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AN EXAMPLE OF CONCURRENT ENGINEERING

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Abstract

The Collaborative Engineering Design and Analysis Room (CEDAR) facility allows on-the-spot design review capability for any project during all phases of development. The required disciplines assemble in this facility to work on any problems (analysis, manufacturing, inspection, etc.) associated with a particular design. A small highly focused team of specialists can meet in this room to better expedite the process of developing a solution to an engineering task within the framework of the constraints that are unique to each discipline. This facility provides the engineering tools and translators to develop a concept within the confines of the room or with remote team members that could access the team's data from other locations. The CEDAR area is envisioned as excellent for failure investigation meetings to be conducted where the computer capabilities can be utilized in conjunction with the Smart Board display to develop failure trees, brainstorm failure modes, and evaluate possible solutions.

Introduction

The various components of the CEDAR facilitate teamwork and expedite engineering solutions. The previously mentioned smart board is a large display unit with interactive capability between the team members and computers. The room consists of areas with conference tables and teleconferencing phone equipment. Computer aided design (CAD) and computer aided engineering (CAE) workstations can be used for performing concurrent engineering during these fast track processes. CAD translators within this facility enable participants to import design work from areas that use software that is not maintained within CEDAR. A large server within the facility acts as a repository for storing and sharing the team files and as a database for accessing historical data from other projects. Naturally, the function of these type teams requiring regular status presentations and eventual documentation of results necessitate excellent interfaces and access with publishing software packages.

This type facility is essential to be able to quickly respond to the many concept evaluations, failure investigations, and design developments that we at MSFC are being asked to respond with increased productivity during this time of decreasing manpower. CEDAR places cutting edge tools in an environment that facilitates a diverse group of technical experts in making technical judgments very expeditiously. This kind of forward thinking efforts will keep MSFC on the cutting edge of technology development in the areas of Space Transportation, Microgravity, and Propulsion.

Utilizing The CEDAR for Training

The CEDAR is fairly new and has not been extensively used for training to date; however, the following examples serve to demonstrate its potential. The cedar's first training use was on a Computer Aided Design (CAD) database software called Pro/INTRALINK. This software is a moderately complicated Oracle based product data management system that automatically utilizes the relationships and associativity of the model and drawing files created in the CAD package. At the time, these new users were at the front end of a project using this package. The

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product application engineers visited to teach proper use of the Pro/INTRALINK functionality. The engineers were allotted three days here to get the job done. By utilizing CEDAR with three groups of users they were able to effectively demonstrate the software in about half the time, this also allowed semi hands-on experience for the users while allowing all to see the effects of their actions. The users typically rotated using the various commands during the session which reduced significant time on training. The application engineer's experience was utilized extensively during the remaining time to help set up the architecture of the new project. This surely saved us many man-hours of inevitable mistakes and frustration that accompany new products of this type.

The next training related use of CEDAR was similar in that a CAD software applications engineer came to the facility to demonstrate an upcoming version of their CAD software to several small groups of users. This was a benefit because there were significant differences in the upgrade, so this saved us aggravation and smoothed the transition to the new version. This type of "upgrade demo" is uncommon because the software company has to send a cadre of people and equipment to the site which is costly. In our case it was not, as one engineer did the job on our equipment.

Our next training session used CEDAR to standardize a CAD configuration file between MSFC and our design contractors. This file allows passing designs to each other without conflicts. We were able to work through a complicated file and then test it while those of us who didn't understand its usage gained some valuable experience.

Future Training Uses of the CEDAR

Currently, the MSFC Structural Design Division is compiling a library of symbols which is used as a timesaving aid in producing production drawings. When the library is in a more mature state we will have a division training session on its use.

Solid Edge and UniGraphics are CAD packages that are new to some of our division personnel. These software companies provide tutorial Compact Discs (CD's) to help the beginning user with the initial steep learning curve. These CD's will be used by small groups in a collaborative effort to speed and reinforce their learning.

Our onsite technical CAD support personnel will conduct custom software training tailored to our needs. This facility will no doubt be used in this manner by other organizations at the center. The division personnel will be trained to use the functionality of Net Meeting. This software allows collaborative engineering between desktops over the Internet, white board feature with paintbrush mark ups, and viewing the same CAD models/drawings at both sites while talking to each other. This training should be effective because we will be using the equipment we would use in an actual review.

We will have the ability to handle computer related problems by assembling the effected users in one place and contacting the off-site applications engineer for real-time training on a specific problem or fix.

The next obvious step would be to use the CEDAR capability to have our personnel trained by a remote applications engineer in our facility instead of leaving the job site.

Technical Interchange Meetings

The capabilities of the CEDAR are best utilized for design reviews and discussions. The Quench Module Insert design team has used the CEDAR for weekly team status meetings, design reviews, and requirements reviews.

At the weekly status meetings, the agenda and action items are shown. Using the Smartboard, the team can update actions and set the next agenda real time. Virtually any document that is pertinent to the discussion can be displayed on the Smartboard for the whole team to see, eliminating running back to the office to print a document. Team members can also display their CAD models. This has been extremely beneficial for reviewing the design progress, discussing design issues, and brainstorming design solutions. The Smartboard capabilities allow the designer to stand at the screen and manipulate the model, and turn on and off features to show in exact detail

the problem areas. The light pen feature of the Smartboard allows the design team to graphically display their solutions or ideas right on the CAD model. The brainstorming ideas are understood better when they are shown and rather than just talked over.

The CEDAR has also been used for design reviews with the Thermal and Structural Analysts . The Smartboard provides the opportunity for interactive discussions with the analysis team. In the past, the design was shown using a couple of views of the design only and it was hard to show the necessary details. It was left up to the designer to anticipate the questions and have backup views available. In the CEDAR, the entire assembly can be manipulated to show an infinite variety of views or configurations. It has been extremely beneficial to have these interactive reviews with the analysis teams because the better they understand the design, the quicker they can perform there analysis. During brainstorming periods, the analysts and designers can interact with the CAD model by using the light pens to display their ideas.

The CEDAR can also be used for design reviews to management. The flythrough capabilities of the CAD software can be displayed on the Smartboard in an impressive overview of the design. If management wants to see more detail in the presentation then the CAD model is readily available to display infinite detail of the design.

The CEDAR has been used by the Quench Module Insert team for requirement development reviews. The preliminary design can be shown on the Smartboard so that all the reviewers have a better understanding of the project. The requirements can also be displayed on the Smartboard and changes can be made real-time. The design can also be displayed again at any time to aid in the discussion of a particular requirement.

An example of interactive design integration using CEDAR

The CEDAR is an excellent tool for real-time design integration between multiple design partners. The ability to run CAD software from a common server on the large screen in a conference room environment makes this real-time interaction between many participants possible. An excellent example of a successful design integration is the Water Recovery System Rack 1 (WRS1) packaging effort.

The WRS1 is the International Space Station Environmental Control and Life Support System (ECLSS) rack that includes the Urine Processor Assembly (UPA) and the Water Processor Assembly (WPA). The UPA is being designed by MSFC's local support contractor Sverdrup, the WPA is being designed by Hamilton Standard-Connecticut, and MSFC is the overall integrator. The WRS1 is packaged into a Boeing International Standard Payload Rack (ISPR). WRS is scheduled to launch on Space Station Node 3 the end of 2002.

During the initial rack packaging studies by each of the support contractors, a volume crisis arose. The volumes that each team required for their assemblies exceeded the available ISPR payload volume. Efforts to negotiate the volume allocations by MSFC via telecon over several weeks were unsuccessful. It became apparent that more insight was needed into the design constraints, concerns, and issues of each party to be able to make the right packaging decisions. The only way to do this was in a technical interchange meeting between the actual designers. Conventional methods for this type of meeting are slow, cumbersome, and not completely effective. The "old" way of doing it is by making viewgraphs of portions of drawings or shaded views from three-dimensional Computer-Aided-Design (CAD) models and showing them in a meeting using an overhead projector. These viewgraphs take time to generate, only tell part of the story, and often can't address questions that come up during design discussions. It would normally take several of these meetings over a period of weeks to come to an acceptable solution to a difficult design problem. The CEDAR is a much better tool for conducting this type of interchange meeting.

The CEDAR is a conference room environment with a Windows NT workstation connected to the big screen monitor called the Smart board. The Smart board has the capability of controlling all keyboard and mouse functions by just physically touching the screen. You can make any menu pick or icon pick with your finger while standing and discussing your design. All of the major CAD software tools and Office-type applications

that the MSFC Structures and Dynamics Laboratory owns are available in the CEDAR. The CEDAR is also equipped with complete telecon facilities.

MSFC, Sverdrup, and Hamilton Standard were all using Pro/Engineer for the WRS design. This would be the main tool used in the CEDAR for the interchange meeting. But Microsoft Excel and Powerpoint were also useful for communicating other design information and for making charts of the group results, including "snapshots" of the final rack packaging solution.

Sverdrup and Hamilton Standard transferred their Pro/Engineer design files to MSFC electronically using File Transfer Protocol (FTP). Once the files were received at MSFC they were decompressed, loaded onto the CAD server in appropriate file structure and the overall assembly models were opened and manipulated to insure that all data had been transferred accurately. We were now ready for the meeting. Three engineers flew in from Hamilton Standard, the lead design integrator represented Sverdrup, and three engineers were present from MSFC. A Pro/Engineer operator then opened the models, manipulated views, measured dimensions, and moved components within the rack until all parties agreed on a design solution. The telecon facilities were used to communicate with other designers back at the contractor's offices. The total time in the CEDAR on the CAD station for the group was about an eight hour day. Once the team had agreed on their compromises and built a new assembly that fit within the available volume, Powerpoint charts were created directly from the CAD model during the meeting to document results. The understanding and insight that the designers achieved about the other groups' designs was invaluable in helping the team reach a compromise. Once each side could visibly see the constraints, concerns and design goals each other had then it was much easier to set priorities and make decisions. This would not have been possible so easily without the real-time interaction in the CAD environment using the CEDAR.

Opportunities for improving the CEDAR and the process

The CEDAR facility at MSFC as described above is still in its "infant" stage. Their are several additions and improvements that can be made to the facility that would make it an even more powerful tool. Some of these enhancements are described below:

(1) The computer workstation that drives the Smart Board needs to be top of the line. Processing times are critical for making the group interaction process effective. A CPU that is adequate for an engineer working alone on a design is not necessarily appropriate for the group environment. A two minute wait for the screen to update or for a process to finish is not a big deal for an individual but it can completely kill the energy and concentration of a room full of people. To get the maximum effectiveness from CEDAR, its CPU must be the best available.

(2) Additional workstations are needed to allow for inter-discipline collaborative engineering. The original intent of CEDAR was to do collaborative engineering. To do this, the other disciplines (stress, dynamics, materials, operations, etc.) need to be able to access their applications and data on separate workstations. Then each of their workstations could be made active on the Smart board when needed for interactions among the team. This functionality is the only way to have all of the design information available to make any decision required "real-time".

(3) "Internet-meeting" functionality is needed to reduce the need for travel by participants. The meeting that is described in the design integration example given above would not have required any travel if Internet-meeting functionality was used. Internet-meeting allows for collaboration between multiple users on workstations using the Internet. Each user can view whatever the other user has active on their workstation screen. This would have allowed Sverdrup and Hamilton Standard to keep their Pro/Engineer files local on their systems. Then everyone could have accessed their designs locally and connected using Internet-meeting and the same interaction could have taken place via the existing telecon facilities. Internet-meeting application software is already available. It can be downloaded as "freeware" from of the Internet. Using it is mainly a training and coordination issue.

(4) Video conference capability would further eliminate the need for travel. Video conferencing would allow other more traditional media to be displayed during meetings. It would also helps communication and flow of the meeting because of the visual information available. (People don't have to identify themselves every

time they speak, some non-verbal communication is possible, etc.)

(5) Finally, a CEDAR administrator is needed to facilitate meetings. The hardware and software needed for the room is complicated. An administrator who is responsible for understanding these systems and helping people use the facility to its fullest potential is very important The administrator should be responsible for maintenance, service, and upgrades.

Summary

This progress assessment of the CEDAR facility has been documented to demonstrate that the NASA Technology initiatives for an Intelligent Synthesis Environment (ISE) has provided opportunities for existing technology to be highlighted for engineering to reap short turn gains from this collaborative engineering program. The future was accentuated in these examples to further emphasize the need to focus on folding in new technology as it become available and to stay abreast of your next steps in this continual cycle of improvement. Tools are a major part of the record as presented within this text, but it should be noted that culture shifts have to occur to enable these new practices to thrive in any environment. MSFC is in the middle of this change in the traditional methods to allow new technologies to streamline our processes.