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Advanced Engineering Environment Pilot Project

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Abstract

The Advanced Engineering Environment (AEE) is a concurrent engineering concept that enables real-time process tooling design and analysis, collaborative process flow development, automated document creation, and full process traceability throughout a product's life cycle. The AEE will enable NNSA's Design and Production Agencies to collaborate through a singular integrated process. Sandia National Laboratories and Parametric Technology Corporation (PTC) are working together on a prototype AEE pilot project to evaluate PTC's product collaboration tools relative to the needs of the NWC. The primary deliverable for the project is a set of validated criteria for defining a complete commercial off-the-shelf (COTS) solution to deploy the AEE across the NWC.

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Executive Summary

Currently, the NWC's engineering environment is fragmented and the collaboration capabilities for engineering data are uncoordinated across organizational elements and partner sites. To enable better engineering decision-making and collaboration on current and future weapons projects, the development and deployment of the Advanced Engineering Environment (AEE) is necessary. The AEE 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 engineering by enabling the seamless, parallel flow of digital models and information across a secure distributed networking environment with the enforcement of need-to-know user access.

This project researched and prototyped an AEE development system to enable NNSA's Design and Production Agencies to collaborate using a singular integrated process. This environment builds upon and integrates with the infrastructure and software tools currently in place throughout the NWC. It will serve to capture information and knowledge of the process, add document and information management, allow analysis to begin earlier in the process, and reduce required travel and expenses.

The three primary objectives for the AEE Pilot were:

1. Evaluate a commercial off-the-shelf (COTS) software solution from Parametric Technologies Corporation (PTC) for applicability for the AEE.
2. Based on the evaluation of the PTC product and with input from staff at other NWC sites, develop a validated set of requirements for the AEE to use as the basis for procuring a COTS product solution from commercial vendors.
3. Provide a demonstration of the PTC software solution to DOE/NNSA program managers and staff from other NWC sites.

This project addressed only the in-process engineering activities associated with Product Life Cycle Management (PLM). It did not address the management of product definition or product structure, nor did it address the formal processes of PLM.

A basic requirement for the evaluation of the PTC software solution was that there would be no customization of the product and it would be tested only in its 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.

This report documents the Phase 1 implementation of the AEE Pilot. The initial effort centered on the acquisition and deployment of a development system on Sandia/CA's internal unclassified network. Once the system was operational, the AEE Team began evaluating the PTC collaboration product suite (Windchill, ProductView and Arbortext). Several use cases were identified as candidates for determining how well the product works for typical NWC applications. The Team worked with engineering teams within Sandia and from other NWC sites to evaluate the product.

Three use cases were exercised in Phase 1 as part of the PTC product evaluation:

1. Engineering Authorizations (EAs) are used throughout the NWC to authorize and document all engineering design changes. Because the EA is based on existing requirements (TBP/IBP

404) it offered an ideal test of the PTC product suite's ability to meet precise requirements. It was also an opportunity to exercise Arbortext Editor's ability to be configured (not customized) to meet specific NWC needs.

2. Operational procedures (OPs) are also used throughout the NWC. An existing unclassified OP was imported into the PTC software suite to give the AEE Team an opportunity to test the integration between the Arbortext publishing program and the Windchill product data manager (PDM).
3. This "Advanced Engineering Environment Pilot Project" SAND Report was selected as a use case to show Arbortext's capabilities for creating formatted technical reports. The SAND Report has clearly defined formatting requirements and it must present a corporate common look and feel. This exercise gave the Team an opportunity to evaluate the ease of use of the technical publishing software, as well as its ability to meet the documented requirements for publishing a SAND Report.

The AEE Team's conclusion was that the PTC off-the-shelf product performed well for most aspects of the three use cases exercised in Phase 1. In particular, the EA application was notable in that the exercise was tailored specifically to address an existing need for an improved solution for LANL applications. With no customization and only a moderate amount of configuration, the AEE Team created a user-friendly EA form that will be tested for applicability by LANL staff. Also notable was the ease with which documents within Arbortext can be edited and republished with little or no formatting by the user. Although Arbortext may not be as user-friendly as more common word processing applications, the configuration management control it offers, as well as its ability to link to files in the PDM make it a potential solution to many NWC applications.

The Team identified a number of gaps between the PTC product's capabilities and those required for implementing the AEE:

1. Problems were encountered with incorporating user authentication methods which are a mandatory requirement for classified network deployment and intersite collaboration. Sandia uses a non-standardized, inhouse mechanism for user authentication. The Team had initial concerns as to whether using Sandia's method would allow non-browser access to Windchill (i.e., Pro/E, Arbortext, ProductView). Since it was determined that these applications use HTTP to access Windchill, the Team was informed by PTC's R&D and Senior Global Services staff that access using the application(s) browsers would probably not be an issue. The Team is still in the process of testing this out on the restricted network.
2. The Arbortext publishing software can only link with XML file types, limiting the value of the integration with the Windchill product data manager (PDM).
3. Using a standard document type definition (DTD) from the Arbortext library was inadequate for publishing a SAND Report. A standard DTD was extensively modified with the addition of XML tags to address many, but not all of the required elements of the SAND Report structure.
4. There was inadequate documentation for installing and configuring some of the applications, including Oracle listener, HTTPS, and the Windchill/Arbortext integration. However, it should be noted that this was in part due to the fact that this pilot project was the first customer use of the PTC product suite and published information is now available from PTC.

The AEE Team developed a set of validated criteria to be used for the procurement of a collaborative software solution to enable the Advanced Engineering Environment across the

NWC (Appendix A). These criteria came from existing NWC requirements for collaborative applications, from contributing staff at NWC sites, and from the Team's development system work and the three use case exercises.

At the conclusion of Phase I, the Team laid the groundwork for replicating the development system on Sandia's internal classified network. They purchased hardware and prepared to deploy the new system to enable intersite collaboration. Following the success of the classified network development system, a full production system will be deployed at the Sandia/California site. The documentation compiled through these phases will support the eventual deployment of AEE systems throughout the NWC, making the Advanced Engineering Environment a reality.

Acronyms

- ACL ▪ Arbortext Command Language
- ACO ▪ advanced change order
- ADC ▪ authorized derivative classifier
- AEE ▪ Advanced Engineering Environment
- API ▪ application program interface
- CAD ▪ computer-aided design
- CAL ▪ client access license
- CM ▪ configuration management
- CMII ▪ Configuration Management II
- COTS ▪ commercial off-the-shelf (product)
- DA ▪ design agency
- DCE ▪ distributed computing environment
- DDM ▪ Design Definition Manager
- DDR ▪ double data rate
- DTD ▪ document type definition
- DOE ▪ Department of Energy
- EA ▪ engineering authorization
- EBOM ▪ electronic bill of materials
- ECAD ▪ electrical computer-aided design
- ECM ▪ enterprise content management
- ECR ▪ engineering change request
- EP ▪ engineering procedures
- ERP ▪ enterprise resource planning
- FSB ▪ frontside bus
- GB ▪ gigabyte
- GHz ▪ gigahertz

GUI ▪ graphical user interface

HAR ▪ hazards analysis report

HR ▪ human resources

HTML ▪ hypertext markup language

HTTP ▪ hypertext transfer protocol

HTTPS ▪ hypertext transfer protocol-secure

IBP ▪ intersite business process

IP ▪ internet protocol

ICSI ▪ Integrated Cyber Security Initiative

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

MBIT ▪ model-based integration tools

MCAD ▪ mechanical computer aided design

MHz ▪ megahertz

MIME ▪ multipurpose Internet mail extensions

MS ▪ Microsoft

NNSA ▪ National Nuclear Security Administration

NTK ▪ need-to-know

NWC ▪ Nuclear Weapons Complex

NWie ▪ Nuclear Weapons Information Environment

OP ▪ operational procedure

OS ▪ operating system

OOTB ▪ out-of-the-box

OTS ▪ off-the-shelf

PA ▪ production agency

PC ▪ personal computer

PDF ▪ portable document format

PDM ▪ product data manager

PLM ▪ product life cycle management

Pro/E ▪ Pro/Engineer

PRS ▪ product realization standards

PTC ▪ Parametric Technologies Corporation

QER ▪ qualification evaluation release

RAID ▪ redundant array of independent disks

RAM ▪ random access memory

REN ▪ reevaluation notification

RPM ▪ revolutions per minute

SAND ▪ Sandia Report

SCN ▪ Sandia classified network

SCSI ▪ small computer system interface

SGML ▪ standard generalized markup language

SNL ▪ Sandia National Laboratories

SNL/CA ▪ Sandia National Laboratories/California

SNL/NM ▪ Sandia National Laboratories/New Mexico

SQA ▪ software quality assurance

SRN ▪ Sandia restricted network

SS21 ▪ Seamless Safety for the 21st Century

SXN ▪ specification exception notification

SXR ▪ specification exception release

TBP ▪ technical business practice

3D ■ three dimensional

TMM ■ Technology Model Manager

VPA ■ volume purchasing agreement

XML ■ extensible markup language

Y12 ■ Y12 National Security Complex, Oak Ridge, TN

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Introduction

1.1 Description

To achieve NNSA's vision of a more responsive infrastructure, the NWC sites must develop and deploy the 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 engineering by enabling the seamless, parallel flow of digital models and information across a distributed networking environment. It provides the added benefit of better and more immediate communication 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 will enable real-time process tooling design and analysis, collaborative process flow development, automated document creation, and full process traceability in a collaborative environment. This environment will help ensure NWC mission success through a single, integrated engineering environment. The AEE will support a virtual presence and shared visualization system for engineering data facilitating seamless real-time engineering collaboration between project participants. A commitment to modernizing the NWC engineering infrastructure is a crucial step in assuring its ability to effectively serve the nation well into the 21st century.

The AEE will 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 Scope

Product Life Cycle Management (PLM) is the process of managing the entire life cycle of a product from conception through the design, manufacture, service and disposal phases. These multiple phases of PLM involve countless professional disciplines and require multiple skills, tools, and processes. A subset of PLM is the iterative or in-process cycle of a product phase.

A cycle may include activities such as the design development, product and design updating, prototyping, design and peer reviews, specification and process development. During a cycle, these types of activities usually have a defined sequence to follow, are interrelated to other cycles, and may run concurrently.

This project addressed only the in-process engineering activities associated with PLM. It did not address the management of product definition or product structure nor did it address the formal processes of Product Life Cycle Management. 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 the corporate PLM system upon the completion of a cycle.

The AEE Team evaluated only one commercially available product, a collaborative software tool suite from Parametric Technology Corporation (PTC). The Sandia project team was supported by PTC consultants throughout the installation, evaluation and demonstration process. They also had the advantage of being the first customer to install Arbortext with the Windchill integration. This gave the Team the unique opportunity to partner with PTC's R&D and Global Services staffs to develop and document the installation process, and to test the software integration on the AEE development system.

A guiding principle for this project 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 was allowed. However, it is expected that any commercially available product will require configuration to adapt the applications to specific NWC business process needs. Examples include the ability to plug-in the required enterprise authentication mechanism; a built-in capability to connect to existing corporate information systems; an integrated, configurable workflow mechanism to enforce an existing process; and the capability to provide object level user and group access control. With that in mind, PTC's staff were asked to perform configuration of the various tools to optimize them for the specific use cases the AEE Team employed.

The development server system used at Sandia/CA to install and test the software tools and their integration with Pro/E was intended only as a research platform, not as a production tool. However, care was taken to insure that the architecture was a close approximation of what the Team believed would be needed to deploy this as an enterprise resource on a classified network. This meant insuring that all software and hardware was approved for use on Sandia's Classified Network (SCN) and that the configuration could pass all computer security tests.

1.3 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 the first phase of the AEE Pilot focused on building a collaboration framework which is a key subset of the tools needed for a full implementation of an Advanced Engineering Environment.

For Phase One, the AEE Team's objectives were:

- Install a server system on the Sandia unclassified internal network.
- Determine the level of effort required to install and configure the PTC product suite.
- Evaluate the product's applicability to a limited number of typical use cases.
- Demonstrate the application of the product to staff at other NWC sites and get their input for developing requirements.

- Identify gaps between NWC needs and the COTS product.
- Develop a set of validated criteria to use as the basis for procuring a complete COTS solution to meet the NWC's needs.
- Document the project activities and distribute the information to the NWC sites.
- Lay the groundwork for deploying a quality system on Sandia's classified internal network.

Future efforts in Phase 2 will continue the work begun in Phase 1. A development system will be replicated and installed on Sandia/CA's internal classified network. When that system is operational, another classified system is planned for the Sandia/NM site. The two systems will be linked through Sandia's classified network to demonstrate connectivity between site servers.

The next step will be to deploy systems at other NWC sites to determine how to effectively link them together as the foundation of the AEE. This will require the cooperation of the sites to work within each site's cyber security requirements, information access restrictions, and other potential roadblocks. The deliverable will be a demonstration of connectivity between site servers.

Finally, the AEE Team will evaluate what is needed to deploy a production system throughout the NWC. Lessons learned from Phase 1 and Phase 2 will be applied to develop a recommendation for a complex-wide AEE solution.

1.4 Background

The AEE concept grew out of earlier collaboration projects that included visualization design facilities and classified videoconferencing. In both cases, the technology employed only addressed real-time or synchronous collaboration. To address the asynchronous aspect of collaboration, additional work needs to be done to develop, integrate, and deploy the necessary technology that will enable secure, on-demand access to data from within a fully integrated information infrastructure. Tying together both the synchronous and asynchronous aspects of collaboration is the basis for an Advanced Engineering Environment.

The AEE infrastructure will be a standardized electronic process available across the NWC with enforcement of information classification and need-to-know criteria that will satisfy data ownership requirements. The AEE will allow multiple creators and reviewers to work on a data source in a concurrent, real-time, collaborative mode. At present, some NWC sites have stand alone ProjectLink servers that allow unclassified web access to anyone with access privileges, regardless of their affiliation. The AEE is an environment that enables each site's servers to talk to one another. This will allow users to log onto their local system and have access to information (within their authorization privileges) independent of where the data is located.

By setting up multiple servers, each site will be responsible for supporting their own user base and projects. This will allow the data owners to store their data locally. This architecture is driven by the reality that while the NWC sites all want to collaborate, there are many impediments to sharing classified engineering data. It also takes into consideration the different ways the sites have implemented their computer and network security requirements. It is similar to the way that IP videoconferencing was set up, with each site owning their equipment, but cooperating in such a way that the individual systems can work together.

The biggest risks to this architecture are to get the servers to talk to each other, and to ensure that each of the sites has the network and computing infrastructure to support it. Further, implementing this environment is heavily dependent upon strong, cohesive teamwork among the sites.

Examples of how the AEE can be applied:

- Use the system to merge tooling models and data with the weapon models to enable the study of configurations of interest prior to building any of the tooling. This will help to minimize the number of face-to-face walk-downs and tooling redesigns.
- Use the system to bring together all of the documentation needed for a peer review. This will provide participants the opportunity to familiarize themselves with the documentation prior to attending the review. In addition, ProductView models will be available to provide visual information in areas that are difficult to put into words or are outside the technical knowledge of the reviewer.
- Use the system to develop a document with live links to engineering models and data. This means that as the data changes so too will the document. It will also provide the capability for multiple authors and editors to work concurrently on the various sections of a document. Examples of documentation that would benefit from this include assembly procedures, engineering procedures, product specifications, and weapon development reports.
- Use the system to construct, analyze, and test new designs and processes quickly within a simulated environment. Since this does not involve building physical prototypes, it will make it possible to look at a larger number of designs and to make a decision based on the best design option, rather than simply adopting the first successful one.
- While the AEE is focused primarily on projects with associated 3D models, it can also be used to manage any project that generates data. This includes design and program reviews, distributed component and system design, and remotely assessing problems during weapons dismantlement and assembly.

As previously stated, the AEE Pilot addresses only the “in-process” phase of an engineering product cycle. To achieve the goal of a fully integrated environment with tools for design collaboration, version management, design analysis and visualization, and technical publishing, the requirements for a product solution are extensive. For example the product must:

- Fully integrate with PTC’s Pro/Engineer, the CAD program currently used throughout the NWC.
- Provide a secure environment that enables distributed multidisciplinary teams to collaborate with concurrent engineering as if they are co-located.
- Be available at the user’s desktop.
- Enable intersite and intrasite collaboration.
- Interface with external and legacy data management and information systems.
- Meet all computer security requirements of the various NWC sites.

Other desirable features to be considered include:

- Configuration management to ensure the user has the most recent version of information to work with.
- Built-in workflow to ensure that a user must complete a step in the process before advancing to the next step. This insures product quality by enforcing process consistency. This also provides a baseline for process improvement.
- MCAD neutrality so that users can view product data through the use of a single visualization application. It should provide a way to combine models from multiple CAD

applications. This means that the formal product definition (i.e., Pro/E models) will remain in the hands of the information owner until ownership is formally transferred.

- Automatic model conversion to enable users to log on via their MCAD application and publish their models into the visualization application's format. Information can be exchanged and modified in "sandbox" mode without the formalities of PDM system. When the project is completed, the user can archive and check the data in to the corporate PDM system.
- Document neutrality so that users can store just about any data information source and tie it to the model information. This includes anything that has a MIME type such as MS Office documents, pictures, and video.
- Change notification to notify users if a data source they are interested in is modified. They should also be able to use the built-in workflow engine to route a document to the necessary reviewers.
- Collaborative visualization to enable the sharing and interaction of a 3D model between a local computer and one or more remote computers. A collaborator can interact with the model they are viewing only if the model owner gives them control.
- Provides data and information exchange to provide access to other data sources (ERP, HR databases, PDM servers, etc.) from within a user's project space.
- Authentication and access control that can be integrated to use any authentication system that is compatible with Apache web server. A corporate authentication server (i.e., LDAP, DCE) is used to build a user base, but owners can control what files a user has access to using a local LDAP directory.
- A user configurable interface so that users can modify templates and web pages to fit their needs. ProjectLink is built on web services and Java server pages. If a user is knowledgeable in these technologies, they can do the modifications themselves.
- Has compatibility with MS Project so that users can define their project in MS Project and import the data into the project space, which in turn "manages" their project.

1.5 PTC Product Suite

The AEE Team's decision to evaluate PTC's product suite for this project was driven by the following reasons:

1. Pro/Engineer is the standard MCAD application for all sites in the NWC.
2. The NWC has a volume purchase agreement (VPA) with PTC which provides a substantial discount on software purchases.
3. Per the terms of the VPA, the Windchill and ProductView clients are included with each purchased Pro/E license, or seat.
4. With PTC's recent purchase of Arbortext and the subsequent integration of Arbortext and Windchill, the PTC product suite now has the capability to associate all product documents to a master model. This will help to ensure that any information concerning a product is readily available at any stage within that product's life cycle.

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. Like many MCAD vendors, PTC also has its own PDM application, called Windchill. In recent years, Windchill has evolved into several "link" applications. Relevant to this project, the Team used the PDMLink and

ProjectLink applications. PDMLink was used for document management and ProjectLink was used for collaboration and project management.

ProductView is a visualization tool which 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.

Arbortext and its suite of applications is an enterprise-level technical publishing system that has been integrated into Windchill to manage its documents. 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 PDM 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.

Implementation

2.1 Implementation Overview

The core AEE Project Team consisted of Jill Schwegel and Alan Pomplun from SNL/CA and Rusty Abernathy and Scott Campbell from PTC Global Services. Jill served as the project manager and provided expertise in the areas of collaborative visualization, web technologies, and application frameworks. She is also the Sandia liaison for collaboration technologies within the NWC, which provided the Team with the opportunity to network with the other NWC sites. Alan managed the Team's project plan and was responsible for all project documentation including this SAND report and the AEE Validated Criteria. He is currently leading the effort to replicate the development system on Sandia's classified network. Rusty Abernathy was the technical consultant for Windchill/Arbortext integration. Based on Rusty's prior position as the CAD manager at LLNL, he provided application expertise in the business side of PLM specific to the NWC. Scott Campbell was the Team's Arbortext expert. He led the Arbortext development work, including the EA forms and the SAND Report DTD.

The implementation of Phase 1 of the AEE Pilot was completed in approximately eight months. The initial effort centered on the acquisition and deployment of a development system on Sandia/CA's internal unclassified network. Once the system was operational, the AEE Team began evaluating the PTC collaboration product suite (Windchill, ProductView and Arbortext). Several use cases were identified as candidates for determining how well the product works for typical NWC applications. The Team worked with engineering teams within Sandia and from other NWC sites to evaluate the product.

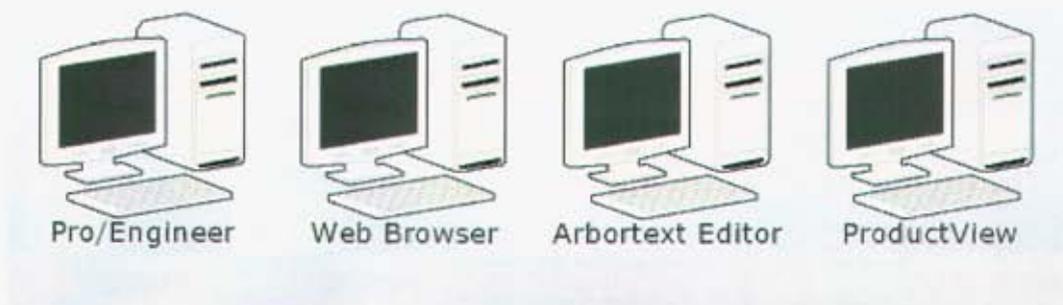
The Team then researched existing NWC requirements for collaborative applications and added new requirements based on input from NWC sites and from their work with the development system. Using this information, they developed a set of validated criteria that can be used to procure a collaborative software product for implementing the AEE across the NWC.

At the conclusion of Phase 1, the Team laid the groundwork for replicating the development system on Sandia's internal classified network. They purchased hardware and prepared to deploy the new system to enable intersite collaboration.

2.2 Unclassified Development System

The AEE development system was the first customer installation of the integrated PTC product suite. The servers that were purchased were intended for future scale-up to a production system capable of servicing 200-300 customers. Server specifications were based on those used for Windchill PDM systems with comparable capability. The hardware recommendations, included later in this report (Appendix B), are derived from the lessons learned from this development system.

Client Applications



Application Servers



Data Sources

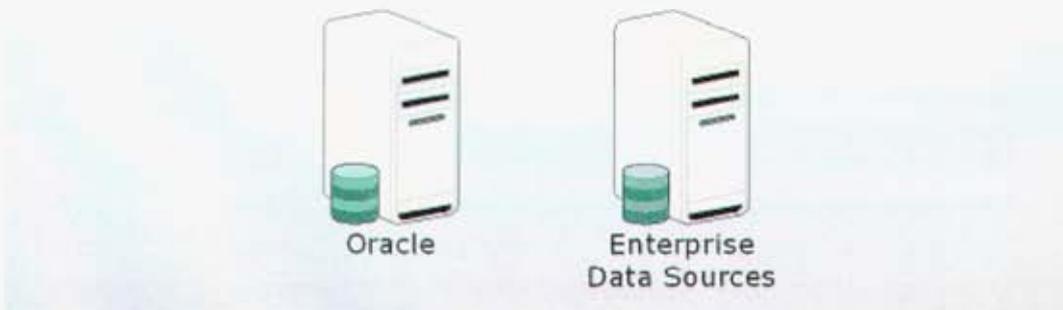


Figure 2.2.1 The AEE Multi-tier Development System Architecture.

Although a monolithic server installation could have been used, the Team chose to use a multi-tier architecture for the development. This approach was used to separate the database server from the application and publishing servers to allow the flexibility to swap out or re-configure components without affecting the other applications or modules. This type of architecture provides scalability and added security to the data store since access is through the middleware components. The primary applications run on separate servers thus improving the overall system performance.

2.2.1 Hardware

Three servers and one general purpose client PC were used for the development system. The general specifications of the three development servers are:

- Dell PowerEdge 2850
- Two dual core Intel Xeon processors, 2.8GHz, 800Mhz FSB
- 16GB DDR2 400MHz
- Windows Server 2003 OS (Standard version)
- 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



Figure 2.2.1.1 The AEE Unclassified Development System.

2.2.2 Software

The following applications were loaded on the development servers and the client PC:

- Application Server
 - Windchill PDMLink 8.0 (data manager)
 - Windchill ProjectLink 8.0 (project management and collaboration)

- Acrobat Distiller add-in
- ProductView 8.0 (Visualization)
 - ◆ Lite (browser-based visualization)
 - ◆ Standard (desktop visualization and collaboration)
 - ◆ ProductView adapter for PDF
- Oracle Client 9i
- 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
- Database Server
 - Oracle Server 9i
- Client (PC)
 - Pro/Engineer Wildfire 2.0 (MCAD)
 - Arbortext Editor 5.2
 - ◆ Used to create and edit XML and SGML content
 - Arbortext Styler
 - ◆ Used to create stylesheets for editing and multichannel publishing
 - Arbortext Architect
 - ◆ Provides configuration, development and prototyping tools that help developers build Arbortext applications

Because this project was the first customer installation of the PTC product suite, the Team compiled extensive documentation throughout the software installation process. All of the installation and configuration procedures for Windchill, Arbortext and Oracle were fully documented by Rusty Abernathy in a separate report (Abernathy, *Windchill/Arbortext Integration*).

The Team took advantage of unused Windchill licenses that were included in the Sandia/CA site Pro/Engineer licenses. Windchill is included in the Pro/Engineer VPA used by the NWC. Arbortext was a new software purchase under the NWC VPA. The Oracle installation used an existing Sandia/CA site license. The development system was installed on its own sub-net to facilitate future replication on the classified network. DCE/Kerberos authentication was used for the unclassified system.

Use Cases

Three use cases were used to evaluate the PTC product suite for applicability for typical NWC uses: an engineering authorization (EA); an operational procedures manual; and a Sandia technical report (SAND Report).

3.1 Engineering Authorization

EAs are used throughout the NWC to authorize and document all engineering design changes. Because the EA is based on existing requirements (TBP/IBP 404), it offered an ideal test of the PTC product suite's ability to meet precise requirements. It was also an opportunity to exercise Arbortext Editor's ability to be configured (not customized) to meet specific NWC needs.

The selection of the EA as a use case was driven in part by a request from a group of Los Alamos National Laboratory (LANL) engineers who had an immediate need for a new solution for completing their EAs. The AEE Team met with the LANL engineers to provide an overview presentation on the PTC product suite's capabilities and to discuss how LANL needs might be incorporated into the AEE Phase 1 effort. Based on the enthusiastic response from the LANL engineers, the Team decided to spend considerable effort on an EA solution.

The LANL engineers provided the Team with written requirements that they had already developed as part of their process for evaluating commercial software solutions for their EAs. They spent time with the AEE Team, describing both the mandatory and the desired characteristics of the ideal EA solution. The primary drawbacks to the current LANL EA process included user difficulty in entering data and no validation mechanism for the data when it was entered into the EA.

The Team developed a user-friendly solution to the EA process by creating several easy-to-use XML forms. The main form is for data entry. It captures metadata and places it in the EA. Several smaller forms were created specifically for the review and approval processes and for distribution lists. All forms were created within Arbortext Editor. Arbortext Command Language (ACL) is used to take data from the form and write it into the EA.

The Team created a first iteration of the EA forms and demonstrated them to the LANL engineers. Using their feedback, the forms were fine tuned and presented as a potential solution for LANL's needs. The LANL engineers were impressed with the EA solution and are moving forward with the purchase and implementation of the PTC product suite for testing purposes. They are using the work completed with this project's development system as the starting point for implementing a production-ready system.

The forms offer several benefits compared to the existing LANL EA process:

- Data entry is simplified. In many cases the user selects from pull-down menus.

- Data is validated upon entry, greatly reducing entry errors.
- Dependencies are automated. When an EA is opened, the appropriate data fields appear.
- The forms offer better business workflow. The EA system currently in use at LANL requires the authors to construct the EA in a very rigid manner. Users have expressed the desire for a system that is flexible enough to allow them to enter data as it is available while still maintaining the proper data validation.

An example page of the LANL EA form is shown in Figure 3.1.1. For a detailed explanation of the forms, refer to *Sandia National Laboratories Engineering Authorization Application v1.0*.

The screenshot displays a web-based form for creating or modifying an Engineering Authorization (EA). At the top, a section titled "Weapon Programs" contains a table with three columns: "Weapon Program", "Mod Number", and "Alt Number". The "Weapon Program" column has the value "W80". To the right of the table are three icons: a triangle, a cross, and a checkmark. Below the table are two buttons: "View All" and "Add to form".

Below the table is a navigation bar with four tabs: "ADC Information", "Approver Information", "Distribution", and "Related Drawings and Authorizations". The "ADC Information" tab is selected, showing "ADC Reviewer Details". This section contains several input fields:

- Site: AL
- Reviewed By: John DOE
- Title: Reviewer
- Telephone: (XXX) XXX-XXXX
- Email Address: John.DOE@doe.gov
- Mail Stop: (empty)
- Organization: DOE

Figure 3.1.1 The Engineering Authorization “Create/Modify” Page from the LANL EA Use Case.

The process for using the EA is as follows:

1. The user checks out the model from the Windchill PDM.
2. The user opens the model in the Pro/Engineer application.
3. The user edits the model.
4. The user checks the model back into the Windchill PDM.
 - a. A ProductView model is autocreated at checkin.
5. The user opens the Arbortext Editor application.
6. The user creates a new EA in Arbortext.
 - a. A new file is opened using the EA DTD.
7. The user completes all data entries for the EA.

8. The user saves the EA into the Windchill PDM.
 - a. The EA is now a managed document that is linked to the edited model.
9. The EA is approved.
10. Both the edited model and the EA are promoted to the “released” state.
11. The user creates a new baseline for the model.

The AEE Team’s prototype version of the Arbortext-based Engineering Authorization system was designed so that an EA could be created without the need for a connection to Windchill PDMLink. The intent was to build a universal solution that could be used by NWC sites that are using other PDM products. For this EA exercise, the Team used PDMLink as the repository to store the EAs that were constructed with Arbortext.

One of the requests made by LANL staff was to incorporate the ability to read information from CAD documents and existing EAs currently stored in PDMLink and then use that information to populate sections of an EA where appropriate. Examples include the Drawing List, the Affected Assemblies, and the related authorization documents. This feature ensures that the data fields will be populated from the actual object(s) that the EA references, thus eliminating data entry errors by the authors.

While working to implement this request, the PTC consultants found that the COTS Arbortext Editor browser (the mechanism for finding and checking Arbortext documents stored in PDMLink) was hard-coded to display only Arbortext documents. The consultants implemented a solution that used Info*Engine webjects (web services) to query the PDMLink database to allow the user to select CAD documents and to consequently populate the EA with information from those documents.

3.2 Operational Procedures

The AEE Team’s first exercise of the integration between the Arbortext publishing program and the Windchill PDM was conducted with an existing operational procedure (OP) that had been created for Sandia/CA’s computer visualization theater, the Interactive Design Center (IDC). The IDC OP’s MS Word text file was converted to XML format and imported into Arbortext’s standard “Doc Book v4.0” DTD. The Team had not purchased the Word importer for Arbortext, so a trial version of DocSoft’s Wordplay was used for the conversion. Once the XML content was imported to Arbortext Editor, it was edited into the appropriate structure using the various XML tags as allowed by the DTD.

This document provided an opportunity to experiment with bursting documents into reusable components. For each DTD, a burst specification defines how the data will be separated into components and stored in Windchill. Each of these components is treated independently and all components are combined when the document is composed or published. For this operational procedure, the document was burst by section. It could just as easily have been burst by chapter, or down to individual sentences if warranted.

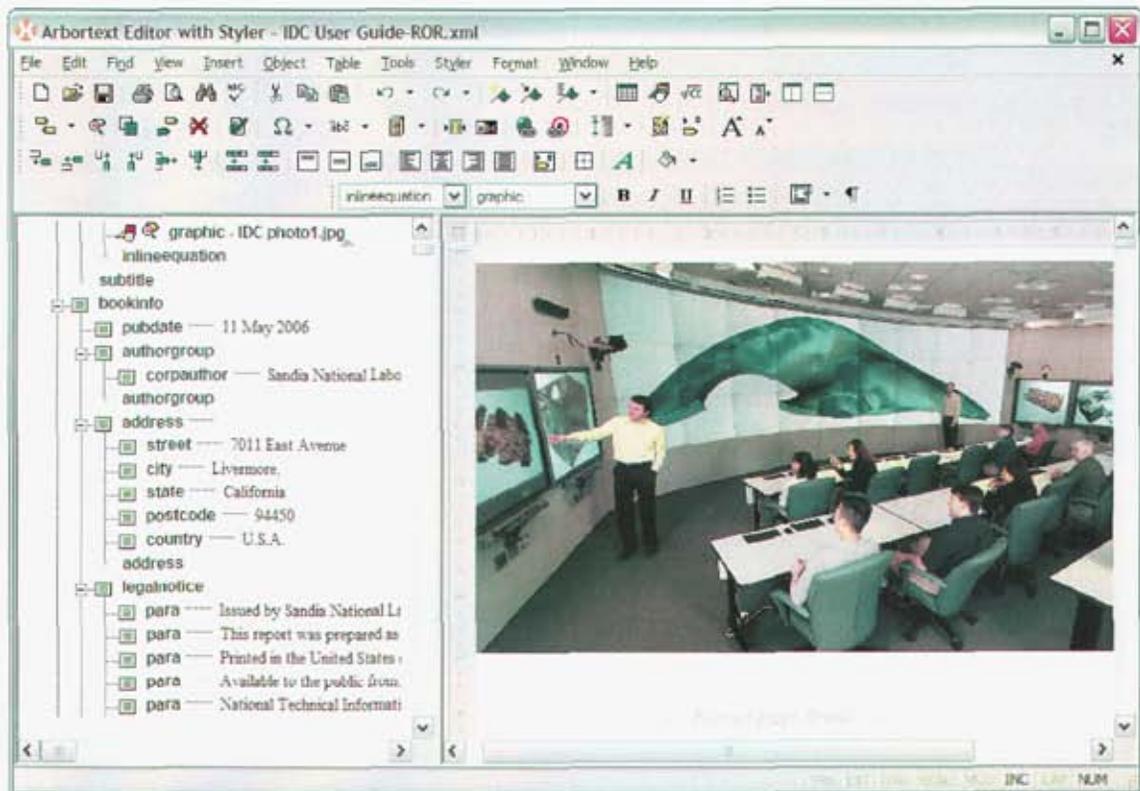


Figure 3.2.1 The IDC Operational Procedure in Arbortext.

This structure makes it possible to easily manage content within the PDM. The individual components can be modified as needed and each modification is applied to the document the next time it is published. The PDM's management ensures that users have the most recent version of content at their disposal and future published versions incorporate all changes to the individual components.

All of the graphics used for this OP were imported as JPEG files and stored on the Windchill server. The graphics are imported to the Arbortext server when composing and publishing the document. This separation of content improves the performance of Arbortext.

The Team found that Arbortext worked well for this type of document. Because there were no special formatting requirements, the "Doc Book v4.0" DTD included all of the tags needed to create the document. In this exercise, formatting in Arbortext was easier than with MS Word. For example, new chapters were easily inserted with XML tags and the table of contents was automatically updated as the chapters were added. Because style sheets are independent of the content, the user does not need to worry about what output format will be used. Style sheets for each output format (PDF, html, etc.) are applied when publishing the document and are transparent to the user.

As an example of the ease of editing in Arbortext, the Team realized that the OP used for this exercise contained references to classified computer network configurations and other sensitive information throughout the body of the text. These sensitive sections were quickly deleted from the Arbortext document and no reformatting was required. All chapters, sections and figures were automatically renumbered.

The process for the operating procedure exercise was as follows:

1. Translate the MS Word document to XML and import the operating procedure (OP) into Arbortext using the “Doc Book v4.0” DTD. As an alternate to translation, the text could have been copied from the MS Word document and pasted into the Arbortext file on a paragraph by paragraph basis.
2. Open the Arbortext editor.
3. Connect to the Windchill PDMLink.
4. If an appropriate workspace does not already exist, create a new workspace where the document will be stored.
5. Save the XML file as a Windchill object (check it in). If a burst specification exists in the system, the XML document will be broken into components as defined in the specification.
6. Show the Arbortext editor browser (object browser) and show the checked-in document.
7. Checkout an object (a document component as created by the burst specification).
8. Edit the section and check it back into Windchill.
9. Publish a PDF representation of the document with Arbortext.

3.3 SAND Report

A Sandia “SAND Report” was selected as a use case to show Arbortext’s capabilities for creating formatted technical reports. The SAND Report has clearly defined formatting requirements and it must present a corporate common look and feel.

The “Doc Book v4.0” DTD from the Arbortext library was selected for this exercise. It is a general purpose DTD that is suitable for technical reports. However, the AEE Team found that this DTD did not meet all of the requirements of the SAND Report formatting criteria as described in “*Guide to Preparing SAND Reports and Other Communication Products*”. The PTC consultants extended the DTD by inserting additional XML tags as needed to meet many of the SAND Report requirements. The tags that were added include:

- Title page (required)
 - SAND Report number
 - Distribution limitation
 - Print date
 - Abstract
- Acknowledgments (optional)
- Table of Figures (optional)
- Executive Summary (optional)
- Acronyms (optional)
- References (optional)

- Glossary (optional)
- Distribution list (required)

This exercise demonstrated the complexity of using the Arbortext product for applications where specific formatting requirements must be met. A great deal of time was spent modifying the DTD to insert the appropriate XML tags where needed. As an example, the title page required new tags to allow the insertion of the report number, the classification and the print date prior to the title. Another tag was required for inserting the abstract after the author information. In addition, the spacing of all of the title page elements had to be adjusted to meet the SAND Report criteria. Modifications to the style sheet to change variables such as font style, size and color were also required.

Several elements of the SAND Report were not addressed in this exercise:

- The distribution limitation category that is required for the report cover. The category can be one of many, and a pull-down menu for user selection would be ideal. Because this report was intended for “Unlimited Release” only, the issue was left for a future effort where it can be incorporated as an attribute. In this exercise a simple “classification” tag was added for manual entry of the information.
- The requirement to include the classification category information in the headers and footers on each page of the report.
- The standardized preprinted report cover pages that Sandia requires for SAND Reports. The cover pages were created using a separate MS Word file template independent of the body of the report.

The standard “axdocbook” style sheet from the Arbortext library was copied and modified to produce a PDF file with the required SAND Report formatting. Prior to publication, the Team submitted this report for Sandia’s Review and Approval process. The draft report was circulated to the Classification and Public Relations & Communications reviewers as a PDF file. Their recommended corrections and edits were incorporated into the Arbortext components and a new PDF was created to print this report.

One of the difficulties in using Arbortext editor is its complexity and the need to understand how to use XML tags based on the document’s DTD. For the typical user, the Team found that Arbortext is not as simple to use as MS Word for document creation. For the SAND Report exercise, text entry was at times tedious. For example, to create ordered and numbered lists, individual tags had to be entered for each list item. To create an Acronyms List and a Glossary, four tags were required to enter each term and its definition. Each tag group could be copied and pasted, but the process was slow. There are faster alternatives if a user has enough experience with Arbortext to understand what options are available and when to use them for best results. For example, the report’s Acronyms List could have been created in MS Excel and pasted into the Arbortext document using the “Paste Excel” command.

On the other hand, once the text is entered, the content is very easily modified and the individual content components can be quickly reassembled or deleted as desired and then published without any manual reformatting by the user. The Team’s conclusion is that most engineers will not want to take the time to learn how to use the Arbortext editor. Therefore, an effective use of the product will be with the creation of templates or easy-to-use forms as demonstrated with the EA, where users do not have to be familiar with the XML editor and the use of tags, but simply enter data

and text as needed. An alternative approach would be to have an experienced technical writer do the first structured version of an Arbortext document then turn it over to the content owner for subsequent content edits.

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Deliverables

The primary AEE Pilot Project Phase 1 deliverable was a set of validated criteria to use as the basis for procuring a COTS solution for deploying the AEE. In addition, the Team provided a number of demonstrations of the AEE concept and their development work to staff and managers at several NWC sites. This report fully documents their work and can serve as a reference for future AEE work both at Sandia and at other NWC sites.

4.1 Demonstrations

The AEE concept was introduced by Jill Schwegel at the April 2006 NWC MBIT Working Group Meeting. This was followed by an overview of PTC's strategic vision by Netesh Gohic from PTC's R&D Group. Due to the beta state of the actual Arbortext/Windchill integration, the demonstration of the software was done by Jeremy Morse and Ann Hein from PTC's Pre-Sales Group.

Because Sandia was the first customer to deploy the Windchill/Arbortext integration, Jill Schwegel and Chuck Oien (AEE Program manager, Sandia) were invited to present at the PTC User 2006 World Conference in Dallas, TX. Their presentations generated significant interest among conference attendees due to the fact that the AEE Team was already showing two actual use cases, the EA Application and the IDC Operating Procedure, only six weeks after the release of the Arbortext/Windchill integration. Staff from LANL expressed an interest in learning more about the integration and asked to meet with the Team to discuss its potential for their EA application.

In July 2006, the AEE team demonstrated the system to a Sandia/NM project group that was working on revamping their process for generating and maintaining TBPs. This effort was the result of an earlier demonstration to Ken Buck, the Sandia/CA representative for this team. Although this team was in the early formation stage, team members were interested in learning about the capabilities of the PTC product and understanding the possibilities for generating and maintaining new TBPs.

During the July trip, the AEE Team also visited staff at LANL to provide a demonstration and to further discuss the EA application. The LANL staff's interest in the EA application was significant in that they were already evaluating options for updating their current process for creating EAs. They were particularly interested in the fact that the Team was evaluating the PTC product with no customizations. As a result of the demo, LANL staff decided to implement the Arbortext/Windchill solution for their EAs. They are using the work completed on this project as a stepping-off point for their EA application.

Throughout the AEE Team's Phase 1 demonstrations of the Arbortext/Windchill integration product, audience members routinely identified multiple applications of the product that would solve their immediate needs, as well as other less pressing issues. In addition to the use cases documented in this report, other potential applications include:

- Creating a knowledge base of a process or project by associating any electronically generated data to its related product structure. This could include not only reports and specifications, but data analysis results, photographs, movies, or any piece of data that can be saved electronically.
- Authoring and maintaining Technical Business Practices (TBPs).
- Authoring and maintaining training manuals.
- A digital assets management system for viewgraphs, video, photographs, simulations, and other digital information files. Any electronic file with a standard MIME type can be stored and managed in Windchill.
- Creating and maintaining a website.
- Providing a central repository for the exchange of data with external customers. This would mean setting up a system on Sandia's extranet, but this is the primary purpose for PTC's development of ProjectLink. This would fit in well with the work Sandia/CA has done with the development of collaboratory environments.

4.2 Gaps and Lessons Learned

One of the AEE Team's objectives was to evaluate PTC's COTS collaboration product suite to identify gaps between the product's capabilities and the requirements for implementing the AEE. The specific types of gaps they looked for were those where an AEE functional requirement could only be met through the customization of the product's core application code. In addition to documenting the gaps in this report, the Team brought them to the attention of PTC to offer them the opportunity to integrate solutions into their application code for future releases.

Overall, the Team found that the PTC COTS product met nearly all of the AEE requirements that were exercised with the development system deployment and the three specific use cases. As previously described, some configuration and adaptation was needed, for example, to create user-friendly EA forms and to extend the standard "Doc Book v4.0" DTD for the SAND Report. The EA application was notable in that the exercise was tailored specifically to address an existing need for an improved solution for LANL applications. With no customization and only a moderate amount of configuration, the AEE Team created a user-friendly EA form that will be tested for applicability by LANL staff. Also notable was the ease with which documents within Arbortext can be edited and republished with little or no formatting by the user. Although Arbortext may not be as user-friendly as more common word processing applications, the configuration management control it offers, as well as its ability to link to files in the PDM make it a potential solution for many NWC applications.

The Team identified the following gaps between the PTC product's capabilities and those required for implementing the AEE:

- **Authentication:** The Team had problems with incorporating authentication methods, but these may be independent of the product. However, it is a critical issue for classified network deployment and intersite collaboration.
- It was difficult to get specific hardware recommendations from PTC. PTC has provided sample Windchill databases to hardware vendors such as Dell, Sun, HP, etc. in order for the hardware manufacturers to be able to provide proper sizing recommendations. These vendor sizing recommendations should be available by Q1 2007.
- Currently, only the XML file type can be used in Arbortext. In an upcoming release, PTC will add the capability to put ProductView "viewables" into an Arbortext document.

- The standard DTDs included with Arbortext did not meet the requirements for publishing a SAND Report. Extending the DTD with additional XML tags addressed some, but not all of the issues and took considerable time and effort.
- The COTS Arbortext Editor browser (the mechanism for finding and checking Arbortext documents stored in PDMLink) was hard-coded to display only Arbortext documents. CAD documents could not be directly accessed.
- There was inadequate documentation for installing and configuring some of the applications, including Oracle listener, HTTPS, and the Windchill/Arbortext integration. However, it should be noted that this was in part due to the fact that this was the first customer use of the PTC product suite and published information is now available from PTC.

The Team also compiled the following “Lessons Learned”:

- The Enterprise version of Windows Server 2003 is needed or the system can’t use more than 4GB of RAM. Due to the Team’s lack of knowledge with the use of Windows Server, they made the error of using the Windows Server 2003 Standard edition on a system with 12 GB of RAM installed on all three servers. This error wasn’t caught until all the software was installed and a complete reinstallation would have been required to implement the Enterprise version (there isn’t an upgrade path from Standard to Enterprise). The decision was made to continue to use the Standard edition on the development machines. The 8 GB of unused memory was removed from each server and was later installed in the three new servers that will be used to replicate the system on Sandia’s classified network. Those servers were intentionally purchased with only 4 GB of RAM each.
- The Arbortext Editor has a learning curve and the typical engineer is not likely to want to take the time to learn how to use it.
- For documents that stay within an existing DTD’s structure, Arbortext can be relatively easy for document creation. For documents with unique formatting such as the SAND Report, the creation of application-specific DTDs and style sheets may be needed for typical users.
- There is no simple way to convert a MS Word Document to Arbortext. Although MS Word 2003 does have the ability to save a document in XML format, the format is WordML. To get WordML into Arbortext’s DocBook format (or any other DTD in its library), a converter is needed. While there are several commercial and open source converters available, a successful conversion is highly dependent upon how the Word document was formatted. It is also dependent upon the author’s diligence in the use of styles versus manually formatting the text since the styles are what determine which XML tags will be used in the output. As such, even if the conversion isn’t perfect the Team found that using a converter and doing some cleanup work in Arbortext was much more efficient than using a cut and paste method from Word to Arbortext.

4.3 Validated Criteria

The AEE Team researched NWC and Sandia documentation for existing requirements for collaborative systems and identified the ones that apply to the AEE. Applicable criteria have been included from several documents (Hodge, Hoover, Meeks). They also gathered input from engineering groups within Sandia and at other NWC sites, some of whom were in the process of evaluating solutions for specific applications that fall within the AEE domain. Throughout the process of installing the development system and completing the use case exercises, the Team documented any difficulties they encountered as well as the gaps they identified with the PTC product.

All of this information was compiled into a set of validated criteria that can be used as the basis for procuring a commercial off-the-shelf software solution for the AEE. The Validate Criteria includes a statement of work, mandatory requirements, desired capabilities and an extensive list of technical evaluation criteria. The Team created a draft version and circulated it among interested staff at many of the NWC sites to give them an opportunity to provide feedback and additional criteria. Their responses were incorporated into the final version, which can be found in Appendix A. The Team does not consider these Validated Criteria to be an absolute representation for the AEE, but rather, are a starting point for any NWC sites as they consider implementing the AEE.

4.4 Documentation and System Demonstration

The AEE Team is using this report to document their Phase 1 efforts and to serve as a reference for anyone who wants to take advantage of the foundation established by this project. As mentioned earlier in this report, two other publications were produced to document the Phase 1 work:

- *Windchill/Arbortext Integration Version 1.1*
- *Sandia National Laboratories Engineering Authorization Application v1.0*

As the final Phase 1 deliverable, the Team will present a demonstration of the development system and PTC product to DOE/NNSA and NWC partner sites in October 2006.

4.5 Replication of the Development System on Sandia's Classified Network

By the end of Phase 1, the AEE Team had begun the effort to deploy a duplicate development system on the Sandia internal classified network. A second set of servers were purchased and installed with the PTC software suite. The process for approving the servers for use on the classified network had been initiated. Sandia's computer security staff advised the Team to incorporate the system into an existing classified server computer security plan as opposed to creating a new one. Incorporating the system into this plan requires system testing and validation, but does not require a formal approval process for the plan itself. This approach will reduce the time for system approval by as much as several months. Deployment of the classified development system will be completed in the Team's Phase 2 work.

A potential issue for the classified system is the user authentication mechanism that is required for system accreditation. This issue has been a moving target, which is the reason that many of the sites within the NWC have delayed their own implementations of a similar system. The primary issue for Sandia is that the current intersite authentication method is based on DCE/Kerberos, which is no longer being supported by IBM. The ICSI Team is in the process of developing a new authentication method, but its actual implementation has been delayed for several years. Currently, the ICSI Team is in the process of setting up test environments across the complex for certification and accreditation testing. Because the AEE Team understands that the new method will still be based on Kerberos, they decided to implement the classified system with the current mechanism (DCE/Kerberos) and make any subsequent changes once the new system is ready.

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AEE Glossary

Active Directory

A directory service from Microsoft that is part of Windows programs.

Apache

Also known as Apache HTTP Server, Apache is the web server platform used as the basis for Windchill's Internet Architecture.

Arbortext

Parametric Technology Corporation's technical publishing software.

Baseline

A model reference state against which future versions can be compared. In a configuration management system, baselining is the marking of a significant state against which a subsequent state can be compared.

Concurrent Versions System (CVS)

An open-source version control system typically implemented as part of a software project.

DOORS

Telelogic DOORS, a requirements management tool.

DynamicDocument

A Windchill data type for Arbortext documents.

eMatrix

MatrixOne's PLM application, currently used as the framework for Sandia's TMM/DDM.

EPMDocuments

A Windchill data type for Pro/Engineer files.

HTML

Hypertext markup language. An authoring language used for creating documents for the World Wide Web (www).

iCalendar

A standard for calendar data exchange.

Info*Engine Webjects

A mechanism for reading and writing to and from the Windchill database. Webjects can be called from Java server pages or from Java applets.

Java

A high-level programming language developed by Sun Microsystems.

Kerberos

A computer network authentication protocol developed by the Massachusetts Institute of Technology (MIT).

Pro/Engineer (Pro/E)

Parametric Technology Corporation's model-based computer-aided design (CAD) software.

ProductView

Parametric Technology Corporation's visualization software.

ProjectLink

Parametric Technology Corporation's collaborative project management software.

Subversion

Also known as SVN, Subversion is a revision control system designed to be a modern replacement for CVS.

Windchill PDMLink

Parametric Technology Corporation's product data management (PDM) software.

WTPart

A Windchill configuration management part.

NWC Terms and Definitions (NWC TBP-DEF 2005)

Advance Change Order (ACO)

A change authorization issued before the drawing changes are all incorporated in new drawing issues.

Advance Engineering Release (AER)

A release that authorizes the use of the listed minimum product definition by a PA to prepare for production, e.g. design or fabrication of tooling, fixtures, PA gages or testers, procurement of long lead-time items, fabrication of units authorized by Pilot Production Program Definition (PPPD), and fabrication of limited quantities of directive schedule units. The AER itself must clearly state the PA activities for which the product definition is to be used.

Authentication

The process of determining that an individual is genuine, i.e. whom the person says he/she is. A record is authenticated by the signing, initialing, stamping, or dating of a record by authorized personnel. Authentication may also include a statement that clearly identifies the responsible person or organization.

Change Release

The generic term for Engineering Authorizations (EAs) used to request changes to product and product definition or to specify incorporation of changes into product and product definition.

Concurrent Engineering

A systematic approach to the integrated design of products and their related processes, including manufacture and support. This approach is used from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, manufacturability, and user requirements.

Contractor

A commercial manufacturer or supplier acting as the seller of parts, components, or apparatus to the procuring agency.

Definition Release

The generic term for EA used to release product definition and/or authorize development, production, or reprocessing actions.

Design Agency (DA)

The organization responsible for the design of DOE/NNSA of weapon materiel and the integrity of the design through stockpile life.

Development Engineering Release (DER)

A document that issues engineering information and authorizes specific PA actions related to design, development, or fabrication of development hardware for DA use. The DER may authorize preparation of product definition for DA review and sign-off. In this case, DOE/NNSA six-digit drawing numbers and part titles are assigned via the DER.

Documents

Documents, including both design agency drawings and specifications, and manufacturing and inspection work instructions, procedures, drawings, and specifications, may be in hard copy form or software stored on computer tapes, discs, or other suitable media. They may be transmitted to the point of use without being transcribed on paper, such as to a computer terminal, or directly to a machine.

Document Type Definition (DTD)

The DTD is a mechanism or grammar used to define constraints on the logic structure and verifies the data inputs. The DTD may use both internal and external markup declarations.

DOE/NNSA Acceptance Process

The DOE/NNSA activities that ensure product quality through a combination of verification inspections, surveys of contractor's quality assurance program for compliance with QC-1 and DOE/NNSA's examination of the contractor's QA activities, which includes their hands-on inspection, surveys, testing and qualification activities, etc.

Engineering Authorization

A document used to publish general information, specify instructions, authorize/justify actions, or delineate changes that pertain to a product or product definition.

Engineering Change Request (ECR)

A request submitted by a PA to the DA to request a drawing change.

Engineering Procedures (EP)

Technical procedures and guidelines used by the NWC prior to TBP implementation.

Extensible Markup Language (XML)

XML is a subset of Standard Generalized Markup Language (SGML) and describes both the structure of the data objects (i.e. XML documents) and the behavior of the computer program that processes them (i.e. the authoring applications). XML provides a mechanism to impose constraints on the logical structure of information being processed.

Extensible Stylesheet Language (XSL)

XSL and XSL/FO are formatting languages for expressing how to render the stylesheets. A stylesheet specifies the presentation of XML documents by describing how the information is to be transformed through the use of the formatting vocabulary.

Hazard Analysis Report (HAR)

Analysis of weapon-specific operations, including operational settings and facility interfaces.

Information Engineering Release (IER)

A release that may be used to document general information not normally documented in other engineering releases. The IER is used to formally release certain types of engineering documentation.

Infrastructure Business Practice (IBP)

In cases where an information interface (protocol) between all sites to implement a TBP is needed, an IBP is generated. IBPs define the information interface between NWC agencies required to allow information of a specific type to transfer to an agency's firewall securely and accurately. Like the TBP, the IBP must be followed by each site and therefore requires concurrence by all agencies.

Life Cycle

The duration of a project as agreed upon by the customer and supplier.

Model

Any 3-dimensional computer and/or mathematical representation or approximation of a product or portion of that product used to analyze, design, define, fabricate, simulate, accept, or validate the product and/or its environment.

Model-Based Engineering

A collaborative approach that characterizes and defines design and manufacturing processes through the concurrent use and exchange of computer and numerical representations.

Modification (Mod)

A change to a nuclear weapon major assembly that alters its operational capabilities. This kind of change involves the user and requires positive control to ensure that the operational capability is clearly defined. A change in operational capability results from a design change that affects delivery, fuzing, ballistics, or logistics.

Need-to-know (NTK)

A determination made by an authorized holder [Information Steward] of classified information that a prospective recipient requires access to specific classified information in order to perform or assist in a lawful and authorized governmental function.

Nuclear Weapons Complex (NWC)

The group of DOE sites that actively participate in the development, certification, production, maintenance and surveillance of nuclear weapons.

Nuclear Weapon Complex Hub (NWC HUB)

The NWC HUB is a central server, maintained by Sandia National Laboratories (SNL/NM), through which Engineering Authorizations can be transmitted between NWC sites.

Portable Document Format (PDF)

Image file format read with Adobe Acrobat.

Product Definition

The information set released by the DA that defines a product, specifies acceptance requirements to satisfy product performance requirements, and describes product identification elements. Product definition may also specify additional design and manufacturing requirements to assure design intent is met. The product definition shall include a part defining drawing or model, and may include other models and drawings, specifications, DA specified procedures, and/or supplemental information.

Production Agency (PA)

The organization responsible for the production or procurement of DOE/NNSA weapon materiel. The term production applies to processing new and/or reused materiel as well as repair, modification, surveillance, test, disassembly, and reassembly operations.

Qualification Evaluation Release (QER)

A release that assigns the qualification status of a product, process, software, acceptance equipment, or system test equipment, and (if the evaluation results are satisfactory) authorizes the listed items for an intended use.

SIGMA

A category of access control applied to all nuclear weapons information to indicate that the information has special requirements for access or handling. SIGMA designators (SIGMA Categories) compartmentalize access to weapon information on the basis of need-to-know and approved security clearance level.

Software

Computer programs, procedures, rules, and any associated documentation and data. Computer programs, procedures, rules, and any associated documentation and data.

Software Product

A software deliverable typically consisting of an executable software program and associated operational data from a product realization process. Software product may include any or all of the elements that define the software, including software requirements specifications, design documentation, source code, executable code, operational data, maintenance procedures, test plans, quality plans, configuration management plans, and other variations of these software pieces.

Software Quality Assurance

Planned and systematic actions necessary to provide adequate confidence that a software product conforms to established technical requirements.

Technical Business Practice (TBP) System

A system providing uniform procedures and guidelines governing activities related to development, production, acceptance, stockpile surveillance, and dismantlement of components and weapons at NWC agencies or suppliers. Among the specific functions covered by TBPs are:

- Design and production drawing and specification release control, including change control
- Assurance that production processes are adequately reviewed before they are released for production
- A system for product realization that will encourage planning and teamwork, facilitate the use of modern quality tools, and reduce cycle times. TBPs will be structured according to an approved hierarchy relating higher level program requirements to process specific TBPs.

Traceability

The ability to relate individual measurement results through an unbroken series of calibration to one or more of the following:

1. U.S. national standards maintained by the National Institute of Standards and Technology (NIST).
2. National standards of other countries which are correlated with U.S. national standards.
3. Accepted values of fundamental physical constants.
4. Values derived by the ratio type of self-calibration techniques.
5. Values obtained using nationally accepted measurement systems.
6. Comparison with consensus standards.

Validation

The determination by review of quality evidence that a particular project, product, or process has met specified requirements.

Work Breakdown Structure (WBS)

A product or task oriented hierarchy identifying activities, hardware, software, services, data, facilities and other contributing elements of the project.

XML Documents

XML documents contain either parsed or unparsed data. Parsed data consists of either character data or markup encoding which describes the document's storage layout and logical structure.

XML Processor

XML processor is a software module that reads data and renders output of XML documents. Whichever processor software used must be capable of implementation all of the World Wide Web Consortium (W3C) standards for Extensible Stylesheet Language Transformations (XSLT).

A

AEE Validated Criteria

A.1 Description

The development of new capabilities to reduce weapons project design cycle times is a major thrust within programs at the Nuclear Weapons Complex (NWC) sites. An environment that enables real-time process tooling design and analysis, collaborative process flow development, version management, automated document creation, and full process traceability is needed to meet current and future national security mission requirements.

Product Life Cycle Management (PLM) is the process of managing the entire life cycle of a product from conception through the design, manufacture, service and disposal phases. These multiple phases of PLM involve countless professional disciplines and require multiple skills, tools, and processes. A subset of PLM is the iterative or in-process cycle of a product phase. A cycle may include activities such as the design development, product/design updating, prototyping, design/peer reviews, specification and process development. During a cycle, these types of activities usually have a defined sequence to follow, are interrelated to other cycles, and may run concurrently.

This Statement of Work (SOW) solicits a commercial off-the-shelf (COTS) solution to manage the in-process engineering activities associated with PLM. It must provide an integrated suite of tools for design collaboration, version management, design analysis and visualization, and technical publishing. The product must fully integrate with PTC's Pro/Engineer, the current standard CAD program used throughout the NWC.

The product shall provide a secure environment that enables distributed multidisciplinary teams to collaborate with concurrent engineering as if they are co-located. It shall be available at the user's desktop, it shall enable intersite and intrasite collaboration, and it shall interface with external and legacy data management and information systems.

The product shall require no customization or require changes to the application code base in order to meet the needs of the NWC sites. It is expected that the product will require configuration to adapt the application(s) to specific NWC business process needs. This includes, but is not limited to, the ability to plug-in the required enterprise authentication mechanism; a built-in capability to connect to existing corporate information systems; an integrated, configurable workflow mechanism to enforce an existing process; the capability to provide object level user and group access control; and the ability to automatically convert Pro/Engineer models into a ProductView file format.

This SOW does not include the management of product definition or product structure nor does it address the formal processes of Product Life Cycle Management. 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 the corporate PLM system upon the completion of a cycle.

A.2 Mandatory Requirements

The following requirements must be met for the product to be considered for award:

1. Must provide a fully integrated comprehensive tool set for:
 - a. Design collaboration
 - b. Design analysis and visualization
 - c. Technical Publishing
2. Must seamlessly integrate with PTC Pro/Engineer, the NWC's current standard CAD software.
3. Must seamlessly integrate with ProductView, the NWC's current standard MCAD viewer.
4. Must be a web-enabled application.
5. Shall require no customization (changes to source code) to meet NWC needs; product configurations are acceptable.
 - a. Shall provide the capability to integrate external applications and information systems (legacy systems) such as IMS, EBOM and NWie.
 - b. Has the ability to integrate with enterprise authentication mechanisms including Kerberos, CryptoCard, and ISCI.
 - c. Has integrated workflow capability.
 - d. Must provide automated conversion from Pro/E into the visualization application (B-reps).
6. Must provide configuration management (CM) to ensure the user is working with the latest model or document version.
7. Must have project and process management capability:
 - a. Can execute and track tasks from a project plan developed in an external application (MS Project, etc.).
 - b. Has a requirements management system capability or the ability to integrate with an external application (DOORS, etc.).
8. Must be capable of running in an unattended mode (no login required):
 - a. Windows service
 - b. UNIX daemon
9. Must be scalable to support 5,000 or more users.
10. Must have an integrated search engine.
11. Must allow for external vaulting for large data sets.
12. Must log transactions to enable auditing.
13. Must provide the 24/5 technical support and maintenance services (telephone, web-based and on-site support).
14. Must provide a complete Data Dictionary for the product.

A.3 Desired Capabilities

The following criteria are not required, but are highly desirable:

1. Integration with software configuration management tools (CVS, Subversion, etc.).
2. Has the ability to import legacy documents (Filemaker, etc.).

3. Has a bulk load capability.
4. Has an electronic signature feature.
5. Has digital rights management capability.

A.4 Technical Evaluation Criteria

These criteria will be used to evaluate products that meet the mandatory requirements.

1. Software:
 - a. Configuration requirements (how much configuration is required for the various NWC applications?)
 - b. Future software versions must install with relative transparency (no customization, minimal configuration).
 - c. Has a published application program interface (API)
 - d. Has a documented quality process
 - e. Meets SQA requirements
 - f. Has an intuitive user interface for ease of use and modest learning curve
 - g. Server software runs on Windows and UNIX platforms
 - h. User client software runs on Windows platforms
 - i. Web-enabled features:
 - i. Web-access capabilities
 - ii. Web-based query support
 - iii. Web-based viewing support
 - iv. Web-based markup/redline support
 - v. Web-based CM support (i.e. checkin, checkout, release)
 - j. Support of notification/subscription (i.e. a user has the ability to request notification if an object is modified)
2. Cyber Security:
 - a. Can use current NWC authentication method
 - b. Is adaptable for future authentication methods
 - c. Can pass all DOE/NNSA software security requirements
 - d. Provides object level user access control (file, data, etc.)
 - e. Access is assigned by the user upon add or check-in of the object.
 - i. The data owner(s) should also be allowed to specify which user(s) can access each item and specify the type of access (e.g. r=read; w=write; d=delete).
 - f. All data vaults, database files, and audit trail files are secure from normal user accounts and accessible only by administrators
 - g. Supports audit trails that include transaction recording and monitoring of application activities
 - h. The identification and authorization interface conceals the typed passwords when entered by a user with the ability to handle six or more non-blank characters for the password
 - i. All users have a unique login and password assigned to them

- j. Has password management capabilities such as password expiration
 - k. All user identifiers and passwords can be suspended
 - l. All vendor-supplied passwords and login names are identified and must be changeable
3. Technical Support/Maintenance:
- a. Response time
 - b. Online help functionality
 - c. Q-cleared support staff (no escorting required)
4. Design Collaboration:
- a. Has built-in workflow (must complete a process step before advancing to next step)
 - b. Has a baseline capability
 - c. Provides change notification when a data source is modified
 - d. Is compliant with CMII or a comparable industry standard
 - e. Management and collaboration on heterogeneous MCAD/ECAD data, software, and documents
5. CAD Integration:
- a. Has the ability to link miscellaneous files to Pro/E configuration models or drawings
 - b. Management of other Pro/E modules such as Pro/Mechanica
 - c. Has the ability to bulk load Pro/E files such as a third party mechanical commercial libraries
 - d. Vendor shall divulge their migration plans to new releases of Pro/Engineer
 - e. Vendor shall identify all Pro/E modules that are not supported
 - f. Has the ability to manage more than just Pro/E files:
 - i. CAE applications such as Veribest
 - ii. Microsoft Office files
 - iii. Viewable image files
6. Technical Publishing:
- a. Uses a common programming language (XML, SGML, etc.)
 - b. Provides general purpose, industry standard DTDs and allows for specialized DTDs
 - c. Has comprehensive content management with full integration to design collaboration environment:
 - i. Provides the ability to break content into reusable components
 - ii. Content is treated both as components and compound documents
 - iii. Has automatic updating when individual components are modified
 - iv. Provides the ability to reuse content across the enterprise
 - v. Provides the ability to limit access to content based on user roles
 - vi. Provides the ability to easily assemble components into application-specific documents
 - vii. Enables inline editing of document components in compound documents
 - d. Can publish information to multiple formats from a single source of content:

- i. Common output formats (html, PDF, etc.)
- e. Has the ability to embed interactive graphics with live links to engineering source data
- f. Has automated document tracking tied to design collaboration workflow
- g. Is capable of integrating with other ECM, PLM, and ERP systems and data sources
- h. Formatting is independent of content:
 - i. Style sheets for specific applications
 - ii. Can easily repurpose content
- i. Ability to link to external data files (Excel, etc.)
- j. Has automatic updating when linked components are modified:
 - i. Must be a “living document”
 - ii. Has active links between various applications
 - iii. Has dynamic content updates
- k. Can import MS Word and other common word processing program files
- l. Has extensive word processing capabilities:
 - i. Cut and paste
 - ii. Drag and drop
 - iii. Change tracking
 - iv. Real-time spell checking
 - v. Multiple levels of undo/redo
 - vi. Keyboard macros
 - vii. Dockable toolbars
- m. Ease of use (familiar controls and commands)
- n. Supports current and next-generation Web standards for sharing content, data and applications
- o. Editor capabilities are accessible through APIs
- p. Can automatically merge data from corporate business systems
- q. Can create and configure dialogs and toolbars through XML configuration files and embedded ActiveX controls
- r. Has controls for assembling content from multiple contributors
- s. Applicability for NWC documents (including, but not limited to the following representative examples):
 - i. LANL Engineering Authorization (Gardiner 2006):
 - I. Can produce up to 70 EAs per week
 - II. Can capture all data fields required for each EA type, per TBP/IBP 404
 - III. Supports configuration management of product definition (can associate EA to Product Definition in a Product Structure)
 - IV. Must be able to identify open ACOs, RENs and ECRs
 - V. Incorporates ADC review process
 - VI. XML file is auto-generated and archived

- VII.** Incorporates an electronic approval process
 - VIII.** Can validate locally and to Sandia Hub
 - IX.** Can be updated as TBP/IBP 404 changes
 - X.** Can print an EA at any point in the creation process
 - ii.** Sandia SAND Report:
 - I.** Provides an easy to use standardized template for common look and feel technical reports
 - II.** Offers all SAND Report structure elements as detailed in “Guide to Preparing SAND Reports and Other Communication Products” and paginates elements as required:
 - A.** Front Cover
 - B.** Disclaimer Page
 - C.** Title Page
 - D.** Acknowledgments
 - E.** Table of Contents
 - F.** Preface (optional)
 - G.** Executive Summary (optional)
 - H.** Acronyms or Abbreviations
 - I.** Body of Report
 - J.** References and Bibliography
 - K.** Back Matter:
 - A.** Glossary (optional)
 - B.** Appendices (optional)
 - C.** Index (optional)
 - L.** Distribution List
 - III.** Creates standardized cover and title pages
 - IV.** Has the capability for incorporating complex equations
 - V.** Can import unique symbols
 - VI.** Standardizes references
 - VII.** Can incorporate classification markings in headers, footers and cover pages
- 7.** Data Analysis/Visualization
 - a.** Real-time analysis and simulation regardless of user location
 - b.** Interactive, multi-site collaborative reviews of entire product design
 - c.** Realistic, interactive digital mock-ups
 - d.** Intuitive, easy to use GUI
 - e.** Provides product information access through a web-centric and scalable environment
 - f.** Has seamless integration with Pro/E:
 - i.** Full, automatic conversion of Pro/E models to visualization tools

- g.** Is fully integrated with other tools in product
- h.** Can integrate with other document types
- i.** Can view myriad product data without the authoring application:
 - i.** CAD files
 - ii.** MS Office documents
- j.** Can measure accurately, section and compare 3D models and assemble parts and complex product structures
- k.** Users can collaborate on centrally organized digital product information through markups and real-time collaboration
- l.** Allows users to easily share visual information across the enterprise

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