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DESIGN AND SPECIFICATION OF A CENTRALIZED MANUFACTURING DATA MANAGEMENT AND SCHEDULING SYSTEM

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Introduction

As was revealed in a previous study [1] the Materials and Processes Laboratory's Productivity Enhancement Complex (PEC) has a number of automated production areas/cells that are not effectively integrated, limiting the ability of users to readily share data. The recent decision to utilize the PEC for the fabrication of flight hardware [2] has focused new attention on the problem and brought to light the need for an integrated data management and scheduling system. This report addresses this need by developing preliminary design specifications for a centralized manufacturing data management and scheduling system for managing flight hardware fabrication in the PEC.

This prototype system will be developed under the auspices of the Integrated Engineering Environment (IEE) Oversight team and the IEE Committee. At their recommendation the system specifications were based on the fabrication requirements of the AXAF-S Optical Bench.

AXAF-S Optical Bench - Production Requirements

AXAF-S has a number of parts and components of which the Optical Bench Assembly is a key structural element. As shown in Figure 1 the Optical Bench Assembly consists of four primary components: the telescope tube, the telescope cone, the mounting pads, and the star tracker mounts. All of these, except the titanium mounting plates, will be fabricated from graphite cyanate composite materials. It is anticipated that all components will be fabricated in the PEC.

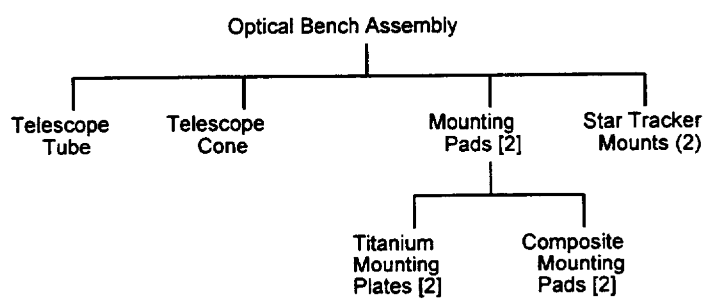

Figure 1: Bill of Material for Optical Bench Assembly

Analysis of preliminary process plans indicates that five work areas will be required to fabricate and assemble the optical bench. The work areas utilized in 4707, as illustrated in Figure 2, include the fiber placement machine, the hand lay-up area, the autoclave(s), the automated ultrasonic test system and an as yet undefined assembly area. The machine shop in 4705 will also be required, however, it will not be directly linked to the system. Instead the scheduling system, described in this document, should have the capability to pass data to and receive data from the Integrated Manufacturing Planning and Control System (IMPACS) used by NASA planning personnel (EH52).

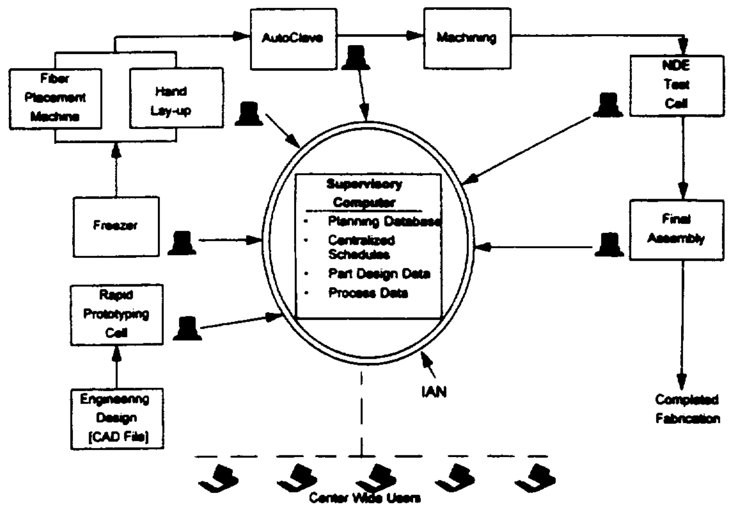

Figure 2: Centralized Data Management and Scheduling System for Productivity Enhancement Complex

Note that in addition to the five fabrication cells two additional workstations will also be linked to the centralized server. The SLA 250 - Stereolithography machine and a composite material freezer in 4707 used for storage of the graphite cyanate material for the optical bench. The SLA 250 was included because it may be used extensively in the early stages of design and prototype development. The link for the freezer was included in order to implement a inventory management system for monitoring composite material usage.

The choice of hardware and software platforms were driven primarily by the current systems in use at MSFC and the prevailing move away from mainframe computing systems. MS-DOS based PC's were chosen as the hardware platform because of their capability and cost effectiveness. In order to minimize overall system costs it is recommended that existing hardware be used where possible. The basic configuration should be an upgradeable 386 or 486 based PC with 8 megabytes of RAM, a 100-200 Mb hard disk drive, 2 floppy disk drives, MS-DOS 5.0 and Windows 3.1. Given the choice of PC's as the hardware platform it is recommended that Novell Netware be chosen as the networking platform. Novell was selected because of its extensive use throughout MSFC and its proven performance capabilities.

This system will require the integration of a scheduling system and a relational database management system. It is recommended that the scheduling system be developed using Microsoft Project, a Microsoft Windows based scheduling package and that Oracle be the choice for the relational database management system. Both packages were pragmatic choices because of there widespread use throughout MSFC. MS-Project is available on WPS and is the scheduling package of choice for the AXAF-S program office. Likewise Oracle was chosen because it is currently used for other applications, such as the IMPACS system used by EH52 (Planning and Control Branch) and the 4707 Tool Crib Inventory system, which could be integrated with the PEC system in the future. Overall, MS-Project and Oracle satisfy the performance requirements of the PEC system and should increase its compatibility with other systems at in place at MSFC.

System Functionality

The PEC data management and scheduling system will have three functional aspects: scheduling, file management and inventory management. This section will review the functional and data requirements for each.

Scheduling

The PEC scheduling system will integrate MS Project and Oracle into an application that allows NASA personnel to plan, monitor, and control the fabrication activities taking place within the PEC. This application will have three levels of functionality: planner level functionality, operator level functionality, and management/engineering level functionality.

The planner level is where detailed schedules will be developed, work order data input, and scheduling and planning reports developed. The primary task at this level is development and maintenance of the planning database. The type of data that will be input at this level includes: the project or work order number, the date the work order was received, the originator, the originator's organization, a description of the project, the desired start and completion dates, the resources/work stations required to complete the task(s), the work breakdown structure (WBS) code, the UPN number, and the CCBD number. Based on this information the planner will develop a base line schedule for the project being initiated. In order to reduce data redundancy and minimize data re-entry the schedules and data maintained in the PEC system should be transferable to other scheduling/planning systems currently used by NASA and/or NASA contractors, including: Open Plan, Time Line, Artemis, Primavera, and IMPACS. Initially, a full time planner will not be required for this system, however, as more fabrication projects come on-line a dedicated planner will become imperative. Given that the fabrication of flight hardware is a relatively new activity within the PEC the processes and procedures for the creating and management of planning and processing data have not been completely defined. Follow-on activities related to this project are being initiated that will address the requirements of the planning level of the system in greater detail.

At the operator level the primary concerns are with documenting the execution of scheduled tasks and providing the operator with the information required to complete the task at hand. At this level, initial entry into the system would involve presenting the operator with a prioritized list of tasks to be worked at their respective work area. Selecting a particular item, via a menu or mouse operation, should bring up the work order log-on window. At this point the operator would enter their name, organization, and identification number, with the system automatically capturing the log-on date and time from the system clock. Logging-off would entail a similar procedure with the system querying the operator for their name, identification, number, organization, the level of completion of the task (i.e., 25%, 50%, 100%, etc.), then automatically recording the log-off date and time and updating the project schedule. After logging-on a task the operator would be presented with a screen showing processing information for the task. Information provided should include the current drawing number and revision, processing sheets/recipes, and the listing of NC files required for any fabrication equipment in their work area. In addition to providing the operator with access to the basic fabrication information the system should also provide the capability for capturing engineering and quality sign-off on fabrication setups and inspections. At present these are captured on paper, however, it is technologically feasible to do this electronically and it makes sense to build the basic functionality into the proposed PEC scheduling and data management system.

Finally at the management/engineering level the primary concern is project management. Users at this level are interested in the current status of component fabrication as well as material and resource usage. They will need access to Gantt charts and Pert networks showing the status of specific programs and projects. Three primary reports will need to be developed, a project status report, and resource and material usage reports. The project status report should indicate where a particular component is in its processing sequence, when fabrication was initiated, and the expected completion date/time. The resource usage report should provide information on work area usage (i.e., manpower and equipment) by project, while the material usage report should indicate the type and quantity of material used by project. In addition to reporting the system should also allow managers to perform what-if analysis on schedules to assess the impact of processing delays on the schedule.

File Management

In addition to the planning and scheduling capability outlined above, the PEC data management and scheduling system should also provide users with the capability to quickly and easily access input and output files from each process. Each workstation associated with an automated piece of equipment (i.e., the fiber placement machine, autoclave, and NDE automatic ultrasonic test system) should have the capability to access and down load control programs (e.g., NC programs in the case of the fiber placement machine) and to upload processing data from the controller.

Inventory Management

The inventory management aspect of the system will provide a computer based system for more effectively monitoring and tracking data on material information and usage history for all composite materials stored in the PEC. It is anticipated that the freezer inventory management system will be written in Oracle but will be accessed through the MS Project based scheduling system. The information stored in the system should include a NASA designated material control number, the material description, the material type, the supplier name, the manufacture date, certification/recertification date, the lot number, the roll or spool number, the storage location (i.e., freezer number), the date initially stored in the freezer, current quantity in storage, cumulative time in the freezer, cumulative time out of the freezer, maximum allowable time out of the freezer and/or the maximum allowable age of the material, the identification number for the person withdrawing material, program number being charged, project/work order number being charged, the removal date and time, the identification number of the person returning the material, the quantity being returned, and the date and time the material was returned.

The freezer inventory management system should flag the user if the material has exceeded its maximum allowable age and/or the maximum cumulative time allowed outside the freezer. The system should also maintain a usage history on the material (i.e., quantity of material used for each program by project). Two basic reports, the material usage history report, and the freezer inventory report, will also be required to effectively manage the materials inventory. The material usage report should provide information on the quantity of each material type used by program and project/work order number. The freezer inventory report will provide information on the material currently stored in the freezer. The primary information presented should include the material control number, material description, material type, quantity in storage, and the cumulative time in and out of each freezer. This report should also flag items close to their expiration date (i.e., within two weeks, etc.).

Conclusion

This study is a first step in the transition of the PEC from a research and development facility to a production facility. As with all changes it will have its moments of pain and confusion, however, these can be minimized through effective planning. The centralized data management and scheduling system described herein is the beginning of this planning process. While this study has addressed many of the technical aspects of the system there are still several administrative issues that must be addressed. The most prominent issues to be addressed include the identification of the lead planning organization, and the delineation of processes and procedures for: development and maintenance of the planning database, the electronic capture of engineering and quality sign-off, the transfer of scheduling data to and from the AXAF-S program office, and the transfer of work order data to and from IMPACS. Follow-on activities are being initiated that will address these issues in greater detail.

References

(1) Farrington, P.A. "Evaluation and recommendations for work group integration within the Materials and Processes Lab," Research Reports - 1992 NASA/ASEE Summer Faculty Fellowship Program, pp. XIV1-4.

(2) Turner, J, "AXAF-S SRR Kick-Off Meeting", March 29, 1993.