Computer-Aided Engineering for CANDU Projects

by
Huang Zhizhang* and David Goland**
*Shanghai Nuclear Engineering Research and Design Institute
**Atomic Energy of Canada Limited

1. Introduction

Qinshan CANDU Project Engineering at Atomic Energy of Canada Limited (AECL) is using several computer-aided engineering (CAE) tools among which a computer-aided design system (3-D CADD) is prominent. The CADD system drives the engineering work process, assuring consistency, quality and speed in producing engineering deliverables, while other CAE tools perform material management, electrical wiring management, document management and various analyses. A distinction is made here between a new CANDU project and a repeat project, such as the Qinshan project. Yet other CAE tools are used for detail design and for mechanical design. A portion of Qinshan engineering work consists of adapting the design from a reference plant on which Qinshan project is based, into the specific Qinshan design. This paper describes project tasks that are performed through the CADD/CAE system and the challenges that are met. The Qinshan tasks and deliverables include the production of 3-D models, clash (interference) resolution, 2-D drawings extracted from models, text reports, external links to material management, and 3-D visual design reviews.

2. Qinshan Project CADD System

2.1 CADD system Overview

The 3D model is in the center of the system, with input flowing into it from three sources:

A Reference Database which supplies information about shapes and dimension of plant items, industry and vendor standards, and allowable item types and ranges according to engineering specifications.

The human designer who selects items to place in the model, decides where to locate the items in 3-D space and chooses the routing of piping lines.

An intelligent Process and Instrumentation Diagram (flow-sheet or P & ID) from which the model is fed with information on piping line numbers, specification names, and line sizes, as well as design and operating temperatures and pressures.

The 3-D model consists of graphic files linked to an alphanumeric database.
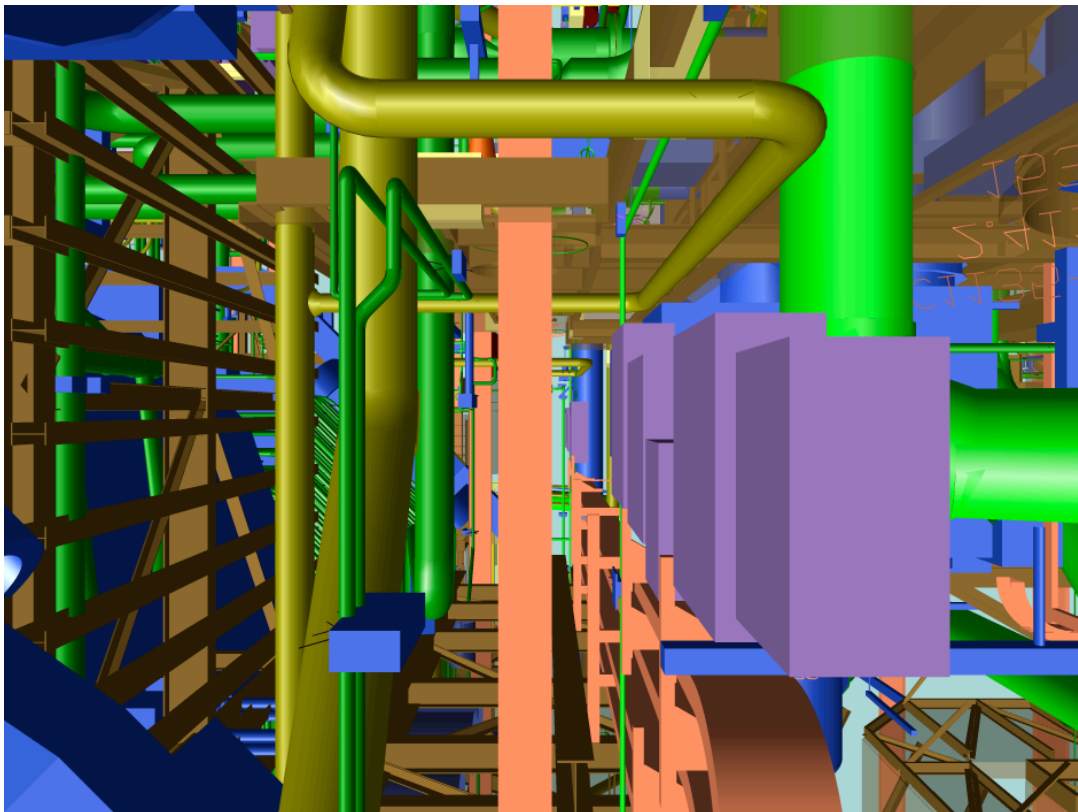The software automatically checks the model clashes (interference) while the designers correct the layout until the model is clash-free. Also during the design, the model is

viewed through realistic 3-D walk-through software for design review, for layout coordination and for clash resolution.

The completed and checked model is the source of engineering, fabrication and construction documents such as the piping isometrics, general arrangement and layout drawings, bill of materials, piping line lists and weld lists. Other products of the 3-D model are illustrations and movies. The diagram below depicts the 3-D CADD system used on Qinshan Project.
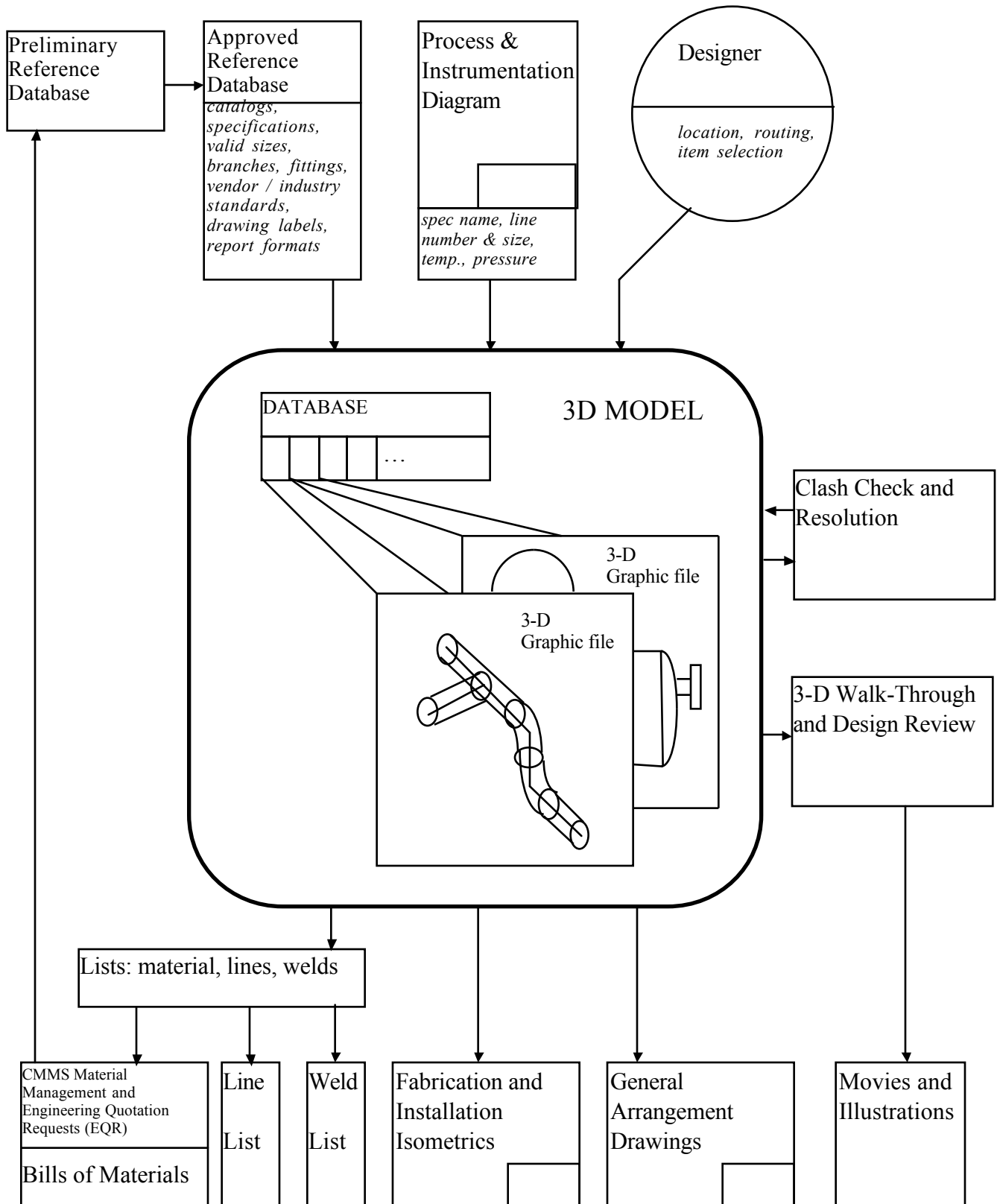
Since Qinshan Project design is based on a existing Reference Project, AECL was able to replicate large portions of the 3D model from a pre-existing space-allocation model of the reference project. It has been necessary, however, to enter much data into the model database regarding vendor-specific information and data which were missing from the space-allocation model.

The CADD system hardware consists of several servers, some on AECL's premises and others at a sub-contractor's in another city. Connected with high-seed data line, the servers appear to all users to be practically at the same location. Multiple copies of the 3-D models are installed at the construction site for viewing with walk-through software.

Detail from the 3D model

2

3D CAD SYSTEM: QINSHAN CANDU PROJECT

Preliminary Reference Database

Approved Reference Database
catalogs, specifications, valid sizes, branches, fittings, vendor / industry standards, drawing labels, report formats

Process & Instrumentation Diagram
spec name, line number & size, temp., pressure

Designer
location, routing, item selection

3D MODEL

DATABASE

...

3-D Graphic file

3-D Graphic file

Clash Check and Resolution

3-D Walk-Through and Design Review

Lists: material, lines, welds

CMMS Material Management and Engineering Quotation Requests (EQR)

Bills of Materials

Line List

Weld List

Fabrication and Installation Isometrics

General Arrangement Drawings

Movies and Illustrations

3

2.2 Civil Design

Computer-Aided Engineering tools for Civil/Structural Engineering at AECL CANDU are based on the Intergraph FrameWorks software. The software is used for the construction of a 3-D model including concrete slabs, floors, walls and holes, and well as steel linear members such as columns, beams and braces. The software also handles steel platforms, stairs and rails. The software creates graphic files which define the geometry as well as a local database which defines the materials and properties of the structural members.

2.2.1 Steel Catalogs

FrameWorks software uses catalogs of standard linear steel members from many fabricators including China, Europe, USA and Canada.

2.2.2 Link with Analysis

FrameWorks is capable of generating input data for STAAD III structural stress analysis software. Qinshan project is not using STAAD III, while ANSYS and STARDYN used on Qinshan for stress analysis and design are not linked to the 3D CADD model.

2.3 Process Design

2.3.1 Intergraph's PDS P&ID

PDS P&ID (Plant Design System - Process and Instrumentation Diagram) is used for the creation of intelligent process and instrumentation diagrams. P&ID stores graphic information in graphic files and alphanumeric data in relational databases. The data includes equipment, piping and instrumentation labels for items and associated design/operating conditions.

In a typical session, the designer places graphics for equipment with nozzles and then connects the equipment items with piping. Valves and specialty items are then placed on the piping lines, followed by the definition of instrumentation loops and the placement of instrument items owned by these loops. The designer then places line attribute breaks, flow arrows, and labels for equipment, piping lines, and instruments.

The next step is propagation. The act of propagation serves to read the text information from the graphic file and uses it to populate the relational database. In this database (called "task database") the data changes often, as the P & ID's are developed.

The 2-D reference database (RDB) governs the attributes of the graphics, the symbols, and allowable values for alphanumeric information, as well as format of lists (e.g., valve lists) extracted from the task database.

Another use for the P & ID is the transfer of information from it, into the 3-D piping model. The information consists of piping line information, such as piping specification, size, fluid, number, temperatures and pressures, which are loaded into the 3-D center-line.

2.3.2 PD _Design for Piping Modeling

A module of Intergraph's plant design system, PD_Design is used to create and modify 3-D models of piping and tubing systems, including in-line instrumentation and support location. PDS Piping stores project layout graphics in graphic files, while the alphanumeric information, linked to the graphics, is stored in relational databases. The data is used for clash detection, drawings/reports extraction, walk-through, and stress analysis.

During a typical modeling session, the designer routes intelligent pipe center-lines which carry data. The data for the center-line, such as line size, specification, pressures and temperatures, come either from manual entry or directly from the P & ID. As the center-line is routed, the designer sees all the models from other disciplines and other designers' piping and equipment models, so the designer is able to visually fit the layout around objects already placed in the plant model and to connect to nozzles on equipment. The designer then calls up valves, and specialty items from the 3D Reference Database, and places them in their proper locations on the center-line. The designer also situates fitting-to-fitting assemblies in the model. Finally, the software places automatically all remaining fittings and pipes, as defined by the specs.

There are three databases for the Piping PDS (plant design system) application:

i. **Piping/Equipment Design Database**, which holds all the instances of the model components, such as piping fittings, pipes, nozzles, and the associated data, e.g., wall thickness, material grade, and pressure rating. Each graphic component in the graphic file is uniquely linked to an entry in the Design Database.

ii. **Piping Reference Database (RDB)**, which holds all piping specifications and manufacturer catalog information. The specifications contain information regarding the allowable fittings, materials, sizes, etc. In addition to the relational database, the RDB includes information in other formats (ASCII files and Intergraph library files), which contain, among other things, dimensional information, industry standards, Project standards for model graphics and messages, drawing labels, and piping component verbal descriptions.

iii. **Project Administration Database**, which holds information about the way the Plant model is partitioned into files, their location on the computer network, and the geographical location that the model in each file spans in the Plant. The location and description of models from other disciplines is also stored here, to

allow integrated tasks, such as clash check, drawing composition, and walk-through. This database also contains information about the orthogonal drawings which are defined in the project, the isometrics that are extracted, the material reports formats and content, as well as the information on clashes and their management.

It should be noted that where practical, the Piping application shares reference data with the P&ID RDB. This sharing helps to ensure that consistent standards are applied across a design project.

2.3.3 PD_EQP for Equipment Modeling

PDS PD_EQP is used for modeling anchored equipment items such as pumps, heat exchangers, and vessels with nozzles which are connected to PDS piping models. This software is used also for modeling equipment for other disciplines such as electrical panels, embedded parts, pipe hangers and cable tray supports. The software defines equipment volumes, for clash (interference) checking, for graphics to be placed in extracted drawings, and for walk-through sessions. The equipment volume may include only the physical volume of the equipment, or also its maintenance and installation envelopes. Access corridors which are not associated with any specific equipment item are also modeled with PD_EQP. The clash checker will identify a "hard" clash with the physical equipment volume, and a "soft" clash with the reserved access envelope.

Equipment models are composed of graphics in graphic files, and from alphanumeric data, which are stored in a relational database. The alphanumeric data include the equipment tags and descriptions, as well as the nozzles properties.

During a typical modeling session, the designer places primitive shapes, for example, cylinders, cones and boxes, and groups them into equipment items (pumps, vessels, etc.). The dimensions and weights are keyed in from manual equipment data sheets. Most of the nozzle information (such as flange outside diameter) is read directly from piping specifications in the piping Reference Database.

2.4 Electrical, C & I Design

2.4.1 Schematics
The suite of software module for the creation of electrical schematics is not advanced enough in its development for use on a project. The production of instrument loop diagrams, one-line diagrams, elementary diagrams is done manually, using drafting software and graphic files.

2.4.2 3D Raceways

EE_Raceway, part of Intergraph's PDS (plant design system), is used to create and modify 3-D models of electrical raceways, including cable trays, conduits, junction boxes, and air-ways (free cables). The software stores the project layout in graphic files, while the alphanumeric data, linked to the graphics, may be loaded into a relational database.

During a typical modeling session, the designer routes intelligent tray and conduit center-lines which carry data, such as tray cross-sectional dimensions, material, system and unit-weight. The designer can place tray fittings manually, or dress up the center-line automatically with fittings and straight tray.

There are two databases for EE_Raceways:

i.   The Design Database, which holds all the instances of the model components, such as fittings, straight trays, conduits and junction boxes. Each graphic component in the graphic file is linked to an entry in the Design Database.

ii.   Reference Database, which contains trays and conduit specifications, such as materials, dimensions, and weights. The designer is restricted to the choices which are available from the Reference Database.

These databases must have a common "RIS schema file" with P & ID and with Piping/Equipment to allow the sharing of data.

The software features material take-off and weight/center-of-gravity reporting.

The EE_Raceway model is clash-detectable.

2.5 Clash Checker

This is a module of Intergraph's PDS software, used for the detection and management of clashes in the 3-D model.

The clash detection software produces one picture per clash, showing the two clashing items, their location in the plant, the type of clash ('soft' for envelopes and insulation, 'hard' for hard physical items), and the model files which contain them.

The clash management software allows the review of the clashes on the screens of the work-station, in 3-D, for the approval and/or commenting of the clashes for action (who moves). A unique clash number is assigned to each clash for tracking through the design process. This number is not re-used even if the clash is approved or resolved. Clashes are approved as penetrations, or as false clashes (usually stemming from simplified modeling).

A separate clash pre-processor prepares the 3-D model files for a clash check, through processes called 'envelope creation' and 'envelope verification'.

2.6 Orthogonal Drawings Generator
PD_Draw, a part of the PDS (plant design system) software, is used for creation of drawings, including plans elevations and sections, as well as isometric views. It allows the designer to define drawings in the Project database, including the boundaries of the drawing's volumes (rectangular boxes "carved" out of the Plant, which are projected onto the drawing sheet), the view orientation and scale, as well as the model files and item categories that are to be shown.

The selection of files by disciplines, allows the creation of drawings for Process (piping, equipment, and HVAC arrangement drawings), and for Instrumentation Control & Electrical (tray arrangements, instrument location).

The software performs hidden-line removal to convert the view from an incomprehensible wire-frame into a standard line-drawing.

The software allows the semi-automatic annotation of the drawing, i.e., the draftsperson points at items in the drawing, and the software retrieves their labels from the database and allows the draftsperson to place them in the drawing.

2.7 Isometric Drawings Generator
PDS Isometric interface extracts and converts PDS Piping data and transfers them to ISOGEN (by Alias, UK). The software then creates fully annotated piping fabrication isometric drawings with the related bill of material. Isometrics extraction can be done in interactive or in batch mode. The interactive extraction is used for testing piping model integrity and for testing the batch setup. The batch mode is used for the Project bulk isometric drawings production. Once Isometrics software support staff sets up the batch process, the extraction is fully automatic for the whole Project or for a selected portion. Some additional annotation is required at times, e.g., for the addition of welded attachments

A wide selection of drawing formats exists in the software, for various standards and for setting criteria for the selection piping lines.

2.8 List, Bills and Reports Generator
This PDS module extracts bills of materials, weight reports and center-of-gravity reports from the 3-D piping models. The reports may include implied materials (gaskets, bolts, nuts), size-dependent commodity codes, full verbal descriptions for piping items, in-line instruments, and pipe supports.

The reports are controlled by two types of files:

- format files - to determine where on the sheets the information will appear
- discrimination files - to determine search criteria

The users can then generate reports by piping line number, by process system, by construction area, by piping size or class, etc. Types of reports include material takeoff, line list weld list and insulation quantity.

AECL has linked these reports to CANDU Material Management System (CMMS) which automatically creates the material demand in the system.

2.9 3D Walk-Through

DesignReview is Intergraph's software for review of 3-D models. It displays the combined model files on a specially-equipped work-station with a large screen and a high-performance graphics card. The display is in fully shaded perspective, with a capability of movement through the model. "Walking" along three global axes and three local axes is possible, as well as rotation of the viewer's virtual head about these axes. In the "encircle" mode, an object of interest is brought to the center of the view, and then viewed from all sides.

The reviewer can point at objects in the model and view text information about them, such as piping line number, pressure, tray system number, weld number and item tags. Groups of items can be turned on or off, or re-colored for clarity, or moved and rotated for "what-if" analysis. The reviewer can measure distances in the model as well.

During the review sessions the reviewer can place comments in a special tag file, which can be recalled by other reviewers, or sent back to the designer to take actions for model revision.

Periodically, the DesignReview Integrator software collects selected information from the databases and then loads it, together with the models' graphics, into the DesignReview work-station, for updating the DesignReview files. This is necessary, since the DesignReview software operates in a stand-alone mode, without direct access to the Project database and graphics.

2.9.1 Illustrations and Movies

During a 3-D walk-through in the model, the images may be stored either as still pictures or a sequence of frames. A software for movie frames manager (e.g., Adobe Premiere) is employed for the generation of video clips and full fledged movies with titles, special effects and sound.

Intergraph's ModelView software is used for the creation of photo-realistic pictures of the 3-D model using the ray-tracing technique, including cast shadows, reflections, refraction, and material assignment. The software is capable of repairing and improving the resulting pictures, and it allows their annotation.

3. Non-CADD Computer-Aided Engineering Tools

3.1 Stress Analysis

3.1.1 STARDYNE, ANSYS and PATRAN

These are widely-used software packages for civil/structural and mechanical stress analysis. Based on the finite-element method, they are used for the static and dynamic analysis of structures and machines.

The key factor in proper use of these software packages (and any other software based on finite-element, e.g., ADLPIPE), is the correct representation of the physical structure by the mathematical finite elements. This includes the correct selection of elements and nodes, and the correct representation of restraints and loads.

Graphic and numeric user interfaces facilitate data entry and the review and evaluation of the results of the analysis. Plots of deformation and stress contours are produced for this purpose.

A post-processor allows the combination of loads, but it does NOT perform Code evaluation. In light of this, structural design, such as automatic section selection, plate sizing, and concrete re-bar sizing are not done in AECL through these software packages.

AECL is using mainly STARDYNE on Qinshan Project, primarily for seismic floor response spectra (FRS) calculations. The software is used without any links to the CADD model.

3.1.2 ADLPIPE for Piping

A commercial nuclear piping stress analysis code, ADLPIPE is the preferred tool for piping stress analysis on new CANDU reactor designs. ADLPIPE has been integrated into the AECL's design software suite, and is compatible with PDS piping models via PD_stress. Some of the features of ADLPIPE are: It meets ANSI and nuclear ASME codes, dynamic loads with multiple response spectra, special load combination and reports, and one-way restraints.

Detailed descriptions of ADLPIPE are available in ADLPIPE Manuals.

3.2 Thermalhydraulic Analysis

AECL has developed these three software packages for fluid flow, pressure drops and heat transfer calculations. None of this software has links to other portions of CAE.

NUCIRC is used for steady-state thermalhydraulics
PTRAN is used for fluid flow transients.
ALITRIG is used for Shutdown System 2 transient analysis.

3.3 Detail Design

3.3.1 Pipe Support Design

This software is still under development.
AECL is aiming for a software package that will perform the following tasks:
- Automated pipe support design and detailing system.
- Conformance with ASME Section III, Subsection NF design.
- A detailed bill of materials for each pipe support.
- Local interference check.
- Check integrity of existing designs.
- Deliverables: Bill of material, stress summary report, attachment point loads file (loads transferred to the building).

3.3.2 Embedded Part Design

Software is currently under development for managing embedded parts, including a database that lists their numbers, location and items passing through them (e.g., pipe penetration) or attached to them (e.g., supports base plates). No software is currently being used for the detail-design of embedded parts.

3.4 IntEC - Electrical Cable Management

IntEC is a program developed at AECL in order to computerize via an interactive database, a nuclear plant's cabling and wiring design and management.

IntEC is comprised of three databases:
   The first database contains reference as well as cable specification, conductor and terminal configuration tables. These tables contain the data validation and design rules required by other IntEC applications. There is only one reference schema for a project. The IntEC reference database also contains tables required by Intergraph's Electrical Engineer (EE) product line of software.
   The second database contains the device catalog information, the structures data and all the network file management data as customized by AECL for managing CANDU design files.

The third database contains the electrical project design data which includes all the cabling and wiring data.

IntEC contains all the cabling, wiring and support data required to construct, commission and operate a plant.

IntEC features include:
Standard object definitions for Cable and Conductor Specifications, Device Specification and Device Terminal Configuration, and Cable Assemblies
Structures Management
Raceway Data Management for Raceway Data Definition, and Raceway Network Definition
Cable Management for Cable Assignment, Cable Definition
Material Demand
Devices Management for Device Definition and Terminal Definition
Wiring Design Applications for Structures (Panel) Wiring, Cable Terminations and End-to-End Wiring

3.5 CMMS - CANDU Material Management System

This system has been developed by AECL for the management of construction materials of CANDU Projects.

The material demand from the various disciplines is created as the design progresses, and the material is added up manually (before 3D CADDS existed) and then keyed-into the CMMS. The supply is created as the Engineering Quotation Requests (EQR) are entered manually into the system based on manual estimates from previous projects. The information is entered as stock code numbers and the corresponding quantities. The system produces bills of materials, EQR's, tenders, purchase orders, and reports for planning and monitoring.

Since some of the CANDU design is not done within AECL, not all the material is entered into the system. Structural steel, for example, is handled outside CMMS and outside AECL.

Since Qinshan project employs 3D CADDD, AECL has established a link between the 3-D models and CMMS so that the demand is created and entered automatically for modeled piping and for electrical cable trays. This results in a much more accurate estimate of the total demand for these items.

3.6 Mechanical Engineering

AECL is using, outside Qinshan Project, a mechanical design software package which is not integrated with the other project disciplines. A typical mechanical design package includes features such as:

- Parametric feature-driven solid modeling.
- Single parametric feature-driven database:
- Advanced feature design Shell, Complex Domes, 3-D sweeps and complex blends.
- 2-D design.
- Compile assemblies.
- Non parametric 2-D design
- Dynamically moving shaded design.
- Management and coordination of multiple teams of designers.
- Automatic mesh generation of FEM of thin-walled designs.
- Automatic FE mesh generation.

Mechanical design software is used in the mechanical discipline where a tight coupling of detail design, analysis and fabrication is required. The requirements from the software are that is features a parametric solids modeler with facilities for production of solid models, production of finite element meshes, a connection to commercial finite element solvers (such as ANSYS), drawing production facilities and connection to numerically controlled (NC) machines.

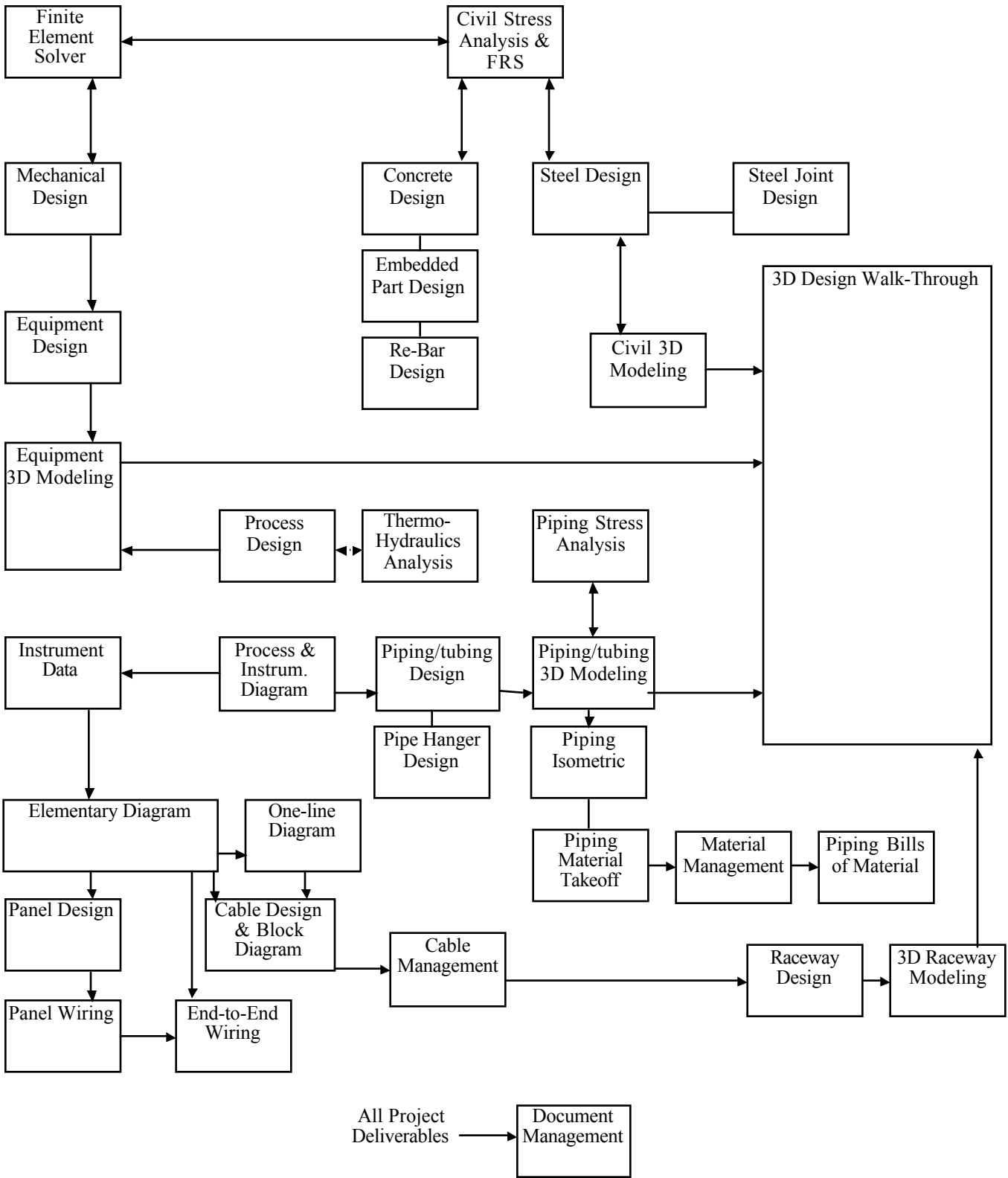## 3.7 AIM/TRAK - Document Management System
AIM (asset information management by Intergraph) is the system which controls official project documents. TRAK is an additional software that AECL developed to suit the corporate special needs.
All official drawings and reports extracted or created using CADDS, as well as non-CADDS documents are stored and managed using Intergraph's AIM software. The official documents are created, checked, approved, revised, electronically signed and issued as per existing procedures for drawing revision control.
AIM features capabilities for searching, viewing and tracking revisions of documents through a set of meta-data which describe the properties of the document and its history.

4. Design Process
The illustration below describes the generic CANDU design process using advanced engineering tools. However, repeat projects, such as Qinshan do not require all the design steps. For example, stress analysis for Qinshan design is minimal, and is usually done by assessment rather than by calculation. Another occurrence that is typical in a repeat project is the minimal requirement for repeating detailed design, such as in embedded parts, supports and structural joints and re-bar.

Finite Element Solver

Civil Stress Analysis & FRS

Mechanical Design

Concrete Design

Steel Design

Steel Joint Design

Equipment Design

Embedded Part Design

3D Design Walk-Through

Re-Bar Design

Civil 3D Modeling

Equipment 3D Modeling

Process Design

Thermo-Hydraulics Analysis

Piping Stress Analysis

Instrument Data

Process & Instrum. Diagram

Piping/tubing Design

Piping/tubing 3D Modeling

Pipe Hanger Design

Piping Isometric

Elementary Diagram

One-line Diagram

Piping Material Takeoff

Material Management

Piping Bills of Material

Panel Design

Cable Design & Block Diagram

Cable Management

Raceway Design

3D Raceway Modeling

Panel Wiring

End-to-End Wiring

All Project Deliverables

Document Management

CANDU Project Design Modules

Note: Software modules and links not yet integrated into the overall system are shown in dashed lines

5. Challenge And Success on Qinshan CANDU Project
AECL was faced with several new challenges when it was decided to use 3D CADD for the first time in a full-fledged CANDU construction project.

5.1 From Theory to Practice
AECL has been using PDS software for over ten years in a product development environment, which is quite unlike a construction project. The detail of 3D modeling is much greater in a construction project, and the volume and rate of data entry are on a large scale. AECL needed to train additional staff for the use and operation of the software.

5.2 Design-By-Area - A New Concept
To achieve an effective engineering and construction schedule, AECL divided up the Qinshan plant into Areas. By contrast, the reference project did not employ the concept of release for construction (RFC) by area, i.e., the engineering deliverables were issued for a whole process system in a single release, regardless of the plant areas it traverses. For this reason, the model imported from the reference plant was organized in files whose content spanned many plant areas. As a result, when we imported the preliminary model from the reference project, we had to break up the model files into areas, so that the items in each model file are contained in a single area. This proved to be a considerable effort.

5.3 Software Customizing and Development
The Plant Design System (PDS) software, as delivered from its vendor (Intergraph Corporation), required adjustments, customizing and selection of specific options to suit the project needs. A particularly challenging task was the creation of computerized piping specs which will accommodate the existing CANDU 6 design. Also, new software features which were introduced during the course of the project required testing and integration into the work process. AECL's pre-existing project practice required a robust link with CANDU material management system. Consequently, AECL has developed special software which reads data from the lists extracted from the 3D model and then inserts these data as demand-items into the corporate material management system.

5.4 Pioneering New Software Feature
AECL is one of the first users of a new feature in Intergraph software, which draws reference grid lines on piping isometrics. An earlier software version generated the isometrics without reference grid lines, resulting in the need to have manual addition of such lines using drafting software. AECL needed to test various options together with the software vendor before this feature could be used in production. Also, the whole 3D model needed to go through a version translation and a database re-configuration to benefit from this feature.

5.5 Cable Trays Modeling

AECL has devised an original method in modeling electrical cable trays. The 3D model is composed of two parts: a "physical" model which, looks like cable trays and is used for clash checking and visualization, and a "logical" model which contains intelligence for producing engineering documents for tray fabrication and installation. The latter is a model built with piping modeling software, enabling the automatic production of isometric drawings and bills of materials.

5.6 Materials: Specification Versus Procurement

AECL endeavors to improve existing piping material specification with the intention of standardizing piping components throughout the project. The CADD system has been a major force in driving AECL's Engineering towards use of less diversified piping components. However, due to schedule requirement that vendors deliver piping materials to site before the completion of the CADD model, pre-existing information from the reference plant was largely utilized in the engineering quotation requests (EQR). Hence the project could achieve only a partial standardization of piping materials.

5.7 Use of Absolute Coordinates

The use of absolute coordinates is paramount in 3D CADDS, while previously on CANDU 6 projects, construction documents were based on relative dimensions pointing to column grid lines. CADD Support group needed to educate the staff in the drawing office, in Project Engineering and at Qinshan construction site with regard to the use of absolute coordinates.

5.8 Plant-Wide Weld Numbering

In the past, AECL or its piping fabrication contractors used to assign weld numbers that were local to each spool piece and therefore not unique throughout the project. In response to a construction site request, the design office has utilized a software feature in 3D CADD to implement a plant-wide weld numbering system. Construction site staff use the weld numbers to record weld procedures, non-destructive examination, and other weld data. Although the advantage of having unique weld numbers is obvious (for easy tracking), work methods at the construction site and the format of the drawings needed change to accommodate this new system. The unique piping weld numbers occur consistently in three places in the project deliverables:
1. Piping Isometrics
2. The 3-D walk-through model
3. Weld list

6. Benefits from Use of 3D CADD for Qinshan CANDU Project

AECL has improved the plant layout through the use of the 3D model. Aided by CADD software, Project Engineering has detected and resolved clashes (interference) which were created due to design changes, new equipment dimensions and inaccurate reference plant

drawings. Also, newly added concrete-embedded parts were viewed in the 3D model to assure alignment with their attachments, e.g., pipe supports.

We have achieved a high degree of consistency among engineering documents, such as piping isometrics and bills of material, as they are both derived from the same database. Through the use of CADD, we have brought about a significant degree of material standardization, although we were restricted by pre-existing engineering quotations and material purchase orders.

We have automated the production of most engineering deliverables including drawings, line lists and bill of materials. We also supplied the construction site shops with a detailed list of piping welds, as well as a precise 3-D model which is viewable and navigable on low-cost desk-top and lap-top computers, to facilitate planning and construction sequence.

We have produced visualization aids such as colour perspectives and video movies, and made it possible for the CANDU engineering staff to view alternate layouts and the final layout in unprecedented clarity.

Lastly, AECL as an engineering company has benefited from the use of 3D CADD on Qinshan project in that we have gained experience in employing this state-of-the-art engineering tool. We have an advanced engineering tool that gives AECL a competitive edge in future projects. We can now reach farther, higher and faster with our existing resources.