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Advanced Engineering Environment Collaboration Project

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Abstract

The Advanced Engineering Environment (AEE) is a model for an engineering design and communications system that will enhance project collaboration throughout the nuclear weapons complex (NWC). Sandia National Laboratories and Parametric Technology Corporation (PTC) worked together on a prototype project to evaluate the suitability of a portion of PTC's Windchill 9.0 suite of data management, design and collaboration tools as the basis for an AEE. The AEE project team implemented Windchill 9.0 development servers in both classified and unclassified domains and used them to test and evaluate the Windchill tool suite relative to the needs of the NWC using weapons project use cases. A primary deliverable was the development of a new real time collaborative desktop design and engineering process using PDMLink (data management tool), Pro/Engineer (mechanical computer aided design tool) and ProductView Lite (visualization tool). Additional project activities included evaluations of PTC's electrical computer aided design, visualization, and engineering calculations applications. This report documents the AEE project work to share information and lessons learned with other NWC sites. It also provides PTC with recommendations for improving their products for NWC applications.

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CONTENTS

Acknowledgments	4
Executive Summary	9
Recommendations to PTC for Product Improvements	16
Acronyms	19
1 Introduction	23
1.1 Advanced Engineering Environment Concept	23
1.2 Background	23
1.2.1 Windchill 9.0 Tool Suite	24
1.3 Scope	26
1.4 Objectives	26
2 Windchill 9.0 Installation on the AEE Servers	29
2.1 Overview	29
2.2 Unclassified Three-Tier Server Implementation	29
2.2.1 Oracle Server	29
2.2.2 Windchill Server	30
2.3 Classified Three-Tier Server Implementation	32
2.4 AEE Training Server Implementation	32
2.5 Windchill 9.0 Installation Documentation	32
2.6 Lessons Learned	33
2.7 Recommendations to PTC for Windchill Improvements	34
3 Windchill Configuration for Sandia Business Practices	35
3.1 Project Collaboration	35
3.2 Configuration Summary	36
3.3 Recommendations to PTC for Improvements	36
4 Training Assessment, Development and Delivery	37
4.1 Training Needs Assessment	37
4.2 PDMLink Training	38
4.3 Pro/Engineer Wildfire 4 Update Class	41
4.3.1 Course Design	41
4.3.2 Course Delivery	41
4.4 Lessons Learned	42
5 Integration of the Windchill 9.0 Tools for the B83 Project	43
5.1 Overview	43
5.2 Current B83 Workflow Process	43
5.3 Electronic Check Print Process	44
5.4 B83 Training Workshop	47
5.5 B83 Implementation and Evaluation of the Windchill 9.0 Tools	48
5.5.1 Client Installations	49
5.5.2 Training/Mentoring for B83 Engineers	49
5.5.3 Classified AEE Server Implementation	49
5.5.4 Data Migration	49
5.5.5 Material Files	50
5.6 B83 Team's Assessment of the Windchill Tools	50
5.6.1 Windchill Strengths	51
5.6.2 Recommendations for Improvement	52

5.6.3	Next Steps.....	52
6	ECAD Tools Evaluation.....	53
6.1	Overview.....	53
6.2	Windchill ECAD Workgroup Manager Suite.....	54
6.3	ECAD Hands-On Workshop.....	55
6.3.1	ECAD Workgroup Manager Installation, Verification and Configuration.....	55
6.3.2	Tool Capabilities.....	55
6.3.3	ECAD Process Gap Determination and Process Discussions.....	55
6.4	Current ECAD Processes.....	55
6.4.1	Review of Designs Maintained by the Design Agency.....	56
6.4.2	Review of Designs after Transfer of Maintenance to the Production Agency.....	57
6.4.3	Accessing Released Data.....	57
6.5	New Windchill 9.0 ECAD Design Review Process Description and Presentation.....	57
6.5.1	Current ECAD Workflow.....	58
6.5.2	New Process Definition.....	58
6.5.3	New Process Demonstration.....	60
6.5.4	Feedback.....	61
6.6	Evaluation Results and Recommendations.....	61
6.6.1	ECAD Workgroup Manager Suite Evaluation.....	61
6.6.2	Comparison to Other Applications.....	62
6.6.3	New ECAD Design Review Process.....	63
6.6.4	Recommendations for Product Improvements.....	63
6.6.5	Lessons Learned.....	64
6.6.6	Next Steps.....	64
7	VisualizationTools Evaluation.....	67
7.1	Product Descriptions.....	67
7.1.1	ProductView Lite.....	67
7.1.2	ProductView Standard 8.0.....	68
7.1.3	ProductView MCAD Professional 9.1 Beta Release.....	68
7.1.4	Division Mockup 2000i2.....	68
7.2	Division Mockup Workshop.....	69
7.3	Weapons Assembly Animation.....	69
7.4	Recommendations to PTC.....	70
8	Mathcad Evaluation.....	71
8.1	Product Description.....	71
8.2	Implementation.....	72
8.3	Evaluation.....	73
8.3.1	Licensing and Configuration Issues.....	73
8.3.2	Ease of Use.....	73
8.3.3	Mathcad Applications at Sandia/CA.....	74
8.3.4	Integration with other applications.....	74
8.3.5	Mathcad Use Cases.....	74
8.3.6	Comparison to similar applications.....	75
8.3.7	Strengths and Weaknesses.....	75
8.4	Recommendations.....	76
	References.....	77
A	AEE Server Specifications.....	79
A.1	Three-tier Development Servers.....	79
A.2	Single-tier Training Server.....	80

B	Windchill Configuration for Sandia Business Practices	81
B.1	Auto-Numbering	81
B.2	Lifecycle	81
B.3	E-mail Notifications	82
B.4	Libraries	84
B.5	Table Views	85
B.6	User Help Files	86
B.7	Designer Role Rename	86
B.8	Data Migration	87
B.9	Classified Windchill Server Implementation	88
B.10	B83 Implementation of Windchill	89
B.10.1	CAD File Parameters	89
B.10.2	Setting CAD File Revision on Check-In	89
B.10.3	Setting the Initial Revision Level of Soft Documents	89
B.10.4	Attaching Documents to a CAD File	89
B.10.5	File Rename Issue	89
B.10.6	Managing Microsoft Office Documents in Windchill	90

FIGURES

Figure 1.2.1.1 Advanced Engineering Environment collaboration toolset	24
Figure 4.2.1 Training options table.....	40
Figure 5.3.1 B83 electronic check print process data flow diagram.	45
Figure 5.3.2 A B83 electronic check print process storyboard slide showing a step in the promotion request process.	47
Figure 6.5.2.1 New ECAD design review process workflow.	59
Figure 6.5.2.2 Compressed ECAD design review process for the workshop demonstration.	59
Figure B.2.1 The AEE Windchill 9.0 lifecycle configuration.....	82
Figure B.4.1 The Windchill libraries include the five B83 libraries, a Help library and two test libraries.	84
Figure B.5.1 Sandia workspace view.	85
Figure B.5.2 Sandia folder view.	86
Figure B.6.1 Sandia user help files.	86
Figure B.7.1 Access control settings for the B83 Windchill roles.....	87

Executive Summary

The Advanced Engineering Environment (AEE) is a model for an engineering design and communications system that will enhance project collaboration throughout the nuclear weapons complex (NWC). The AEE will contain a comprehensive set of engineering design and analysis tools with integrated data repositories which are linked together and made accessible through a computer network. This approach facilitates concurrent engineering by enabling the seamless, workflow driven, parallel flow of digital models and information across a secure distributed networking environment with the enforcement of need-to-know user access.

This project builds upon an FY06 AEE pilot project that established a set of validated requirements for the AEE Team to use as the basis for procuring a commercial off-the-shelf (COTS) product solution from commercial vendors. The focus for this project was on the application and evaluation of a COTS product for Sandia and NWC applications, Parametric Technology Corporation's Windchill 9.0 product lifecycle management (PLM) application and their integrated suite of design and collaboration tools.

This project addressed the installation, configuration, application and evaluation of PTC's Windchill 9.0 integrated tool suite for nuclear weapons project applications. Windchill 9.0 was deployed on development servers in both unclassified and classified environments. The project scope was limited to only the in-process engineering design activities associated with PLM. This is a front-end step in a model-based engineering (MBE) process that leads up to and occurs prior to the release of formal product design definition.

The AEE project's objectives were:

- Implement the Windchill 9.0 platform on the AEE development servers to enable testing and evaluation of the tool suite.
- Perform a training assessment and deliver training to enable Sandia staff to use and evaluate the PTC tools.
- Partner with the B83 Weapons Project Team to test the integration of Windchill 9.0 and the Pro/Engineer mechanical computer aided design (MCAD) and ProductView visualization applications for in-process design iterations.
- Perform an evaluation of the Windchill 9.0 electrical computer aided design (ECAD) tools for applicability to current weapons design processes.
- Perform an evaluation of the PTC visualization tool suite to determine applicability for Sandia weapons program applications.
- Perform a limited evaluation of PTC's Mathcad application, independent of the Windchill environment, to determine its applicability for Sandia project work.
- Use PTC's Arbortext technical publishing software to produce this project report to share lessons learned with other NWC sites as they prepare to implement Windchill 9.0.

Windchill 9.0 Installation and Configuration: Sandia/CA's two existing AEE three-tier development server systems were upgraded to Windchill 9.0 and configured to the NWC Product Realization Standard (PRS) 12005. These systems had been established with the FY06 AEE project, but were running the older Windchill 8.0 application. The installation, configuration and validation of the Windchill 9.0 application on these systems were supported by PTC consultants, working with Sandia staff. Because this was one of the first implementations of the Windchill

9.0 application in the NWC domain, there was a learning curve for both Sandia and PTC staff. Problems were encountered, and all were either resolved, or suitable work-around solutions were implemented. The installation procedure and all problems and solutions were documented and are available to share with other NWC sites.

The intent of this project was to test Windchill 9.0 in its out-of-the-box (OOTB) configuration. However, it was apparent to the AEE Team that some configuration of the application would be required. Although the PTC solution architect had configured the Windchill installations to PRS12005, features such as lifecycles, auto-numbering and others as delivered in the OOTB configuration did not align with Sandia and NWC business practices. Therefore, a great deal of staff effort was put into configuring Windchill 9.0 to apply Sandia business practices where possible to provide Sandia designers and engineers with a familiar working environment.

Training Assessment and Delivery: Because the Windchill 9.0 platform is new to Sandia, AEE team members and project partners required training for the implementation, use and evaluation of the PTC design and collaboration tools. The AEE Team worked with a PTC training consultant to conduct a training needs assessment for the project. This assessment resulted in recommendations for specific workshops, training courses and training delivery methods to meet the needs of the various AEE project teams.

Working with PTC, the AEE Team also developed two Sandia-specific training courses tailored from the content of several existing PTC courses: “Sandia National Labs Introduction to PDMLink 9.0 and CAD Data Management” and “Wildfire 2 to Wildfire 4 Update”. These new courses focus only on content that directly relates to the way Sandia designers and engineers use the PTC tools. The courses are web-based and are accessible to Sandia staff at any time through the PTC University training program. In addition, an on-site “Wildfire 2 to Wildfire 4 Update” course was conducted both at Sandia/CA and Sandia/NM to provide training to CAD designers for the update of the Pro/Engineer application, which is the NWC standard MCAD application. The AEE Team also worked on the development of an internal training capability for the Windchill 9.0 application. This course will provide training to staff who will be working with the production Windchill 9.0 system that Sandia/NM will soon deploy.

B83 MCAD Design Collaboration: A primary goal for this project was to demonstrate the integration of some of PTC’s design and collaboration tools for NWC applications. To achieve this goal, the AEE Team partnered with the Sandia/CA B83 weapons project team to exercise and evaluate select Windchill 9.0 tools. The AEE Team and their PTC consultants worked with B83 engineers to develop a new real time collaborative desktop process for design and engineering. This new MCAD “electronic check print” work process uses the Pro/Engineer, PDMLink and ProductView applications to facilitate collaborative in-process design iterations between project designers and engineers working from their desktops. Working with requirements and guidance provided by the B83 engineers, the AEE Team developed and demonstrated the new process for the B83 Team using the unclassified AEE Windchill 9.0 server. Based on their positive response for the new process, the AEE Team provided a hands-on training workshop for B83 designers and engineers to help them begin using the tools. The workshop’s objective was to familiarize team members with the new electronic check print process and give them enough practice so that they could begin to use the Windchill tools for their project work. B83 team members were extremely supportive of the new process and they wanted to begin using the system immediately. Because the classified Windchill server had not yet received the required security approvals for operation, initial B83 project work was conducted on the unclassified server. Once the classified system

was approved for operation and configured for Sandia business practices, it was released to the B83 Team for their use as well.

As the B83 Team began using the Windchill 9.0 servers, they encountered a number of problems, as would be expected with any new, complex software application. These problems were usually resolved by working with the PTC consultants, or by using the PTC Technical Support system. The significant problems and their solutions are documented in Chapter 5 of this report.

The B83 Team's assessment of the Windchill 9.0 application and related tools is an essential part of this project. Their conclusion is that this tool suite provides significant benefits for their design processes and project data management. It is a step toward a true concurrent engineering environment and a model-based engineering process.

Windchill 9.0 provides these significant benefits for the B83 Project Team:

- All project data is stored with configuration management in a single repository. This includes not only the model and product definition, but all other associated and/or required documents, specifications, materials files, project plans, presentations, and other "soft" documents.
- Team members can share information in a secure environment and have ready access to all project information in real-time with just a few mouse clicks.
- Remote desktop collaboration between the designer and engineer will increase the efficiency of in-process design work. Electronic notifications for design changes will simplify the review and approval process.
- Engineers can view and mark up models and drawings using the ProductView viewer rather than having to know how to use the Pro/Engineer MCAD application. All design markups are retained, providing a record of why, when, and how designs were changed.
- E-mail notifications keep everyone current and prevent multiple versions of models from circulating. Notifications always point to the current model version.
- Windchill provides 100% traceability for files, regardless of the file state. This eliminates the possibility of file overwrite.
- Change control is documented through every step of the design process. Team members can see how a design has evolved over time.
- Because Windchill is web-based and requires no client application, access is not restricted to specific machines, and software installation problems are minimized.

ECAD Tools Evaluation: The AEE Team conducted an evaluation of PTC's ECAD tool suite to determine how these tools could benefit NWC Design Agency review and data management processes for ECAD design work. A critical element of the evaluation was to determine compatibility between the PTC ECAD tools and Mentor Graphics Expedition, the current NWC standard ECAD application. The AEE Team coordinated their work with staff at Kansas City Plant (KCP), who will be conducting their own evaluation of the PTC ECAD tools from the perspective of a NWC Production Agency.

The AEE Team evaluated the following PTC ECAD Workgroup Manager Suite tools:

- EDA Conduit, which translates a native Mentor Graphics design file into the common ".eda" file required by the other tools in the suite.

- EDA Expert, which provides designers and customers with remote view, review, comparison and mark up capability via the “.eda” files.
- PV Compare, which utilizes the “.eda” files for capturing detailed comparisons between two revisions of a design or between two different designs.
- ECAD Workgroup Manager, which provides the interface between the tools listed above and PDMLink via Windchill.

PTC’s ECAD Workgroup Manager is integrated with the Windchill 9.0 application, providing the ability to establish a collaborative design process for ECAD. Files can be managed within the PDMLink application and features such as automated e-mail notification for design changes can be used to facilitate concurrent engineering. These tools also provide remote reviewing capabilities outside of the native ECAD application, including detailed interrogation, markup and design iteration comparison.

To gain familiarity with PTC’s ECAD Workgroup Manager Suite, the AEE Team hosted a hands-on learning workshop that was conducted by a PTC subject matter expert (SME). The workshop participants were ECAD designers from both the Sandia/CA and Sandia/NM sites. The workshop was intended as an avenue for “training the trainers.” Participants were expected to become familiar enough with the tools to begin a deeper evaluation within the Sandia design environment and to be able to convey tool capabilities via demonstrations to engineering customers, management and other ECAD designers. In conjunction with the workshop, a PTC process architect worked with the AEE Team’s ECAD designers to define the current Sandia ECAD design review workflow and to develop a new electronic ECAD design review process using the PTC ECAD tool suite.

Using what they learned in the workshop, the AEE ECAD Team made a presentation of the ECAD Workgroup Manager Suite capabilities and the new review process to some of their engineering customers to gauge customer interest in using the application for their project work. The new process provides the following benefits to ECAD design reviewers:

- Team members can share information in a secure environment.
- Remote desktop collaboration between the designer and engineer is provided.
- Engineers can view, interrogate, mark up and perform overlay comparisons of schematics and layouts without the use of Mentor Graphics tools.
- When a design is checked out of the product data manager (PDM) it can be locked, allowing others to view the design, but preventing anyone from changing it.
- E-mail notifications of schematic and layout changes to team members will simplify the review and approval process. A direct link to the viewable file is contained in the e-mail, providing the reviewer with “one click” access to the design information.

The AEE Team’s ECAD evaluation provided the following conclusions:

- The ECAD Workgroup Manager Suite provides an electronic design review capability that is needed for a true model-based design process.
- Communication via stored and retrievable marked up viewables and comparisons proved more attractive than the typical “marked up print” methodologies that designers and engineers are currently employing. Customer feedback indicated that if the price were right and maintenance was low, engineering and design personnel would use these tools. The predominant factors for their interest were the tool interrogation capabilities outside of

the native design software, the ability to mark up and revisit historical markups, and the ability to download manufacturing files from the PDM without having to download the whole design.

- Adoption of these tools at other sites can also provide DA engineers the ability to easily interrogate and comment on changes to designs that have been transferred to other sites for maintenance. This would eliminate the need for transferring “information copies” of entire designs between sites.
- There are two major areas of concern for the implementation of the ECAD Workgroup Manager Suite. The software requires one Electronic Design Interchange Format (EDIF) translator for Mentor Graphics Design Capture or Mentor Graphics DxDesigner to create viewable files for schematic diagrams. Also, Mentor Graphics is in the process of encrypting the files that PTC needs to generate viewable files. Unless PTC and Mentor Graphics maintain a close working relationship, these changes may render the ECAD Workgroup Manager Suite useless for the ECAD design review process.

Visualization Tools Evaluation: The AEE Team conducted an evaluation of PTC visualization tools to determine their applicability for two specific applications. The first was for desktop viewing applications to enable engineers to view MCAD files without having to open the native MCAD application. The second was for the creation of weapons model assembly/disassembly animations and movies.

The first application was exercised with the development and implementation of the new B83 electronic check print process. Engineers used the ProductView Lite viewer to view and mark up CAD drawings and models for in-process work interactions with designers. This viewer is included in the Windchill application, and with a simple one click installation of the ProductView Lite client, the engineers had the tool at their desktop. This proved to be convenient and adequate for many of the engineers’ requirements.

The second visualization tool application of interest was the creation of weapons model assembly animations. Weapons engineers find it valuable to use assembly animations to show proposed assembly techniques and any problems or interference issues that may result from design changes. These animations are typically used to support design reviews. The AEE Team evaluated PTC’s Division Mockup 2000i2 product for this application.

The AEE Team conducted a hands-on Mockup learning workshop to gain a basic understanding of the tool and enough working knowledge to perform a limited evaluation with a weapons assembly animation use case. While the animation exercise demonstrated that Mockup can be used for weapons assembly animations, the basic lessons learned were that new users face a significant learning curve and the application’s complexity requires users to maintain their skills through regular use of the application. This does not fit the current needs at Sandia/CA, where the demand for high-end weapons assembly animations is infrequent.

The AEE Team’s conclusion is that there is not a justification for continuing to work with Mockup, especially in light of the knowledge that PTC is incorporating some of the features of Mockup into future releases of ProductView (Professional version).

Mathcad Evaluation: The AEE Team conducted a limited evaluation of PTC’s Mathcad application to gauge its value to Sandia staff. Mathcad is an engineering calculation application that can be used in stand-alone mode or in conjunction with Pro/Engineer to capture and associate

equations and intellectual property with a Pro/Engineer MCAD model or drawing. The Team's objective was to determine if a broader pilot evaluation exercise should be undertaken to determine whether Mathcad should be added to Sandia's common operating environment (COE). The intent of this first effort was to find a number of engineering staff who are currently using Mathcad or who would like to learn how to use it and have them evaluate it in the context of their normal work.

The evaluation team found significant value in using Mathcad for a variety of their engineering applications. All of the evaluators felt that the capabilities and usefulness of Mathcad warrant consideration for including it in the Sandia Common Operating Environment (COE). However, the general consensus is that further evaluation by a broader group of Sandians should be conducted before management commits to an investment in Mathcad. Because this evaluation was limited to a small number of weapons engineers who were already using Mathcad or had a desire to use it, it does not fully represent the general Sandia population. A broader pilot evaluation should include staff from a much wider range of disciplines.

If Mathcad were added to the Sandia COE, it would not be intended to replace other comparable applications such as MATLAB, which is widely used by engineering staff throughout Sandia. The goal would be to provide access to a relatively easy to use tool that can complement those already being used by a broad range of staff to support their work. This evaluation demonstrated that Mathcad, MATLAB, and other comparable programs all have strengths and weaknesses, and the selection of a particular application can be dependent not only on the intended use, but on the user's comfort level with the application as well. Adding Mathcad to the COE would not restrict or discourage the use of any other comparable application.

Project Collaboration: The work conducted throughout this project consisted of collaborative effort between Sandia/CA AEE Team members and numerous project partners and contributors:

- Parametric Technology Corporation was a primary source for consultants and subject matter experts who were instrumental in supporting the installation, configuration and validation of the Windchill 9.0 applications on the AEE development servers. They also supported the AEE Team's other project activities, including training development, the design of the B83 electronic check print process, and the ECAD and visualization tools evaluations.
- B83 project engineers and designers were active partners who contributed to the development and evaluation of the new MCAD electronic check print process.
- Staff from the Sandia/NM 2990 departments provided extensive technical support to the AEE Team for resolving Windchill installation and configuration problems. They were also active participants in the ECAD tools evaluation and the PDMLink and Pro/Engineer training course development.
- The AEE Team coordinated their ECAD tools evaluation with staff from Kansas City Plant (KCP), who will be conducting a similar evaluation. KCP staff were also a resource for resolving Windchill business administration configuration issues.
- The AEE Team has and will continue to share information with project partners at other NWC sites. A "lessons learned" document that details how the AEE Windchill servers were configured was shared with Sandia/NM and KCP staff, along with a series of "user help topics" that the AEE Team developed. The formal Windchill 9.0 installation documentation provided by PTC as a project deliverable is available to all NWC sites as a resource. Finally, this project report will be distributed to key staff at NWC sites to share lessons learned from the AEE project work.

Next Steps and Future Work: As the AEE Team completed this limited term project, there was still one significant operational problem to resolve with the AEE Windchill development servers. Users were typically unable to perform multiple file check-in when migrating data into Windchill, and could only check them in one file at a time. This problem was consistent between both the unclassified and classified Windchill servers. Because the B83 Team would like to continue using the AEE servers for their near-term project work, this issue must be resolved. However, that will require a funding source for continued Windchill server development and support.

There is still a learning curve ahead for the B83 team for using Windchill 9.0, both in learning how to fully utilize the capabilities, as well as determining how to best apply the system within the requirements of Sandia's business practices. However, the successful demonstration and adoption of the new electronic check print process by the B83 Team and their efforts to begin using Windchill for B83 collaborative project design work reflects the significant process improvements that Windchill 9.0 provides.

Sandia AEE Team members are maintaining close contact with KCP personnel involved in evaluating the ECAD Workgroup Manager Suite. KCP's conclusions will provide a Production Agency perspective on the ECAD tools and may direct Sandia and KCP toward additional avenues for intersite collaboration. Sandia will also be monitoring the relationship between PTC and Mentor Graphics to verify sustainable value of PTC's ECAD tools. Once a strategic PTC/Mentor relationship has been confirmed, Sandia/CA's ECAD designers can begin further development work with their engineering customers to implement a Windchill ECAD design review process.

The Sandia/CA AEE Team members will continue to work with their Sandia/NM counterparts to exchange information as both sites continue to develop Windchill systems, capabilities and a knowledge base. The lessons learned and the capabilities demonstrated with this development project will directly benefit the Sandia/NM efforts to implement Windchill 9.0 production servers in the near term.

The real time collaborative desktop design and engineering process developed for the B83 Team should be integrated into future project work not only for the B83, but for other projects as well, both within and outside of the NW realm. The tools and processes established with this project provide a solid foundation for other project teams to build upon. The AEE Team will be providing briefings and demonstrations of the B83 electronic check print process to Sandia weapons project managers and other potential users to promote the use of the Windchill 9.0 capabilities. Ideally, the next SNL/CA NW project will use the Windchill PDMLink platform for their project.

To achieve a true Advanced Engineering Environment, interagency collaboration between the NNSA, the Production Agencies and the Design Agencies must be established. A logical next step is to pilot the extension of the Windchill environment to enable data sharing among agencies.

Recommendations to PTC for Product Improvements

One of the deliverables for this project was a list of recommendations to PTC for product improvement. The AEE Team offers the following recommendations based on the work that was performed throughout the course of this project, with the understanding that they are in a learning curve and their time using the product was limited. It is possible that some of their recommendations may relate to issues that can already be resolved in Windchill given more experience and working knowledge.

Windchill 9.0 Recommendations:

- The PTC Windchill installation documentation needs improvement. The numerous installation documents often reference one another and each may use different terminology. These documents should be consistent in terminology so that users can easily understand them.
- An error in the NWC PRS 12005 configuration code caused major problems with the unclassified system configuration. The error was determined to be incorrect punctuation in the code that was written by a PTC consultant, which was subsequently corrected and will not impact other NWC sites. This code should have been tested and validated in advance to avoid disrupting a client's system.
- The PTC solution architects were very knowledgeable in their specific areas of expertise, but not necessarily in others. For example, while one was a Windchill expert, his limited knowledge of the Oracle application and configuration required calls to PTC Technical Support and/or other PTC SMEs to resolve installation issues. The time to pursue solutions through this avenue slowed down the Windchill installation process. Because the Windchill installation requires the integration of multiple applications, the PTC staff supporting these installations should bring enough knowledge to support the complete process.
- PTC's public knowledge database is not meeting the needs of its customers. There is a wide gap between the information contained in the public database compared to PTC's private knowledge database and the gap seems to be widening. The result is that users do not have direct access to information that may help resolve technical problems. Information for Windchill 9.0 is sparse in both databases.
- PTC's Help Database search engine is ineffective for locating content and it needs to be improved.
- It would be helpful if PTC provided guidance on hardware requirements for the Windchill servers. PTC's website provides a software matrix with guidance for the operating system (OS) and the supported Windchill components and versions, but nothing in terms of RAM, hard drive capacity, etc., nor do they provide guidance on the solution for best performance and scalability (Microsoft Windows, UNIX, or LINUX).
- The Windchill documentation should provide more examples of how to setup PDMLink in context to real business application scenarios. The AEE Team repeatedly was unable to find what they needed in the documentation and had to place calls to PTC Technical Support for assistance to configure Windchill parameters.
- Consistency in how the various Windchill 9.0 software management tools function would be helpful to users. Many of these tools have controls and icons that look and behave differently from one another. For example, to use the "Type and Attribute Management"

tool, the user must first press an edit icon to access the controls. In other tools, the user must first press an edit button, rather than an icon. While this may seem a small difference, the inconsistency can be confusing for users.

- The notification e-mails generated throughout a promotion request process should display the initiator's comments so that the recipient has immediate access to the sender's intent. Recipients should not have to dig down several levels within PDMLink to find that critical information.
- The Windchill documentation for the OOTB default access policies lacks clarity, and the hierarchy for access policies is unclear as well.
- The Windchill search capability is too specific. Users would like the ability to start with a global search and then refine the search parameters from there. For example, entering the Sandia six digit file number as the search query should bring up every file type with that number. The Windchill search is limited to a single file type.
- Designers want to be able to quickly revert to their last workspace. When they select the "Workspace" pull-down menu, they have to go through extra steps to get back to the last workspace.
- When importing a Pro/Engineer file, Windchill brings every referenced file into PDMLink as well. Designers would like to restrict the import to only external references, not every parent/child reference. For example, when a designer is working on a small subassembly with 10 or 20 parts, they may not want the entire 500 part full model imported.
- Designers would like the ability to change the revision designation for a new work in progress (WIP) file after it is checked into Windchill. At present, once a file is checked into Windchill, it has to be re-versioned to change the revision designation. Although the revision designation can currently be changed prior to the initial file check-in, this requirement slows down the data migration process. If designers could change the revision designation for a new WIP file, it would help them "clean up" legacy data that has been migrated into Windchill.

Training Recommendations:

- The AEE Team encourages PTC to be more flexible in its approach to the development and delivery of custom training courses. While their standard training approach may be effective with the majority of their customers, Sandia and other NWC sites typically prefer to partner with PTC to develop internally taught courses that are based on standard PTC content with the addition of NWC-specific content to represent the actual working environment. PTC's intellectual property rules prevent the NWC sites from using PTC content for these custom internally taught courses.

ECAD Tools Recommendations:

- PTC should work with Mentor Graphics to eliminate the use of EDIF translators, which result in a schematic that does not look like its parent. Text fonts and sizes, line fonts and other aesthetics change appearance.
- If the PTC ECAD tools must use the EDIF translators, PTC should license them from Mentor Graphics or another vendor and bundle them with the EDA Conduit application.
- Mentor Graphics Design Capture border data (variables for format metadata such as drawing number, classification, etc.) do not come across the EDA Conduit. This is because

border data is driven by a side file that the EDA Conduit does not read. PTC needs to find a way to “pull in” this information.

- PTC needs to address the fact that multiple instances of a circuit within a DxDesigner hierarchical schematic are not handled by the EDA Conduit.
- Windchill should offer some separation between a “final” design upload for review versus an interim “administrative non-review” upload to avoid sending automated e-mail notifications every time a design is checked-in to the PDM.
- The ECAD/MCAD collaboration available within Windchill is limited to the automated e-mail notification to MCAD designers and their ability to view design changes at their desktops. There is no real ECAD/MCAD interaction process. PTC and Mentor Graphics have other collaboration tools that could take this process to the next step and offer more tightly integrated collaboration capability.
- PTC should add the capability to download multiple files from within Windchill. Manufacturing files are available for download from Windchill separate from the rest of the design, but can only be downloaded individually. With an average of thirty files involved, this can become cumbersome.
- PTC should assign protections at the file level, not the object (folder) level as is currently the case. Object level protections complicate the folder structure for designs because Official Use Only (OUO) manufacturing files would need to be in a separate folder from non-OUO files, even when all other aspects of the files would make them common.

Visualization Tools Recommendations:

- Accelerate the integration of advanced features of the Division Mockup application into ProductView to make it a more comprehensive product.
- Provide comprehensive user training. Users would benefit from advanced courses for all ProductView capabilities, such as animation. They should also offer a course for application customization using the new API.
- Improve ProductView documentation and include user guides for all product capabilities.

Mathcad Recommendations:

- Improve the plotting capability.
- Make further enhancements to the documentation with embedded links for sub-functions and the methods used in a given tutorial or help page.
- Provide web-based training in PTCU.

Acronyms

- AEE ▪ Advanced Engineering Environment
- API ▪ application program interface
- BOM ▪ bill of materials
- CAD ▪ computer-aided design
- CHK ▪ check
- CM ▪ configuration management
- COE ▪ common operating environment
- COTS ▪ commercial off-the-shelf (product)
- DA ▪ design agency
- DART ▪ Design through Analysis Realization Team
- DDR ▪ double data rate
- DOE ▪ Department of Energy
- EBOM ▪ electronic bill of materials
- ECAD ▪ electrical computer-aided design
- EDIF ▪ electronic design interchange format
- FSB ▪ frontside bus
- FTP ▪ file transfer protocol
- FY ▪ fiscal year
- GB ▪ gigabyte
- GHz ▪ gigahertz
- GUI ▪ graphical user interface
- HTML ▪ hypertext markup language
- HTTP ▪ hypertext transfer protocol
- HTTPS ▪ hypertext transfer protocol-secure
- IBP ▪ intersite business process
- IP ▪ intellectual property

IDI ▪ interoperability data interface

IMS ▪ image management system

JPEG ▪ Joint Photographic Experts Group

KCP ▪ Kansas City Plant

LANL ▪ Los Alamos National Laboratory

LDAP ▪ lightweight directory access portal

LLNL ▪ Lawrence Livermore National Laboratory

MBE ▪ model-based engineering

MBIT ▪ model-based integration tools

MCAD ▪ mechanical computer aided design

MHz ▪ megahertz

NIF ▪ National Ignition Facility

NNSA ▪ National Nuclear Security Administration

NTK ▪ need-to-know

NW ▪ nuclear weapon

NWC ▪ Nuclear Weapons Complex

OIR ▪ object integration rule

OS ▪ operating system

OOTB ▪ out-of-the-box

OUO ▪ official use only

PA ▪ production agency

PC ▪ personal computer

PCB ▪ printed circuit board

PDF ▪ portable document format

PDM ▪ product data manager

PLM ▪ product lifecycle management

Pro/E ▪ Pro/Engineer

PRIDE ▪ Product Realization Integrated Digital Enterprise

PRS ▪ product realization standard

PSD ▪ power spectral density

PTC ▪ Parametric Technology Corporation

PTCU ▪ Parametric Technology Corporation University

PWA ▪ printed wiring assembly

PWB ▪ printed wiring board

RAID ▪ redundant array of independent disks

RAM ▪ random access memory

REL ▪ release

RMI ▪ Requirements, Modernization and Integration

RPM ▪ revolutions per minute

SAND ▪ Sandia Report

SAS ▪ serial attached SCSI

SCN ▪ Sandia classified network

SCSI ▪ small computer system interface

SME ▪ subject matter expert

SNL ▪ Sandia National Laboratories

SNL/CA ▪ Sandia National Laboratories/California

SNL/NM ▪ Sandia National Laboratories/New Mexico

SRN ▪ Sandia restricted network

TIFF ▪ tagged image file format

3D ▪ three dimensional

URL ▪ uniform resource locator

VPA ▪ volume purchasing agreement

WIP ▪ work in progress

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1

Introduction

1.1 Advanced Engineering Environment Concept

Sandia's research and engineering contributors have always been geographically dispersed, which makes it difficult to collaborate effectively. As part of the nuclear weapons complex enterprise, Sandia, and the other NWC sites must modernize their engineering technology infrastructure through which this fundamental engineering data and scientific knowledge can be easily stored, retrieved, visualized and exchanged between Design Agencies and Production Agencies, regardless of location.

To achieve NNSA's vision of a more responsive infrastructure, the NWC sites must develop and deploy an Advanced Engineering Environment (AEE). The AEE is the enabling technology of model-centric engineering. It is a computational and communications system that contains a comprehensive set of engineering design and analysis tools with integrated data repositories which are linked together and made accessible through a computer network. This approach facilitates concurrent model based engineering by enabling the seamless, parallel flow of digital models and information across a distributed networking environment. It provides the added benefit of real time engineering collaboration between multidisciplinary groups who are involved in a product's design and development process, which in turn results in higher quality products that are developed in less time and at a lower cost.

The AEE's long term goal is to provide the following benefits to the NWC:

- Accelerate the development of highly advanced scientific, research and engineering projects.
- Provide consistent, comprehensive engineering data to all authorized project participants.
- Provide a mechanism through which Sandia can collaborate on digital engineering data with other DOE/NNSA sites and partner Universities to increase efficiencies, eliminate errors, and reduce cycle time and cost.
- Improved design intent understanding through enhanced visualization, leading to better and more timely decision-making.
- Facilitate work on projects with widely geographically distributed participants.
- Knowledge retention by capture of engineering decision bases.
- Faster response to engineering issues, reducing project delays.

1.2 Background

This project is the continuation of a proof of concept pilot that was completed in FY06¹. That project established a set of validated requirements for the AEE to use as the basis for procuring a commercial off-the-shelf (COTS) product solution from commercial vendors. In addition,

1. *Advanced Engineering Environment Pilot Project*, SAND2006-6191, October 2006.

two three-tier AEE development server systems were established, one on Sandia's classified network and the other on the unclassified restricted network. These servers were used to test a suite of design and collaboration software tools from Parametric Technology, Inc. (PTC). A specific area of focus was the evaluation of PTC's Arbortext technical publishing software for NWC applications. Use cases included engineering authorizations, operational procedures and a project report.

This AEE project continues the work begun in FY06 by implementing and evaluating PTC's current collaboration and design tools. This toolset is based on the Windchill 9 product lifecycle management (PLM) applications. A specific area of interest is in applying the collaboration capabilities for real weapons project use cases.

1.2.1 Windchill 9.0 Tool Suite

The Windchill 9.0 tool suite integrates applications for data management, MCAD, ECAD, visualization and analysis, intellectual property capture, and technical publication. The AEE Team was interested in applying these tools to collaborate remotely and to store and manage all design and associated project data in a single repository as illustrated in Figure 1.2.1.1.

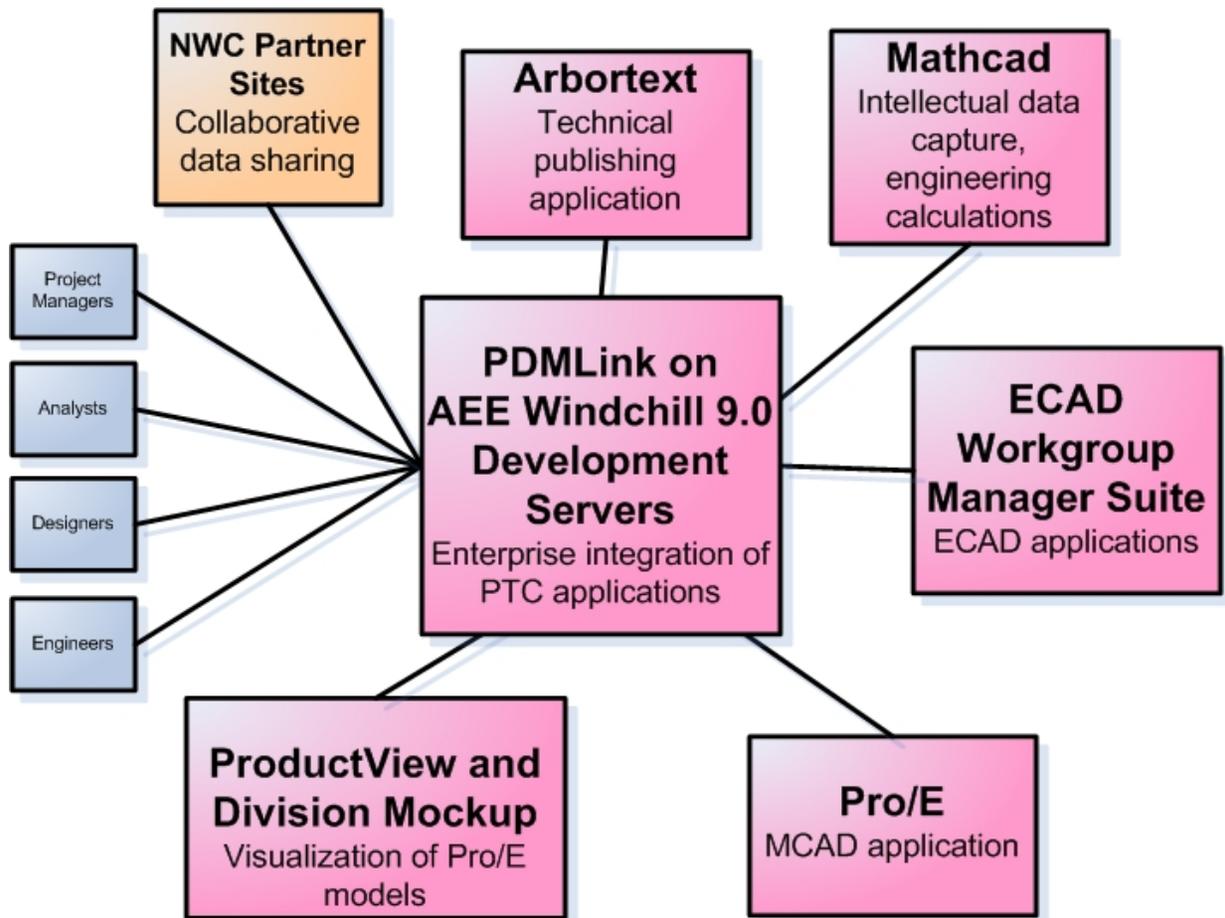


Figure 1.2.1.1 Advanced Engineering Environment collaboration toolset.

PDMLink: Like many MCAD vendors, PTC also has its own PDM application, called Windchill. In recent years, Windchill has evolved into a suite of related applications including PDMLink

and ProjectLink. For this project, the AEE Team used PDMLink as the document management application. Some of the benefits of Windchill 9.0 include:

- Windchill is a single repository for managing and archiving project files.
- Windchill integrates CAD and visualization applications.
- Content is fully traceable.
- All files have a known pedigree.
- Revision history is retained through stored design iterations.

Pro/Engineer: PTC's flagship product is their Pro/Engineer MCAD application. In 1991 it was chosen as the de facto standard for weapon design throughout the NWC. Pro/Engineer is integrated with Windchill 9.0 for seamless interaction between the PDM and CAD applications.

ProductView: ProductView is a visualization tool that provides the mechanism to view CAD models outside of the actual CAD application. While it is a PTC product, it can handle multiple CAD formats, which in turn makes it possible to merge models from disparate CAD applications into one product structure.

- ProductView Lite is a reduced capability version of PTC's standard ProductView application. Lite is included within the Windchill application and was selected as the viewer for the Windchill evaluation due to its ease of use and minimal learning requirements.
- ProductView Standard 8.0 is the current "full" version of ProductView. AEE Team members had used it in the past and they found the user interface cumbersome. The application had a tendency to crash during the development of assembly animations. The AEE Team chose not to use ProductView Standard 8.0 for this project, as a much improved version 9.1 will be released by PTC in the near future.
- ProductView MCAD Professional 9.1 became available as a beta application at the latter stages of this project. The user interface is much improved from version 8. The Team had planned to participate in the beta test program for the application, but declined to do so when they learned that no animation capabilities were included in the beta version.

Division Mockup: This visualization tool provides many more features than ProductView and is better suited for higher level work such as animated model fly-throughs of large models, high quality renderings, and applications that require constraints, behaviors, and action-driven sequences. Mockup does not integrate with the Windchill platform, and therefore is best used for individual applications rather than on-going processes where model updates must be integrated into animations.

ECAD Workgroup Manager Suite: PTC's ECAD Workgroup Manager Suite allows users to view, review, mark up, and run comparisons on Mentor Graphics ECAD files independent of the Mentor Graphics application. This capability allows engineers to review ECAD designs created with Mentor Graphics, even if they have no working knowledge with that application.

Arbortext: Arbortext and its suite of applications is an enterprise-level technical publishing system that has been integrated into Windchill. One of the advantages to using the PTC collaborative suite for technical publishing is its ability to manage documents. Version control ensures that users are working on the latest update and when a person checks-out a document for editing, the document is locked to other users until it is checked back in. The individual components reside on the Windchill server and each can be accessed for modification. When any

of the components, (i.e., a chapter, a photo or drawing) are modified, future publication of the information incorporates the modification. Arbortext can also be used as a standalone application.

Mathcad: Mathcad is an application for performing engineering calculations and for capturing intellectual property. It can be used as a stand-alone application or it can be integrated with Pro/Engineer to associate calculations with a model.

1.3 Scope

This project's high level goal was to evaluate the applicability of PTC's suite of collaboration and design tools for a model-centric enterprise for the NWC. The project objectives were focused on the installation, configuration, application and evaluation of PTC's Windchill 9.0 integrated tool suite for Sandia and NWC applications.

This project deployed and evaluated PTC's Windchill 9.0 on development servers in both unclassified and classified environments. Although Sandia/NM has deployed a Windchill 8.0 system, there has been limited effort to evaluate the integration of PTC's Windchill tool suite and how it can be used to support collaborative processes. The AEE project addressed this gap.

A basic requirement for the evaluation of the Windchill application was that there would be no customization of the product and it would be tested only in its commercial off-the-shelf (COTS) state. Specifically, no alteration of the application code base was allowed. However, configuration to adapt the applications to specific NWC business process needs was allowed. Specifically, the application servers were configured to the current NWC product realization standard, PRS12005. In addition, the Windchill application was configured to represent Sandia business practices.

This project addressed only the in-process engineering activities associated with product lifecycle management (PLM). This is a front-end step in a model-based engineering (MBE) process. It did not address the management of product definition or product structure nor did it address the formal processes of PLM. However, the intent is for the data and artifacts generated during an in-process state to be in a format that can be stored and managed by a PLM system upon the completion of a cycle.

This project did not require an extensive process analysis or system architecture effort for the deployment of the AEE development systems. That over-arching model-based process is being addressed with other ongoing NWC projects (PRIDE, RMI) and it is out of the scope of this project. This AEE project is in line with those efforts, and therefore, the AEE Team evaluated only the PTC tools that are in line with PRIDE's 5 year plan.

PTC Consultants: Because this project focused on the implementation and evaluation of PTC's design and collaboration tools, the AEE Team worked with PTC consultants throughout the course of the project. PTC's consultants assisted the AEE Team in the installation and validation of the tools, the design of new work processes for taking advantage of the capabilities the tools provide, and training users. This support was essential for completing this project in a short time period.

1.4 Objectives

Implementing the Advanced Engineering Environment will require the full integration of tools, systems, and data across all of the sites in the NWC. The efforts of this AEE development project focused on implementing a number of PTC's Windchill tools to evaluate their integration for weapons project applications.

The AEE project's objectives were:

- Implement the Windchill 9.0 platform on the AEE development servers to enable testing and evaluation of the tool suite.
- Perform a training assessment and deliver training to enable Sandia staff to use and evaluate the PTC tools.
- Partner with the B83 Weapons Project Team to test the integration of Windchill 9.0 and the Pro/Engineer and ProductView applications for in-process design iterations.
 - Manage drawings, models, documents and other data.
 - Share the data among designers/engineers/analysts using Windchill tools.
 - Use visualization tools to view, analyze and mark up drawings and models for design collaboration among designers and engineers.
 - Perform an evaluation with a weapons project use case.
- Perform an evaluation of the PTC ECAD tools:
 - Determine the compatibility between the ECAD Workgroup Manager Suite and Mentor Graphics Expedition.
 - Exercise and evaluate each tool supplied with the ECAD Workgroup Manager Suite.
 - Compare the ECAD Workgroup Manager Suite tool capabilities to those available in the Mentor Graphics Expedition design tool, Sandia's current standard ECAD application, to determine the strengths and weaknesses of each.
 - Evaluate the ECAD Workgroup Manager Suite applications and their integration with PDMLink for ECAD data collaboration and management.
 - Demonstrate ECAD Workgroup Manager Suite capabilities to engineering customers and ECAD designers.
- Perform an evaluation of the PTC visualization tool suite to determine applicability for Sandia weapons program applications.
 - Exercise tools with use cases.
 - Determine the best tools for weapons project needs.
- Perform a limited evaluation of PTC's Mathcad application, independent of the Windchill environment, to determine its applicability for Sandia project work.
- Use Arbortext to produce a project report to share lessons learned with other NWC sites as they prepare to implement Windchill 9.0.

The demonstration and evaluation of the integration of PTC tools for weapons program applications was a priority for this project. Specifically, the integration of the Pro/Engineer MCAD and ProductView visualization tools with PDMLink, within the Windchill 9.0 collaboration environment. To achieve this objective, the AEE Team partnered with the Sandia/CA B83 Weapons Project Team to create an "electronic check print" process for their in-process design work using the Windchill 9.0 tools. This activity provided the AEE team with a real-world application for the tools evaluation and also provided the B83 Team with a new way to do business.

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2

Windchill 9.0 Installation on the AEE Servers

2.1 Overview

Sandia's two existing AEE three-tier development systems were upgraded to Windchill 9.0 and configured to the NWC PRS 12005. The three primary objectives were to:

1. Install and test the hardware and the Windchill 9.0 applications in both unclassified and classified environments.
2. Fully document the installation and configuration process.
3. Document any installation or configuration issues as lessons learned.

The intent was to learn from this experience and share it with other NWC sites who will soon upgrade their production PDM systems to Windchill 9.0.

The two three-tier servers had been in operation for two years with no upgrades. They were running Oracle 9.i and Windchill 8.0. For this project phase, Oracle was upgraded to 10g and Windchill to 9.0, M030. The unclassified servers were upgraded first, followed by the classified servers. These installations were performed by a team consisting of the Sandia system administrator and several PTC solution architects. The hardware and software specifications for the AEE servers can be found in Appendix A.

2.2 Unclassified Three-Tier Server Implementation

2.2.1 Oracle Server

Although a clean install of Oracle 10g was implemented, the legacy data on the current system had to be addressed. The process required backing up the existing database, removing the 9i application, installing the 10g application, and loading the old database into the new 10g installation.

Before the existing database could be backed up, the Oracle administrator password had to be found. Oracle 9.i had been installed by a PTC consultant in 2006 and the Sandia system administrator had no record of the password. The Oracle backup runs from a command line ("DOS window") action that requires both the Oracle administrator account name and a password. The current PTC solution architect knew it existed in a preference file, but did not know the location. The password was located after some searching and the database backup was completed. Although the delay was modest, this glitch points out the need to maintain complete documentation for the system. The lesson learned is to change the out-of-the-box password to one generated by Sandia's password generator utility, and to keep the password on a secure list that can be accessed as needed. Install logs should also be encrypted and stored in a safe location for future reference. This will be beneficial for future upgrades, when there is a change of the system administrator, or if current staff simply forget the infrequently used password.

One change of note from Windchill 8.0 to Windchill 9.0 is that passwords are embedded in the install logs, so it is possible to find them if necessary. The install log will also reveal any deviation from “out-of-the-box” name changes to the default accounts. Although it was not an issue on the AEE servers, it should also be noted that the Oracle default password must be changed to meet Sandia’s password requirement rules. Network scans will detect the use of inadequate passwords, which can result in the lockout of the system.

2.2.2 Windchill Server

The Windchill 9.0 installer menu showed significant improvement over Windchill 8.0. However, the documentation was at times unclear. It appeared that the documentation was an incomplete upgrade from the Windchill 8.0 installation documentation and that some sections had been written by different authors. Specifically, some terminology was inconsistent between sections, which created confusion for the user. This was very apparent between the different PDF documents which are referenced in the installation guide.

There were several problems with the installation of the worker agents that caused considerable delay in standing up the servers. The first was with Adobe Acrobat. Although Acrobat 6 is recommended and included with the Windchill installation disks, it is not approved for use by Sandia Computer Security. Therefore, Acrobat 9 had to be installed. This worker agent did not work properly at first, and the source of the problem was unclear. The problem turned out to be the various pop-up windows that appear after a new installation of Acrobat is launched. Once these windows “pop-up”, they must be closed before the program will function. These windows were not seen by the installers.

During the Acrobat installation, the registration screen appeared and the system administrator selected “Never register, don’t remind me again”. After the completion of the installation and on the first launch of Acrobat, another pop-up window appeared with instructions for activating the application via the internet. That action was completed and the system administrator presumed that the installation was finished and he proceeded to try the Microsoft Office worker agent. The Office agent worked on the first attempt, but failed on subsequent attempts. After considerable troubleshooting effort, the installation team discovered that Acrobat was trying to spawn additional pop-up windows, which were failing to appear on-screen. Because these pop-up windows did not actually appear, they were not responded to, and this effectively froze Acrobat and prevented the program from functioning. These pop-up windows included messages such as “Would you like e-mail updates for new products?” and “Would you like to get e-mailed with tips and tricks?” There were several of these cleverly disguised prompts that encourage the user to register the product, even though “Never register” was selected during the installation. The Sandia system administrator has surmised that the reason these pop-ups were not seen is because of the way in which Windchill invokes the Adobe products, which is different than the way a user would interact with the applications directly. Once the problem was identified and the pop-ups were cleared by launching Adobe directly numerous times until they stopped appearing, the worker agent functioned correctly. The lesson learned was that the registration window and other pop-ups that appear immediately after a new application installation must be cleared for the application to function properly.

The CAD worker agent also posed a problem. Windchill uses the FTP protocol for Pro/Engineer work that is performed via a separate Pro/Engineer server. Sandia network security blocks FTP on the unclassified network and therefore an alternate solution was required. The Server

Team looked at two possible solutions, both of which presented problems with the way that “ownership” and authentication worked out:

- Secure FTP protocol, which is approved for use at Sandia.
- A shared/mapped folder.

The Team made an attempt to use Secure FTP, however, they could not get a “handshake” between the AEE and Pro/Engineer servers. There was no PTC documentation on how to make Secure FTP work with Windchill, and the Team did not feel it could spend time researching a solution. They were under pressure to get the system functioning as quickly as possible to enable the tools evaluation to begin.

The Server Team also attempted to use a mutually shared folder and mapped drive letters. This method presented problems because of share authentications and their reluctance to leave a share “wide open” as a work-around. In addition, when a server was rebooted, the share folder mapping was lost and had to be manually reestablished.

The solution the team employed was to install Pro/Engineer on the Windchill server to eliminate the need for FTP, Telnet, or folder shares. The down side of this approach is that these servers will have to be upgraded when a Pro/Engineer application upgrade is instituted. By using the site Pro/Engineer server, this can be avoided.

With regard to Pro/Engineer, it appears that the Windchill server should always be running the same or newer version of Pro/Engineer and Microsoft Office as the client systems. The PTC “Windchill System Administrator’s Guide” states “You can use older versions of your authoring applications for designing and engineering, however, the CAD worker must be configured to use a higher version of the authoring application for publishing and generating viewable files on the Windchill server” (reference the doc, page 10-2). The implication is that if users are downloading the latest version of Pro/Engineer and trying to use it with Windchill, there will be problems.

It should be noted that after the initial Windchill installation and configuration, none of the “worker agents” performed correctly. The Server Team had precisely followed the PTC Windchill 9.0 “Installation and Configuring” guide instructions for creating and configuring worker agents, yet the agents did not function. After several days of trying various recommendations from PTC Technical Support, the Team was advised that they did not have a required “auth.properties” file. Neither the “Express” nor the “Advanced” versions of the PTC “Windchill Installation and Configuring” included any instruction for the creation and/or need for this file. This is an example of wasted time due to poor Windchill documentation.

The configuration of the unclassified server with the NWC product realization standard (PRS 12005) created significant problems. The custom configuration scripts created by PTC had comment lines with incorrect punctuation, which led to numerous application errors. The solution that was attempted was a command line restore to a backup that had been created prior to the PRS installation. This did not correct all of the problems and considerable time and effort was spent trying to resolve them. PTC’s master solution architect ultimately provided a missing “fixLDIF” custom batch file which resolved the problem. The correct procedure that should have been implemented was a GUI restore. Unfortunately, this procedure was not included in the PTC’s NWC PRS configuration documentation. The PTC solution architect corrected the script errors and the PRS loaded correctly on the classified server. He also modified the installation process to

include the option to restore from the LDAP browser. The lesson learned is to create backups from both the command line and the browser.

One area that still needs to be addressed is the implementation of a robust automated backup process for the servers. At present, completing thorough backups takes time and the servers have to be taken offline. It should also be noted that the servers have to be brought back on line in a specific sequence for them to function properly. If necessary, a system reboot can be performed to restart everything in the correct sequence.

2.3 Classified Three-Tier Server Implementation

Because the unclassified server system was the first to be fully implemented and tested, implementation of the classified server system was a relatively easy process with regard to the Windchill installation.

However, the classified system was not rolled out to users until late in the project due to Sandia security requirements. The primary delay was the relocation of the system from its existing network location to a subnet that would allow access to the new users. This also required moving the classified system to a new security plan, which took considerable time for approval to operate.

After the system was moved to the new subnet and approved for use, a classified e-mail entity account was created to enable Windchill to send the review and approval notifications. New user accounts and permissions were set up, and the system was ready to be configured for Sandia business practices using the same settings that had been applied and validated on the unclassified system.

2.4 AEE Training Server Implementation

The AEE team implemented a dedicated single tier server for training applications. PTC consultants recommended this approach, as opposed to using one of the AEE three tier development systems for both the B83 project work and training applications. The Windchill installation on the training server was completed by cloning the applications from the unclassified three tier AEE development server.

On the three-tier system, the worker agents were referenced to the separate servers (Windchill, Oracle). To redirect the worker agents to the application locations on the single-tier system, the PTC consultant wrote a script which was used to correct the references.

2.5 Windchill 9.0 Installation Documentation

The primary system documentation deliverables that were required from PTC were:

- A system installation guide for performing an OOTB Windchill 9.0 installation on a Microsoft Windows platform². It contains a comprehensive list of the installation disks required, how to stage them for installation, and a guide for responding to the installation questions and prompts.

2. *NWC PDMLink Installation Guide Version 9.0 – Updated for the Sandia/CA Installation*, November 2008.

- An environment management plan to enable the system administrator to perform system backups, change passwords, and other ongoing requirements³.
- A system-specific performance tuning assessment and configuration guide for optimizing AEE server performance⁴. This guide provides instruction for setting Windchill and Oracle parameters such as how much RAM to allocate, how many processing cycles to attempt before aborting, etc.

In addition, the PTC solution architect documented all problems that were encountered during the installations and the subsequent solutions. These are being incorporated into an NWC Windchill 9.0 installation guide that is being developed by PTC's Rusty Abernathy under a contract with another NWC site. This installation guide will be available to Sandia when it is completed.

2.6 Lessons Learned

The positive aspects of the Windchill installation were:

- The PDMLink 9.0 installer is much improved compared to the one used in Windchill 8.0. Windchill 9.0 has a tool that allows the user to copy all of the installation disks into a folder prior to the installation. Once the installation begins, the tool automatically pulls the content from the folder so that the user does not have to sequentially load the individual disks over the course of the installation process.
- For the issues the PTC solution architects could not resolve themselves, they did a good job of pursuing the solutions by using available PTC resources.

The negative aspects of the Windchill installation were:

- The PTC Windchill installation documentation needs improvement. The numerous installation documents often reference one another and each uses different terminology. They need consistency in terminology so that they are consistent and understandable for users.
- An error in PTC's NWC PRS 12005 configuration code caused major problems with the unclassified system configuration. The error was determined to be incorrect punctuation in the code. This code should have been tested and validated in advance to avoid disrupting a client's system. The code error was corrected by PTC and therefore should not be an issue for other NWC sites.
- PTC does not provide documentation or support for using Secure FTP protocol with Windchill. Although Sandia may differ from other NWC sites in its requirements, the inability to use Secure FTP protocol for a separate visualization server required the installation of Pro/Engineer on the Windchill server for publishing visualization files. This configuration had a severe impact on system performance for the unclassified three-tier server, which had limited system memory.
- The PTC solution architects were very knowledgeable in their specific areas of expertise, but not necessarily in others. For example, while one was a Windchill expert, his limited knowledge of the Oracle application and configuration required calls to PTC Technical Support and/or other PTC SMEs to resolve installation issues. The time to pursue solutions

3. *NWC PDMLink 8.0 Maintenance and Operations Guide – Sandia/CA Update for PDMLink 9.0*, November 2008.

4. *PDMLink R9 Wildfire 3 Architectural Assessment*, September 2008.

through this avenue slowed down the Windchill installation process. Because the Windchill installation requires the integration of multiple applications, the PTC staff supporting these installations should bring enough knowledge to support the complete process.

2.7 Recommendations to PTC for Windchill Improvements

Public Knowledge Database: An issue that surfaced while Sandians were working with PTC staff during the server upgrade process is that PTC's public knowledge database includes far less information than its private knowledge database. This private database is not open to users. PTC staff acknowledged that this information gap between these databases seems to be getting wider. The result is that users do not have direct access to information that may help resolve technical problems. It should also be noted that information for Windchill 9.0 was sparse in both databases.

Help Database Search Engine: The AEE system administrator found the search engine for PTC's Help database rather ineffective for locating content. The content filters seem to be ignored, as queries in the database don't return the expected content. For example, checking the box to limit a query to only Pro/Engineer Wildfire 4 returned responses for Wildfire 2. As another example, typing in a specific PTC "TPI" number should bring up that specific document, but that was not the case.

Hardware Guidance: It would be helpful if PTC provided guidance on hardware requirements for the Windchill servers. PTC's website provides a software matrix with guidance for the operating system (OS) and the supported Windchill components and versions, but nothing in terms of RAM, hard drive capacity, etc., nor do they provide guidance on the solution for best performance and scalability (Microsoft Windows, UNIX, or LINUX).

3

Windchill Configuration for Sandia Business Practices

Upon the completion of the installation, testing and validation of the Windchill 9.0 application on the unclassified AEE server system, the AEE Team began to prepare a demonstration of the system for the B83 weapons project team. This demonstration would implement the new B83 electronic check print process that had been developed cooperatively by the AEE Team, the PTC process architect, and B83 team members. The preparation for this demonstration required AEE Team members to become familiar with Windchill 9.0 and determine how to use the application in the context of Sandia's business practices.

Although the intent of this project was to test Windchill 9.0 in its OOTB configuration, it was soon apparent to the AEE Team that configuration of the application would be required to provide a familiar environment that the B83 designers and engineers would be interested in using. The PTC solution architect had configured Windchill to PRS12005, however, features such as lifecycles, auto-numbering and others were in the OOTB configuration and did not correlate to Sandia and NWC business practices. Therefore, a great deal of staff effort was put into configuring Windchill to apply Sandia business practices where possible.

The AEE Team worked with PTC consultants and PTC customer support to configure Windchill to Sandia requirements. The specific configurations, the problems encountered, and solutions that were implemented are detailed in Appendix B.

3.1 Project Collaboration

The AEE Team worked with a number of PTC consultants and the PTC technical support team to configure Windchill to Sandia requirements. They also received generous support from their colleagues at Sandia/NM and KCP. Henry Rodarte and Jeremy Plake (Sandia/NM) were significant contributors for the resolution of many problems the Team encountered during the Windchill implementation and configuration. Gayle Alley (KCP) was a valuable resource for questions and problems related to the business administration aspects of Windchill.

The AEE Team has and will continue to share information with project partners at other NWC sites. A "lessons learned" document that details how the AEE Windchill servers were configured was shared with Sandia/NM and KCP staff, along with a series of "user help topics" that the AEE Team developed. The formal Windchill 9.0 installation documentation provided by PTC as a project deliverable is available to all NWC sites as a resource. AEE Team members also shared project information with NWC colleagues at the October 2008 MBIT conference in Los Alamos, NM. Finally, this project report will be distributed to key staff at NWC sites to share lessons learned from the AEE project work.

3.2 Configuration Summary

The AEE Team noted the following positive features though the course of the Windchill server configuration:

- The performance of the Windchill system is very good compared to Windchill 8. This was noticeable for viewing workspaces, browsing folders, and file check-in and check-out.
- Templates were very useful for defining products.
- The “Import to Workspace” function identifies files that are already in PDMLink.

Problems and shortcomings included:

- There is little PTC documentation for setting up business administration configurations.
- When setting the state of CAD files and assigning lifecycles, each file must be treated individually. There is no batch process available for these assignments. This was a problem for the AEE Team, who needed to reassign lifecycles to more than one hundred files.
- The “Reuse” function within the “Import to Workspace” function does not work with family tables.
- The PTC documentation for the Windchill OOTB default access policies lacks clarity.
- The hierarchy for access policies is unclear, causing confusion for users.
- The Windchill Attributes that were originally planned to be used as search parameters for the ParaCAD Library parts need to be removed, but the AEE Team was unsure of how to accomplish this task. The parameters have been known to cause ParaCAD files and the assemblies they are used in to fail when added to a workspace to be opened in Pro/Engineer.
- There were problems migrating files onto the new servers that have not been completely resolved. It was initially thought that difficulties loading multiple files were due to the unclassified server’s limited RAM, but problems were also encountered with the classified server, which has significantly more RAM installed. This issue remains to be resolved.

3.3 Recommendations to PTC for Improvements

The Windchill documentation should provide more examples of how to setup PDMLink in context to real business application scenarios. The AEE Team repeatedly was unable to find what they needed in the documentation and had to place calls to PTC Technical Support for assistance to configure Windchill parameters.

Consistency in the how the software management tools function would be helpful. Many of these tools have controls and icons that look and behave differently from one another. This can be confusing and it makes using the tools difficult. For example, to edit the setting in the “Type and Attribute Management” tool, an edit icon must be clicked for access to any of the controls or all of the controls and setting appear grayed out on the screen. In other tools, an “Edit” button needs to be pressed to view and access the settings and controls.

The notification e-mails generated throughout a promotion request process should display the initiator’s comments so that the recipient has immediate access to the sender’s intent. Recipients should not have to dig down several levels to find that critical information.

4

Training Assessment, Development and Delivery

Because the Windchill 9.0 platform is new to Sandia, AEE team members and project partners required training for the implementation, use and evaluation of the PTC design and collaboration tools.

4.1 Training Needs Assessment

As a first step, a PTC training consultant conducted a training needs assessment for the project. This assessment included the following recommendations for training delivery methods as well as specific courses for the various AEE project teams, as each has different needs:

- **CAD Designers:** Designers typically handle the CAD data management tasks on projects, as most engineers and analysts typically prefer not to deal with the data management. Therefore, they need extensive training for the PDMLink application. The PTC consultant's recommended solution was to customize the PTC PDMLink introduction and data management courses by adding Sandia content to address Sandia-specific business processes.
- **B83 Team:** This team of designers and engineers partnered with the AEE team to put the Windchill 9.0 tools in practice to evaluate their applicability for the B83 project. The training solution was to provide a customized hands-on workshop for core team members. The workshop focused on how to use the "electronic check print process" the AEE Team developed for the B83 Team (refer to Chapter 5 for details). In addition to the workshop, other team members were provided with demonstrations of the Windchill 9.0 collaboration tools to let them know what the core team was engaged in.
- **Visualization Team:** This team consisted of two visualization experts who were interested in evaluating PTC's ProductView and Division Mockup visualization tools for weapons animation applications. The first training solution was to have a PTC subject matter expert conduct a custom hands-on training workshop for the Division Mockup application. The second was to have the staff participate in PTC's beta evaluation of the ProductView MCAD Professional 9.1 pre-release. However, when the beta application was released, they found that the application was missing all animation capabilities and it was of little value for their intended use.
- **ECAD Designers:** This team was asked to evaluate PTC's ECAD Workgroup Manager Suite tools to determine their value for Sandia applications. The suite includes the following individual applications: EDA Conduit, EDA Compare, PV Compare, and ECAD Workgroup Manager. The training solution was to develop a custom hands-on training workshop led by a PTC subject matter expert. The workshop focus included basic capabilities as well as integration of the application with PDMLink.
- **Mathcad Evaluators:** This team was tasked to do a limited evaluation of PTC's Mathcad application. Team members either had experience using Mathcad, or if they didn't, they felt confident they could learn it adequately using the application tutorial and "Help" feature. To

bring the users up to speed on the current Mathcad release, the solution was to host two PTC demonstrations of Mathcad.

4.2 PDMLink Training

The delivery of effective training classes for PTC's products is a high priority for the Sandia CAD departments. Previous training efforts have included on-site and off-site PTC instructor-led courses, online courses using PTC University (PTCU), and internally developed courses led by Sandia subject matter experts (SMEs). Each of these training methods has benefits and shortcomings. One of the objectives for the AEE project was to design an effective delivery method for PDMLink training for Sandia designers and engineers. Sandia will be moving to a production Windchill 9.0 system in the near future and this will require the training of 120 to 150 users.

Sandia currently uses a three-step process for providing Windchill 8 training for CAD designers at Sandia:

1. Students must complete three web-based PTC University classes:
 - a. Windchill PDMLink 8.0 – Application Orientation
 - b. Windchill PDMLink 8.0 – CAD Data Management
 - c. Windchill ProjectLink 8.0 and Windchill PDMLink 8.0 Collaboration
2. A 2-day instructor-led hands-on course developed and taught by Sandia SMEs.
3. Follow-up mentoring by a Sandia SME (approximately 4 hours per person).

In preparation for the Windchill 9.0 roll-out, the AEE Team wanted to improve upon the existing training. They asked the PTC training consultant to assist by providing an assessment of the existing Sandia PDMLink data management training that was developed internally for Windchill 8.0. PTC's training approach uses a three step "tell me", "show me", "let me" approach. The consultant felt the Sandia content is missing the "tell me" step in which the focus is to provide basic information to the student prior to the "show me" step, which uses demonstrations, and the "let me" step, which uses hands-on exercises.

In general, PTC prefers to provide training using their instructors, with their content, at their facilities. While this approach may prove effective for other organizations, Sandia's CAD training coordinators have found that the absence of specific Sandia and NWC business practices in the content significantly reduces the effectiveness of the training. They also found it beneficial to use internal instructors who can also act as mentors after the initial training classes are completed.

The AEE Team provided the PTC training consultant with the following "ideal" requirements for the PDMLink training:

- Content should reflect Sandia business practices and processes so that students learn the tools in the context of how they will be used in their day to day work. Examples are naming conventions, lifecycles, roles and the release process.
- Content should use real Sandia models, not generic PTC models, such as a golf cart or tractor.
- Training should be on a real Sandia system, rather than a VMWare image that doesn't fully represent a working system.

- Sandia would like PTC to “train the trainer” so that Sandia SMEs can provide training to staff as needed.
- Sandia must own the training content so that it can be delivered as needed by Sandia SMEs.
- Provide a take-away document for the student, such as a quick reference guide.

The PTC consultant presented the AEE Team a range of options for the training environment, the training content, and the instructor, as shown in Figure 4.2.1.

After considering the pros and cons of the various options, The AEE Team agreed to the consultant’s recommendations:

- A dedicated Sandia/CA server for the PDMLink training.
- Custom training developed by PTC to incorporate some of their training course content along with newly developed Sandia-specific content.
- Instructor led classes with a PTC education specialist.

However, when the details for putting this plan in motion were discussed, the PTC training consultant informed the AEE Team that PTC treats its training content as intellectual property, and it would not be made available to the Sandia SMEs for their internal training sessions. It would only be available for classes taught by PTC instructors, or through web-based PTCU courses. The AEE Team felt this was not an approach they wanted to pursue, as it did not meet their requirements.

As an alternative, the AEE Team took the following approach for PDMLink training:

- The Sandia/CA and Sandia/NM CAD SMEs worked with PTC to develop a configured introductory course using content from PTC’s existing Windchill 9.0 courses. This is a modular web-based PTCU class that Sandia students will take as a precursor to an internally developed customized Windchill 9.0 course. The AEE Team reviewed the content for two PTC PDMLink courses and selected the training modules and exercises that best represent how Sandia designers will work with PDMLink. The PTC consultants configured the course content and added the new “Sandia National Labs Introduction to PDMLink 9.0 and CAD Data Management” class to the web-based PTCU course offerings. The PTCU course has six required modules and six optional modules the student can complete or opt out of at their discretion.
- The Sandia CAD SMEs developed a customized Windchill 9.0 course based on the materials that were that previously developed for their internal Windchill 8.0 training courses. They will conduct internal training classes in the future when Sandia rolls out a Windchill 9.0 production system. Ideally, an experienced PTC SME will participate in those training sessions to assist with answering students’ technical questions.

The customized PDMLink course “A Designer’s Overview of Windchill PDMLink 9.0” is based on materials gathered from both Sandia/NM and KCP. The course development is based on the structure of a custom Windchill 8.0 course that was developed by Sandia/NM and LANL. Content was updated with new Windchill 9.0 screen shots to illustrate how information is accessed and presented in the Windchill 9.0 environment. By using custom screen shots, the students can see Windchill functions in the context of how they will apply it to their work. The course also includes a series of training exercises that are specific to NWC business practices.

Training Environment Options	Pros	Cons
1. PTC standard VMWare image.	Image already exists, saving time and effort. Portable and not reliant on network access. Easy to recover from mistakes by returning to earlier snapshot.	Sandia cannot use the content for internal training courses, all training must be delivered by PTC.
2. Sandia unique VMWare image.	Sandia retains ownership of the training content. Portable and not reliant on network access. Easy to recover from mistakes by returning to earlier snapshot.	Time and money required to build the unique VMWare image. Sandia would have to purchase licenses for the software used for the image.
3. Use an existing Sandia/NM PDMLink server.	Using the actual system allows immediate familiarity for students after training.	No flexibility for training needs. The system is limited because it is used for other purposes as well.
4. Install a dedicated training server at Sandia/CA.	Flexible for training needs. Can be configured independent of development or production systems. Allows training prior to conversion of the PDMLink 8.0 servers to PDMLink 9.0.	Time and effort required to install Windchill 9.0 on new server. System administration and maintenance costs.
Training Content Options	Pros	Cons
1. PTC standard training.	Course was developed to quality standards and learning practices and improved over time.	Course content is not Sandia-specific.
2. PTC customized training.	Incorporates Sandia standards and business practices. Facilitates re-use by other NWC sites with modest updates. Maintains quality standards and learning practices.	Development costs.
3. PTC revises Sandia's existing Windchill 8.0 training materials.	Incorporates Sandia standards and business practices.	Development and revision costs. Relies on text and verbal instructions.
Instructor Options	Pros	Cons
1. PTC education specialist.	Professionally trained instructor who is familiar with PTC content and the course flow.	Unfamiliar with Sandia content.
2. Sandia SME instructor.	Familiar with Sandia processes.	Not a full-time instructor.

Figure 4.2.1 Training options table.

4.3 Pro/Engineer Wildfire 4 Update Class

Sandia's current production CAD application is Pro/Engineer Wildfire 2. Wildfire 4 is being used on a limited basis by developers in the CAD departments, and it was required for this project, as Windchill 9.0 does not integrate with Wildfire 2. All of the work with the B83 check print process therefore required the AEE and B83 Teams to work with Wildfire 4. An NWC-wide transition from Wildfire 2 to Wildfire 4 will also occur in the near future as the NWC moves from Windchill 8.0 to Windchill 9.0. The incompatibility between Wildfire 2 and Windchill 9.0 requires this transition.

4.3.1 Course Design

To provide training for the B83 designers, and to help facilitate the Sandia and NWC transition from Wildfire 2 to Wildfire 4, the AEE Team worked with a PTC learning consultant to create a Sandia-specific instructor-led Wildfire 4 course. The Team reviewed the course content for PTC's existing 8-hour Wildfire 4 training class and determined that a shortened course would be preferred for Sandia designers. A full-day course is always difficult to schedule for a large number of students, and the AEE Team felt that the full PTC course was more than was needed for experienced Wildfire 2 users. In addition, the full course is available through PTC University if any designer wants to see the full content.

The AEE Team designed the course by removing topics on features that are not needed or used at Sandia and by eliminating exercises that seemed too fundamental. The new course was mainly lecture and demonstrations that focused on the significant differences between the old and new versions of Wildfire. This course was posted in PTC University and is now available to Sandia designers on-demand. The course title is "Wildfire 2 to Wildfire 4 Update".

4.3.2 Course Delivery

A total of five classes were conducted, two at Sandia/CA and three at Sandia/NM. PTC's Mike Smith instructed the course at Sandia/CA. He used the configured course text to introduce Wildfire 4 topics, followed by live demonstrations of the new features. Students were encouraged to perform learning exercises at their workstations. Mike's teaching approach prompted students to ask in-depth questions about the new features. An added benefit was that students learned from Mike's efficient working techniques as they watched his demonstrations.

While some of the Sandia/CA designers believed that the instructor's breadth of knowledge was lacking, many felt that the course provided them with the right amount of information in the least amount of time. Because the hands-on-exercises were few and optional, less experienced students did not feel intimidated and were more inclined to attend the class. The general consensus among students was that the four hour class allowed sufficient time for the instructor to present and demonstrate all of the significant functional changes from Wildfire 2 to 4, and there was plenty of time for student questions.

PTC's Derek Oliviera instructed the three courses at Sandia/NM. While the majority of the students enjoyed the course and appreciated the shortened length, they were disappointed by the lack of time for hands-on exercises. The training manual that accompanied the course was appreciated and will be a good addition to the Sandia training process. The NM CAD organization managers felt that with the absence of the hands-on exercises, the course did not address all levels of Pro/Engineer users. Many students were also disappointed that the content for the course was that same, although condensed, as that in the PTCU course.

4.4 Lessons Learned

The lesson learned with the training effort was that PTC's intellectual property rules prevent Sandia from using PTC training content for internally taught courses. While this is perhaps understandable, it frustrated the Team for two reasons:

1. Sandia and PTC are "strategic partners", and as such, the AEE Team expected more flexibility from PTC.
2. The AEE Team spent considerable time working with a PTC learning consultant to plan the development of a custom PDMLink training course to meet the Team's stated requirements. However, they were not made aware of the PTC training content restriction until late in the process. Had they known at the start of the planning, they would not have pursued the custom training solution, which they ultimately had to abandon.

Although the AEE Team included a Sandia/NM CAD SME in all training discussions and decisions, they could have done a better job of collaborating with other Sandia/NM CAD organizations. In particular, more discussion for the content and delivery of the Wildfire 4 update course would have been appreciated by the NM managers. Some were not happy with the limited amount of "hands on training" and exercises in the course.

With regard to the Wildfire 4 update course, the majority of Sandia/CA students generally preferred this Sandia-specific configured course compared to the generic PTC OOTB course. For improvement, the lab exercises would benefit from more screen shots to support the concepts.

5

Integration of the Windchill 9.0 Tools for the B83 Project

5.1 Overview

A primary goal for this project was to demonstrate the integration of PTC's design and collaboration tools for NWC applications. To achieve this goal, the AEE Team partnered with the Sandia/CA B83 weapons project team to exercise and evaluate the Windchill 9.0 tools. The AEE Team and their PTC consultants worked with B83 engineers to develop a new "electronic check print" work process that uses PDMLink and ProductView to facilitate collaborative in-process design iterations between project participants from their desktops. The AEE Team developed and demonstrated the new process for the B83 Team. Based on their positive response for the new process, the AEE Team provided a hands-on training workshop for B83 designers and engineers to help them begin using the tools. The B83 Team employed the tools and provided evaluation input for this report. The AEE Team concluded this work by providing demonstrations of the new tools and process to weapons project managers and engineers at both the CA and NM sites.

5.2 Current B83 Workflow Process

The current B83 MCAD work flow process for creating or revising design definition information for the purposes of creating a check print for engineering review is referred to as a check print process. For this project, the focus is specifically on the revision of existing drawings and models, and work in progress design iterations primarily involving designers and engineers. The same tools can also be used for the generation and review of a new design definition.

The current B83 check print process consists of the following steps:

1. The system engineer, component engineer, pertinent stakeholders, and the designer meet to discuss a new part or an alteration to an existing part.
2. The designer checks the model out of the product data management system (PDM).
3. The designer changes the drawing or model.
4. The designer and engineers meet to review the revised drawing or model.
5. The designer incorporates the changes into the model and regenerates the drawings.
6. The review and update process cycle is repeated until the engineers sign-off on a final version.
7. The designer checks the revised model and drawing back into the PDM and releases it.

The B83 check print process is fairly informal, which leads to a number of issues:

- Not everyone is informed when changes are made to a drawing or model.
- Multiple iterations of a drawing or model may be circulating among project members, who may not be working from the most current version.

- There is no formal notification process for changes.
- The process typically consists of an engineer looking over the shoulder of a designer at his or her CAD workstation to communicate the design changes to the designer.
- The current process is time consuming and inefficient.

5.3 Electronic Check Print Process

PTC's Windchill 9.0 suite of tools offers an opportunity to develop an "electronic check print" process to benefit the B83 project team. The AEE team and PTC consultants worked with the B83 team to develop and demonstrate this new process. They began by asking the B83 engineers to describe the characteristics of an electronic check print process that would benefit their work. The B83 engineers provided the following "ideal" requirements:

- Project team members can access models and drawings through the Sandia networks from their desktop computers without the use of CAD software (Pro/Engineer).
- The engineer can rotate the model, view it in cross section, change the view angle, check dimensions and tolerances, and mark up desired changes with red line marks and text box annotations.
- The designer and engineer can simultaneously view a model or drawing at their respective desktops while communicating via telephone, instant messaging or e-mail.
- The change history can be documented and older drawing and model versions should remain accessible for roll-backs to previous versions.
- A material list can be generated from a drawing.
- Check prints are available as hard copy "C" size paper drawings.
- The engineer can "drill down" through an assembly to view lower level components by clicking on those components in the assembly drawing.

A PTC process architect worked with the AEE Team and B83 designers and engineers to define the current workflow and to develop the new electronic check print process using the following approach:

1. Define the current B83 work flow, match Windchill tools to the current work process, and develop a new process that will provide a solution for:
 - a. CAD data management
 - b. Change management within a work in progress state:
 - i. How to replicate the paper-based check-print process using models (collaboration between designer and engineer).
 - ii. How to baseline a model.
 - iii. Engineering changes.
 - iv. Data state changes.
 - c. Document management for Microsoft Word, PowerPoint and other project documents in PDMLink.
 - d. Collaboration among designers and engineers.
 - e. Notification and team management.
 - f. Visualization tools for users with little or no Pro/Engineer experience
2. Develop a demonstration of the new process and get buy-in from the B83 team.

3. Conduct a hands-on training workshop for the B83 team.
4. Provide follow-up mentoring for the B83 team as they began to work with the tools for project work.

Figure 5.3.1. represents the data flow in the new B83 electronic check print process the AEE Team and PTC consultant developed. The process includes not only designers and engineers, but system analysts and manufacturing staff as well. The AEE Team found through interviews with various B83 staff that these personnel needed to be included in the notification process as well.

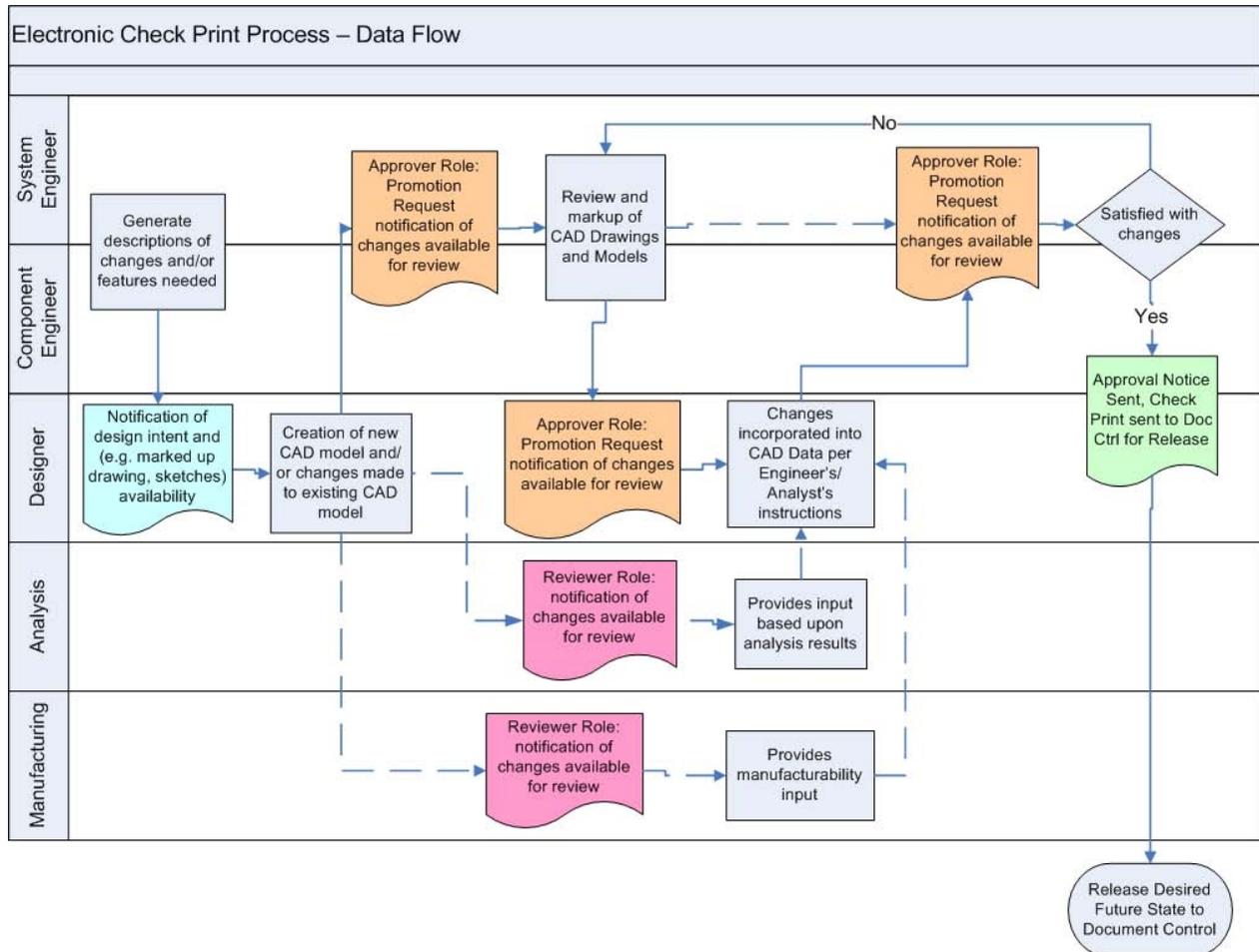


Figure 5.3.1 B83 electronic check print process data flow diagram.

The new electronic check print process provides the following benefits to the B83 Team:

- Team members can share information in a secure environment.
- Remote desktop collaboration between the designer and engineer.
- Engineers can view and mark up models and drawings without the use of Pro/Engineer.
- Everything associated with a model can be stored in the PDMLink repository; the model, the product definition, all associated required documents, project plans, presentations, etc.
- When a model is checked out of PDMLink it is “locked”; others can view it, but no one other than the person checking out the model can change it.

- E-mail notifications keep everyone current and will prevent multiple versions of models from circulating. The notification points to the current model version.
- Notifications for model and drawing changes will simplify the review and approval process. Designers will not have to chase after engineers or other reviewers for approvals, and vice versa.
- PDMLink can be configured to require all metadata on model check-in; the analysts need this data to perform their work.
- Designers can store a baseline to capture all associated files at a point in time in PDMLink. It will enable concurrent work by designers/engineers/analysts who typically want to benchmark a model so that they know what model the analysts have taken to use for their analyses.
- Analyst models can be linked to the master file by treating them as associated secondary content files, the same way Microsoft Word, Project and PowerPoint files are handled in Windchill.

The next step was to develop a demonstration by building a storyboard presentation from the process work flow. The intent of this presentation was to show users exactly what they would see at their workstation as they worked through the new process. This required the creation of a PowerPoint presentation with screen captures from one of the AEE servers. The unclassified system was used both for the screen captures and for the subsequent training workshop for obvious reasons of convenience.

The AEE Team had a clear vision on what the storyboard should contain. They felt it should display exactly what the B83 designers and engineers would see when they sat down to work on the B83 project at their desktops. By configuring the servers and capturing real screen shots, they would eliminate the distraction of generic screen shots for unrelated products. They also insisted on the inclusion of screen captures for every screen the users would see with the new electronic check print process. The reason for this approach was that the AEE Team wanted the B83 Team to see the process in its exact form and they knew that if the storyboard consisted of generic screen captures for unrelated products, there was a good chance that some of the engineers might not embrace the application.

Designer requests an approval from the Engineer using the PDMLink Promote function

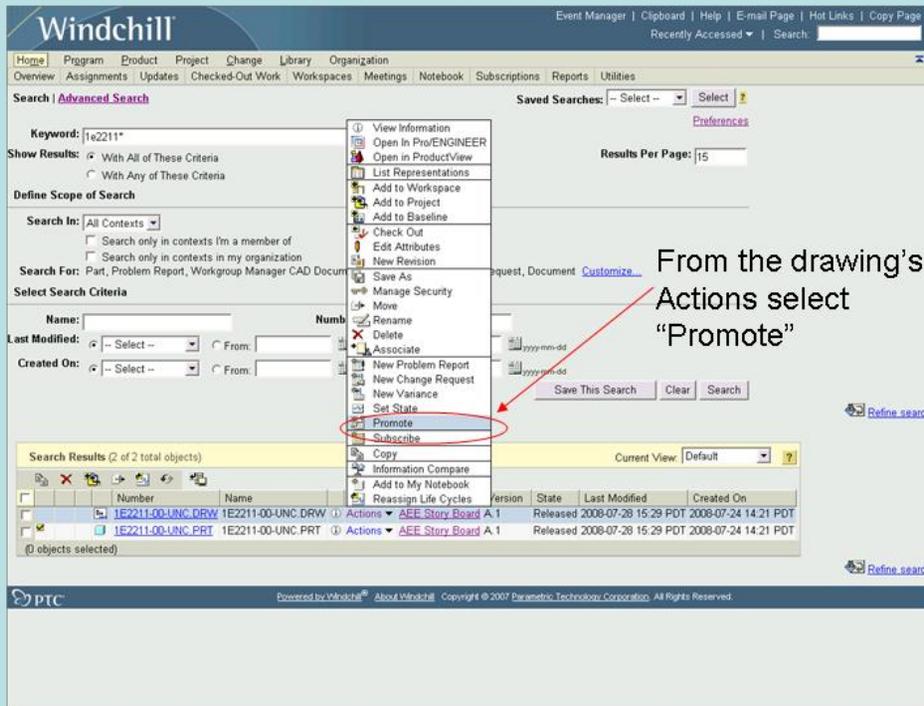


Figure 5.3.2 A B83 electronic check print process storyboard slide showing a step in the promotion request process.

The AEE Team presented the new process to the B83 Team before proceeding. Their response was very positive and they signed on to participate in a hands-on workshop.

5.4 B83 Training Workshop

The AEE Team and the PTC process architect conducted a hands-on training workshop for core B83 MCAD designers and engineers. The workshop's objective was to familiarize team members with the new process and give them enough practice so that they could begin to use the Windchill tools for their project work.

The B83 electronic check print process storyboard was the basis for the workshop. Participating designers and engineers were first shown the full process storyboard to re-familiarize them with the new process. They were then assigned their respective roles (designer, engineer) and were asked to log into the Windchill system to participate in a design iteration exercise from individual workstations. AEE team members walked them through the process step-by-step using the storyboard process presentation. Designers and engineers were paired up to walk through the following exercise:

- The designer checked out an existing drawing (version "A.1"), modified it and completed a promotion request to get approval from the engineer. The "in Work" promotion state

was selected for the promotion request. This is the equivalent of “work in progress” for Sandia’s workflow.

- The engineer opened the promotion request by clicking on a link in the notification e-mail that he received, which opened Windchill through his internet browser (Microsoft Explorer).
- The engineer viewed the drawing by opening it in ProductView Lite (which is imbedded in the browser, it is not a separate application that they had to open).
- The engineer added markup and annotations to the drawing using ProductView’s mark up and annotation tools.
- The engineer saved the markup drawing and then rejected the designer’s request for approval. This generated a rejection notification e-mail to the designer.
- The designer received the rejection notification and clicked on the link in the e-mail to open the drawing in PDMLink through his internet browser.
- The designer opened the engineer’s markup file and reviewed the engineer’s instructions.
- The designer then opened the drawing in Pro/E, made the changes requested by the engineer, and then submitted another request for approval which generated a new notification to the engineer.
- This iterative cycle is repeated until the engineer is ready to approve the design changes.
- When the final changes are made, the designer completes a new promotion request and selects “Released” as the promotion state.
- The engineer opens and reviews the new promotion request and submits an approval.
- The drawing is now released in PDMLink as a new version and will be listed as version “A.2”.

The response to the new B83 electronic check print process workshop was highly favorable from B83 team members. Their collective response was “When can we start using this tool?” Although the PTC consultants had considered the unclassified AEE servers to be ready to go with an OOTB configuration, the AEE Team felt the servers should be configured to better represent the Sandia work environment prior to launching the systems for B83 project work. These configurations are detailed in Chapter 3 of this report.

5.5 B83 Implementation and Evaluation of the Windchill 9.0 Tools

All of the initial AEE server installation and configuration work was performed on the three-tier unclassified server system. This system was ready for the B83 Team to use shortly after the completion of the B83 training workshop. The classified server system was not yet ready at this time due to security requirements that had not yet been completed. Although the B83 Team conducts the majority of their work on classified systems, the designers were eager to begin using the unclassified system. They knew they would need to migrate data from the unclassified system to the classified system once it was operational, but felt it was important to begin using the Windchill platform. This also gave the AEE Team an opportunity to work through additional configuration issues prior to the roll-out of the classified system.

The B83 designers began using the unclassified AEE system by migrating unclassified project parts and assemblies into the B83 product folder in PDMLink. The next step was to migrate Tiff files, Microsoft Word files and PDF files. These files contain the project standards and specifications. The AEE Team had decided to limit the library parts in PDMLink to only those

specifically needed for the B83 project. The B83 designers provided the AEE Team with a list of the required parts, which they migrated into newly created libraries. All library parts were set to the “Released” state in PDMLink. An “AEE Group” was created and populated with all B83 team members to provide them with access to the libraries.

5.5.1 Client Installations

No installation was required for the B83 Team to use Windchill 9.0 at their desktop machines. They can either log onto the Windchill server through a web browser, or they can click on the link in an E-mail notification and log in.

The ProductView Lite viewer had to be installed on each client machine, but this was a simple one time action that was prompted by the Windchill application the first time a user logged on. The application is loaded onto the client machine directly from the Windchill server and takes only a minute or two to complete.

5.5.2 Training/Mentoring for B83 Engineers

The three primary designers for the B83 project were fully involved throughout the development and roll-out of the new B83 electronic check print process. They championed the implementation of the new process and they have been and will continue to be instrumental in the success of the process. Because they typically handle all CAD data management activities, the project engineers are much less involved in the PDM system. Although the B83 hands-on workshop provided basic training for these engineers, the designers provided additional training through one-on-one mentoring with the project engineers to help them apply the new tools for their project work. One training method employed by the designers was to send e-mail notifications of mock design changes to the engineers to request them to review and approve the changes, which required the engineers to exercise the new process.

5.5.3 Classified AEE Server Implementation

The AEE Team configured Windchill 9.0 on the classified SCN server by duplicating the work that had been performed on the unclassified Windchill server. The first step was the creation of the AEE lifecycle. The next step was to create a template file from the existing B83 Product on the unclassified server to duplicate the folder structure, team members, object integration rules (OIRs) and access policies. The template file was exported as a zip file and transferred to the classified Windchill server where it was used to create a new product. Logon names for the B83 Team members were changed to reflect their classified network logon names.

5.5.4 Data Migration

The AEE Team worked with the B83 designers to develop a new method for migrating CAD files into PDMLink. The most common problem they faced in migrating assembly data into PDMLink was how to resolve the “same name already exists” error, which is generated when any component in the migrated assembly already exists in PDMLink. In Windchill 8.0 these files were identified with the “new and modified” status. They could be added to the workspace using the “Add to Workspace” function. Library part instances are particularly difficult to update with this method because a complete set of instances (often hundreds or thousands) appear in the workspace for each generic instance that is used in the assembly.

In Windchill 9.0, family table instances pose a problem. The “Reuse” function within the “Import to Workspace” function cannot be used to migrate these files.

The preferred technique the AEE Team employed utilizes Windchill 9.0's "Import to Workspace" function and Pro/Engineer's "Backup" command. The process begins by opening the assembly in a Pro/Engineer session with no connection to PDMLink. The assembly is backed up to a temporary folder and all of the "vl" generic files are deleted from the folder. The PDMLink server is then activated and the assembly to be added is selected using the "Import to Workspace" tool. This tool identifies all components that are already in PDMLink and references the missing "vl" components with placeholder objects. The "Reuse" function, which directs the use of the file in common space, is applied to these components and the placeholders. Completing the "Import to Workspace" function adds all new assembly component files, all copies of any referenced files already in common space, and any referenced instances and their generics to the workspace.

An alternate method for migrating files is to simply go to the directory where the file is stored, open the file, work on the file on the local hard drive, and once work is completed, check the file into PDMLink. This is only recommended for small files, or if problems are encountered using the previously described preferred method.

The B83 Team encountered a serious problem when migrating a CAD assembly that contained a family table instance library part. Once it was checked-in to PDMLink, the assembly could not be added to a workspace to be opened in Pro/Engineer. This error corrupted the workspace, preventing the opening of all other product CAD files. After lengthy investigation, the Team discovered that the library part (a fastener) was the cause of the problem. A feature's dimension in the part's family table used the same name as a PDMLink attribute (designated parameter). The name "Length" is used to represent a PDMLink parameter of data type "real". The feature dimension controlling the fastener's length is of the same data type. This problem was rectified by changing the name of the feature dimension to "dim_length". After this correction was applied, the CAD assembly could be added to the workspace and opened in Pro/Engineer. This problem was particularly difficult to diagnose because it was discovered only when the assembly was to be opened in Pro/Engineer; because other assembly files that contained other library instances did not exhibit the same behavior; because a new method of migrating data was tested on the same assembly; and because the problem was encountered soon after a major change to access policies was implemented.

5.5.5 Material Files

The B83 Team has a goal to fully populate CAD models with all related metadata to provide a fully detailed model. For their initial work using the AEE servers, the designers will populate PDMLink with 7-digit material files that are empty. They will later add the material values as they become available from material engineers. To achieve this, the material parameters must be accessible through PDMLink for updating. A PTC consultant suggested mapping the material parameter in the "Workgroup Manger CAD Document" (Under "EPM Document") using the "Type and Attribute Manager" tool under "Site/Utilities". The AEE Team tried this approach but the tool was disabled. Time constraints prevented the Team from resolving this issue. This is a significant issue that the B83 team would like to see resolved, and therefore, should be included in any future AEE project work.

5.6 B83 Team's Assessment of the Windchill Tools

As previously described, the B83 Team embraced the concept of the electronic check print process and the Windchill platform for the project design work. The designers moved forward with their use of the unclassified and classified Windchill servers as soon as they were available. As the project concluded, the B83 designers were in the process of moving many of their project files

onto the servers. Throughout the course of this evaluation, the B83 Team was limited to mock design exercises, as they had no active project design during this time period. The B83 team looks forward to exercising the new process on real design iterations in the near future.

5.6.1 Windchill Strengths

The B83 engineers and designers identified the following benefits for using the Windchill tools and the electronic check print process for B83 project work:

- All project data is stored with configuration management in a single repository. This includes not only the model and product definition, but all other associated and/or required documents, specifications, materials files, project plans, presentations, and other “soft” documents.
- Team members can share information in a secure environment and have ready access to all project information in real-time with just a few mouse clicks.
- Remote desktop collaboration between the designer and engineer increases the efficiency of in-process design work. Notifications for design changes will simplify the review and approval process. Designers will not have to chase after engineers for approvals.
- Engineers can view and mark up models and drawings without the use of the Pro/Engineer CAD application.
- All design markups are retained and they provide a record of why designs were changed. In addition, the engineers can add comments with further detail. This addresses a significant problem with the current process, in that engineers may have a difficult time determining why previous design changes were made. Typically, documentation for past design changes was stored separately from the design documents, and can be difficult to locate.
- E-mail notifications keep everyone current and will prevent multiple versions of models from circulating. The notification points to the current model version.
- Designers can quickly and easily check-in a drawing or model to provide immediate access to the file for other project members.
- Windchill provides 100% traceability for files, regardless of the file state. This eliminates the possibility of file overwrite, which has been a significant problem with the current process. As an example, if a drawing was released, and it contained unreleased parts (not in a locked state), any future changes to a part file overwrites the file without the creation of a new revision.
- Change control is documented through every step of the design process. Team members can see how a design has evolved over time.
- Designers no longer have to track files on their local PC once they are checked-in to PDMLink. Previously, designers might have many revisions stored locally on their hard drive. Alternately, a single file would be stored on a shared folder, which is risky, as anyone can modify or delete files within the folder.
- Because Windchill is web-based and requires no client application, access is not restricted to specific machines.
- Windchill enables updates “on-the-fly”, allowing designers to make temporary changes on individual parts.
- Users can view and edit parameter values in Windchill without having to open the part, assembly or drawing file.
- A lifecycle can be applied to all documents in Windchill, and they can all be versioned.

- When a file is opened in Windchill, all dependent files (located in Windchill) are automatically pulled-up. With the current E-Matrix system, the designer has to check-out all of the dependent files.
- The Windchill user interface actively notifies the user when changes are made to a file in the workspace. With the current E-Matrix system, this happens only on file uploads and check-in.

5.6.2 Recommendations for Improvement

The B83 engineers and designers recommend the following improvements to the Windchill tools:

- The Windchill PDMLink search capability is too specific. Users would like the ability to start with a global search and then refine the search parameters from there. For example, entering the Sandia six digit file number as the search query should bring up every file type with that number. The PDMLink search is limited to a single file type.
- Designers want to be able to quickly revert to their last workspace. When they select the “Workspace” pull-down menu, they have to go through extra steps to get back to the last workspace.
- When importing a Pro/Engineer file, Windchill brings every referenced file into PDMLink as well. Designers would like to restrict the import to only external references, not every parent/child reference. For example, when a designer is working on a small subassembly with 10 or 20 parts, they may not want the entire 500 part full model imported.
- Designers would like the ability to change the revision designation for a new WIP file. At present, once a file is checked into Windchill, it has to be re-versioned to change the revision designation. If designers could change the revision designation for a new WIP file, it would help them “clean up” legacy data that has been migrated into Windchill.
- Material files need to be easy to store, access and update to facilitate changes to their parameters after they have been loaded in PDMLink.

5.6.3 Next Steps

The B83 Team intends to use Windchill for their project design activities from this point forward. The designers are already fully engaged with the Windchill application and they do not want to revert to their previous process. When the B83 Team initiates its next design modification cycle, designers and engineers will use the Windchill electronic check print process for remote collaboration throughout the design update process.

The B83 designers are migrating project data to the unclassified and classified Windchill servers. As they check-in files, they are also loading all available metadata to achieve their goal of having fully defined models. This includes assigning the right materials and adding all model-based tolerances, which will benefit the B83 analysts.

To achieve a true Advanced Engineering Environment, interagency collaboration between the NNSA, the Production Agencies and the Design Agencies must be established. A logical next step is to pilot the extension of the Windchill environment to enable data sharing among agencies.

The B83 Team’s new design and engineering process can be a flagship example of process improvement for other project teams within Sandia and throughout the NWC. Demonstrations of the new tools and process should be provided to project partners and other interested groups.

6

ECAD Tools Evaluation

6.1 Overview

The AEE Team's main objective for the ECAD tools evaluation was to determine what value might be added to Design Agency (DA) processes with the use of PTC's ECAD Workgroup Manager Suite of tools in the following areas:

- ECAD designer/ECAD engineer/MCAD designer collaboration (review, interrogation, markup, etc.).
- ECAD change management within a "work in progress" (WIP) state.
- ECAD data management including post-release access to ECAD manufacturing files from the Windchill data repository.

Although the primary focus of the evaluation was process-specific for a DA, evaluators were also cognizant of the larger Design Agency/Production Agency (PA) relationship. Therefore, opportunities for adding value at this higher level were also discussed. Because Sandia's strategic PA partner, Kansas City Plant (KCP), would be conducting similar evaluations of the ECAD Workgroup Manager Suite, the AEE Team worked with staff at KCP to avoid duplication of effort. They knew that some overlaps in activities would still occur due to differing site business practices.

The process for the ECAD Workgroup Manager Suite evaluation was as follows:

1. Determine the compatibility between ECAD Workgroup Manager Suite and Mentor Graphics Expedition.
2. Exercise and evaluate each tool supplied with the ECAD Workgroup Manager Suite.
3. Compare the ECAD Workgroup Manager Suite tool capabilities to those available in the Mentor Graphics Expedition design tool, Sandia's current standard ECAD application, to determine the strengths and weaknesses of each.
4. Evaluate the ECAD Workgroup Manager Suite applications and their integration with PDMLink for ECAD data collaboration and management.
5. Develop a new ECAD review workflow process using Windchill 9.0 and the ECAD Workgroup Manager Suite.
6. Provide a demonstration of the new process to select members of the B83 Team, ECAD engineering customers and ECAD designers.
7. Obtain feedback from the demonstration audience to determine the perceived strengths and weaknesses of the tools particular to their disciplines.

6.2 Windchill ECAD Workgroup Manager Suite

Sandia's current standard ECAD design application is Mentor Graphics Expedition. PTC's ECAD Workgroup Manager Suite allows users to view, review, mark up, and run comparisons on Mentor Graphics ECAD files independent of the Mentor Graphics application. This capability allows engineers to review ECAD designs that were created with Mentor Graphics, even if they have no working knowledge with that application.

Because the ECAD Workgroup Manager Suite is integrated with the Windchill 9.0 application, it provides the ability to establish a collaborative design process for ECAD. Files can be managed within the PDMLink application and features such as automated e-mail notification for design changes can be used to facilitate concurrent engineering.

The ECAD Workgroup Manager Suite consists of several individual software tools:

- **EDA Conduit 2.1:** This application translates the native Mentor Graphics design file into the viewable “.eda” common file format, which is required by the other tools in the suite. This application may be launched manually in stand-alone mode, it can be invoked from within the Mentor Graphics schematic capture application (Design Capture or DxDesigner), or it can be launched automatically through the Windchill ECAD Workgroup Manager application.
- **EDA Expert 5.3 M20:** This application is used to view, review and interrogate the viewable “.eda” files. This file can be accessed through a web browser, which enables multiple reviewers to generate markups and perform informal, “light” overlay comparisons without launching the Mentor Graphics application. This tool may be launched as a stand-alone application, or through the Windchill application.
- **PV Compare 9:** This software utilizes the “.eda” files for formalized, “heavy” comparisons of two different revisions of a design. It allows refinement of comparison criteria and provides detailed descriptions of the differences of the compared designs. These differences can be exported to a report for formalized documentation. The current version of PV Compare 9 can only be used as a stand-alone application. Future releases will be integrated with the Windchill application.
- **ECAD Workgroup Manager:** This application resides in Windchill 9.0 and provides precise configuration control for native ECAD data. It can be used to generate an electronic bill of material (EBOM) from the schematic data, and it can be used to partition manufacturing files into intuitive “bundles” to facilitate file extraction for downstream processes.

PTC refers to the first three tools in the ECAD Workgroup Manager Suite as “Intercomm” tools because of their lineage. They were originally developed and given the “Intercomm” tag by OHIO Design Automation, Inc., which was acquired by PTC on April 8, 2004. PTC continues to use the “Intercomm” terminology for these three tools in its sales brochures and web pages.

Actual Sandia ECAD design test cases were used in the evaluation of the PTC ECAD tools. The designs were created using the following Mentor Graphics flows:

- Mentor Graphics Design Capture/Expedition flow 2005.3 (SNL/CA flat design).
- Mentor Graphics DxDesigner/Expedition flow 2005.3 (SNL/NM hierarchical design).

6.3 ECAD Hands-On Workshop

PTC subject matter experts conducted a four-day ECAD Workgroup Manager Suite workshop for the AEE Team. The workshop was intended as an avenue for “training the trainers.” Participants were expected to become familiar enough with the tools to begin a deeper evaluation within the Sandia design environment and to be able to convey tool capabilities via demonstrations to engineering customers, management and other designers. Administrators loaded the OOTB EDA Conduit, EDA Expert and PV Compare applications prior to the workshop.

6.3.1 ECAD Workgroup Manager Installation, Verification and Configuration

The agenda for workshop days one and two focused on the installation and verification of the ECAD Workgroup Manager application on the unclassified AEE Windchill 9.0 development server. Administrators were led through installation and system level configuration procedures for PTC’s ECAD Workgroup Manager.

Additional administrative configuration was performed on the OOTB product to align it with Sandia’s ECAD file structure and file types. This included recognition of the various EDA Conduit support files that are not automatically loaded on install but are required for recognition of the various design file types (Design Capture versus DxDesigner, etc.).

6.3.2 Tool Capabilities

The agenda for workshop day three was to use a structured hands-on approach to familiarize select ECAD designers from SNL/CA and SNL/NM with the ECAD Workgroup Manager Suite tools. Topics included the configuration of the tools for Sandia-specific applications and the capabilities of the tool suite, such as compare/verify, markup, automated workflow notifications, etc.

6.3.3 ECAD Process Gap Determination and Process Discussions

Workshop day four was reserved for unstructured ad hoc discussion specific to Sandia processes. Designers compared the tool capabilities against current SNL/CA and SNL/NM ECAD processes to determine gaps. They identified areas where the ECAD Workgroup Manager Suite tools might be useful, and they looked at modifying Sandia processes where possible to accommodate tool functionality, if sufficient value would be added.

6.4 Current ECAD Processes

The AEE Team identified two Sandia processes where the ECAD Workgroup Manager Suite applications could have a significant positive impact:

1. ECAD design review, both local and inter-site.
2. Access to released data for easily and intuitively obtaining ECAD manufacturing files while maintaining need-to-know (NTK) protections.

ECAD designs, unlike their MCAD counterparts, are defined by several elements, not just a single model. Each of these elements has its own idiosyncrasies when it comes to review methodology:

- **Schematic Diagram:** The schematic diagram is a symbolic representation of the electrical connectivity of a printed wiring assembly (PWA). It has no physical correlation with the PWA layout. The schematic displays all electrical components, their part numbers and values, and their interconnections. Information electronically extracted from the schematic provides the “intelligence” that drives the PWA layout and populates the bill of

material (BOM). Schematic diagram review is fairly straightforward, as the schematic, in conjunction with BOM, provides pretty much everything needed in a 2D drawing format.

- **Printed Wiring Assembly Layout:** The PWA layout is the actual physical design. Importing the “intelligence” from the schematic, designers place components within the physical board outline and multiple layers of circuitry are routed to provide the interconnections between the pins of the placed components. PWA designs do not lend themselves well to drawing reviews. Little of the design itself is defined on a dimensioned drawing, and none of the internal circuitry is shown on the drawing. The designer can generate prints of the different circuit levels of the design for their customer, but these can be cumbersome to generate and are difficult to work with, especially for boards with 8 or more layers. There is also no easy way to “find” or trace a critical net on such a printout.
- **Manufacturing Files:** These files are extracted from the PWA layout and are used by fabricators and assemblers to build the bare board and to load components into the bare board. It is not uncommon to have 20 or more such files. Artwork files for each circuitry layer help “fill in the gaps” that the dimensioned drawings do not cover. These files can be converted to PDF and printed out in hardcopy as part of a review package.

6.4.1 Review of Designs Maintained by the Design Agency

The current SNL/CA ECAD review process for the designs maintained by SNL/CA consists of the following steps:

1. The electrical engineer and designer meet to discuss an alteration to an existing part.
2. The designer checks the model out of the product data management system (PDM).
3. The designer changes the schematic and provides a check print to the engineer, either in PDF, TIFF, or paper plot format.
4. The engineer reviews the revised schematic and provides suggestions or changes via a marked up PDF, TIFF, or paper plot.
5. The designer incorporates the changes into the schematic.
6. The review and update process cycle is repeated until the engineer is satisfied with the schematic.
7. The designer forward annotates the intelligence from the schematic into the layout tool and creates the physical printed wiring assembly layout.
8. The designer generates a review “package”, normally a combination of paper plots and electronic files in PDF or TIFF form. The actual content of the “package” is determined by the level of review the engineer wants.
9. The engineer reviews the package.
10. For critical areas, the engineer will sit with the designer at his or her workstation with the design displayed in the native Mentor Graphics software. The two will then act as driver and navigator, interrogating the native design, highlighting critical circuit paths, measuring critical clearances, turning circuitry layers on and off for clarity, until the engineer is satisfied all requirements are satisfactorily met.
11. The designer finalizes all drawings.
12. The designer performs an internal SNL/CA process that generates Interoperability Data Interface (IDI) files for each graphic drawing. These IDI files are used by SNL/CA to automate the upload of drawing graphics into the Image Management System (IMS), Sandia’s long-term electronic drawing image storage area.

13. The designer “zips up” the design file structure into a single compressed file.

14. The designer checks the compressed file into the PDM and releases it.

As depicted above, the ECAD review process is fairly informal, but there are some controls in place because only one design “model” exists, and the ECAD designer “owns” and controls that model until PDM release. Also, there is normally a one-to-one relationship between the designer and engineer. Board layout is not usually a multi-engineer “team” activity.

The current ECAD review process has a number of shortcomings:

1. An MCAD designer who is using a Pro/Engineer representation of the PWA may not be informed when changes are made that affect form and fit.
2. There is no formal notification process for announcing or capturing design changes.
3. To insure a thorough review of an ECAD design, the engineer must look over the shoulder of a designer at his or her CAD workstation to interrogate the various layers of the native Mentor Graphics design and to communicate design changes to the designer.

6.4.2 Review of Designs after Transfer of Maintenance to the Production Agency

Once a design has been transferred to the PA, the DA must obtain an “information copy” of the entire design to fully evaluate any future proposed design changes. Again, interrogation would require the designer and customer to work in tandem using the native Mentor Graphics design software.

6.4.3 Accessing Released Data

There are two PWA manufacturing steps that require manufacturing file retrieval from the PDM. Each of these steps requires a different set of manufacturing files, and each step is performed by a different outside vendor:

1. The fabrication of a bare printed wiring board (PWB) with no components loaded. This step requires circuitry artwork, drill and contour files.
2. The assembly of the electrical components into the fabricated PWB. This step requires component placement and orientation files for automated placement of the parts onto the PWB.

Although these manufacturing files are well-partitioned within the Mentor Graphics design directory structure, the current method for ECAD design release into the PDM is to save all ECAD files as a single compressed (“zipped”) file. To obtain the manufacturing files, a copy of the entire design file must be downloaded from the PDM to extract the individual PWB and PWA manufacturing file partitions. This can be problematic for Official Use Only or classified designs, where the fabrication team does not have a need-to-know assembly data, and the assembly team does not have a need-to-know fabrication data.

6.5 New Windchill 9.0 ECAD Design Review Process Description and Presentation

A PTC process architect worked with the AEE Team’s ECAD designers to define the current Sandia ECAD workflow and to develop a new electronic ECAD design review process using the following approach:

1. Define the current design review work flow.

2. Develop a new review process using the Windchill 9.0 tools to provide the following solutions:
 - a. Replication of the current paper-based check-print process using viewable design files that are not tied to the native design software.
 - b. Intuitive visualization tools that allow users to fully interrogate a design with minimal training.
 - c. Design markup and other collaboration between ECAD and MCAD designers and engineers.
 - d. E-mail notification for design changes and promotion requests.
3. Develop and conduct a demonstration of the new process for ECAD designers, engineering customers and select members of the B83 Project Team.
4. Get feedback from the ECAD designers, engineering customers and B83 Team to determine if these tools and the new workflow process add significant value.

6.5.1 Current ECAD Workflow

PTC consultants worked with the AEE Team's ECAD designers to examine the existing design review process and to develop the following "ideal" requirements for the new process:

- Design information can be easily accessed through the Sandia network from an engineer's workstation without the use of the native Mentor Graphics software.
- The engineer can fully interrogate designs to obtain trace widths, clearances, signal names, component part numbers, or any other data critical to form, fit or function.
- The engineer can electronically mark up a viewable file, pass that markup to the designer for incorporation, and have the ability to retrieve historical markups.
- The designer and engineer can simultaneously view a schematic and/or layout at their respective desktops while communicating via telephone, instant messaging or e-mail.
- The change history can be tracked and older design versions should remain accessible for intelligent comparison.
- A material list can be generated from a schematic.

6.5.2 New Process Definition

Based on the outcome of the ECAD tools workshop, participants and the PTC process architect negotiated a proposal for a new ECAD design review process using the ECAD Workgroup Manager Suite. The overall process is shown in Figure 6.5.2.1. with optional review steps noted in orange boxes.

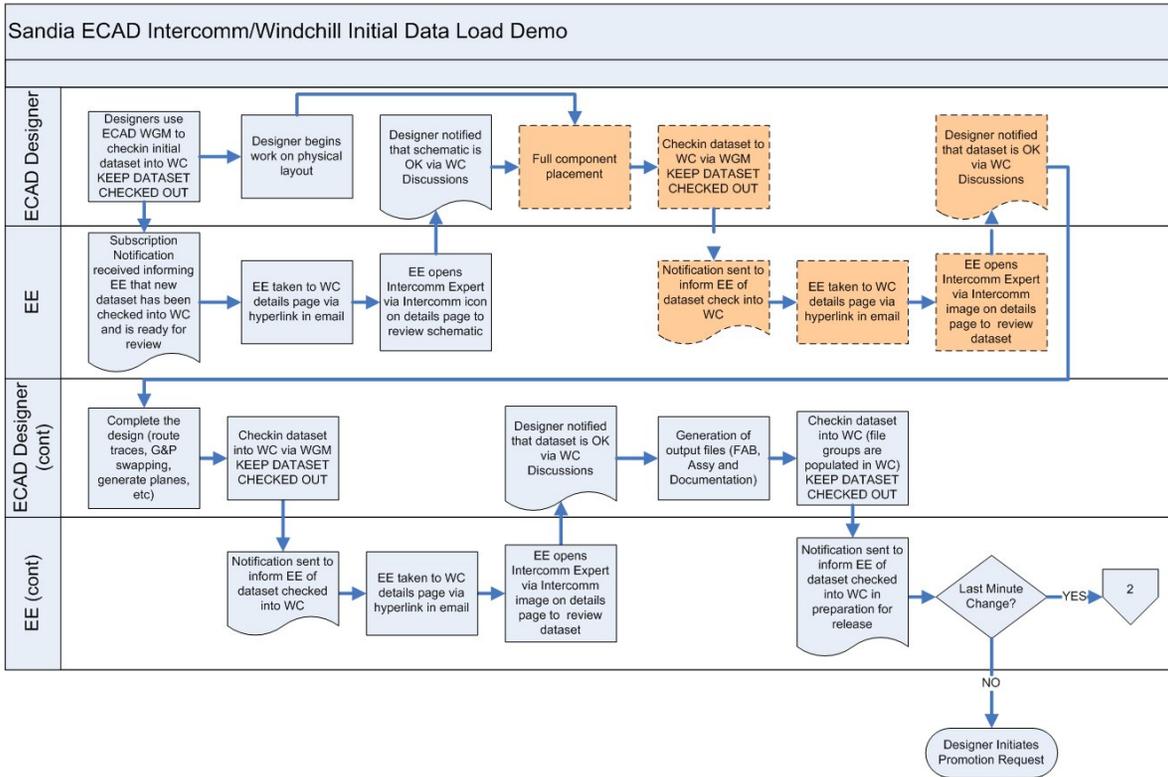


Figure 6.5.2.1 New ECAD design review process workflow.

From the process diagram, one can see that each review step in the process is fairly consistent. To avoid unnecessary repetitive actions during the workshop, a compressed process was demonstrated, as shown in Figure 6.5.2.2. This compressed process, which begins at the indicated “1” icon, was sufficient to adequately showcase the new process and the ECAD Workgroup Manager Suite tool capabilities.

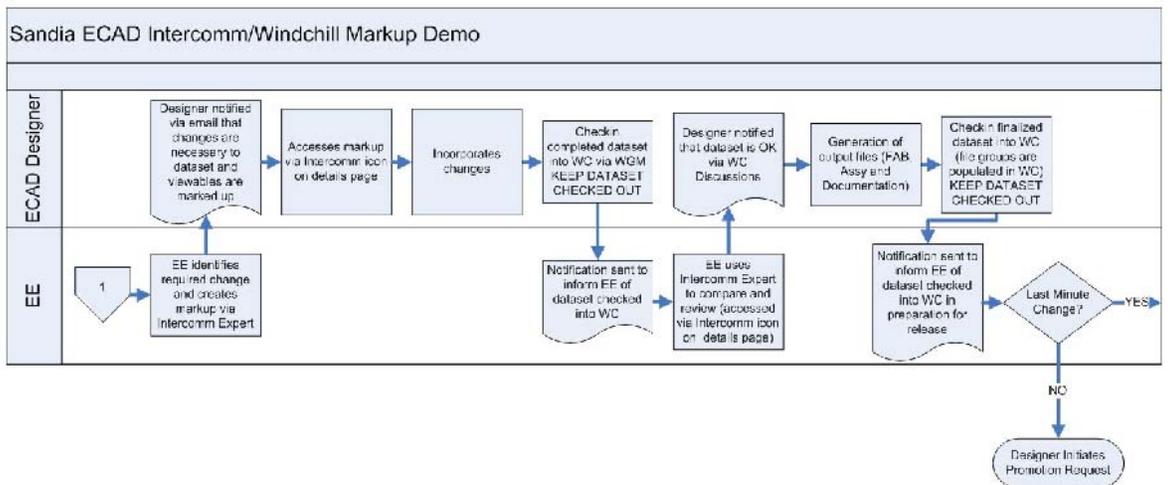


Figure 6.5.2.2 Compressed ECAD design review process for the workshop demonstration.

The new process provides the following benefits to ECAD design reviewers:

- Team members can share information in a secure environment.
- Remote desktop collaboration between the designer and engineer is provided.
- Engineers can view, interrogate, mark up and perform overlay comparisons of schematics and layouts without the use of Mentor Graphics tools.
- When a design is checked out of the PDM it can be locked, allowing others to view the design, but preventing anyone from changing it.
- E-mail notifications of schematic and layout changes to team members will simplify the review and approval process. A direct link to the viewable file is contained in the e-mail, providing the reviewer with “one click” access to the design information

6.5.3 New Process Demonstration

Shortly after the completion of the ECAD workshop, the AEE Team’s lead ECAD designer and the PTC process architect provided a detailed demonstration of the new design review process to several B83 team members, engineering customers and ECAD designers. The demonstration included the following actions:

- A designer used the ECAD Workgroup Manager application to check-in an ECAD design, which was listed as version “A.0”. The viewable “.eda” files were automatically generated upon file check-in.
- The ECAD designer inserted URL links for the Windchill schematic and layout viewable files into an e-mail and sent it to an engineer to notify him that the schematic and layout were ready for final review.
- The engineer clicked on the links in the notification e-mail, which opened the Windchill 9.0 application using his internet browser (Microsoft Explorer). The link took the engineer directly to the page where the schematic viewable icon resided.
- The engineer clicked on the schematic viewable icon, which opened up the viewable file in the EDA Expert application. The engineer performed the following functions within the schematic viewable file using the EDA Expert tool:
 - Used the markup capabilities to add comments to identify two signals as having high current carrying requirements that dictated a 0.050” trace width on the layout side, and to delete an erroneous extra schematic sheet.
 - Entered a comment to request the addition of a resistor. The engineer entered this comment as a link to the resistor’s vendor data sheet so that the designer or other reviewers could double-click on the comment in the viewable to open the data sheet PDF.
 - Bookmarked these individual comments with descriptive names so that the designer and other reviewers could easily “jump” directly to them in the viewable file.
 - Saved and exited the schematic viewable.
- The engineer returned to the notification e-mail, opened the link to the layout viewable file, and performed the same markup functions as he had with the schematic viewable file.
- The engineer replied to the designer through the original notification, stating that changes were required and that the marked up viewable files were now available at the URL links included in the notification.
- The designer opened the engineer’s markup viewable and reviewed the engineer’s instructions.

- After completing the requested design changes, the designer sent out an e-mail notification that the design had been updated. Again, the notification contained the URL links for the viewable files.
- The engineer brought up the viewable files and performed an inspection using the EDA Expert capabilities:
 - A visual inspection of the schematic.
 - Cross-probing (automatic highlighting and cross-hair identification) of both the schematic and layout viewable files to find the critical signal traces in the layout.
 - Interrogation to insure that these traces were in fact .050” wide, and to verify minimum clearances on several other traces in the layout.
 - A visual overlay comparison of the old Gerber artwork file to the new design file. Differences between files were indicated by color differentials on the designs. These differences included pads that were added for a new resistor and wider traces for the critical signal traces.
- The engineer reviewed a new bill of materials (BOM) in Windchill to verify that it reflected the design changes made by the designer. The new BOM, created by the ECAD Workgroup Manager, did indeed include the added resistor.

With all design changes verified as being complete and correct by the engineer, the final process steps would be for the engineer to respond to the designer’s e-mail notification and ask the designer to promote the design, at which time the designer would release the design into the PDM.

6.5.4 Feedback

The AEE Team conducted a short post-demonstration survey of workshop participants, which yielded the following information:

1. Reviewers would use the PTC ECAD tools if they were of reasonable cost and low maintenance.
2. The most important aspects of the tools common to all disciplines were, in order of importance:
 - a. Schematic and layout interrogation.
 - b. The ability to download manufacturing files without having to download an entire design.
 - c. The design markup capability.

Responses from participating engineers also indicated they value the ability to access and interrogate the design file without the need to open the native Mentor Graphics application. This feature was not as important to the designers, who are all experienced Mentor Graphics users.

6.6 Evaluation Results and Recommendations

The AEE Team’s objective was to implement and evaluate the PTC ECAD tools and to look at how they can be applied for weapons project applications at an NWC Design Agency. Their findings, conclusions and recommendations are summarized in the following sections.

6.6.1 ECAD Workgroup Manager Suite Evaluation

The ECAD Workgroup Manager Suite evaluation yielded the following information:

- The ECAD Workgroup Manager’s automated generation of the “.eda” files worked flawlessly.

- Review, markup and simple design file comparisons using the EDA Expert tool were relatively straightforward. Some of the intricacies of the “heavy” comparison provided by the ProductView Compare tool were not as fully explored, as this was a brand new application release that had no real supporting information.
- Generation of the BOM within the ECAD Workgroup Manager application resulted in a complete BOM that even included the graphic parts present in the schematic. This is an improvement upon the native Mentor Graphics tools, which ignore any symbols for parts not directly mounted on the board. For example, a schematic can show the board contents plus a front panel with all of the symbols that are wired to the board but are not a part of the board. These front panel components are part of the assembly, even though they are not part of the board itself, and the BOM should include them for that assembly.

6.6.2 Comparison to Other Applications

Most of the PTC ECAD Workgroup Manager Suite capabilities that were evaluated by the AEE Team are available within the native Mentor Graphics design tool or in other tools utilized by the Sandia ECAD design process. The great advantage of the PTC tools is that engineers can review design data without the need for the expensive Mentor Graphics design tools.

Electronic markup of drawings and screen dumps can be accomplished using Adobe PDF Professional, and the interrogation of artwork can be accomplished within CAM350 or GerbTool applications. However, the ECAD Workgroup Manager Suite of tools provides this level of review and markup and a considerable depth and breadth of information via a simple mouse-click.

While design comparisons using overlays are possible via MicroStation reference files, the PTC tools accomplished these comparisons with more control, more capability for documentation and refinement, and in fewer steps.

The AEE Team’s ECAD evaluation included discussion of PTC’s library administration capabilities within the ECAD Workgroup Manager application and Windchill 9.0. ECAD designers in Sandia/CA, Sandia/NM and KCP all use the same ECAD library of electronic parts. A tool that simplifies inter-site library interactions, such as real-time library updates that are accessible by designers at all three sites, would help the efficiency of the ECAD library administration process. This was not a capability that the ECAD Workgroup Manager could perform, however. Its capabilities were in providing electronic component “used-on” traceability and part obsolescence data. These functions are currently handled by the three sites via other enterprise tools.

The ECAD Workgroup Manager Suite enables ECAD/MCAD collaboration by providing an MCAD designer with the ability to open and mark up an ECAD viewable file without using the Mentor Graphics application. Mentor Graphics and PTC both have other tools that extend this collaboration, but those tools are not included in the ECAD Workgroup Manager Suite.

The ECAD Workgroup Manager’s configuration management capabilities are comparable to Sandia’s current Matrix product data management (PDM) system, with the exception that it has slightly better resolution. For example, The ECAD Workgroup Manager partitions ECAD designs into “Assembly”, “Board”, and “Schematic” groupings, and interactions with the tool can therefore be refined to these three areas of interest. By providing the ability to access and download manufacturing files independent of the rest of the design files, the ECAD Workgroup

Manager provides better need-to-know controls than that of the current Matrix ECAD release configuration.

6.6.3 New ECAD Design Review Process

The new ECAD design review process includes an automated notification capability, which was tested and validated. Workshop participants felt that the control over the triggers that initiate the e-mail notification was not fine enough to eliminate potential e-mail spam. They preferred a manual process where a URL link for the viewable file was copied and pasted into an e-mail template and then sent to the reviewer. This notification process worked seamlessly for the participants.

6.6.4 Recommendations for Product Improvements

The EDA Conduit requires one EDIF schematic reader/writer for each schematic design tool type, be it Mentor Graphics DC2005.3 or Mentor Graphics DxDesigner 2007. Without this EDIF translator, no “.eda” file is extracted from the schematic. Without the “.eda” file, no schematic viewable file is created, and therefore no schematic interrogation or cross-probing between the schematic and the layout files can be accomplished. Licenses for these translators are expensive (\$8K to \$12K) and neither can be purchased from PTC.

Additionally, any use of an EDIF translator results in a schematic that does not look like its parent. Text fonts and sizes, line fonts and other features change appearance through the translation process. The AEE Team recommends that PTC should either license the translators from Mentor Graphics or another appropriate vendor and bundle them with the EDA Conduit application, or work with Mentor Graphics to eliminate the EDIF translator requirement altogether.

Mentor Graphics Design Capture border data does not translate through the EDA Conduit application. The border data, which are the variables for format metadata such as drawing number and classification, are driven by a side file that the EDA Conduit does not read. The AEE Team recommends that PTC find a way to “pull in” this information.

Multiple instances of a circuit within a DxDesigner hierarchical schematic are not interpreted correctly by the EDA Conduit. The design software recognizes each symbol in each instance as a separate unique entity. This uniqueness disappears in the EDA Conduit translation. There are missing reference designators, part numbers and other symbol properties that make a schematic entity unique. The AEE team suggests that PTC provide correct multiple instance translation through the EDA Conduit, since most future designs will be hierarchical in nature.

The AEE Team would like better control of automated notifications that are triggered by checking a file into the PDM. At Sandia, designers are often encouraged to check their designs into the PDM, even though they may not be complete. This might be the case when a designer goes on vacation or business travel. If check-in is the trigger for automated notifications to other design team members, they may perceive these unnecessary notifications as spam. The AEE Team requests some separation between a “final” file upload for review versus an interim “administrative non-review” file upload.

With the exception of the e-mail notification to MCAD designers who can “see” the design changes in a viewable file, the PTC ECAD Workgroup Manager Suite offers no real ECAD/MCAD collaboration. PTC and Mentor Graphics have other collaboration tools that should be applied to enhance ECAD/MCAD collaboration.

Manufacturing files that are stored in the Windchill PDM can be downloaded individually, separate from the rest of the design files. With an average of thirty manufacturing files per design, this can become cumbersome. PTC suggested “zipping” up common files before release so that the single compressed file could be downloaded as a solution. Although this process would work, it requires numerous additional actions by the designer. The AEE Team requests that PTC add the capability of downloading multiple files from within Windchill.

File protections are assigned at the object (folder) level in Windchill, not at the file level. This complicates the folder structure for designs because Official Use Only (OUO) and non-OUO manufacturing files would need to be stored in separate folders, even though all other aspects of the files would make them common. The AEE Team requests PTC to offer the option for file-level protections.

6.6.5 Lessons Learned

If the ECAD Workgroup Manager Suite applications are loaded in the “C:\Program Files” folder, the blank space in the file path may cause problems. Installing the tools in the “C:\PTC” folder eliminates this concern.

The AEE Team and the PTC consultant spent nearly two days installing the ECAD Workgroup Manager Suite applications and configuring XML files to recognize Sandia’s ECAD folder structure. This raises concern that any time Mentor Graphics or the NWC decide to change their folder structure, Sandia will have to redo the configurations. Because changes to the folder structure do typically occur on an annual basis, Sandia would need a subject matter expert to implement configuration changes when needed.

The critical elements of the ECAD design review process are the exchange and storage of markup information within the one-on-one pairing of the engineering customer and the ECAD designer. Communication via stored and retrievable marked up viewables and comparisons proved more attractive than typical “marked up print” methodologies. The ECAD workshop participants favored the flexibility of the ECAD Workgroup Manager Suite tools as presented over the more traditional constrained workflows that require formal approval sign-offs before the next design step can be performed. All participants were aware that the more constrained workflow options could be easily implemented if needed.

Sandia engineers would normally require only the EDA Expert and PV Compare review and compare tools on their desktop machines, with access to floating site licenses. Designers would need those tools as well as the ECAD Workgroup Manager and EDA Conduit tools installed on their machines. These additional tools are required for automated “.eda” file generation, BOM generation and manufacturing file partitioning.

6.6.6 Next Steps

The EDA Conduit, EDA Expert and PV Compare tools are currently available to Sandia/CA ECAD designers and engineering customers as stand-alone applications. Sandia has purchased the EDIF translators required for EDA Conduit to create the “.eda” files from Mentor Graphics Design Capture and DxDesigner schematics. However, to implement the new ECAD design review process, ECAD Workgroup Manager will need to be installed and configured on a Windchill production server.

With Mentor Graphics moving to encrypted ASCII in their EE2007.3 product release, there is uncertainty as to how PTC will generate its “.eda” files. The AEE Team would like to test Mentor

Graphics EE2007.3 to determine if the ECAD Workgroup Manager Suite will be compatible with Mentor Graphics' new database structure.

If the NWC production agencies adopt the ECAD Workgroup Manager Suite tools, the design agencies need to determine how they can employ them for design interactions. One specific area of interest is how the tools can assist with in-depth DA review of PA-proposed design changes for designs that have been transferred to the PA for maintenance. Exchange of the ".eda" viewable files would be perfect for this type of review.

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Visualization Tools Evaluation

The AEE Team was interested in evaluating the PTC visualization tool suite for two different applications:

1. As a desktop viewer for designers and engineers to use in their design collaborations.
2. To create assembly/disassembly animations for weapons models.

The first application was exercised with the development and implementation of the new B83 electronic check print process. Engineers initially used the ProductView Lite viewer to view and mark up drawings and models for in-process work with designers. This viewer is included in the Windchill application, and with a simple one click installation, the engineers had the tool at their desktop. This proved to be convenient and adequate for many of the engineers' requirements.

The second visualization tool application of interest is the creation of weapons model assembly animations. Weapons engineers find it valuable to use assembly animations to show proposed assembly techniques and any problems or interference issues that may result from design changes. These animations are typically used to support design reviews.

AEE team members have experience using PTC's currently released ProductView Standard 8.0 for weapon assembly animations. They found the product unstable and chose not to use it for this application. An alternative the AEE Team wanted to pursue with this project is PTC's Division Mockup 200i2. It is used extensively at Lawrence Livermore National Laboratory (LLNL) for the National Ignition Facility (NIF) project, and staff there recommended it as an alternative to ProductView Standard 8.0.

The AEE Team was also interested in using ProductView MCAD Professional 9.1, which has not yet been released by PTC. It was expected that PTC would initiate a beta release for the application during the period of this project, and the Team planned to participate and evaluate the pre-release product.

7.1 Product Descriptions

7.1.1 ProductView Lite

This visualization application is a browser plug-in that is integrated into the Windchill platform. The application requires a simple one-time installation on the client machine from the Windchill server to activate. The ProductView Lite viewer enables the user to open and view drawings and models stored in Windchill without having to open the application they were created with, such as Pro/Engineer. This is a convenience for engineers who may not be fully versed with those applications.

ProductView Lite has an intuitive user interface and it provides the option for setting controls to emulate those used in Pro/Engineer. The markup capabilities enable users to red line and annotate

drawings and models to facilitate collaboration. Other features include sectioning, measurements, and multiple simultaneous display views for side-by-side comparisons of models.

Because ProductView Lite is integrated into Windchill, it is easy to use and requires very little user training, it was the right visualization application for the B83 electronic check print process. One of the requirements from the B83 engineers was that they wanted to be able to easily open, view and mark up a CAD drawing or model without having to open the Pro/Engineer application. While some of the engineers have considerable experience using Pro/Engineer, others do not. ProductView Lite provided the required desktop solution for viewing and marking up files.

7.1.2 ProductView Standard 8.0

- ProductView Standard 8.0 is a stand-alone desktop application which offers more features and controls than ProductView Lite. This includes cross-sectioning capability, peer-to-peer collaboration, and enhanced search capability. In conjunction with the Realizer add-in, it can be used for the creation of interactive assembly/disassembly animations and movies, kinematic mechanisms, and computational motion envelopes.

AEE Team members have worked with ProductView Standard 8.0, the currently released standard ProductView application, and have two significant complaints:

- The user interface is not very user friendly. The user interface was significantly improved with ProductView Lite 9.0 and it will be used for ProductView MCAD Professional 9.1 when it is released to replace ProductView Standard 8.0.
- Previous efforts to use ProductView Standard 8.0 for weapons assembly animations proved frustrating, as the application had a tendency to crash randomly. The AEE Team's colleagues at LLNL had experienced similar problems and began using Division Mockup in its place.

7.1.3 ProductView MCAD Professional 9.1 Beta Release

The long awaited beta version of ProductView MCAD Professional 9.1 was released for customer testing before the conclusion of this project. The AEE Team had intended to test 9.1 extensively for weapons project animation applications. Unfortunately, the beta release had limited functionality and did not include any animation capability. This was a disappointment, as the Team had looked forward to evaluating the improved user interface and the greatly increased processing speed that PTC has claimed.

7.1.4 Division Mockup 2000i2

Division Mockup 2000i2 is a stand-alone visualization application with different capabilities than ProductView. Mockup is better suited for higher level work such as animated fly-throughs of large models, high quality renderings, and applications that require constraints, behaviors, and action-driven sequences. Mockup does not integrate with the Windchill platform, and therefore is best used for individual applications rather than on-going processes where model updates must be integrated into animations.

For the AEE Team's application, Mockup offers a number of advantages over ProductView:

- Individual animation sequences can be created for individual components, sub-assemblies and assemblies and stored in a library. These sequences can be combined into a single animation file to create a movie. This allows the user to edit the individual sequences as needed without disrupting the other sequences that make up the movie.

- Reverse engineering can be used to create assembly procedures. A fully assembled model is disassembled by peeling away parts one by one. The motion paths are saved and when complete, the animation paths are reversed to create an assembly sequence.
- Mockup offers much better control of materials, lighting, surfaces, and rendering.
- The camera view is dynamic and can be changed as an animated sequence is played. The view is fixed in ProductView.
- Users can save baselines for models and recall them as needed.
- Mockup has both static and dynamic interference checks:
 - Static: For determining if parts are in contact at rest.
 - Dynamic: For determining if parts come in contact during assembly/disassembly sequences.
- Mockup has better cross-sectioning capability.
- Mockup has an action-driven engine; you can initiate actions, such as pushing a door open, starting an engine, starting a disassembly procedure, etc.
- Mockup has real-time mechanism workings (constraints, behaviors, etc.)

7.2 Division Mockup Workshop

Division Mockup has a much steeper learning curve than ProductView. In addition, PTC's support for Mockup is limited. Because PTC does not offer training classes for Mockup, the AEE Team conducted a hands-on learning workshop led by a PTC SME. The two AEE visualization staff and the PTC SME designed the one-week course to provide a basic understanding of the tool and enough working knowledge to perform a limited evaluation with a weapons assembly animation use case. The workshop objectives were:

- Install, configure and validate the application on a stand-alone unclassified PC.
- Learn the program basics, including:
 - Basic commands and controls
 - Creating assembly/disassembly animations
 - Applying constraints to a model
 - How to publish, store and maintain data

7.3 Weapons Assembly Animation

Following the Mockup workshop, the AEE Visualization Team used Mockup to create a short demonstration unclassified weapons assembly animation using a simplified B83 model. This animation was created using the Mockup Sequencer animation tool.

While the animation demonstrated that Mockup can be used for weapons assembly animations, the basic lesson learned was that the application has a big learning curve and its complexity requires regular use to maintain a user's skills with the application. This does not fit the current needs at Sandia/CA, where the demand for high-end weapons assembly animations is infrequent.

The AEE Team's conclusion is that there is not a justification for continuing to work with Mockup, especially in light of the knowledge that PTC is incorporating some of the features of Mockup into future releases of ProductView (standard version).

7.4 Recommendations to PTC

The AEE Team applauds the improvements PTC has incorporated into the beta release of ProductView MCAD Professional 9.1 and recommends the following improvements for the next product release:

- Integrate features of Division Mockup into ProductView, including:
 - Improved mechanisms/kinematics.
 - Improved animation capabilities (e.g. sequence libraries) and movie generation (multiple output formats).
 - Improved application stability.
 - Behavioral modeling (action triggered events).
 - Improved texture/materials/lighting.
- Improved User Training: PTC offers only introductory courses for its ProductView applications. Users would benefit from advanced courses for all ProductView capabilities, such as animation. They should also offer a course for application customization using the new applications program interface (API).
- Better Documentation: PTC expects users to learn ProductView from the help menu, which in itself is poorly documented. PTC should provide user guides, including:
 - A basic user guide.
 - A programmer's guide for the API.
 - A system administration guide that includes:
 - ◆ Instruction for installing and configuring the application in standalone mode.
 - ◆ Details for the recipe files for both standalone mode and integration with Windchill.

8

Mathcad Evaluation

The AEE Team conducted a limited evaluation of PTC's Mathcad application to gauge its value to Sandia staff. The objective was to determine if a broader pilot evaluation exercise should be undertaken to determine whether Mathcad should be added to Sandia's common operating environment (COE). The intent of this first effort was to find a number of engineering staff who are currently using Mathcad or who would like to learn how to use it and have them evaluate it in the context of their normal work.

If Mathcad were added to the Sandia COE, it would not be intended to replace other comparable applications such as MATLAB, which is widely used by engineering staff throughout Sandia. The goal would be to provide access to a relatively easy to use tool that can complement those already being used by a broad range of staff to support their work. This evaluation demonstrated that Mathcad, MATLAB, and other comparable programs all have strengths and weaknesses, and the selection of a particular application can be dependent not only on the intended use, but on the user's comfort level with the application as well. Adding Mathcad to the COE would not restrict or discourage the use of any other comparable application.

8.1 Product Description

PTC promotes Mathcad's primary value as a vehicle to capture intellectual property (IP). It can be used as a stand-alone application for performing engineering calculations and it can be used as an electronic engineering notebook. Mathcad can be integrated with Pro/Engineer to capture and associate equations and intellectual property with a Pro/Engineer MCAD model or drawing.

Mathcad offers the following capabilities:

- The application is an intuitive whiteboard interface. The user may enter content anywhere in the Mathcad document without the limitations of a spreadsheet.
- Text, math and graphics can be combined to fully capture the IP.
- The Mathcad file can be published or used for presentations.
- Units (English, metric) management maintains consistency in calculations.
- Numeric and symbolic calculators.
- Because the math engine is always running, users can type in basic equations manually and immediately get a result.
- Users can select an equation from an extensive set of libraries, or they can enter an equation manually.
- 2D and 3D plotting capabilities.
- Users can import Excel data, MATLAB data and text. Imported data can be dynamically linked to the original data file so that as data changes, it is updated in the Mathcad equations.

- Mathcad has many built-in templates for performing work. Users can also create custom templates.
- Mathcad is designed for publishing, not just calculations. It spans all engineering applications (mechanical, electrical, structural, nuclear, etc.).
- Users don't have to know how to write script to use Mathcad.

Mathcad has numerous engineering handbooks in its library that are typically a collection of templates to assist the user. Users can copy and paste equations from a handbook into their workbook to avoid manual equation entry. They can also create their own custom handbook to include frequently used equations. A useful feature is the ability to protect sections of a workbook by assigning "areas" and collapsing the content. The collapsed area will still execute the equations in the area, but will not be visible. Users can apply titles to the areas and use password protection as well. This feature facilitates the protection of sensitive information.

The integration between Mathcad and Pro/Engineer is functional with Wildfire 3 and Wildfire 4. It does not work with Wildfire 2, which is the current Pro/Engineer release used throughout Sandia. As a result, this integration was not exercised and evaluated. However, there is considerable interest among staff in this capability. Some of the benefits include:

- Linked Mathcad and Pro/E files have bi-directional data flow; changing variables in the Mathcad file are reflected in the Pro/E file's geometry and vice versa.
- Users can predict the behavior of the model by changing the parameters in Mathcad. Users set up a Mathcad template with defined input parameters and output parameters and Mathcad sends critical results as outputs to the Pro/E model to update the geometry.
- Mathcad lives in the Pro/E environment; Users can check documents in/out in the PDMLink PDM.
- Mathcad can be used independent of Pro/E on your desktop (different licensing available).

A current limitation for the integration of Mathcad in the Windchill environment is the lack of full integration. Mathcad files are currently treated as secondary content in PDMLink, the same way Microsoft Word and other "soft" documents are managed. Because there is currently no workgroup manager in PDMLink for Mathcad, users have to manually associate the Mathcad and Pro/E files. The future PDMLink v.X20 will fully integrate Mathcad and will allow features such as fast search, which will search the content of the Mathcad documents stored in PDMLink. Mathcad is also not fully integrated with PTC's Arbortext technical publishing application.

Competitor products are MATLAB, Maple, and Mathematica. MATLAB is widely used by engineering staff throughout Sandia. Although Microsoft Excel spreadsheets are often used for engineering calculations by Sandia engineers, they have limitations. They don't provide a platform for publishing, they offer no management of units of measurement, and they don't provide a convenient vehicle to capture the reasons for the calculations (the IP).

8.2 Implementation

Sandia/CA has a total of 52 Mathcad licenses. These licenses are bundled with the site's Pro/Engineer licenses under the current NWC volume purchasing agreement with PTC. Until this pilot project, the general site population was unaware of the availability of these licenses, and they were not being used.

The AEE Team asked several managers of weapons engineering groups to identify engineers who might be candidates to participate in the Mathcad evaluation. Of the candidates who agreed to participate, some currently use Mathcad to support their work and others were interested in learning Mathcad. Surprisingly, none of the current Mathcad users knew that Sandia has site licenses available. These users had purchased their own Mathcad licenses, which may or may not have included access to the Mathcad libraries and extensions, which add considerable functionality to the application. All of the evaluation participants were given access to the site licenses, which include the libraries and extensions.

PTC's Mathcad sales team provided two Mathcad demonstrations for Sandia. The first was a general overview of the application for AEE Team members and potential evaluators. The second was a repeat of much of the general information, but also included a demonstration of the integration of Mathcad and Pro/Engineer. The audience included potential Mathcad evaluators as well as CAD designers who were interested in the integration of Mathcad with Pro/Engineer.

8.3 Evaluation

Because the scope of this evaluation was limited, the number of participants was relatively small and the focus was on how these Sandians are using Mathcad to support their specific work. The feedback from these participants is summarized in the following sections.

8.3.1 Licensing and Configuration Issues

Installation of the application on the client machines was relatively easy. The only problem encountered was when the machine had an existing version of Mathcad. The existing version had to be uninstalled prior to the installation of the new application or it would not function properly.

8.3.2 Ease of Use

Evaluators found Mathcad intuitive and easy to learn. This is due in part to the fact that the user can simply write out an equation as they would on a piece of paper. The user interface enables calculations to be performed with realistic equations and notation. The general consensus was that engineers and scientists who are first-time users can be using Mathcad effectively in an hour or so without any training. There is a slight learning curve to perform more complex calculations. Mathcad also seems to have an equivalent functionality to MATLAB, which makes the learning curve easier for MATLAB users.

Mathcad has a number of tutorials available that cover basic functionality through the more complex capabilities. Users found the help files extensive and useful.

Mathcad also offers QuickSheets that contain premade templates that can be used directly or modified to fit a specific application. The QuickSheets were also useful for helping users learn the specific Mathcad syntax. With the standard help files, QuickSheets, and tutorials, users found Mathcad fairly easy to learn and use.

Evaluators were offered the option of a training class, but all felt that it was unnecessary for this exercise. If Mathcad is presented as a tool for a broader group of Sandians, they felt training would be valuable for both novices and experienced users. A formal training class would help those new to Mathcad come up to speed much more quickly. This could likely be a large factor in determining the overall usage and long-term success of Mathcad at Sandia. Training would also benefit experienced users by familiarizing them with new features they are unaware of or are not fully utilizing. One evaluator suggested a short class focused on the most common

tasks. Another suggested that a useful tool would be a sample worksheet which shows users how to perform the most common tasks.

Mathcad's extension modules provide additional functions, which a moderately-experienced user can learn using the help files. Using these modules effectively is dependent upon a user's mathematical and statistical background, and if they are familiar with the concepts.

Evaluators found Mathcad's user interface to be user friendly, and possibly the most intuitive program in its class. There are many helpful shortcut and macro keystrokes that could easily be summarized in a user guide that could save users time in learning the basics of the application. Once users have the basic tools, their background and experience with math and statistics will enable them to do a lot with Mathcad software.

8.3.3 Mathcad Applications at Sandia/CA

The evaluators use Mathcad primarily to perform engineering calculations and data analysis and reduction. It lends itself to solving systems of equations and/or performing parametric evaluation of designs. It is also useful for modeling mechanical, electrical, and optical systems for technical publications and presentations. Since modeling within Mathcad is done primarily with publication-quality notation, equations and modeling can be more or less directly copied into a document for publication or presentation. This is a time-saving feature that many engineers and scientists should welcome.

8.3.4 Integration with other applications

Some of the Sandia evaluators have interfaced Mathcad with MATLAB and Microsoft's Excel. Mathcad provides easy-to-use functions for importing and exporting to both of these programs. Since most engineers at Sandia use one or both of these applications, adopting Mathcad should be an attractive option. Evaluators also use the equation editor in Microsoft's Word in conjunction with Mathcad. As previously stated, none of the evaluators are using Mathcad in conjunction with Pro/Engineer.

8.3.5 Mathcad Use Cases

One evaluator recently used Mathcad for the design of a compact heat exchanger. He used Mathcad to solve a system of equations describing the heat transfer within the heat exchanger as a function of the system geometry and fluid flow rates and properties. The goal was to maximize the heat exchanger performance while minimizing the size of the system under a set of design constraints. Mathcad is his tool of choice for this kind of design work.

Another evaluator recently used Mathcad to curve fit experimental data from Raman spectroscopy. Raw data was imported into Mathcad. The fundamental equations relating Raman shifts to carrier concentration and mobility were extracted by curve-fitting. Fitting parameters were computed and used to determine the carrier concentration and mobility in a non-contact method.

Another application is for performing numerical integrations. Mathcad was used to perform the computation to produce a "quick" answer that was sufficient to answer the immediate question at hand.

An engineer used Mathcad for the engineering calculations required to solve a system of equations for a simple analytical heat transfer model for a telemetry system under development. He was able to quickly and repeatedly solve the system of equations while varying the parameters used for the heat transfer model.

Mathcad was used for data analysis/reduction by an evaluator. The raw accelerometer data collected from twelve channels collected during vibration tests was processed in Mathcad to generate power spectral density (PSD) plots.

8.3.6 Comparison to similar applications

The evaluators tend to use MATLAB and Mathcad for different applications. They feel MATLAB is superior for data analysis, plotting, and dynamic system analysis. Some evaluators believe Mathcad is much easier and more intuitive to use for mathematics, static systems of equations or parametric studies of design variables.

Mathcad is preferred to Microsoft Excel for doing desktop engineering analysis. Mathcad has a huge advantage in terms of ease of use. Trying to understand even a simple equation in an Excel worksheet can be difficult, whereas it is simple to program a Mathcad worksheet and it is easy for others to understand what it does. In addition, data from Excel tables can be imported into Mathcad and then easily manipulated.

The evaluators believe Mathcad has the strongest built-in symbolic manipulation and solving skills among MATLAB, Mathcad, and Excel. Mathcad also has libraries of equations for solving most fundamental mechanical and electrical engineering problems. Only the parameters and application-specific constants must be changed.

One of Mathcad's strengths is that it displays mathematical symbols, equations and expressions symbolically, just as a person would write them on paper. This differs from MATLAB and Mathematica, which use a "code" for displaying this information, namely, layers and layers of parentheses and brackets to show the order of operations. This sets Mathcad apart from its main competitors.

Mathcad also evaluates the expressions on worksheets in a very intuitive, top-down, left-to-right manner, much like people read a page in a book. This makes it easy to tell what order the expressions are being evaluated in, rather than having to stare at a screen full of code to figure it out, as is the case with MATLAB and Mathematica. This advantage is significant for transferring knowledge between engineers. When a project is handed off from one engineer to another, if the calculations were done in Mathcad, it would be much easier for the new engineer to understand what the previous engineer had done.

Evaluators are disappointed with Mathcad's plotting capabilities. For data analysis, MATLAB, Excel, SigmaPlot and KaleidaGraph are preferred choices. This is an area for improvement that would be of value to Sandians. Likewise, for signal processing, the features offered by MATLAB are more extensive than those offered by Mathcad. Although the observation is based on a comparison for one instance, Mathcad did not perform the previously described computationally-intensive accelerometer data analysis/reduction as quickly as MATLAB.

8.3.7 Strengths and Weaknesses

The Mathcad Evaluation Team noted the following strengths of the application:

- Ease of use
- Resemblance to written equations
- Quick learning curve
- Publication-quality notation

- Symbolic manipulation.
- Intuitive user interface.
- Great equation editor

The Evaluation Team noted the following shortcomings for Mathcad:

- Unless the math engine is disabled to initiate calculations on command, calculations may be performed before the entire equation is entered.
- The user base of Mathcad is not as large as MATLAB, making it harder to find third-party programs.
- Some advanced or “hidden” capabilities of Mathcad are more difficult to learn and are not well documented.
- There are currently no PTC University (PTCU) web-based courses available. Because Sandia subscribes to PTCU, courses would be of benefit.

8.4 Recommendations

The evaluation team found significant value in using Mathcad for a variety of their engineering applications. All of the evaluators felt that the capabilities and usefulness of Mathcad warrant consideration for including it in the Sandia Common Operating Environment (COE). However, the general consensus is that further evaluation by a broader group of Sandians should be conducted before management commits to an investment in Mathcad. Because this evaluation was limited to a small number of weapons engineers who were already using Mathcad or had a desire to use it, it does not fully represent the general Sandia population. A broader pilot evaluation should include staff from a much wider range of disciplines.

Because there is currently no comparable tool included in the COE, the evaluators feel that Mathcad or a similar application would be of benefit to Sandians who perform mathematical calculations. This is a significant portion of the Sandia population. However, it is not clear if Mathcad is indeed the ideal tool to fill this need. One potential obstacle for the adoption of Mathcad is that many Sandians are devoted MATLAB users who might not see an immediate value in Mathcad. On the other hand, some Sandians may find MATLAB too challenging, and Mathcad presents an easy to learn alternative with far more capabilities than Microsoft Excel.

A Mathcad feature that should be exercised and evaluated in a broader pilot is the integration with Pro/Engineer. The ability to associate Mathcad calculations and other IP with a Pro/Engineer file and store it in PDMLink should be of great interest to weapons program engineers and managers. Mathcad’s potential as an electronic engineering notebook is another application to consider for future evaluation.

The Mathcad Evaluation Team had the following recommendations for improving Mathcad:

- The evaluators would like to see an improvement in Mathcad’s plotting capability. It is extremely limited, especially in comparison to MATLAB and other packages such as KaleideGraph.
- The evaluators noted recent advances in Mathcad’s functionality and documentation, but would like to see further enhancements in the documentation with embedded links for sub-functions and the methods used in a given tutorial or help page.
- The availability of web-based training in PTCU would be a helpful addition for bringing potential users up to speed with the application.

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A

AEE Server Specifications

A.1 Three-tier Development Servers

The unclassified and classified AEE three-tier server development systems have the following general specifications:

- Hardware:
 - Dell PowerEdge 2850
 - Two dual core Intel Xeon processors, 2.8GHz, 800 Mhz FSB
 - 4GB DDR2 400MHz (unclassified servers)
 - 13GB DDR2 400MHz (classified servers)
 - RAID 5 controller
 - Hard drive configuration:
 - ◆ Application server: Four 300GB 10K rpm Ultra 320 SCSI drives
 - ◆ Publishing Server: Three 73GB 10K rpm Ultra 320 SCSI drives
 - ◆ Database Server: Three 73GB 10K rpm Ultra 320 SCSI drives
- Software:
 - Application server:
 - ◆ Pro/Engineer WF4 M020 initially, then upgraded to M040
 - ◆ Windchill 9.0 MO30
 - ◇ Windchill PDMLink 9.0 (data manager)
 - ◇ Windchill ProjectLink 9.0 (project management and collaboration)
 - ◆ Windows Server 2003 OS (standard version on unclassified server, professional version on classified server)
 - ◆ Acrobat Distiller add-in
 - ◆ ProductView (Visualization)
 - ◇ ProductView Lite 9.0 (browser-based visualization)
 - ◇ ProductView Standard 8.0 (desktop visualization and collaboration)
 - ◇ ProductView adapter for PDF
 - ◆ Oracle Client 10.g
 - Database server:
 - ◆ Windows Server 2003 OS
 - ◆ Oracle 10.g
 - Publishing server:

- ◆ Arbortext Publishing Engine (Used to extract, assemble and publish XML and SGML content to multiple media)
- ◆ Arbortext SysTrack (Optimizes system performance and prevents system problems)
- ◆ Arbortext Digital Media Publisher (Assembles files and folders for publication on multiple types of digital media and to Web applications; enables distribution of publications on CD-ROM, DVD or other storage media; provides browser-based access)
- ◆ Arbortext Dynamic Link Manager (Used to create and manage the relationships among document components)

A.2 Single-tier Training Server

The unclassified AEE single-tier dedicated training server has the following general specifications:

- Hardware:
 - Dell PowerEdge 2950
 - Two dual core Intel Xeon processors, 2.66 GHz, 800 Mhz FSB
 - 4GB DDR2 400MHz
 - RAID 5 controller
 - Hard drive configuration: Four 73GB 15K rpm SAS (Serial Attached SCSI) drives
- Software:
 - Pro/Engineer WF4 M040
 - Windchill 9.0 MO30
 - ◆ Windchill PDMLink 9.0 (data manager)
 - ◆ Windchill ProjectLink 9.0 (project management and collaboration)
 - Windows Server 2003 OS (Standard)
 - ProductView (Visualization)
 - ◆ ProductView Lite 9.0 (browser-based visualization)
 - ◆ ProductView Standard 8.0 (desktop visualization and collaboration)
 - ◆ ProductView adapter for PDF
 - Oracle 10.g

B

Windchill Configuration for Sandia Business Practices

This appendix provides the details for the Sandia-specific configurations that were applied to Windchill 9.0 for this project. These configurations were applied to both the unclassified and classified Windchill development servers.

B.1 Auto-Numbering

In its OOTB configuration, Windchill defaults to auto-numbering for file creation. The AEE Team wanted this feature disabled to allow designers the ability to create and rename files per Sandia file naming conventions. PTC resources provided solutions for disabling auto-numbering at both the product level and the organization level. The AEE Team opted to disable auto-numbering at the product level to maintain flexibility in file naming.

B.2 Lifecycle

Initially, the Windchill OOTB lifecycles were used as the AEE Team prepared the B83 check print process demonstration. The Windchill 9.0 OOTB lifecycle states are:

1. In-work
2. Released
3. Obsolete

The NWC standard for PDM lifecycle has the following three states:

1. Work in progress (WIP)
2. Check (CHK)
3. Release (REL)

Because these differences could lead to confusion for the B83 designers, the AEE Team determined that new lifecycles should be created to match the NWC standard.

It should be noted that one of the problems the AEE Team encountered is the B83 Team's desire to begin using the Windchill system immediately. As soon as the AEE Team conducted a hands-on training workshop for B83 team members, B83 designers wanted to start loading data immediately. Although the AEE Team was reluctant to release the system, prior delays in the Windchill installation had shortened the project timeline, thus requiring a prompt initiation of the Windchill evaluation by the B83 Team. This led to some duplication of effort, as files that were loaded initially by B83 designers later had to be exported and checked back in again after the AEE Team completed the configuration of the lifecycles. Any file checked in prior to the configuration was assigned an OOTB lifecycle. These files had to be exported and then checked back into Windchill so that a new NWC lifecycle could be assigned.

It should also be noted that the configuration of the lifecycles to NWC standards proved to be time consuming, primarily due to a lack of PTC support. The PTC resources provided to the AEE Team did not have the level of knowledge and experience that was required and expected for this and a number of other configuration issues. This may be attributed to the fact that PTC expected Sandia to use Windchill 9.0 only in the OOTB configuration.

The process for adding new lifecycles at the “Site” level is as follows:

1. Create a new lifecycle (the AEE Team used instructions provided by Jeremy Plake, Sandia/NM, which were developed for Windchill 8.0).
2. Create a new product level OIR rule to utilize the AEE lifecycle.
3. Set Access control rules for the new lifecycle states in the Policy Administrator menu (at the Product level):
 - EPMDocument,WIP,Designer,Full w/deny Delete
 - EPMDocument,REL,Designer, Revise
 - EPMDocument,CHK,team members, Read, Download

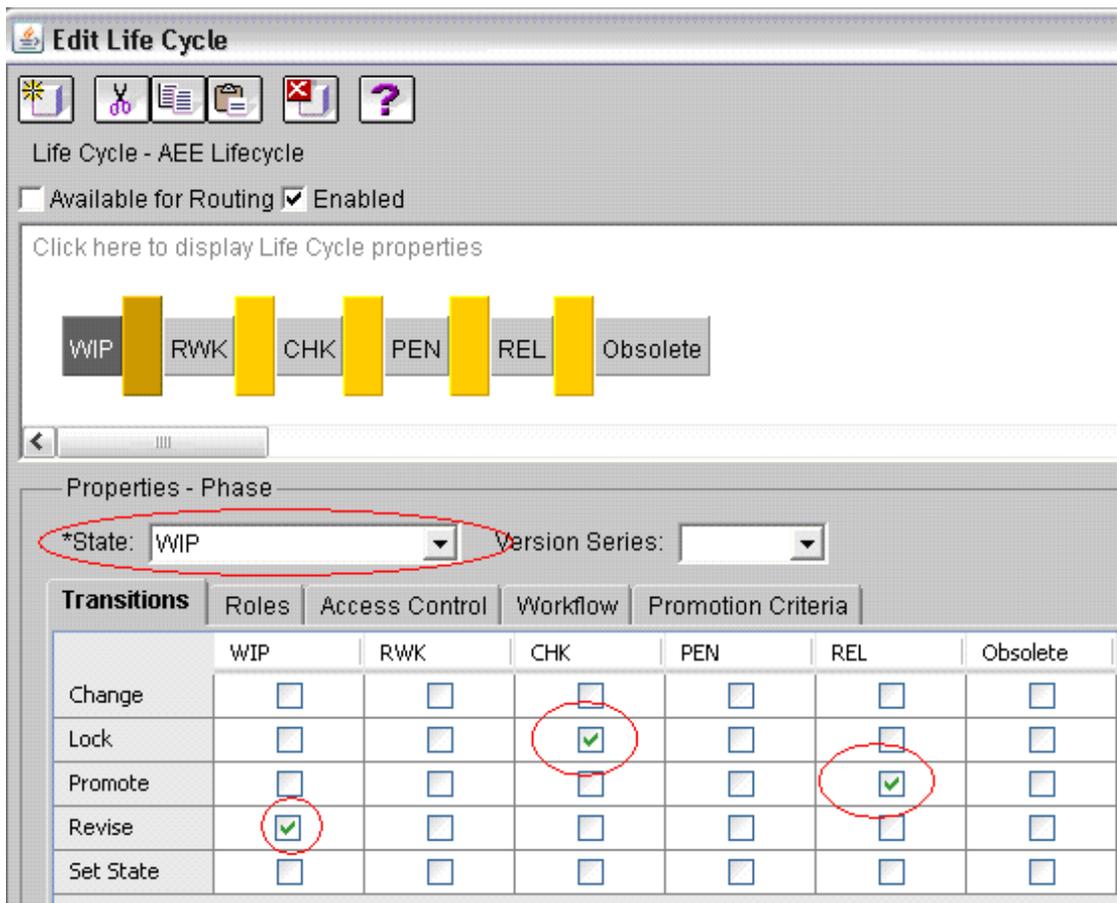


Figure B.2.1 The AEE Windchill 9.0 lifecycle configuration.

B.3 E-mail Notifications

When a designer changes a drawing or model using the Windchill B83 check print process, he or she submits a promotion request to the appropriate engineers. This can be in the form of either a

review or an approval request. Once initiated, the request generates an e-mail notification to the people the designer has identified as participants in the review/approval process.

Ideally, the e-mail notification should provide the recipient with detailed information from the sender and links to the product to eliminate unnecessary mouse clicks and picks. While developing the B83 check print process demonstration, the AEE Team found that the out-of-the-box (OOTB) configuration of PDMLink's e-mail notification did not include the initiator's message. Accessing this message requires the recipient to dig down two levels to get to it. When the reviewers or approvers respond to the designer's request, their comments are also not readily available to the designer in the return e-mail. To address these issues, the AEE Team intended to configure the promotion workflow to include the messages in the notification e-mails. The Team's expectation was that the OOTB notification configuration would not meet the B83 Team's desire for a simple, immediate check print process. Direct access to the initiator's message is an important aspect of the process. Time constraints prevented the AEE Team from implementing a change to the e-mail notifications prior to the B83 training workshop and thus, the promotion process was demonstrated in its OOTB configuration. As expected, the B83 team asked that the requestor's message be included in the notification e-mail so that they did not have to "go looking" for it. The same was true for the reviewer/approver messages in the promotion approval/rejection e-mails.

The AEE Team spent considerable time and effort to configure the e-mail notifications to achieve the desired results. This was another area where the Team felt that PTC support was insufficient. Requests for help from PTC consultants did not yield results. The Team worked toward a solution through repeated trial and error. After considerable time and effort, the Team's success was only partial, in that comments from the reviewers and approvers are now included in their approval/rejection responses. The Team was unable to configure the notification to include the designer's message in the initial promotion request. The engineer still has to dig down two levels to access that message.

The following steps were used to modify the promotion request notification e-mails:

1. Created a copy of the Promotion Request Approval Process workflow and named it "AEE Approval Process" (at the Organization level).
2. Created a copy of the Promotion Request Review Process workflow and named it "AEE Review Process" (at the Organization level).
3. Configured workflows to meet the B83 Team needs.
4. Added the new "AEE Approval Process" and "AEE Review Process" to the default promotion list via the Preference Manager at the Product level.

Although the Windchill e-mail notification process was functioning properly on the unclassified Windchill server initially, the AEE Team encountered a problem with the notification process some time after the completion of the B83 training workshop and electronic check print process demonstrations. The Windchill e-mail functions were working, but the notification process was not. The AEE's system administrator eventually identified the problem by comparing the files loaded on the unclassified Windchill server with those on the classified server, whose e-mail notification process was functioning correctly. The comparison showed that the unclassified server was missing a (what type?) Windchill file, which had been removed on the advice of the PTC solution architect in the effort to resolve a separate unrelated system problem. When the file was restored, the e-mail notification process once again functioned correctly on the unclassified Windchill server.

B.4 Libraries

Five libraries were created by the AEE Team for the B83 Windchill evaluation:

1. **Lib-Configuration:** This library contains the Pro/Engineer start files.
2. **Lib-Connectors:** This library contains connector models.
3. **Lib-Formats:** This library contains the Pro/Engineer format files.
4. **Lib-Material:** This library contains the Pro/Engineer material files.
5. **Lib-ParaCAD:** This library contains the ParaCAD fastener models.

These libraries provide designers with access to drawing formats, start parts, and standard material files. Content data had to be migrated into Windchill to populate these libraries. The method for completing this data migration was not documented, requiring the AEE Team to request help through PTC Technical Support. While PTC provided a solution, it took several days for the response. This delayed response has been fairly common for the AEE Team's requests for support, which has added to the time required to complete the Windchill configurations.

Libraries (8 of 8 total objects)								Current View: All	?
Name	Actions	Owner	Last Modified	Description	Creator	Created On	Private Access		
LIB-B83-TEST	ⓘ Actions ▼	snlca_admin	2008-07-18 10:07 PDT	LIB-B83-TEST	snlca_admin	2008-07-18 10:07 PDT	No		
Lib-Configurations	ⓘ Actions ▼	Grant Kiba	2008-08-13 14:08 PDT	Start Parts and drawing Templates Library	gwkiba	2008-08-12 10:16 PDT	No		
Lib-Connectors	ⓘ Actions ▼	Grant Kiba	2008-09-02 07:26 PDT		gwkiba	2008-09-02 07:26 PDT	No		
Lib-Formats	ⓘ Actions ▼	Grant Kiba	2008-08-13 14:08 PDT	Drawing Format Library	gwkiba	2008-07-24 07:32 PDT	No		
Lib-Help	ⓘ Actions ▼	Grant Kiba	2008-08-13 14:23 PDT	Sandia PDMLink Help files	gwkiba	2008-08-13 14:23 PDT	No		
Lib-Materials	ⓘ Actions ▼	Grant Kiba	2008-08-13 14:09 PDT	Material Files Library	gwkiba	2008-07-24 13:19 PDT	No		
Lib-ParaCAD	ⓘ Actions ▼	Grant Kiba	2008-08-15 13:07 PDT		gwkiba	2008-08-15 13:07 PDT	No		
Lib-PL	ⓘ Actions ▼	Grant Kiba	2008-09-25 13:57 PDT	Purchase Part Library	gwkiba	2008-09-11 09:39 PDT	No		

Figure B.4.1 The Windchill libraries include the five B83 libraries, a Help library and two test libraries.

PTC had recommended to the AEE Team that the full ParaCAD fastener library should not be loaded on the AEE server systems. There was concern on their part that this extensive library would affect server performance and negatively impact the B83 Windchill evaluation. While some AEE Team members thought it would be a valid test of the system to load the full library, the general consensus was that it would be better to load only a subset of the library. By loading only the fasteners required in the B83 design, the time needed to load parts was greatly reduced, especially in light of the file check-in problems that were encountered. The B83 designers generated a list of the fasteners required and the AEE Team edited the generic ParaCAD models to retain only those fasteners. The reduced library was then loaded into Windchill. Although the reduced ParaCAD library does not present a true measure of PDMLink's performance in a production role, that was not a primary objective of this project.

Additional configuration details for the five libraries:

- **Lib-ParaCAD and Lib-Connectors:** The AEE lifecycle OIR had to be applied to these libraries. For all libraries, a group named "AEE Team Members" was created and added to the team for each library. All B83 designers were then added to the group to provide them with access to the libraries.

- **Lib-ParaCAD:** The B83 design team presented a list of 179 ParaCAD fasteners required for the project. As recommended for this pilot project, only the required ParaCAD instances were to be added to PDMLink. A new library was created (Lib-ParaCAD) and generic files were edited to remove all instances not used in the project. The process took 6-8 hours to complete and was further complicated by not being able to check in multiple files. All instances and generics were set to the “REL” state.
- **Lib-Material:** B83 Pro/Engineer material files were added to and stored in this library. Documentation on how to upload the material files (.mtl) was not found in the Windchill documentation. A call to PTC Technical Support was required to find a solution, which was to use the “Import to Workspace” function under the “Tools” pull-down menu within a workspace.
- **Lib-Connector:** The library was populated with connector models by B83 designers. No problems were encountered. All instances and generics were set to the “REL” state.
- **Lib-Format and Lib-Configuration:** These libraries were populated with format and start parts respectively. No problems were encountered. All instances and generics were set to the “REL” state.
- **Modifications to the “config.pro” File:** Folder location paths were set in the “config.pro” file for designer accessibility to formats, start parts, material files, and the ParaCAD fastener library. The server alias “AEE” was used in the path definition. The new “config.pro” file was distributed to B83 designers.

B.5 Table Views

The AEE Team felt that Windchill’s OOTB table views did not provide sufficient information for the B83 designers to work effectively. Designer-to-designer collaborative workspace and folder views were created to fill this need. The AEE Team developed product folder names and a folder structure for containing documents, CAD files, and other relevant B83 project information.

The screenshot shows the 'Object List' window in Windchill. The title bar indicates 'Object List (7 of 7 total objects)' and 'Current View: Sandia Workspace View'. Below the title bar are 'File' and 'Edit' menus and a toolbar with various icons. The main area is a table with the following data:

	File Name	Actions	Version	State	Last Modified	Location
<input type="checkbox"/>	1e2211-00-unc.drw		A.0	In Work	2008-08-07 14:09 PDT	/AEE Story B... and Drawings
<input type="checkbox"/>	1e2211-00-unc.prt		A.0	Released	2008-08-07 14:55 PDT	/AEE Story B... and Drawings
<input type="checkbox"/>	1e2214-00-unc.drw		A.0	In Work	2008-08-06 14:23 PDT	/AEE Story B... and Drawings
<input type="checkbox"/>	1e2214-00-unc.prt		A.0	In Work	2008-08-06 14:23 PDT	/AEE Story B... and Drawings
<input type="checkbox"/>	1e2217-00-unc.drw		A.0	In Work	2008-07-30 08:33 PDT	/AEE Story B... and Drawings
<input type="checkbox"/>	1e2217-00-unc.prt		A.0	In Work	2008-07-30 08:17 PDT	/AEE Story B... and Drawings
<input type="checkbox"/>	d-nwc.frm		A.0	Released	2008-07-31 14:57 PDT	/Lib-Formats

At the bottom of the table, it says '(0 objects selected)'.

Figure B.5.1 Sandia workspace view.

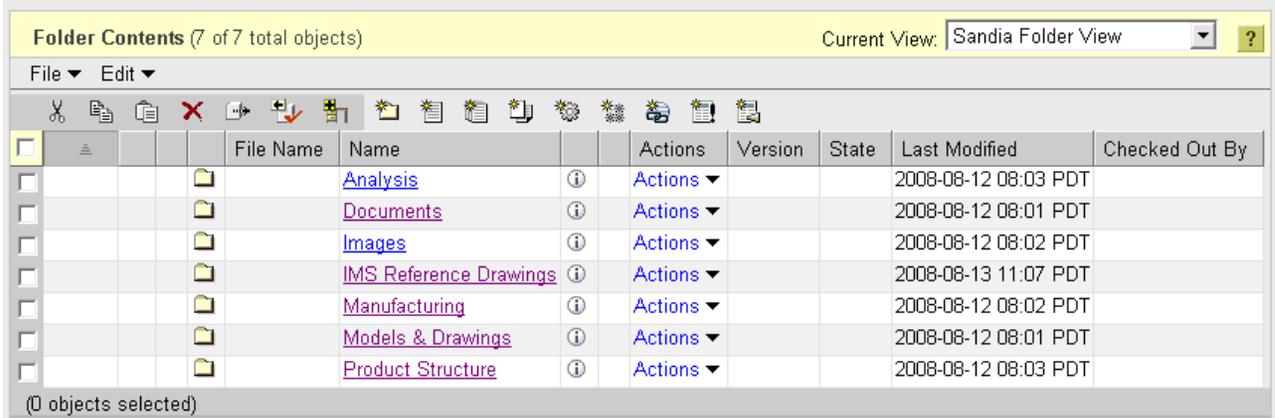


Figure B.5.2 Sandia folder view.

B.6 User Help Files

The AEE Team created a number of “How-to” documents to explain basic PDMLink operating procedures (Figure B.6.1.). The files are stored in a library named “Help-Lib” and access was given to all the B83 team members.

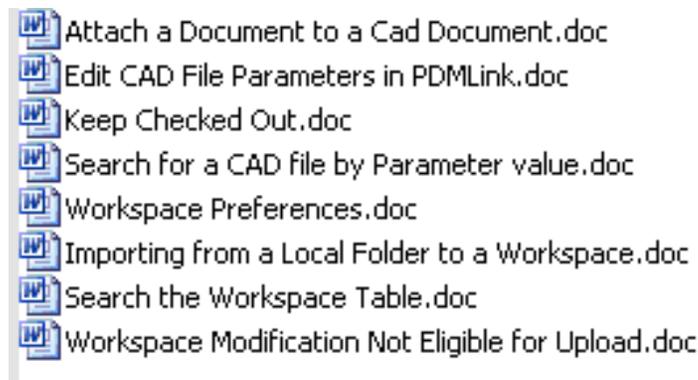


Figure B.6.1 Sandia user help files.

B.7 Designer Role Rename

In its OOTB configuration, Windchill’s “Designer” role had restrictions that would not allow designers to rename the file name or number. Because the AEE Team disabled the auto-numbering feature, this restriction presented a problem. Windchill’s “Rename” functionality was activated for the role of “Product Manager” and it worked as expected. However, the permissions for the “Designer” role excluded this ability. To resolve this issue, the “Policy Administrator” function was used to add a new rule at the “Product” level, which gave the “Designer” role full permissions. While this solved the immediate problem, it created potential problems, as the “Designer” role now had the ability to revise or delete files, set states, and perform other functions that should be limited to the “Product Manager” role.

The better solution was to create a policy for the “Team Member” role for “all” states that granted only “Read” and “Download” permissions. Additional permissions were then assigned to the roles of “Designer” and “Product Manager”. With these Policy settings in place, any

users added to roles other than “Designer” and “Product Manager” are only given the ability to read and download:

- The “Product Manager” was granted full permissions at “all” states.
- For EPM Documents at the “WIP” state, the “Designer” was granted additional permissions:
 - Modify
 - Modify content
 - Modify identity
 - Create by move
 - Create
 - Set state
 - Change domain
 - Change permissions
 - Delete
 - Administrative
 - Deny revise
- For EPM Documents at the “REL” state, the “Designer” was granted “Revise” permission. All other permissions restricting what can be done to a “REL” document were set to “Deny”.

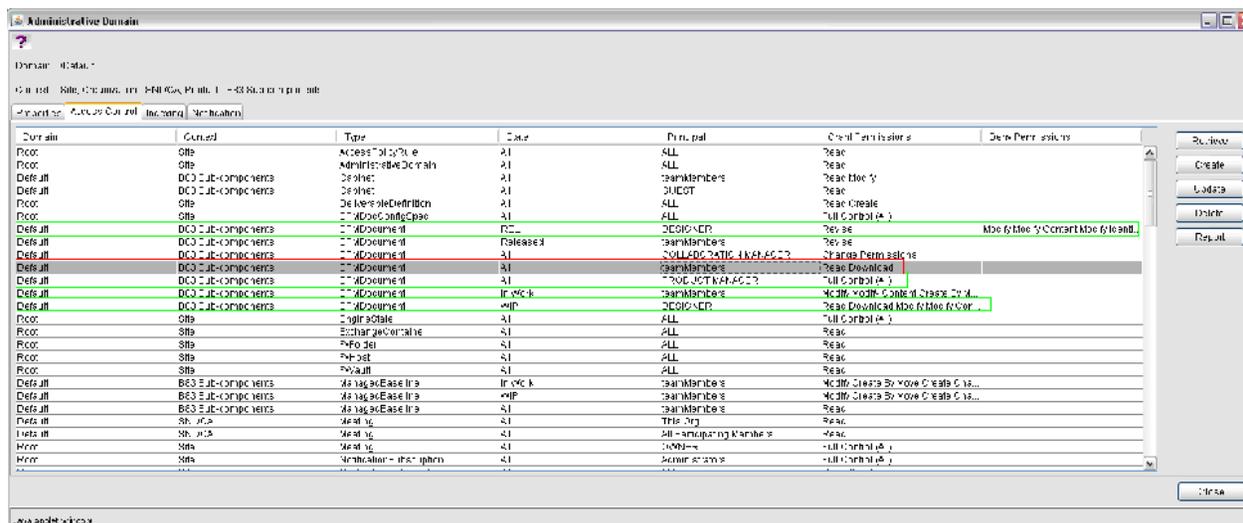


Figure B.7.1 Access control settings for the B83 Windchill roles.

B.8 Data Migration

A Windchill “Product” was created for the B83 project so that data could be migrated into project sub-folders. This “Product” was created using a previously developed template which allowed the duplication of team members, object initiation rules (OIRs), folder views, and preferences.

File check-in proved to be a major problem for the AEE Team. Although multiple files can be checked in simultaneously in Windchill 8.0, the AEE Team could not check in more than a few files at a time with the Windchill 9.0 system. Any time the “select all files” option was used with more than a few files, a “Failure on Check In” message resulted and the event manager reported a

“Failed Connection Failure”. The file sizes seem to be a factor in determining how many files can be loaded simultaneously. Numerous discussions with PTC consultants and PTC Technical Support did not resolve the problem. With no solution found, the only work around was to check files in one at a time, which slowed the data migration dramatically.

The file check in problem resulted in tedious file loads for the B83 designers and AEE Team members. In particular, some 200 files had already been loaded prior to the lifecycle configuration, and all of those files had to be exported and checked back in to Windchill in groups of 1 to 3 files, rather than in a batch. The same problem applied to all of the library files that were loaded. This was a significant issue that drained resources and created significant frustration for system users.

A possible cause for the file check-in problem was eventually identified by a PTC consultant who was working with the AEE Team on a number of Windchill issues. When the unclassified server was purchased and configured in the initial AEE Pilot Project in FY06, it was not expected to be used extensively for Windchill applications. The AEE Team’s expectation was that the classified server would be used for the Windchill test and evaluation. Although it had 8 GB of RAM installed, the unclassified Windchill server was running the standard version of Microsoft Windows Server 2003, which can only use a maximum of 4 GB of RAM. This was a known limitation from the previous project work. However, as described in an earlier section, Pro/Engineer was installed on the Windchill server to publish the visualization files, rather than on a separate visualization server as had been originally planned. In addition, Windchill was configured to publish the visualization files on check-in. This strained the limited system memory, restricting the number of files that could be checked-in simultaneously. A potential work-around for the file check-in problem was to set Windchill to publish the visualization files at night, rather than on check-in. This problem was recognized at the same time as the classified Windchill went into operation, which made this issue a secondary concern. The main focus for the AEE Team became the configuration of the classified Windchill server so that the B83 Team could begin classified project work with the system.

The classified AEE development server system was always intended for fairly heavy use and was configured with additional RAM (13 GB). The classified server runs Microsoft Windows Server Enterprise edition, which is not limited to 4 GB of RAM. The classified server was put into operation shortly after the memory problem with the unclassified server was identified. None of the file check-in problems were observed initially with the classified server, even with files comparable in size to those that had presented problems for the unclassified server. However, the same problem was later experienced with the classified server, suggesting that the source of the problem is not the limited RAM on the unclassified server. At the time of this report publication, the problem remained and the AEE Team continues to work with the PTC Technical Support staff to correct the problem.

B.9 Classified Windchill Server Implementation

Using what they learned with the configuration of the unclassified Windchill server, the AEE Team completed the configuration of the classified server with relative ease. The primary steps were as follows:

- The AEE lifecycle was recreated for the classified server.
- A template was used to duplicate the B83 sub-component product on the classified server.
- Libraries were created for connectors, configurations, and ParaCAD fasteners.
- An “AEE” group was created to provide the B83 team members with access to the libraries.

- The libraries were populated with the required files.

The configuration of the classified server was uneventful with one exception. The AEE Team could not set up any Java-related functions, including lifecycles, OIRs and policies. The Sandia system administrator discovered that the Java client on the machine that was being used had to be updated. He also found that when JAVA was installed, which must be done by someone with administrative rights, a Java “temp” directory was created under the name of the administrator. A system user will not have read/write access to this directory, and therefore, the Java applications will not function. To solve the problem, the system administrator created a “Temp” folder on the “C:” drive and pointed the Java “temp” files to this location. He set the folder permissions to give all users “modify” rights. This enabled the AEE Team to complete the Windchill configuration.

B.10 B83 Implementation of Windchill

The AEE Team supported the B83 designers as they migrated data into the unclassified Windchill system and started using it system for project work. A number of issues were identified by the users, and they made some requests for changes to configurations. Descriptions of these issues follow.

B.10.1 CAD File Parameters

The B83 designers needed to know how to edit parameters in PDMLink. The AEE Team created a custom view to display the parameters in a table to enable the designers to perform the edits. To apply this method to Pro/Engineer assembly files, all dependent files must be checked out.

B.10.2 Setting CAD File Revision on Check-In

The B83 designers wanted to migrate old data files into PDMLink and assign revision levels as appropriate. By default, Windchill sets the revision level to “A” on the first-time file check-in. In the Windchill OOTB configuration, the solution is to use the “Set New Revision” function prior to file check-in. Because the AEE Team had configured a new AEE lifecycle, this standard procedure did not work. They had to revise the AEE lifecycle to enable revisions at the WIP.

B.10.3 Setting the Initial Revision Level of Soft Documents

The B83 designers requested that TIFF file documents other than “revision A” be checked into PDMLink at the document’s current revision level. The AEE Team was unable to find instructions for this feature in the Windchill user documentation. A call to PTC’s Technical Support provided a solution, which was to select “New” from the “File” pull-down menu when in a product folder. By selecting “Insert Document”, the initial revision level can be entered when creating the new document.

B.10.4 Attaching Documents to a CAD File

The B83 Team asked the AEE Team to determine if TIFF image files could be attached to Pro/Engineer files in Windchill. This would be a way to link the legacy TIFF image files that are used to generate the model to the actual model file. The AEE Team spent considerable time investigating this possibility. They found that attaching a document linked it only to a specific Pro/Engineer file iteration. When a new iteration of the Pro/Engineer file was created, the attachment was only available under the “Iteration History” tab within PDMLink. This did not meet the B83 Team’s requirements and the idea was dropped.

B.10.5 File Rename Issue

The B83 designers encountered a problem when renaming family table instances in a workspace. Synchronizing the workspace was ineffective in updating name changes to family table instances

in the workspace. The solution was to add the generic file to the workspace a second time, which updated the instance names.

B.10.6 Managing Microsoft Office Documents in Windchill

The B83 Team wanted to manage their Microsoft Office documents in PDMLink along with all of their CAD files. The AEE Team installed the “Windchill Desktop Integration 2.0” application on the client machines and demonstrated that Microsoft Office Documents can be created, saved, edited, shared and released within the Windchill environment. The B83 Team can now apply full traceability to all project data within PDMLink. This capability is also available to any other project team that needs a document control process, regardless of whether they generate CAD data.

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