling, and controlling steps can contribute to improved productivity and quality of outputs.

OPEN PLAN eliminates much of the painstaking administrative effort required by project management. It has the flexibility to change costs, durations,

dates, and resources with an automatic updating of output reports. This feature is quite useful in early planning where many changes take place. It gives the user a "what-if" capability. Several scenarios can be demonstrated, printed, and distributed for comment prior to actual project design. A great amount of time can be saved by not having to manually redraw diagrams, charts, and refigure costs.

It took about eight hours to prepare the list of activities, estimate duration for each, and develop the network diagram for Project ORION. The Project Manager indicated that it had previously taken him one to two weeks work on initial planning for a project of ORION's size. Of the eight hours, approximately thirty minutes was spent developing the network diagram from a rough sketch. Previously, this task alone required three days to a week to complete manually. This represents a considerable time savings in itself.

Additional time was spent by the clerk-typist typing up notes, rough drafts, memos and revisions. OPEN PLAN eliminates this extra effort by producing the final network and supporting schedules directly from inputted planning data. In this manner, productivity is greatly improved and the project becomes almost self-documenting.

Depending on the skill and experience of the draftsman, quality of manually produced reports and schedules varies. OPEN PLAN produces a standardized set of output reports and schedules. When compared to previous manually prepared outputs, the quality of the pen plotter used with OPEN PLAN was much improved in clarity.

## VII. CONCLUSION

### A. KEY FACTORS IN THE IMPLEMENTATION PROCESS

The following key factors are important to the implementation process:

#### 1. Organizational Responsibilities

Without proper centralized controls, an organization may quickly acquire multiple incompatible computer units and a multitude of redundant software. The use of these incompatible systems may tend to disperse valuable project management information into disorganized pockets. These considerations should not deter an organization from implementation of microcomputer technology, but rather should mandate a prudent, organized process of implementation. To minimize the potential for a random dispersal of microcomputer technology, three key groups should assume responsibilities for the implementation process. These groups are:

##### a. *Management Information Systems (MIS)*

Within the SSAG, this group consisted of the project manager and one or two people knowledgeable in the information systems field. It provided the guidelines for compatibility with respect to microcomputer hardware and software, as well as a centralized training and maintenance function. In larger organizations, this group should develop a master plan for the entire organization. Implementation of microcomputer hardware and software should be carried out consistent with this overall plan. The MIS group, however, must maintain some flexibility in selection of software to be able to fulfill a wide range of requests from departments, while still maintaining compatibility on a total system basis.

### ***b. Programs***

The programs group must provide guidelines for selection of appropriate hardware/software for project management applications to any given project. In the case application presented in this study, the project manager assessed the requirements, size of the project, and duration, etc. and, in conjunction with supporting functional groups, selected an appropriate software package. The hardware was already in place, so it was simply a matter of selecting the best available package considering various compatibility and other selection criteria. In larger organizations, the MIS group would provide the hardware, software, and training to support the project decisions.

### ***c. Functional Groups***

Each functional group performed detailed planning, identified action items, estimated budgets and used the agreed-to software package on the microcomputer. Planning efforts were integrated, interfaces defined, and agreements reached on commitments. Training time was allocated within the groups for familiarization with the software package.

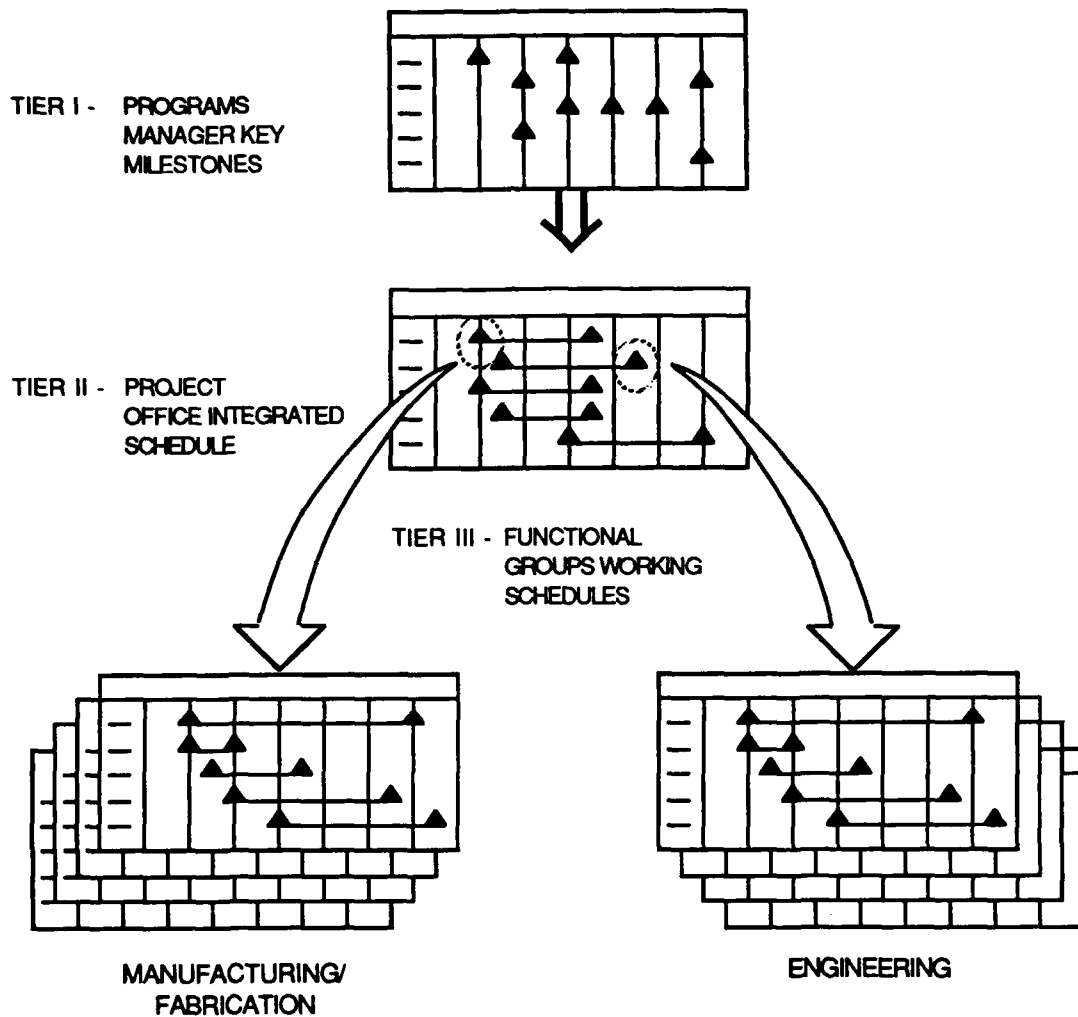
## **2. Multiple Tier Structure Approach**

While this approach is not unique to microcomputer application, it was quite beneficial to define discrete levels or tiers for planning, scheduling, and controlling. Responsibility at each tier was specified, and interfaces between these tiers clearly delineated. For the project application, the tier structure was defined as:

- Tier I: Programs Manager Milestones
  - Interface/Programs Manager to Project Manager
- Tier II: Project Office Integrated Schedule

- Interface/Project Manager to Functional Groups
- Tier III: Functional Groups Working Schedule
  - Interface/Functional Manager to Engineering and Manufacturing Staff/Student

Note that this concept is shown pictorially in Figure 7.1.



**Figure 7.1 Multiple Tier Structure**

### 3. Quantification of Planning Detail

If not properly defined, the planning activities from each of the contributors at the Tier III level will be totally random in the amount of detail,

since this detail becomes a direct function of the manager's propensity for planning. While a variable level of planning is acceptable within a group, coordination between these groups becomes difficult. Some groups do not give enough detail to permit cross-reference, while others waste precious resources in providing excessive details. The Project Manager has responsibility for ensuring a balanced approach.

#### **4. Personnel Training**

Microcomputer applications require far less orientation and training than would be expected by those familiar with mainframe applications of project management techniques. Software systems for planning, resource allocation, data bases, word processing and spread sheets all currently exist in relatively user-friendly formats.

Some formal training was required, however. Sample problems and models included with the software package were used to provide excellent training tools and were a mandatory part of the training program. Some real-time practice on a microcomputer was required to become familiar with the mechanics of the system, but in most cases this amounted to hours instead of days or weeks.

#### **5. Operating Procedures**

Just as in any facet of the organization, operating procedures were established for implementation of microcomputers. Because of the inherent flexibility in use of the microcomputer, it proved essential that procedures be developed. These procedures included computer input control by revision number, date, and log book entry. Controlled backup discs and updating were shown to be necessary as were written machine startup, system entry, report output, and file retrieval. The user's manual and reference manual which accompanied the OPEN

accompanied the OPEN PLAN software package were excellent sources for help in this endeavor. Periodic management reviews of adherence to the operating procedures is continuing, since microcomputer applications seem to promote individual, informal practices as the user becomes more familiar with the system.

## **B. SUMMARY**

Implementation of the microcomputer in this project environment has proven to be beneficial to all project team members. Project planning and scheduling targets are more readily communicated; the day-to-day administrative tasks are more efficiently performed; and project personnel are responsive to commitments, partially because of the increased visibility afforded them. Acceptance of the use of the microcomputer by project members was enthusiastic, since the quality of the work improved and mundane tasks took far less time.

In considering microcomputer implementation in any organization, it is advisable for management to clearly define a single group responsible for the development of a master plan for selection of compatible hardware and software. Also, centralized training is more cost-effective because controls are easier to implement and monitor. Furthermore, since there are a great many alternatives in setting up an organization's microcomputer strategy, there is a tendency to plan for too long a period of time in the future. Thus it is best to develop a plan over a period of a few months, and to implement within that time period. The microcomputer industry is changing too rapidly to warrant spending any more time than that on initial implementation. Costs of microcomputers are relatively inexpensive, and benefits to be gained so attractive, that long delays are not economically justified.

## APPENDIX A

### DEFINITION OF TERMS

**ACTIVITY:** One of the subunits of work that comprise a task. For example, staking out and digging are two activities in the larger task of laying a house's foundation.

**ACTIVITY TIMES:** Estimates of the time necessary to complete an activity in a specified manner.

**ARROW:** A directed line, connecting two events, that depicts the activity necessary to move from the predecessor event to the successor event.

**ARROW DIAGRAM:** Pictorial representation of a project showing all events and their interrelationships through activities. It also may include indicative information such as activity times, costs, and scheduled target dates.

**CRITICAL ACTIVITY:** Any activity on the critical path; such jobs are identified by having zero total float (slack).

**CRITICAL PATH:** That series of tasks or activities that, if delayed, will be the first to cause the delay of the project; the path that leads to the project end task with a minimum of accumulated slack time.

**CRITICAL PATH METHOD (CPM):** A project scheduling method based on the assessment of time required to complete activities on the critical path.

**DUMMY ACTIVITY:** An activity used to account for nonwork/nonbillable portions of a project; for example, waiting time for materials to be delivered.

**DURATION:** The estimated completion time for an activity. This differs from the expected completion time, based on statistical inference, since the duration is usually determined from historical data.

**EARLY FINISH DATE:** The earliest possible date a task or activity can be completed without interfering with the completion of any preceding activities.

**EARLY START DATE:** The earliest possible date a task or activity can begin; it often gives rise to slack time at the end of the previous activity.

**END:** The end of the project; the final node or successor event, that defines the terminus of the critical path.

**EVENT:** Also called "node" or "milestone," an event has no time frame associated with it, but typically serves to mark the start or end of activities and to relate activities to each other.

**EXPECTED COMPLETION TIME:** The most probable time for a given event to be completed.

**FLOAT (SLACK):** The amount of time following the completion of a task or activity but prior to the start of the next dependent task or activity (or project end if there are no dependent tasks/activities).

**GANTT CHART:** Named after its developer, Henry Gantt, a time-based bar, line, or arrow chart depicting start and end points of activities or tasks; the interrelationships/dependencies of activities are not shown.

**LATEST START TIME:** Latest time that any activity leading from a given event can start without delaying the overall project.

**NETWORK:** The structure of relationships among a project's activities, tasks, and events. Same as "arrow diagram."

**NODE:** The intersection of two or more activities in a network diagram.

**PERT (Project Evaluation and Review Technique):** A planning and control tool that identifies the interdependencies of project elements and attempts to determine the time needed to complete each in terms of pessimistic, optimistic, and best-guess estimates.

**PERT CHART:** A diagram representing the interdependencies of work elements against time, typically shown graphically as circles and connecting lines.

**PREDECESSOR:** The begin-node or time of initiation of a particular activity. Carries a numeric identity.

**PROJECT PLAN:** The first phase of the project management cycle, involving development and organization of the work plan.

**PROJECT SCHEDULE:** The second phase of the project management cycle, detailing start and completion times for each task and activity.

**RESOURCE:** Includes manpower, materials, equipment, and any other costed item utilized in completing a project.

**RESOURCE ALLOCATION:** The assignment of resources needed to complete each task or activity.

**RESOURCE LEVELING:** The scheduling of activities with float time to optimize the use of resources, thereby avoiding large fluctuations in resource requirements.

**SCHEDULING UNIT:** The particular time period(s) in which a project is planned--hours, days, weeks, quarters, years, etc.

**SUCCESSOR:** The end-event of an activity, a node which has a numeric identity and is complementary to its predecessor (node). The successor of a preceding activity is the predecessor of a subsequent activity.

**TASK:** A discrete element of a project, consisting of activities; for example, laying a foundation and landscaping are two separate tasks in the project of building a house.

**WORK BREAKDOWN STRUCTURE (WBS):** A comprehensive, hierarchical listing of the work elements and dependencies required to complete a given project; a useful tool for the project planner, serving as a predefinition to speed up the planning process.

## APPENDIX B

### BASIC PROJECT MANAGEMENT

Lock defines project management as "a specialized branch of management which has evolved in order to co-ordinate and control some of the complex activities of modern industry." [Ref. 11] Archibald refers to project management as "the planning and execution of particular efforts called 'projects'." [Ref. 12] According to Archibald much semantic confusion exists regarding the terms "programs, projects, and tasks." Generally accepted practice in modern industry has established the following common usage:

- **Program**--A long-term undertaking which is usually made up of more than one project. Sometimes used synonymously with "project." [Ref. 12]
- **Project**--A complex effort, usually less than three years in duration, made up of interrelated tasks performed by various organizations, with a well-defined objective, schedule, and budget. [Ref. 12]
- **Task**--A short term effort (usually three to six months) performed by one group or organization, which may combined with other tasks to form a project. [Ref. 12]

In short, project management is a set of principles, methods, and techniques for effective planning of objective-oriented work thereby establishing a sound basis for effective scheduling, controlling and replanning in the management of programs and projects.

Project management employs:

- A project-oriented work breakdown structure (WBS).
- A flow plan (network) consisting of all activities to be accomplished to achieve the project objectives, their planned sequence, interdependencies, and interrelationships.

- A flow plan (network) consisting of all activities to be accomplished to achieve the project objectives, their planned sequence, interdependencies, and interrelationships.
- Elapsed time estimates and identification of critical paths in the network.
- A schedule that attempts to balance the objectives, the network flow plan, and availability of resources.
- Analysis of the interrelated networks, schedules and slack values as a basis for continuous evaluation of program status.

Potential benefits of project management are: [Ref. 12]

- Provides discipline that ensures complete project coverage...avoids omission of important tasks.
- Fixes responsibility and assures continuity of effort despite turnover on the project team.
- Identifies real time requirements and provides limits for scheduling.
- Spots potential problem areas in time to take preventive action.
- Uses management-by-exception principle in reporting.
- Measures accomplishment against current scheduled plans and objectives.
- Provides opportunity for consideration of trade-offs in funds, manpower, time, and performance between critical and non-critical areas.
- Permits rescheduling and provides periodic evaluation of plans.
- Provides a historical bank of data and project models for future planning.

#### **PERT/CPM:**

Basic concepts of Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM), such as activities, events, and predecessors, have become a regular part of the language of project managers. They have facilitated communication at every level of management, and across organizational lines--between foremen and engineers, and managers and technicians. PERT was created in the 1950s to plan and accelerate development of the Polaris ballistic missile. Fundamental to PERT is the concept of an 'event' or the reaching of a

certain stage of completion of a project. Also basic is the expected time required to complete activities leading up to that event. [Ref. 13]

CPM is basically concerned with obtaining the trade-off between cost and completion date for large projects. It emphasizes the relationship between applying more men or resources to shorten the duration of given jobs in a project and the increased cost of these additional resources. [Ref. 13]

Fundamentally, PERT and CPM are techniques of project management useful in the basic managerial functions of planning, scheduling, and control.

## APPENDIX C

### REQUIREMENTS CHECKLIST

#### GENERAL INFORMATION:

This checklist is part of a study being conducted on project management within Space Systems Academic Group (SSAG) at NPS.

The requirements listed support the four specific objectives of Project ORION, the initial project application.

- Require minimal inputs to the system. Should not be cumbersome to operate.
- Deliver information to the appropriate manager when needed. Situations requiring immediate attention can be controlled.
- Provide simultaneous horizontal and vertical dissemination of necessary information. Top management and operating departments will be adequately informed.
- Reduce excessive reams of information to meaningful facts for management use.

Review the checklist and respond as appropriate. Each item requires two checks; one regarding whether or not the requirement will be used and the other regarding storage of the information.

For items not listed, request make an addition for your input.

TABLE C-1

REQUIREMENTS CHECKLIST

	DESCRIBE YOUR USE OF INFO			WHERE STORED		
	NEED TO HAVE	NICE TO HAVE	WONT USE	COMPUTER	WORD PROCESSOR	MANUAL/ OTHER
MEANS OF ESTABLISHING AND TRACKING MILESTONES (ACTUAL)						
MEANS OF ESTABLISHING AND TRACKING MILESTONES (PLANNED)						
MEANS OF RECORDING/ DISPENSING KEY INFORMATION						
MEANS OF INDICATING TIME/ SCHEDULE INFORMATION						
FUDNING PROFILE (RESOURCE ALLOCATION)						
WAY OF DESIGNATING TASKS/ SUBTASKS						
PEOPLE RESOURCES (RESOURCE ALLOCATION)						
FLEXIBLE REPORT FORMAT						
UPDATE STATUS OF PROJECT (PROGRESS)						
PROJECT PRIORITY						



REPORT DATE: 11/05/88

ACTIVITY: EST SUBSYS SPEC, BUDT, PERF

PROJECT ORIGIN: RFE HMI-BASED/LEAD DESIGN

ACTIVITY: EST SUBSYS SPEC, BUDT, PERF

TIME: 11/05/88

ACTIVITY: EST SUBSYS SPEC, BUDT, PERF

ACTIVITY	DUR	CRG	ACTV	PROG DESCRIPTION	CODE 1	CODE 2	START	FINISH	TOTAL FREE FLOAT
B00010	44	44	1	EST SUBSYS SPEC, BUDT, PERF	72c		E: 03JUN88 L: 05OCT88 S: EMPTY	E: 03AUG88 L: 05DEC88 S: EMPTY	88 83
B00050	132	132	1	PERF SUBSYS & COMP DESIGN	72c		E: 03JUN88 L: 03JUN88 S: EMPTY	E: 05DEC88 L: 05DEC88 S: EMPTY	0 0
B00060	132	132	1	SUBSYSTEM BREADCRUMBS	62m1		E: 03JUN88 L: 03JUN88 S: EMPTY	E: 05DEC88 L: 05DEC88 S: EMPTY	0 0
B00070	132	132	1	PRELIMINARY DRAWINGS	72c	71b	E: 03JUN88 L: 03JUN88 S: EMPTY	E: 05DEC88 L: 05DEC88 S: EMPTY	0 0
B00080	11	11	1	SUBSYS PRELIM DESIGN REVIEW	72		E: 06DEC88 L: 06DEC88 S: EMPTY	E: 20DEC88 L: 20DEC88 S: EMPTY	0 0
B00090	11	11	1	SYSTEM PRELIM DESIGN REVIEW	72		E: 06DEC88 L: 06DEC88 S: EMPTY	E: 20DEC88 L: 20DEC88 S: EMPTY	0 0
C00000	208	208	1	FINAL DESIGN PHASE	72a	72c	E: 11DEC88 L: 11DEC88 S: EMPTY	E: 06OCT89 L: 08OCT89 S: EMPTY	0 0
C00010	66	66	1	LONG-LEAD COMP PIELD PART PPOC	72d		E: 11DEC88 L: 20JUN89 S: EMPTY	E: 22MAR89 L: 24SEP89 S: EMPTY	132 36
C00020	66	66	1	FAB QUAL MODEL STRUCTURE	67h3		E: 11DEC88 L: 03JAN89 S: EMPTY	E: 22MAR89 L: 05APR89 S: EMPTY	10 0
C00030	132	132	1	COMPLETE DETAILED SYS DESIGN	69e9		E: 11DEC88 L: 23MAR89 S: EMPTY	E: 23JUN89 L: 24SEP89 S: EMPTY	66 0
C00040	132	132	1	COMPLETE FINISHED DWGS	71d		E: 11DEC88 L: 23MAR89 S: EMPTY	E: 23JUN89 L: 24SEP89 S: EMPTY	66 0

Legend: ( for Column 1: S = Start activity, F = Finish Activity, I = Independent

REPORT DATE 11AUG91  
 PROJECT: JPL/ME  
 REPORT: ATTACHED  
 TIME WORK: 12NOV97

ACTIVITY	REM ORIG	ACTY	DESCRIPTION	CODE 1	CODE 2	START	FINISH	TOTAL
F	DUR	DUP	L P E	PROG	DESCRIPTION	START	FINISH	FREE
S								FLOAT
C00051	132	132	1	0	COMPLETE ELECTRONIC PKG DESIGN	E:12DEC88 L:12MAR89 S:EMPTY	E:22JUN89 L:26SEP89 S:EMPTY	66 0
C00052	132	132	1	0	PROCURE PIECE PARTS MATL	E:12DEC88 L:12MAR89 S:EMPTY	E:22JUN89 L:26SEP89 S:EMPTY	66 0
C00073	132	132	1	0	QUALITY STRUCTURE	E:12MAR89 L:05APR89 S:EMPTY	E:22SEP89 L:08OCT89 S:EMPTY	10 10
C00080	132	132	1	0	COMPLETE ALL ANALYSES	E:12DEC88 L:12MAR89 S:EMPTY	E:22JUN89 L:26SEP89 S:EMPTY	66 0
C00090	10	10	1	0	SYSTEM CRITICAL DESIGN REVIEW	E:13JUN89 L:25SEP89 S:EMPTY	E:06JUL89 L:08OCT89 S:EMPTY	66 0
D00300	242	242	1	0	ASSEMBLE & TEST SUBSYSTEMS	E:09OCT89 L:09OCT89 S:EMPTY	E:11SEP90 L:11SEP90 S:EMPTY	0 0
F D00010	132	132	1	0	ASSEMBLE & TEST SUBSYSTEM	E:07JUL89 L:13FEB91 S:EMPTY	E:08JAN90 L:15AUG91 S:EMPTY	418 413
D00020	66	66	1	0	ASSEMBLE FLIGHT STRUCTURE	E:07JUL89 L:12JUN90 S:EMPTY	E:06OCT89 L:11SEP90 S:EMPTY	242 242
D00030	66	66	1	0	ASSEMBLE FLT ELECT HARNESS	E:07JUL89 L:12JUN90 S:EMPTY	E:06OCT89 L:11SEP90 S:EMPTY	242 242
D00040	132	132	1	0	ACCEPTANCE TEST PROC COMP	E:12SEP90 L:12SEP90 S:EMPTY	E:14MAR91 L:14MAR91 S:EMPTY	0 0
D00050	44	44	1	0	ACCEPTANCE TEST SUBSYSTEMS	E:12SEP90 L:14JAN91 S:EMPTY	E:12NOV90 L:14MAR91 S:EMPTY	88 88

Legend: ( for Column 1 ) S = Start activity, F = Finish activity, I = Independent









## APPENDIX F SORTED SCHEDULES FOR ACTIVITIES

NASA Postgraduate School

ACTIVITY CHECK LIST BY DATE FINISH TOTAL FLOAT

PROJECT: ORIONB      MFS MINI-SATELLITE ORION

PAGE: 1

REPORT DATE: 11AUG83

TIME NOW: 01NOV87

S F I	ACTIVITY	REM DUR	ORIG DUR	A L	T P	C E	PROG L	DESCRIPTION	CODE 1	CODE 2	START	FINISH	TOTAL	
													FREE	FLOAT
S	A00020	44	44	1	0	0	0	DEFINE CONSTRAINTS	72	57KJ	E:02NOV87 L:17NOV87 S:EMPTY	E:31DEC87 L:17JAN88 S:EMPTY	11	0
S	A00000	83	88	1	0	0	0	DEFINITION PHASE	72		E:02NOV87 L:02NOV87 S:EMPTY	E:02MAR88 L:02MAR88 S:EMPTY	0	0
S	A00010	83	88	1	0	0	0	DEFINE SYSTEM REQUIREMENTS	72		E:02NOV87 L:17NOV87 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11	0
S	A00020	93	88	1	0	0	0	CONCEPTUAL SYSTEM DESIGN	72	69K1	E:02NOV87 L:17NOV87 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11	0
	A00040	44	44	1	0	0	0	DEFINITION OF INTERFACES	72	695g	E:01JAN88 L:18JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11	0
	A00050	44	44	1	0	0	0	ID SYS TO LAUNCH VEHICLE	62ts	72	E:01JAN88 L:18JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11	0
	A00060	44	44	1	0	0	0	DEFINE SUBSYS INTERFACES	67KJ	62a1	E:01JAN88 L:13JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11	0
	B00010	44	46	1	0	0	0	SPECIFY SUBSYS & COMP RSQ	62m7		E:03MAR88 L:03MAR88 S:EMPTY	E:03MAY88 L:03MAY88 S:EMPTY	0	0
	B00020	22	22	1	0	0	0	BREAK EFFORT INFO WORK PRGS	72b		E:01MAY88 L:04MAY88 S:EMPTY	E:02JUN88 L:02JUN88 S:EMPTY	0	0
	B00070	132	132	1	0	0	0	PRELIMINARY DRAWINGS	72c	72b	E:03JUN88 L:03JUN88 S:EMPTY	E:05DEC88 L:05DEC88 S:EMPTY	0	0
	B00080	132	132	1	0	0	0	SUBSYSTEM BREADBOARDS	62m1		E:03JUN88 L:03JUN88 S:EMPTY	E:05DEC88 L:05DEC88 S:EMPTY	0	0

Legend: ( for Column 1 ) S = Start activity F = Finish Activity, I = Independent



REPORT DATE: 11AUG68

REPORT AUTHORITY:

PROJECT ORIGIN:

REPORT TITLE:

REPORT DATE:

REPORT NUMBER:

REPORT CLASSIFICATION:

REPORT TYPE:

REPORT STATUS:

REPORT SOURCE:

REPORT DATE:

REPORT NUMBER:

REPORT CLASSIFICATION:

REPORT TYPE:

REPORT STATUS:

ACTIVITY	ORIG	DUR	ACT	TV	PROG	DESCRIPTION	CODE 1	CODE 2	START	FINISH	TOTAL /FREE /FLOAT
C00050	132	132	1	0	0	COMPLETE ELECTRONIC PKG DESIGN	62M1		E: 21DEC80 L: 23MAR80 S: EMPTY	E: 22JUN89 L: 24SEP89 S: EMPTY	66 0
C00010	66	66	1	0	0	LONG-LEAD COMP/PIECE PART PROC	72J		E: 21DEC83 L: 23JUN89 S: EMPTY	E: 22MAR89 L: 24SEP89 S: EMPTY	132 66
C00000	208	208	1	0	0	FINAL DESIGN PHASE	72A	72C	E: 21DEC88 L: 21DEC83 S: EMPTY	E: 06OCT89 L: 08OCT89 S: EMPTY	0 0
C00070	132	132	1	0	0	QUALIFY STRUCTURE	67KJ		E: 23MAR89 L: 05APR89 S: EMPTY	E: 22SEP89 L: 09OCT89 S: EMPTY	10 10
C00090	10	10	1	0	0	SYSTEM OPTICAL DESIGN REVIEW	72B	72C	E: 23JUN89 L: 25SEP89 S: EMPTY	E: 06JUL89 L: 08OCT89 S: EMPTY	66 0
D00000	242	242	1	0	0	ASSEMBLE & TEST SUBSYSTEMS	62A	69CK	E: 09OCT89 L: 09OCT89 S: EMPTY	E: 11SEP90 L: 11SEP90 S: EMPTY	0 0
D00010	66	66	1	0	0	ASSEMBLE FLIGHT STRUCTURE	67KJ		E: 07JUL89 L: 12JUN90 S: EMPTY	E: 06OCT89 L: 11SEP90 S: EMPTY	242 242
D00030	66	66	1	0	0	ASSEMBLE FLT ELECT HAPNESS	62M1		E: 07JUL89 L: 12JUN90 S: EMPTY	E: 06OCT89 L: 11SEP90 S: EMPTY	242 242
D00040	132	132	1	0	0	ACCEPTANCE TEST PROC COMP			E: 12SEP90 L: 12SEP90 S: EMPTY	E: 14MAR91 L: 14MAR91 S: EMPTY	0 0
D00050	44	44	1	0	0	ACCEPTANCE TEST SUBSYSTEMS	62CC	69CK	E: 12SEP90 L: 14JAN91 S: EMPTY	E: 12NOV90 L: 14MAR91 S: EMPTY	88 88
D00060	44	44	1	0	0	ASMBL COMP/HRNS TO FLT STRUCT	62CC	67KJ	E: 15MAR91 L: 15MAR91 S: EMPTY	E: 15MAY91 L: 15MAY91 S: EMPTY	0 0

Legend: ( for Column 1, 3 = Start activity, F = Finish Activity, 1 = Independent

SHEET 1428  
 PROJECT: ORIONS  
 REP. RT. ACTORS  
 PROJECT: ORIONS  
 ACTIVITY: HEADLINE BY DATE FINISH DATE  
 NPS MINI-SATELLITE CARRIER  
 TIME NON-UNIONIST

PAGE:

ACTIVITY	REP. ORG. DUR	ACTIVITY	HEADLINE	BY DATE	FINISH DATE	TIME NON-UNIONIST
F 00070	56 60	1	0	PERFORM SYSTEM LEVEL TESTS	E:15AUG91 L:15AUG91 S:EMPTY	TOTAL: 0 FREE: 0 FLOAT: 0
F 00010	133 133	1	0	ASSEMBLE & TEST MBR SYSTEM	E:07JUL89 L:13FEE91 S:EMPTY	TOTAL: 418 FREE: 418 FLOAT: 418

Legend: 1 for Column 1 | S = Start activity, F = Finish Activity, I = Independent

PROJECT: CRICHE

ACTIVITY LINE & UNIT OF WORK & DATE FINISH TOTAL FLOAT

TIME (HOW: 0.100V37)

I	ACTIVITY	RES ORIG	DUR	DUPL	L	P	R	TY	PE	PRG	DESCRIPTION	CODE 1	CODE 2	START	FINISH	TOTAL	
																PERSE	FLOAT
	C00630	132	132	1	0	0	0	0	0	0	COMPLETE ALL ANALYSES	5587		E: 22JUN89 L: 23SEP89 S: EMPTY	E: 22JUN89 L: 23SEP89 S: EMPTY	36	0
	D00640	132	132	1	0	0	0	0	0	0	ACCEPTANCE TEST PPGC COMP	61		E: 14MAR91 L: 14MAR91 S: EMPTY	E: 14MAR91 L: 14MAR91 S: EMPTY	0	0
	D00660	242	242	1	0	0	0	0	0	0	ASSEMBLE & TEST SUBSYSTEMS	5242	590K	E: 09OCT89 L: 09OCT99 S: EMPTY	E: 11SEP90 L: 11SEP90 S: EMPTY	0	0
	D00650	44	44	1	0	0	0	0	0	0	ACCEPTABLE TEST SUBSYSTEMS	5000	390K	E: 12SEP90 L: 14JAN91 S: EMPTY	E: 12NOV90 L: 14MAR91 S: EMPTY	82	36
	B00260	132	132	1	0	0	0	0	0	0	SUBSYSTEM BREADCARDS	6201		E: 03JUN88 L: 02JUN88 S: EMPTY	E: 05DEC89 L: 05DEC88 S: EMPTY	0	0
	C00350	132	132	1	0	0	0	0	0	0	COMPLETE ELECTRONIC PKG DESIGN	6201		E: 21DEC88 L: 23MAR89 S: EMPTY	E: 22JUN89 L: 24SEP89 S: EMPTY	66	0
	D00630	66	66	1	0	0	0	0	0	0	ASSEMBLE FLT ELECT HARNNESS	6201		E: 07JUL89 L: 12JUN90 S: EMPTY	E: 06OCT93 L: 11SEP90 S: EMPTY	242	242
	E00600	198	198	1	0	0	0	0	0	0	PRELIMINARY DESIGN PHASE	6200	71E	E: 03MAR88 L: 18MAR88 S: EMPTY	E: 05DEC89 L: 20DEC88 S: EMPTY	11	11
	B00310	44	44	1	0	0	0	0	0	0	SPECIFY SUBSYS & COMP REC	6200		E: 03MAR88 L: 03MAR88 S: EMPTY	E: 03MAY88 L: 03MAR88 S: EMPTY	0	0
	A00050	44	44	1	0	0	0	0	0	0	ID SYS TO LAUNCH VEHICLE	6203	72	E: 01JAN88 L: 18JAN88 S: EMPTY	E: 02MAR88 L: 17MAR88 S: EMPTY	11	0
	F D00610	132	132	1	0	0	0	0	0	0	ASSEMBLE & TEST SUBSYSTEM	6203		E: 07JUL89 L: 13FEB91 S: EMPTY	E: 08JAN90 L: 13AUG91 S: EMPTY	418	418

Legend: ( for Column 1 ) S = Start activity, F = Finish activity, I = Independent

PROJECT: CHARGE NO MULTI-SATELLITE R&D

ACTIVITY	DUR	ORIG	ACTY	DESCR	CODE 1	CODE 2	START	FINISH	CTA- /FREE FLOAT
D0060	44	44	1	0 ASSEMBLY COMP HBNG TO FLT STRUCT	6211	67KJ	E:15MAR91 L:15MAR91 S:EMPTY	E:15MAY91 L:15MAY91 S:EMPTY	0 0
A0060	44	44	1	0 DEFINE SUBSYS INTERFACES	67KJ	62M1	E:01JAN88 L:13JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
C0020	66	66	1	0 FAE QUAL MODEL STRUCTURE	67KJ		E:21DEC88 L:01JAN89 S:EMPTY	E:22MAR89 L:05APR89 S:EMPTY	10 0
C00670	132	132	1	0 QUALITY STRUCTURE	67KJ		E:14MAR89 L:06APR89 S:EMPTY	E:23SEP89 L:03OCT89 S:EMPTY	10 10
D0060	66	66	1	0 ASSEMBLY FLIGHT STRUCTURE	67KJ		E:07JUL89 L:12JUN90 S:EMPTY	E:06OCT89 L:11SEP90 S:EMPTY	242 242
C0030	132	132	1	0 COMPLETE DETAILED SYS DESIGN	6959		E:21DEC88 L:23MAR89 S:EMPTY	E:22JUN89 L:24SEP89 S:EMPTY	66 0
S A0020	44	44	1	0 DEFINE CONSTRAINTS	70	67KJ	E:02NOV87 L:17JAN88 S:EMPTY	E:31DEC87 L:17JAN88 S:EMPTY	11 0
S A0030	86	86	1	0 DEFINITION PHASE	70		E:02NOV87 L:02NOV87 S:EMPTY	E:02MAR88 L:02MAR88 S:EMPTY	0 0
A0040	44	44	1	0 DEFINITION OF INTERFACES	72	6959	E:01JAN88 L:13JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
S A0010	88	88	1	0 DEFINE SYSTEM REQUIREMENTS	72		E:02NOV87 L:17NOV87 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
S A0030	88	88	1	0 CONCEPTUAL SYSTEM DESIGN	72	6959	E:02NOV87 L:17NOV87 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0

Legend: 1 for Column 1, S = Start Activity, F = Finish Activity, ? = Independent

ACTIVITY: THE BUILD UP OF THE LATE ENGINEERING PLAN  
 PROJECT: CRIBL  
 NP'S MINI-SATELLITE RICH

ACTIVITY	REN	DFIG	ACT	TIME	NO.	SHOW	TOTAL						
I	ACTIVITY	DEF	DUR	L	PE	PPDG	DESCRIPTION	CODE 1	CODE 2	START	FINISH	F/RES	FLCAT
E	800090	11	11	1	0		SYSTEM PRELIM DESIGN REVIEW	72		E:01DEC88 L:06DEC88 S:EMPTY	E:02DEC88 L:02DEC88 S:EMPTY	0	0
E	800080	11	11	1	0		SUBSYS PRELIM DESIGN REVIEW	72		E:01DEC88 L:06DEC88 S:EMPTY	E:02DEC88 L:02DEC88 S:EMPTY	0	0
E	800070	66	66	1	0		PERFORM SYSTEM LEVEL TESTS	72		E:16MAY91 L:16MAY91 S:EMPTY	E:15AUG91 L:15AUG91 S:EMPTY	0	0
E	800060	203	203	1	0		FINAL DESIGN PHASE	723	723	E:11DEC88 L:21DEC88 S:EMPTY	E:06OCT89 L:03OCT89 S:EMPTY	0	0
E	800020	22	22	1	0		BREAK EFFORT INTO WORK PKGS	72B		E:04MAY88 L:04MAY88 S:EMPTY	E:02JUN88 L:02JUN88 S:EMPTY	0	0
E	800030	44	44	1	0		ASSIGN WK PKGS TO SUBSYS MGFS	71E		E:03JUN88 L:05OCT83 S:EMPTY	E:03AUG88 L:05OCT88 S:EMPTY	88	88
E	80009C	10	10	1	0		SYSTEM CRITICAL DESIGN REVIEW	72B		E:22JUN89 L:25SEP89 S:EMPTY	E:06JUL89 L:08OCT89 S:EMPTY	66	0
E	800070	132	132	1	0		PRELIMINARY DRAWINGS	72C	72B	E:03JUN86 L:01JUN83 S:EMPTY	E:05DEC88 L:05DEC83 S:EMPTY	0	0
E	800050	132	132	1	0		PERF SUBSYS & COMP DESIGN	72C		E:03JUN88 L:03JUN88 S:EMPTY	E:05DEC88 L:05DEC83 S:EMPTY	0	0
E	800040	44	44	1	0		EST SUBSYS SKED, EDGT, PERF	72C		E:03JUN88 L:05OCT88 S:EMPTY	E:03AUG88 L:05DEC88 S:EMPTY	88	88
E	800060	132	132	1	0		PROCURE PIECE PARTS/MATL	72D		E:11DEC88 L:23MAR89 S:EMPTY	E:22JUN89 L:24SEP89 S:EMPTY	66	0

Legend: ( for Column 1 ) S = Start activity, F = Finish activity, I = Independent



ACTIVITY	REM DURS	ACTIVITY	DEFINITION PHASE	CODE 1	CODE 2	START	FINISH	TOTAL /FREE FLOAT
B00000	89	1	0	72		E:02MAY88 L:02MAY88 S:EMPTY	E:02MAR88 L:02MAR88 S:EMPTY	0 0
B00010	44	1	0	62M		E:03MAY88 L:03MAY88 S:EMPTY	E:03MAY88 L:03MAY88 S:EMPTY	0 0
B00020	22	1	0	72B		E:04MAY88 L:04MAY88 S:EMPTY	E:02JUN88 L:02JUN88 S:EMPTY	0 0
B00070	132	1	0	72C	7-L	E:05JUN88 L:05JUN88 S:EMPTY	E:05DEC88 L:05DEC88 S:EMPTY	0 0
B00060	132	1	0	62MA		E:05JUN88 L:05JUN88 S:EMPTY	E:05DEC88 L:05DEC88 S:EMPTY	0 0
B00050	132	1	0	72D		E:05JUN88 L:05JUN88 S:EMPTY	E:05DEC88 L:05DEC88 S:EMPTY	0 0
B00090	11	1	0	72E		E:06DEC88 L:06DEC88 S:EMPTY	E:20DEC88 L:20DEC88 S:EMPTY	0 0
B00030	11	1	0	72F		E:06DEC88 L:06DEC88 S:EMPTY	E:20DEC88 L:20DEC88 S:EMPTY	0 0
C00000	208	1	0	72G	72C	E:06DEC88 L:06DEC88 S:EMPTY	E:06OCT89 L:06OCT89 S:EMPTY	0 0
D00000	242	1	0	62BC	69CK	E:09OCT89 L:09OCT89 S:EMPTY	E:11SEP90 L:11SEP90 S:EMPTY	0 0
D00040	132	1	0	62BD		E:11SEP90 L:11SEP90 S:EMPTY	E:14MAR91 L:14MAR91 S:EMPTY	0 0

Legend: ( for Column 1 ) S = Start activity, F = Finish Activity, I = Independent

REPORT DATE: 11 AUG 83

CPEN PLAN

ACTIVITY: PRELIMINARY DESIGN OF TDRS DEPT LAUNCH VEHICLE

PROJECT: ORIGIN: NPS MINI-SATellite CPEN

S F I	ACTIVITY	REM ORG [UR DUR]	A TY L PE	PROG DESCRIPTION	CODE 1	CODE 2	START	FINISH	TOTAL /FREE FLOAT
D00050	44 44	1	0	ASSEMBLY COMPANION TO PUT STRUCT	67KJ	67KJ	E:15MAR81 L:15MAR81 S:EMPTY	E:15MAY91 L:15MAY91 S:EMPTY	0 0
D00070	56 56	1	0	PERFORM SYSTEM LEVEL TESTS	72		E:16AUG91 L:16AUG91 S:EMPTY	E:16AUG91 L:16AUG91 S:EMPTY	0 0
C00020	66 66	1	0	EAS QUAL MODEL STRUCTURE	67KJ		E:11DEC88 L:04JAN89 S:EMPTY	E:12MAR89 L:05APR89 S:EMPTY	10 0
C00070	132 132	1	0	QUALIFY STRUCTURE	67KJ		E:12MAR89 L:06APR89 S:EMPTY	E:22SEP99 L:03OCT89 S:EMPTY	10 10
S A00020	44 44	1	0	DEFINE CONSTRAINTS	72	67KJ	E:02NOV87 L:17NOV87 S:EMPTY	E:11DEC87 L:17JAN88 S:EMPTY	11 0
A00050	44 44	1	0	DEFIN... SUBSYS INTERFACES	67KJ	62M1	E:01JAN88 L:18JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
S A00030	68 68	1	0	CONCEPTUAL SYSTEM DESIGN	72	67KJ	E:01NOV87 L:17NOV87 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
A00010	44 44	1	0	ID SYS TO LAUNCH VEHICLE	62C3	72	E:01JAN88 L:18JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
A00040	44 44	1	0	DEFINITION OF INTERFACES	72	69S9	E:01JAN88 L:18JAN88 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
S A00010	88 88	1	0	DEFINE SYSTEM REQUIREMENTS	72		E:02NOV87 L:17NOV87 S:EMPTY	E:02MAR88 L:17MAR88 S:EMPTY	11 0
B00000	198 198	1	0	PRELIMINARY DESIGN PHASE	61M0	72B	E:03MAR88 L:18MAR88 S:EMPTY	E:05DEC88 L:20DEC88 S:EMPTY	11 11

Legend: for Column 1, S = Start activity, F = Finish activity, I = Independent



CPM PAGE 10 1 2 10 000000 000000 PAGE 1

REPORT ACTCHECK REPORT DATE: 11AUG89

PROJECT: ORICHE TIME NOW: 02H07

ACTIVITY NAME: 100 BY T101 FLGAT WAGE FINISH

REP: MINI-SATELLITE BRDU

I	ACTIVITY	REM	ORI	A	TV	DUR	PE	PROG	DESCRIPTION	CCODE	1	CODE	2	START	FINISH	TOTAL
F	D00010	66	56	1	0	ASSEMBLE FLT ELECT HARNES				0301				E:07JUL89 L:12JUN90 S:EMPTY	E:06OCT89 L:11SEP90 S:EMPTY	242 242
F	D00010	132	132	1	0	ASSEMBLE & TEST SUBSYSTEM				0205				E:07JUL89 L:13FEB91 S:EMPTY	E:08JAN90 L:15AUG91 S:EMPTY	418 418

Legend: ( for Column 1 ) S = Start activity F = Finish Activity, I = Independent

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