



Product Lifecycle Management Road Map™ 2011
October 4 & 5 Plymouth, Michigan
The Escalating Complexity of PLM

The Democratization of Simulation with Intelligent Templates

Realize the Promised Benefits of Simulation

PLM Road Map™ 2011 – October 4 & 5

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NOTE:

This is an edited version of the keynote presentation given at CIMdata PLM Roadmap 2011. A number of slides have been removed.

For the complete presentation, please contact:

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Democratization is Everywhere

- Nations



Afghanistan



Egypt



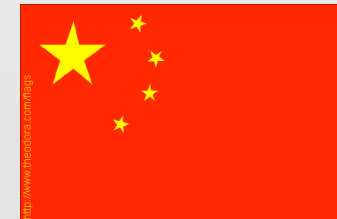
Tibet



Libya



Iraq



China?

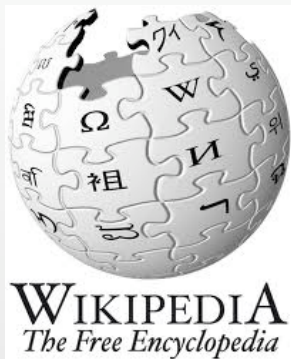


Syria?



Democratization is Everywhere

- Knowledge via the Internet



- Enterprise Solutions – Bottom Up vs Top-Down



What About the State of Simulation?

- “CAD is King” and in its own **Silo**
 - Not engineering performance
- Great CAE Tools in Silos
 - Each is limited to a particular physics & level of fidelity
 - Integrated tools from single vendors – “Use Only My CAE Tools”
- Tool and Domain Experts in Silos
 - Create dependencies and bottlenecks
 - Drive ineffective workflows for design of complex systems
 - Creates experts in the use of particular tools – Tool Experts
- Huge Amounts of Data in Silos
 - Little reuse of data or processes
 - Poor design decision support – *where’s the key data for decision-making?*
 - No integrated view of the engineering models/data – disparate data



CAD

Promise of Democratization of Simulation

- Much more effective workflows
 - Model-Based Systems Engineering
 - Simulation-Driven Design
- Empowered designers, engineers and systems engineers
 - Expertise, tools and data out of silos
 - Engineers allowed to use (multi-vendor) best-of-breed CAE tools
- Information to support design decisions
 - Integrated simulation data from early concept through detailed design phases
 - Single systems view of engineering data
- Simulation achieves business results
 - Early detection of problems → Lower cost of development, higher quality
 - Drive product innovation

Roots of the Next Revolution in Simulation

- Intelligent Templates
 - Anyone can easily and *safely* perform analysis to answer performance questions
- Direct modeling tools (dethrone the King!)
 - Geometry tools for engineers; shift away from CAD-driven/centric design
- Multi-physics/multi-fidelity environments
 - Boundaries of physics and fidelity no longer dictate analysis workflows
- Abstract (Functional) CAE Modeling
 - Templates independent of geometry or topology (configuration) are a game changer for reusability and breaking the CAD dependency
- *No-Overhead, Work-In-Progress* Simulation Data Management
 - Changes the rules for access, collaboration and configuration management

Users of Comet Simulation Templates

- ***Simulation Experts:*** Multi-Disciplinary Processes
 - Create and validate best-practice engineering analysis processes
 - Run the most complex simulations
- ***Design Engineers:*** Standard, Repetitive Processes
 - Run well-defined standard analyses safely & consistently
 - Use web-deployable, role-based Vertical Applications that drive Comet Templates (built and updated by the experts)
- ***Chief Engineers/Program Managers/Systems Engineers***
 - Run multi-fidelity systems analyses from the dashboard
 - Conduct design reviews *effectively*, without needing presentations

Enabling Rapid Vehicle Conceptual Design Studies General Dynamics Land Systems

Military Vehicle Concept Design:

CAD→MATLAB Tool→Adams→FEA

- **Customer:** General Dynamics Land Systems (GDLS)
- **Simulation Problems:**
 - Inefficient, error-prone, manual process – CAD model to MATLAB tool (3-10 days for a single model, single analysis)
 - Changes to the CAD model required recreating the simulation models
 - Not integrated with downstream tools such as Adams and Nastran
 - No configuration mgmt of CAE data
- **Goals:**
 - Single integrated environment from systems engineering to detailed design, *accessible to systems engineers and expert analysts*
 - Rapid (re)analysis using in-house MATLAB tool when CAD changes
 - Efficient and accurate data transfer between the tools, better process mgmt, enforce best practices
 - Single consistent view of the engineering models/data

Enabling Rapid Vehicle Concept Design Studies

Results:

- Compress 3-10 week design evaluation per vehicle by 80%
- Various engineers including Systems Engineers use complex multi-fidelity, multi-tool analysis process
- Drive various tools using Single, Integrated Engineering Model
 - High-fidelity CAD to low-fidelity MATLAB systems model to high-fidelity FEA model
 - Multiple representations of various system components managed seamlessly
- Design decision-making and rapid trades facilitated by Dashboard
- *Major new Army Program will use Comet from concept to delivery*

Leveraging Scarce CAE Expertise to Enable Rapid Design Studies across “Family of Products”

Heavy Equipment Manufacturer (US)
Tangshan Locomotive (China)

Simulation Templates: Before and After

● **Status Quo**

- Many “Vertical Applications” (product-specific analysis templates) exist
- Custom developed – *expensive (>\$200K) & time-consuming (months to create)*
- Usually quite brittle – built for specific cases and specific topologies (*geometry changes, template breaks*)
- Usually created by services organizations and vendors, not the end-users
- Cannot be easily extended by the customer

● **“Intelligent” Templates**

- Templates are geometry/topology independent
- Customer creates their own templates graphically
- Rapid creation - complex templates are created and tested in days
- Easily evolved/enhanced *by the customer* as knowledge/best-practices change

“Democratization of CAE” in China

Tangshan Railway Vehicle Co.,
Ltd



CRH3 350 km/h train

Customer Goal (from the Chief Engineer):

“Use Comet as the integration platform across all engineering work because template-based analysis processes mean much higher engineering productivity and confidence in simulation results, *with fewer staff and lower CAE expertise required.*”

[Location makes it difficult to get/keep top talent]



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Complex Simulation for Anyone - Safely

Results:

- Consistent process enabling rapid analysis of all configurations
Intelligent Templates handle large geometry/configuration changes
- Less experienced people perform complex simulations
Use the same tools that the experts use
- Auto-generated Performance Spec Sheets
Predict performance against requirements without a PhD
- Same concepts/processes can be applied across all product lines
Standard way to safely provide complex simulations to anyone asking performance questions

Systems Engineering Case Study

US Appliance Manufacturer



Refrigerator: System Thermal Performance

Excel → Meshing → FEA → Optimization

- **Customer:** Large US Appliance Manufacturer
- **Simulation Problems:**
 - Many (4) ad hoc Excel systems tools worldwide *for the same calculations*
 - Not integrated with FEA or Optimization tools; inefficient, error-prone manual process
 - Changes to the CAD design required recreating the simulation models (Excel, Ansys)
 - No single view of the engineering models
 - CAE Configuration management issues – *including the thermal systems spreadsheets*
- **Goals:**
 - Single integrated environment from systems engineering to detailed design, *easily and safely accessible to systems engineers, designers and expert analysts*
 - Rapid (re)analysis using in-house Excel tool when CAD changes
 - Efficient and accurate data transfer between the tools, better process management, enforce best practices; manage configurations of the systems spreadsheets
 - Single consistent view of the engineering models/data

This Revolution Does Not Lead to Anarchy

- Breaking the shackles of CAD
Release to Manufacturing + Release to Analysis
- Robust templates, dealing rapidly with design changes
- *Safe CAE for all – not dumbed-down; use the experts' tools*
- Breaking down silo boundaries without eliminating the silos
- Systems Engineering across any levels of fidelity – *use the same analysis tools that the experts use*
- Single view of the systems engineering model capturing the functional aspects of the system (“SysML” to CAD to Mesh)
- Multiple Component Representations managed seamlessly

Direct Benefits of Simulation Democratization

- Capture and Reuse Best Practices & Tools (“Intelligent” Templates)
 - Better Utilization of Scarce Expert CAE Analyst Resources
 - Significantly Reduce/Eliminate Model Re-work per Simulation Iteration
 - Use Best-of-Breed Tools – *not locked into tools from a single vendor*
- Increase Simulation Capacity & Effectiveness (Experts Bottleneck)
 - Many more design alternatives evaluated earlier in the design process
 - Engineers & Systems Engineers can access *all physics tools at all fidelities*
- Have Full Data Access and Results Traceability (Project Tree)
 - Workgroup/project-level WIP configuration control & data capture/sharing
 - *Milestone upload of key project data to enterprise PLM/SDM backbones*
- Collaborate Across Org Silos & Project Teams (Project Tree)
- Make Design Decisions based on Key Design Variables and Performance Metrics (Project Dashboard)

1. What to Expect in the (*Very Near*) Future

Sophisticated Simulation *used safely* by anyone asking product performance questions

- Intelligent Templates capture expertise and make it available, safely
(Heavy Equipment Use Case)
- Vertical Applications (desktop or web-based) drive these templates
(Locomotive Cabin Use Case)
- Ubiquitous access to simulation
 - Mobile tablet device interface to complex analysis
 - Increase analysis throughput by running in *The Cloud*

2. What to Expect in the (*Very Near*) Future

Engineers dealing better with the CAD Shackles

- CAD tools creating hybrid systems (*combining parametric modeling and direct modeling has technical challenges*)
- Direct modeling for engineers (*Gathering steam*)
- Geometry-Independent Intelligent Templates (Now!)
 - Abstract Modeling deals with large geometry & topology changes
 - Assemble systems from subsystems defined with multiple geometry sources

3. What to Expect in the (*Very Near*) Future

Breaking down the barriers between concept analysis (*with or without CAD*) and CAD-based detailed analysis

- Single integrated representation of the engineering models, *spanning all physics, tools from all vendors, and all design phases*
- **Model-Based Systems Engineering**
 - *At any mixed levels of fidelity*
 - *Using the same tools that the experts use in detailed design*
 - *Available to answer systems performance questions during any phase of the design process*

Thank You

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