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The Role of ISO 10303 (STEP) in Long Term Data Retention

Presented at:

Long Term Knowledge Retention Workshop

At N.I.S.T. in Gaithersburg, MD.

March 15, 2006

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Electric Boat Corporation

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AGENDA

- Long Term Data Retention Problem
- Electric Boat Requirements
- ISO 10303 (STEP) as a Potential Solution
- Enhancements Needed to Solve LTKR Problem
- PDES, Inc. and Electric Boat Efforts
- Summary

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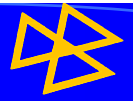
Long Term Data Retention (LTDR) is a Problem

- Products in many industries (e.g. Aerospace, Automobiles, Shipbuilding) have life spans that far exceed the span of the CAD, CAE, or PDM systems that create the Product Models
- Accurate Product Model Data is needed throughout the Life Cycle of the Product for Repairs, Overhauls, In-Service Modifications, etc.
- Data must be retained for the life of the product which can be up to 50 years
- On the other hand, the life of a CAD, CAE, or PDM system used to design the product is often less than 10 years



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Electric Boat Requirements for Data Retention

- EB products (i.e. submarines) generally remain in service for at least 30 years
- Data specifying the product must be maintained throughout its life cycle which could last up to 50 years
- CAD/CAE/PDM systems used to generate the product models will not last that long
- Currently our customer (U.S. Navy) requires that we maintain the hard copy drawings for the life of the ship because there is no evidence we could reproduce them from the product model data in the future

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Current Solution

- **Contractual obligations are met by maintaining hard copy drawings**
  - **Inefficient**
    - Hard to retrieve at remote locations
    - Deteriorate with age
  - **Inaccurate**
    - As-built changes or modifications in service not captured
  - Does not support modification of the model for changes during overhaul or repair

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Hope is to Preserve Product Models Rather than Drawings for Long Term Retention

- Design is captured as a 3D product model
- Revisions, enhancements, overhauls, repairs all require modification be made to the 3D product model
- Thus, it only makes sense to maintain the design as a 3D product model, rather than as a set of hard copy drawings
- However, this can only be done if the customer is convinced that the part can be accurately reproduced from the captured 3D product model

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Look at SEAWOLF Submarine as Example of the Problem

- The SEAWOLF Submarine was designed in the 1980s and built in the 1990s
- Newport News Shipbuilding designed the front end of the ship
- Electric Boat designed the aft end of the ship and constructed all three ships of the SEAWOLF class

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EB Tools for SEAWOLF

- EB Design Drawings were produced on a Computervision CADDS3 system
- Piping Design was done on PIPER Program (internally developed at EB)
- PIPER and analysis programs ran on a UNIVAC 1100 (36 bit Mainframe Computer)
- Data was saved and transferred via 9 Track Tapes
- Data Exchange with NNS was done using IGES Neutral File Format

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Newport News Tools for SEAWOLF

- NNS Design Drawings were produced on a CADAM system
- Piping Design was done on VIVID Program (internally developed at NNS)
- Data was saved and transferred via 9 Track Tapes
- Data Exchange with EB was done using IGES Neutral File Format

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Current SEAWOLF Status

- All three SEAWOLF Submarines are in service and have over half of their life expectancy still remaining
- None of the CAD systems used to Design them are still in use at either shipyard
- Data saved by either yard on the systems in place during design or on the 9 track tapes in use at that time would be largely unusable
- The IGES files (Neutral standard format) generated for exchange can still be read by today's production systems

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Can ISO 10303 (STEP) be the Solution?

- STEP (ISO 10303 - Industrial automation systems and integration - Product data representation and exchange)
- This International Standard is being developed as a series of independent parts which together can capture a complete representation of product model data
- Its primary function is Product Data Exchange, but the representations are also well suited for data Archiving and Long Term Retention

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STEP - STandard for the Exchange of Product Model Data

- International Standard for the computer-interpretable representation and exchange of product data
- The objective is to provide a mechanism that is capable of describing product data throughout the life cycle of a product, independent of any particular computer system
- The nature of this description makes it suitable not only for neutral file exchange, but it also serves as a basis for sharing product databases and archiving

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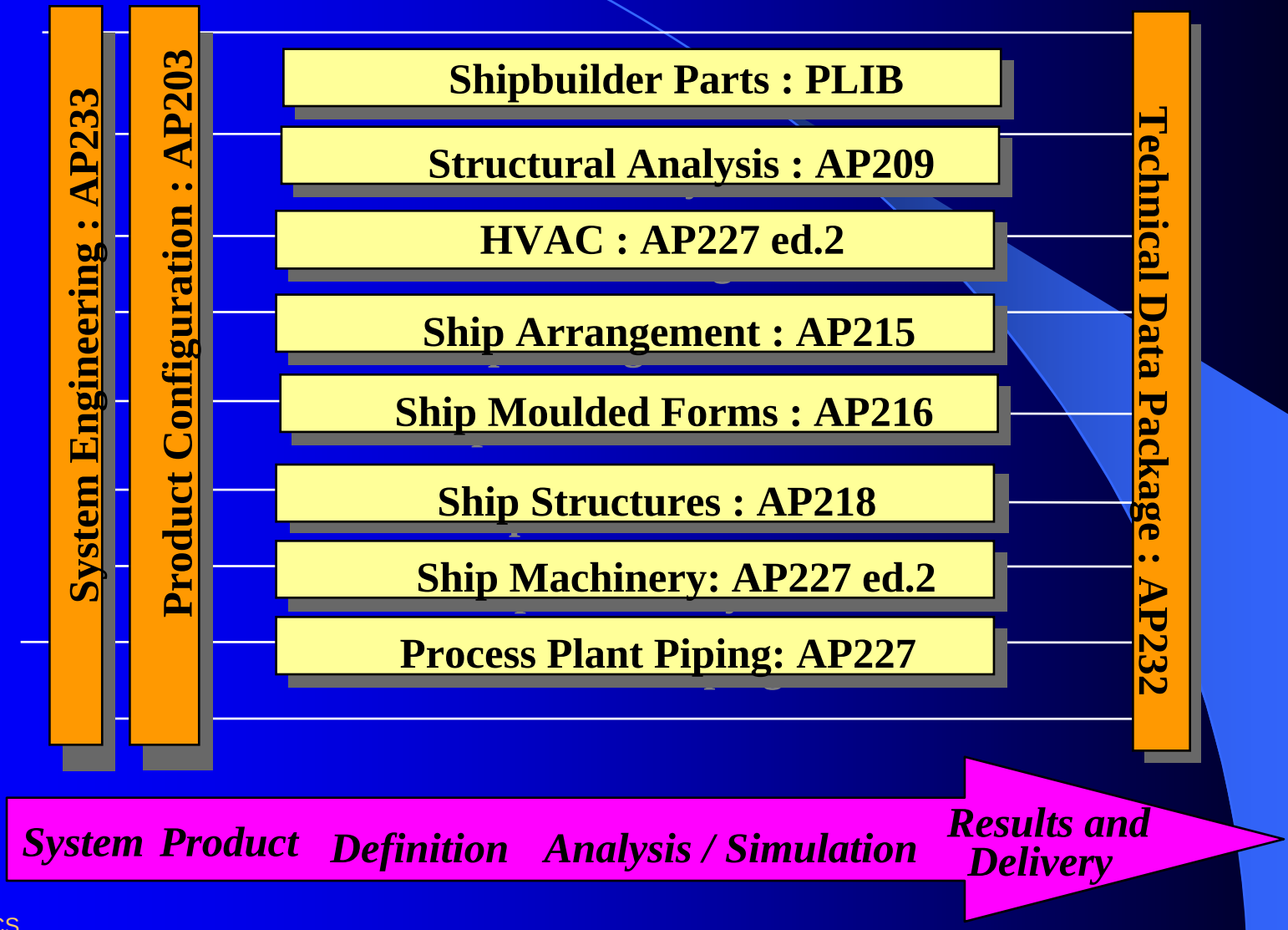
STEP Application Protocols for Shipbuilding



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Potential STEP Shortcomings

- STEP was primarily developed as a tool to capture the finished 3D product model as it saved during Design
- Despite the extensive effort at information modeling that has gone into development of every STEP Application Protocol, their focus was on representing the completed model, not capturing the process and reasoning that went into creating that model

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LTDR Requires Enhancements to STEP

- Design Intent
- Construction History
- Geometric Dimensioning & Tolerancing
- Analysis Results
- Efficient Format
- Upward Compatibility
- Assurance of Long Term Viability of Standard

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EB Hopes to use STEP for Long Term Data Retention

- It is hoped that ISO 10303 (STEP Standard) has a life span greater than EB products (i.e. ships)
- A STEP file saved today should be retrievable on CAD/CAE/CAM/PDM systems of the future
- Customer must be convinced of the long term viability of STEP before the requirement to maintain drawings is lifted

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EB Requirements for STEP

- Upward Compatibility
  - **A STEP file generated today must be interpretable by processors and systems indefinitely into the future**
- Construction History
  - **Capturing Design Intent or Construction History within STEP files of the model will permit modification during overhaul on future computer systems**
- Acceptance of the STEP Standard
  - **STEP must be accepted and implemented universally so that we can have confidence that whatever CAD/CAE/CAM/PDM system we deal with will support STEP files in the format saved today**

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EB and PDES Efforts

- Electric Boat has been working in conjunction with PDES, Inc. and the National Shipbuilding Research Program (NSRP) on a series of projects designed to enhance the capabilities and implementations of STEP and improve its capacity as a tool for long term data retention

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EB and PDES Efforts

- **PDES, Inc. LTDR Pilot Project**
  - The pilot project on Long Term Data Retention is determining and implementing the enhancements needed to STEP to make it suitable for archiving of product model data
- **ISO 10303-28 (XML Representation of STEP)**
  - This part (2nd Edition is currently in its final DIS Ballot stage) will enable STEP files to be represented in an XML format that is more likely to survive over time in the market place
- **ISE Project**
  - The Integrated Shipbuilding Environment (ISE) Project under the NSRP Program is developing and implementing the STEP standards needed for shipbuilding product model data

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EB and PDES Efforts cont'd.

- **Advanced Product Portal (APP)**
  - Under the ISE Project and NSRP Program, we have looked at using this XML database storage format as a means of archiving product model data in STEP format
- **AP209 as Repository**
  - This Application Protocol was designed to maintain a growing repository of engineering analysis results in addition to capturing the current state of the product model
  - A PDES, Inc. Pilot Project has focused on development and implementation of this unique approach
  - The following slides from AP209 presentations demonstrate this approach

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The ISO STEP 10303 Standards are not just about data exchange!

Design

Analysis

STEP AP209
Repository File

Archived
Design/Analysis
AP209
Snapshots

AP209 captures and integrates design, analysis, and CM / PDM information.

Design

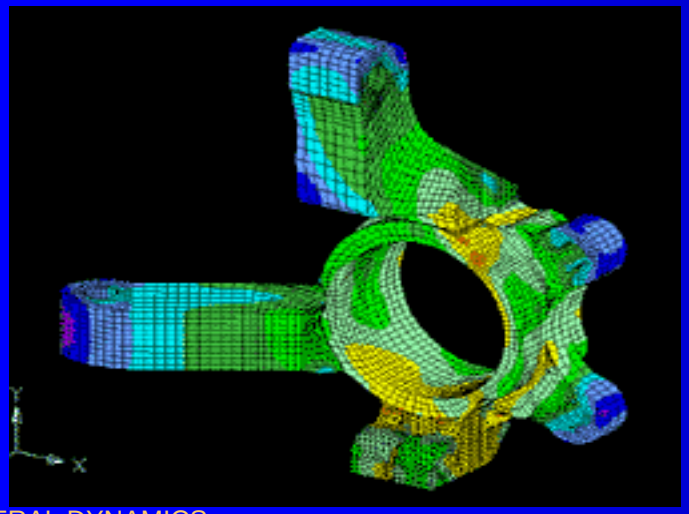
STEP AP209 File

FEA Results
FEA Controls
FE Models
Idealized Geometry
Nominal Geometry
Design Model - PDM

Analysis

STEP AP209 File

FEA Results
FEA Controls
FE Models
Idealized Geometry
Nominal Geometry
Design Model - PDM



Growing Repository File "Built" by Multiple Codes

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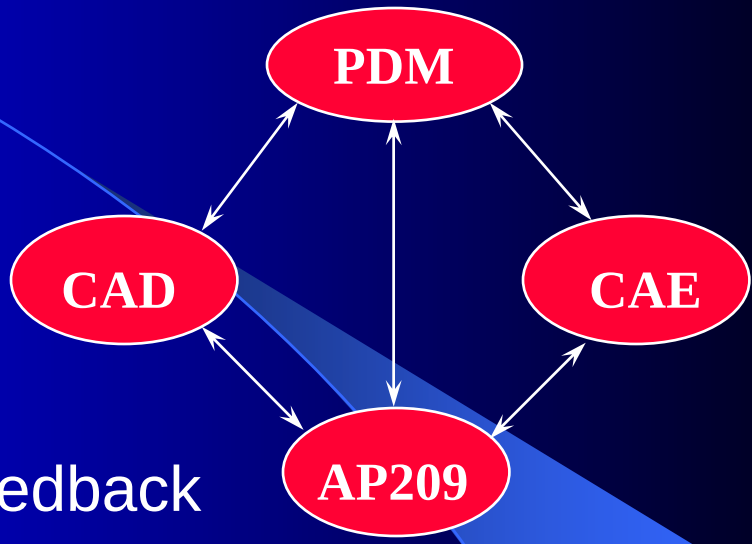
Enterprise Design and Analysis Information Integration with AP209



- Enables sharing of PLM controlled composite and metallic design, analysis, material properties/specs information
- Enables automated, electronic feedback of product shape, performance, and property analyses to CAD with respect to PLM product structure and versioning
- Platform to extend engineering analysis STEP coverage into other analysis disciplines such as Fluid Dynamics
- Provides a long term, potentially growing, repository crucial to many industries and vendors
  - **Neutral format for PLM/CAD/CAE and LTDR**

Summary

- Long Term Data Retention for Product Model Data is a very difficult challenge with no obvious solution
- Current CAD/CAE/PDM systems, proprietary formats, and vendor developed solutions all hold little promise

Summary cont'd.

- There is no certainty that STEP will provide a satisfactory solution to the problem of Long Term Knowledge Retention for Product Model Data
  - Will the STEP Standard survive for the projected life spans (up to 50 years) of today's products?
  - Will enhancements be made to STEP to enable it to capture all the required additional data?
- We can however state with much confidence that any other proposed solutions will not meet the need
  - Products will outlive current CAD/CAE/PDM systems
  - Proprietary or vendor solutions (such as JT Open, U3D, etc.) are not likely to survive over this timeframe
  - Translating data every time system or media changes is not practical over extended periods of time

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Summary cont'd.

- **Despite its uncertainty and questions about its viability as a solution:**
  - **For Long Term Archiving of current Product Models, STEP is the only alternative with any likelihood of success!**