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Spacecraft Technology
Division

Integrated Product Development & Networking

Final Report

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Integrated Product Development and Networking Final Report

1.0 Abstract

The purpose of the Integrated Product Development and Networking study was to research the spacecraft manufacturing processes at TRW Space and Electronics Group, and generate recommendations regarding the implementation of an automated spacecraft assembly system.

TRW detailed in the previous interim report the current "As-Is" process in relation to the flow and dissemination of production and logistics data. The reports focused on current spacecraft assembly programs being performed at TRW Redondo Beach, specifically on the Brilliant Eyes and GPALS programs. The report identified: 1) the functional organizations and their inter-relationships, 2) current electronic information support systems, and 3) related automation tools, procedures and practices. This Final Report details the recommendations related to the implementation for an automated spacecraft assembly system.

2.0 Study Methodology

TRW formed an integrated product team (IPT) consisting of members from the Data Management, Manufacturing, Systems Engineering, Design, and Integration and Test disciplines.

The team's primary goal was to document the current "As-Is" processes. The team then selected candidates for automation based on their technical/economic feasibility, and potential gains due to automation. The team then defined the "Should-Be" processes.

The team also looked at existing automated tools in use at TRW. The team specifically targeted "Islands of Automation" which represent the pockets of electronically available data not currently integrated with the global program environment. The function, source, and user access needs of this data were evaluated for integration with a concurrent engineering automated environment.

3.0 Study Results

3.1 Concurrent Engineering Automated Environment

TRW recognizes automation as a means to address increasingly complex spacecraft requirements and to shorten design and manufacturing cycles, in a climate of intense competition on cost, quality and delivery. CAD/CAM, CAE, process planning, and shop floor controls are becoming everyday fixtures in the modern spacecraft manufacturing enterprise.

However preparing, managing, and distributing engineering data often requires labor-intensive manual methods. Even when computers are used to create engineering designs or manufacturing process information, organizations often resort to paper-based documentation and communication.

Computers are increasingly becoming the primary source of data necessary to design and build spacecraft. Systems used to manage and leverage this critical resource are becoming the foundation on which corporations are building their competitive edge.

The implementation of a concurrent engineering automated environment permits TRW to better organize, access, and manage information related to its spacecraft programs. When implemented properly, this environment supports all people who create or need timely access to accurate information related to design, engineering, drafting, analysis, configuration management, manufacturing, and program management. It provides the right person the right information at the right time. A concurrent engineering automated environment is a key enabler to effectively utilizing TRW's computer resources to gain the competitive advantage.

3.2 Integrated Architecture

The IPT Team defined an architecture which integrates the various aspects of a spacecraft manufacturing program electronically. The architecture, as shown in Figure 3.1.1, would reside on a network linking all facets of the program and would host a distributed database to support a paperless environment. The system would support the development of

Figure 3.1.1 - Integrated Architecture

electronic documents, along with electronic review and approval capabilities. The system would also integrate all of the various functions of the spacecraft program, including Engineering, Design, I&T and Manufacturing. An integrated system would support the spacecraft through all phases of it's development, aid in the integration of the spacecraft system, assist in the operation of the spacecraft, and provide a method for capture of corporate knowledge.

Specific benefits of an electronically integrated program are numerous. Reductions in production and support costs associated with manufacturing cycle time, Engineering Change Orders, scrap, rework and repair costs can be realized. Inventories can be reduced through the use of electronic "just-in-time" material and parts ordering. Use of the architecture to host paperless document reviews can yield savings in both time and labor. Improved cost models can be generated due to better capture of program wide actual-cost data.

3.3 Electronic Document Review

The IPT team found that significant gains in efficiency could be realized in relation to the generation of deliverable documentation. These gains were directly linked to the use of concurrent engineering principles. The IPT team accessed findings from past TRW Total Quality Management and Continuous Process Improvement studies relating to the CDRL (Contract Deliverable Requirements List) approval cycle. This study found that the current "As-Is" process involved many individual sequential steps in the review of a CDRL document. The study also found that time savings of up to 40% could be realized by electronically automating this process.

The IPT formed a technical tiger-team to generate a "Should-Be" process for implementation. It should be noted that simply automating an "As-Is" process without optimization could yield little or no improvement. Through optimization, the tiger-team reduced the CDRL review cycle to 12% of the original "As-Is" Process.

The development of electronic tools to support these concurrent processes becomes essential to the implementation of this new environment. The electronic tools must perform automated routing, status monitoring, and configuration management functions to support administrative tasks. The system must also provide a homogeneous interface, in an easy to use environment otherwise the users will not support a paradigm shift to a totally electronic environment. The system

must also provide timely sharing of data over a geographically large area for connectivity to all of the users of the program.

The use of an electronic document system for the generation, review, comment, distribution and configuration management of program developed documents will greatly improve the productivity of a Spacecraft manufacturing program. The IPT recommends that all program deliverable data be incorporated and controlled via an electronic document system. In addition, the team recommends that the electronic document system be used to host all program related text and drawing files.

3.4 Electronic Document Library

The IPT found that the majority of documents produced by the spacecraft programs were not available to a program wide database. The access to electronic documents could significantly improve program productivity.

A prime area for improvement would be the capability to electronically access requirements, specifications and drawings onto the users local desktop environment. Data associated with Military standards, along with program generated documents and drawing would be housed in distributed program databases. This would greatly reduce the lag time associated with ordering paper copies from CADM, the company technical library, or the program's data library.

There is an added advantage in having the programmatic data, requirements and specifications available electronically. Since the data is available in an ASCII format, text search capabilities can be used. In addition, the text can be electronically copied and pasted to build new documents. This capability greatly enhances the productivity of the authors, and can significantly reduce the cost of documentation through data re-use.

Lastly, the storage of electronic programmatic data aids in the retention of corporate knowledge. Data that would typically be stored on hard copy, or local desktops is now available program wide for research and re-use. This valuable company resource will be retained and accessible for long periods of time.

3.5 Islands of Automation

The IPT team found "Islands of Automation" on the TRW spacecraft manufacturing floors. These islands exist in the form of computer tools for the Manufacturing and I&T people. The tools support shop floor scheduling, labor tracking, engineering orders, and discrepancy reports. These tools are not currently shared with other areas outside of the shop floor. The IPT recommends that these pockets of localized computer tools be integrated into a program-wide database. This would foster a better flow of labor and scheduling information from the shop floor supervisors to the program management.

3.6 Product Data Management System (PDMS)

TRW has made the paradigm shift towards a truly paperless environment. The newly distributed tool set will support the integration of graphics into textual files for formal document deliveries. This is accomplished by filtering CAD/CAM/CAE files into drawing formats that can be displayed on desktop computers. However, the current system lacks the capability of performing the data management task for controlling these types of CAD/CAM/CAE files.

For example, the current engineering design stations used to develop electrical, mechanical and engineering drawings provide only local storage of this design data. This represents an "Islands of Automation" architecture because there is no effort to coordinate the sharing and distribution of this data with the rest of the spacecraft program. The need is for a system to control the engineering data from it's initial generation, through approval, and finally into Data Management control for storage in an electronic vault.

This is the function of the Product Data Management System (PDMS). The purpose of a PDMS is to provide the tool sets to control all aspects of engineering data from "womb-to-tomb". The PDMS would therefore need to provide to the design engineers data management capabilities during the initial phase of drawing generation. The PDMS would need to provide the capability of electronically distributing the drawing for review, and would support this function a multi-tier, iterative review environment. The PDMS would provide its users electronic comment and approval capabilities. The PDMS would also provide applications to permit viewing complex drawings on desktop platforms, like a Macintosh or PC-Type machine. Lastly, the PDMS would support the logging of the final approved

document into an electronic vault in a multi-revision environment. The electronic vault would also need to provide for the storage of very large multi-level drawings, since many of the computer design tools available today support hierarchical design environments.

The associated benefits of a PDMS are obvious. Figure 3.5.1 is an example on how an electrical CAD system integrates into a typical spacecraft program. The PDMS would provide the mechanism for linking design functions of the spacecraft program into a program wide network. It would support ready access to drawings, designs, simulations and test data for various areas of the program, including manufacturing. Cost saving in time and labor due to the accessibility of design data in the manufacturing area would be significant. Additional benefits to the ready access of this data include the retention of corporate knowledge and significant saving due to design re-use.

A PDMS represents a strategic technology for spacecraft manufacturers, providing them control of product information across the entire spacecraft lifecycle from initial design through manufacturing. A successfully implemented PDMS would offer major benefits by reducing the spacecraft design time, minimizing scrap and rework in manufacturing, and maximizing the productivity of engineers, managers, and manufacturing personnel.

4.0 Summary

TRW considers the implementation of a concurrent engineering automated environment essential to remaining a competitive spacecraft manufacturer in the 1990's. Capabilities like an integrated network architecture, electronic document review, electronic data library access, and a program data management system represent substantial increases in productivity. The implementation of this environment will permit TRW to better organize, access, and manage information related to its spacecraft programs and gain a competitive advantage.

Figure 3.5.1 - Example of how an Electrical CAD System Integrates into a Spacecraft Program

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