JT, the 3D-lightweight format for visualization and beyond?

Martin Eigner and Florian Gerhardt

Institute for Virtual Product Engineering
University of Kaiserslautern, Germany

SEPTEMBER 12 - 14
2010 International Conference
Presentation Contents

Agenda

Introduction and motivation
The bigger picture
Key use cases in virtual product engineering
Need for action
Summary and outlook
More than 40 1Tier Supplier!!!!

- We need the best tools for Collaboration:
  - Job #1: Visualization
  - Job #2: Data Exchange
  - Support of Design in Context
  - Support of Downstream Processes
We have reached a very good status in Visualization but...

Problems in supply chain

- Native CAD-files server as primary data carrier within the exchange of design throughout the supply-chain

Dr.-Ing. Jan Dietrich (Manager - Product Development Wiper Systems):  
“Conversion to various CAD-solutions and -versions causes an overhead of 15%”
We have reached a very good status in Visualization but…

Problems in internal parallel and downstream processes
- Native CAD-files server as primary data carrier within internal virtual engineering processes (parallel and downstream)

Question: Can a lightweight solution serve as an alternative to native CAD-files for supporting data exchange and downstream processes?
The Challenges beyond Visualization

Possibilities to optimize product engineering processes
- By integrating a lightweight solution into selective processes

Hypothesis: Y% processes can be rearranged to a lightweight solution. A remaining X% remains dependent of CAD or STEP AP’s. The ratio X/Y depends on data format capabilities and application / translator support.
Presentation Contents

Introduction and motivation
The bigger picture
Key use cases in virtual product engineering
Need for action
Summary and outlook
Vision and Required Work do be Done
Combination of neutral formats for processes that go beyond visualization

Open and lean data solution (neutral pipeline)
- enhanced information (AP 242 XML, ...)
- 3D-lightweight content (e.g. JT)

geometry-oriented
structure-oriented

Neutral formats for downstream processes
(Y% see Slide 7)

Data exchange is the target
Visualization is the basis

Neutral formats for design in context
- automotive
- naval
- aircraft

competencies and investigations in multiple industries

content harmonization
- syntax
- semantics
- structure
...

process-oriented potential analysis
- process analysis
- use cases
- requirements
...

software development and integration in PLM-solutions
Lightweight as Part of a Holistic Neutral Pipeline…

- 3D-lightweight primarily refers to compressed (down to 10%) visualization-oriented data, including geometry and geometry-oriented meta data.
- Neutral pipeline refers to CAD-derived contents

Negligence of design history and the sum of parametrical content

Neutral Pipeline Components

JT file sizes by example

Original CAD

Neutral data

Product structure

Meta data
- Structure-oriented
- Geometry-oriented

Position and orientation
- Of product structure nodes

Approximated geometry
- Different levels of detail

Neutral Pipeline Components

Exact geometry
- e.g. in Form of B-Rep

Enhanced content
- Kinematics
- …

JT with 3 LODs and XT B-Rep
JT with 1 LOD and JT B-Rep
JT with 1 LOD, no B-Rep and LIBRA

Native NX

STEP

JT

Kilobyte

0
2,000
4,000
6,000
8,000
10,000
12,000
14,000

JT file sizes by example

structure oriented

geometry oriented
### Presentation Contents

**Agenda**

- Introduction and motivation
- The bigger picture
- **Key use cases in virtual product engineering**
- Need for action
- Summary and outlook
The ProSTEP iViP Association

Requirements

JT Workflow Forum

JT Content Harmonization

Validation

Applications

JT Translator Benchmark

Harmonisierung

User specific requirements

Use Case

JT Implementor Forum

Process Models

Use cases (JT for...)

Requirements

Management Committment

<table>
<thead>
<tr>
<th>Test Results Matrix (Focus: Placement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATIA V5</td>
</tr>
<tr>
<td>Micro</td>
</tr>
<tr>
<td>CATIA V5</td>
</tr>
<tr>
<td>Siemens &gt;</td>
</tr>
</tbody>
</table>

Legend:
converted
not correct converted

WRITE JT
READ JT

Quality approval

ISO
Process Analysis of the Selected Use Cases

- Process analysis and identification of lightweight format application potentials
  - At four OEMs and one supplier

Potential 2:
Supply based on a lightweight neutral format is imaginable with according measures to ensure correctness and completeness. Some sort of certification must be created at supplier side.

Key quality demands are:
- Correctness: geometrical accuracy within tolerated discrepancy compared to native CATIA
- Completeness: dimensions, tolerances, and PMI data must be complete
- Completeness B-Rep: Compare center of gravity, volume, surface, check for open solids
- Compare tesselated data with B-Rep data. All vertices must lie on the B-Rep surface of the comparison model.

- Pragmatic approach using a workshop character
- Dynamic discussions of requirements relating to a lightweight format

Process models and initial requirements were documented.
JTWF has identified 19 use cases and VPE prioritized 8 to be of key relevance for daily activities.
The 8 Key Use Cases

- Key use cases for further consideration
  - Lightweight format for (hybrid) Design in Context
  - Lightweight format for (non-hybrid) Design in Context
  - Lightweight format for Packaging
  - Lightweight format for Installation Feasibility
  - Lightweight format for high-end Visualization
  - Lightweight format for Multibody Simulation (MBS)
  - Lightweight format for Finite Element Analysis (FEA)
  - Lightweight format for (Digital Factory) Plant or Aggregate Development

- Specification of use cases
  - Generation of a diagram with activities and responsibilities per use case
    - Application-neutral
  - Documentation of pre- and post-conditions
    - Borderlining use cases in terms of process analysis results

8 use cases that represent the core of the analyzed processes were documented. To each use case, there can be deviations and special conditions in industry.
Presentation Contents

Agenda

Introduction and motivation
The bigger picture
Key use cases in virtual product engineering
Need for action
Summary and outlook
Need for action

At their core, many of the use cases are considered straightforward and supportable, such as…
- NF for (non-hybrid) Design in Context (DiC)
- NF for (hybrid) Design in Context (DiC)
- NF for Packaging
- NF for high-end Visualization

Others are considered complex and require further investigations, f.e.:

- NF for Installation Feasibility
- NF for Multibody Simulation (MBS)
- NF for CAM and Digital Factory

Correlation between structure-oriented kinematics (joints & fixes) and geometry-oriented content (e.g. attributes & reference geometry)

Need for features that go beyond PMI
Goals of JT Translator Benchmark
- Neutral quality assurance of available JT translators
- Planned and controlled by JT Workflow Forum
- Technologically supported by JT Implementor Forum
Use Case: NF for Hybrid Design in Context

Different CAD-systems
- E.g. in different design teams at different locations

Direct JT integration without conversion into CAD-internal representation
- Lightweight loading and visualization
- Measurements and other PMI on combined CAD and JT
- Until now only NX support

Hybrid
- CAD-system
- .asm (CAD)
- .prt (CAD)
- NF

Non-hybrid
- CAD-system
- .asm (CAD)
- internal from NF
- .prt (CAD)
- internal from NF

Translation (conversion)

the .asm (assembly) and .prt (part) are exemplary extensions
internal could be new .prt or .asm, or another representation
Further thoughts on the neutral pipeline…

Today, JT is positioned somewhere in-between “visualization-oriented” and a holistic process-format.

- This is because JT features containers to store structure-oriented data as well
  - …but lacks containers for enhanced content
- This leads to confusion for users and application paradigms

What is the right balance between geometry and structure oriented data?
Use Case: NF for Multibody Simulation

“...can we realize missing content given the containers that do exist...?”

- Concepts and prototypical solutions exist, e.g. for kinematics

**Solution 1: Storing kinematical definitions within the product structure**

Nodes with enhanced properties

Virtual sub-structure

Joint nodes with defining properties

<table>
<thead>
<tr>
<th>ASSOCIATED NODE PROPERTIES</th>
<th>KEY</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>JOINT_AXIS</td>
<td>0.0 1.0 0.0</td>
<td></td>
</tr>
</tbody>
</table>

ASSOCIATED NODE PROPERTIES

KEY     VALUE
JOINT_TYPE revolute
JOINT_LINK_1 00>02_1
JOINT_LINK_2 00>03_1

Reference
Neutral formats for intelligent supplier integration

Example properties of supplier parts (excerpt)

- Often not or not completely parametric (depending on contracts)
- IP-protection is needed
- No inner product structure is of interest

Need for (interface) feature information can be stated. In early product development phases these interface were changed and a change management has to established.
Example of Advanced Feature Structure

Proposal for unique feature ID nomenclature according to DIN 6763, [PAHL05, S.542]

We propose a general concept to name features and relevant geometry elements (such as connecting faces) used in collaboration projects.

Proposal for a possible integration of the concept in a visualization tools:

- Unique feature IDs were granted (database or PDM-system)
- Entry point of feature information is stored in the structure of the vis.-data. Feature information itself lives in flexible XML-dataset
- Correlation between feature information (in data structure) and 3D-geometry is granted

Source: Sebastian Handschuh, Daimler
Presentation Contents

Agenda

Introduction and motivation
The bigger picture
Key use cases in virtual product engineering
Need for action

Summary and outlook
Summary 1

...the percentage of supportable processes can be further leveraged
Summary 2

- Other CAD Supplier have to support JT for Hybrid Design in Context
- CAE and DF Supplier have to Support JT for downstream processes
- Combine strengths of structure-oriented (e.g. STEP) and lightweight formats
- Decide how and where structure oriented information must be handled
- Missing functionalities must be provided by formats
- Translators must consistently provide required content
- Certification of translators must be provided by independent organization
Thanks for your kind attention

Questions?

Contact:
Prof. Dr.-Ing. Martin Eigner
E-Mail: eigner@mv.uni-kl.de
Lehrstuhl für Virtuelle Produktentwicklung
Technische Universität Kaiserslautern
Postfach 3049
67653 Kaiserslautern