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2020 Vision of Engineering Analysis and Simulation

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Abstract Modeling Enables Aerospace Corporation Project to Reap Benefits of Concurrent Engineering

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Presentation Agenda

- Space flight Electro-Optical (EO) sensor programs are experiencing large (100%) cost and schedule overruns.
- Simulation Driven Engineering software enables a more effective process – Concurrent Engineering.
- Abstract Modeling – What is it? What are the benefits?
- Aerospace Corporation Project
  - The complex environment and tools we need to use
  - Overview of the Integrated STOP Workspace
  - Overview of the stages of the project
  - How Abstract Modeling and an integrated environment improved our process
  - Project Results
- Q&A

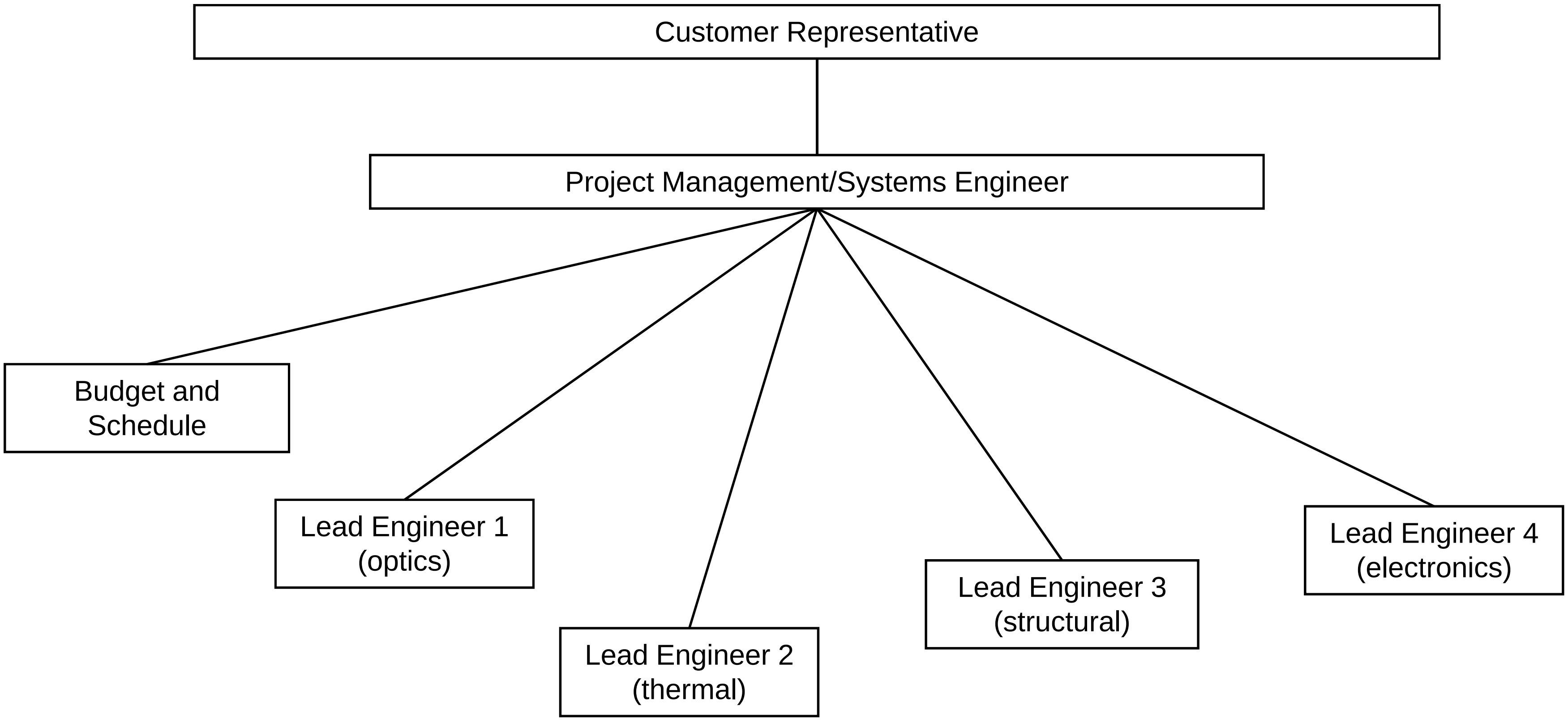
The Aerospace Corporation

- Provides federally funded R&D to U.S. Air Force and technical services to national-security, civil, and commercial space customers.
- Services include:
  - Systems engineering
  - Testing/Analysis/Validation
  - Launch readiness/certification
  - Application of new technologies for existing and next-generation space systems

Statement of the Problem

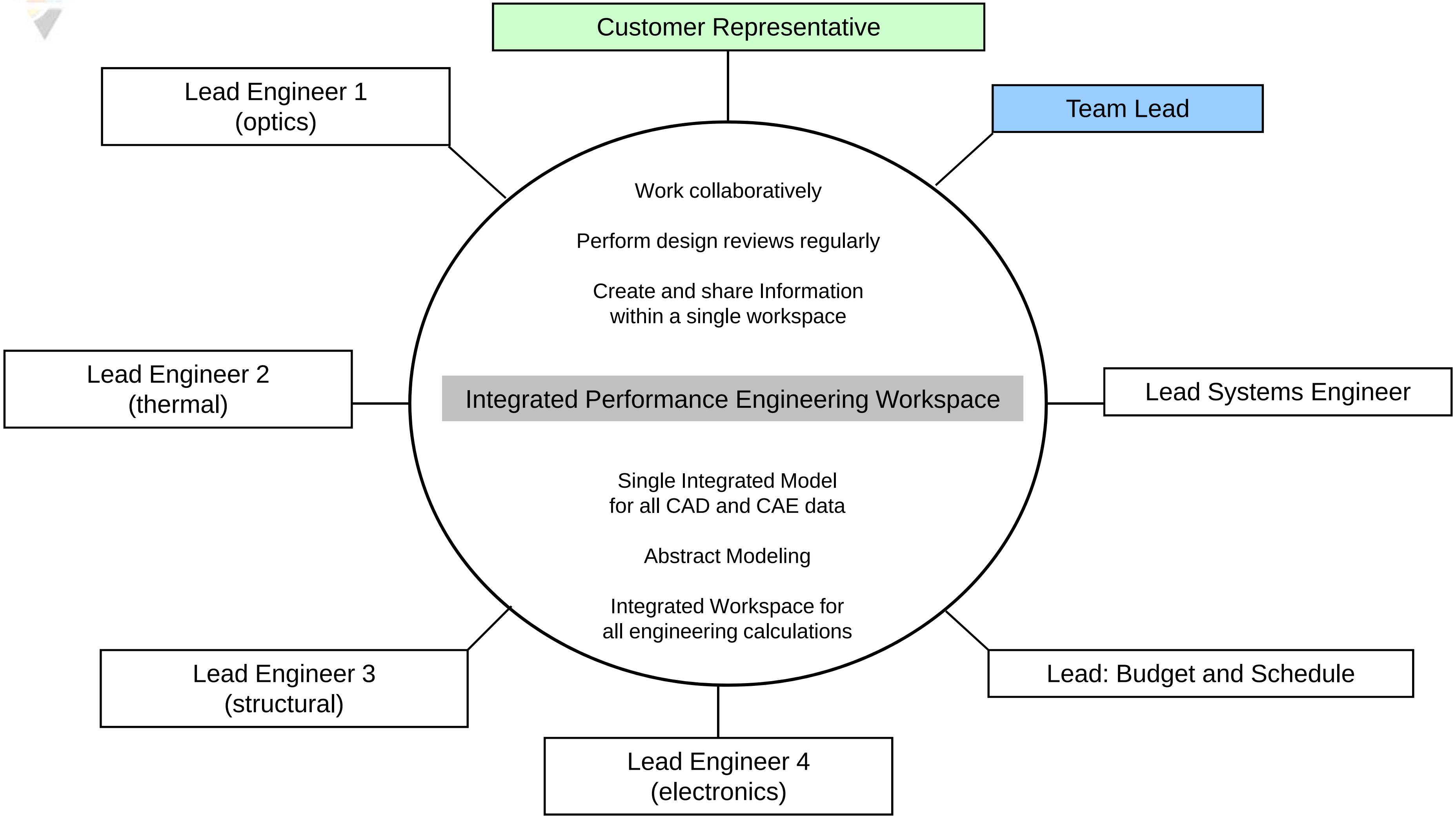
- About 25% of all space-borne EO sensor programs are overrunning budget & schedule allocations by 100% or more.
- Standard program reserves are closer to 20%.
- A 5 times improvement in process cycle time is not likely to result from iterative improvements to existing processes.
- A Concurrent Engineering approach addresses the delays, errors, and late discovery of design problems that underlie our current fragmented process.

Classic Flight Program Organization



Requirements are handed down to stove-piped engineering functions from a central systems engineering function. Inter-disciplinary interactions are infrequent and often indirect.

Concurrent Engineering Organization



Note: Each lead may in turn be supported by a small team of support engineers or specialists

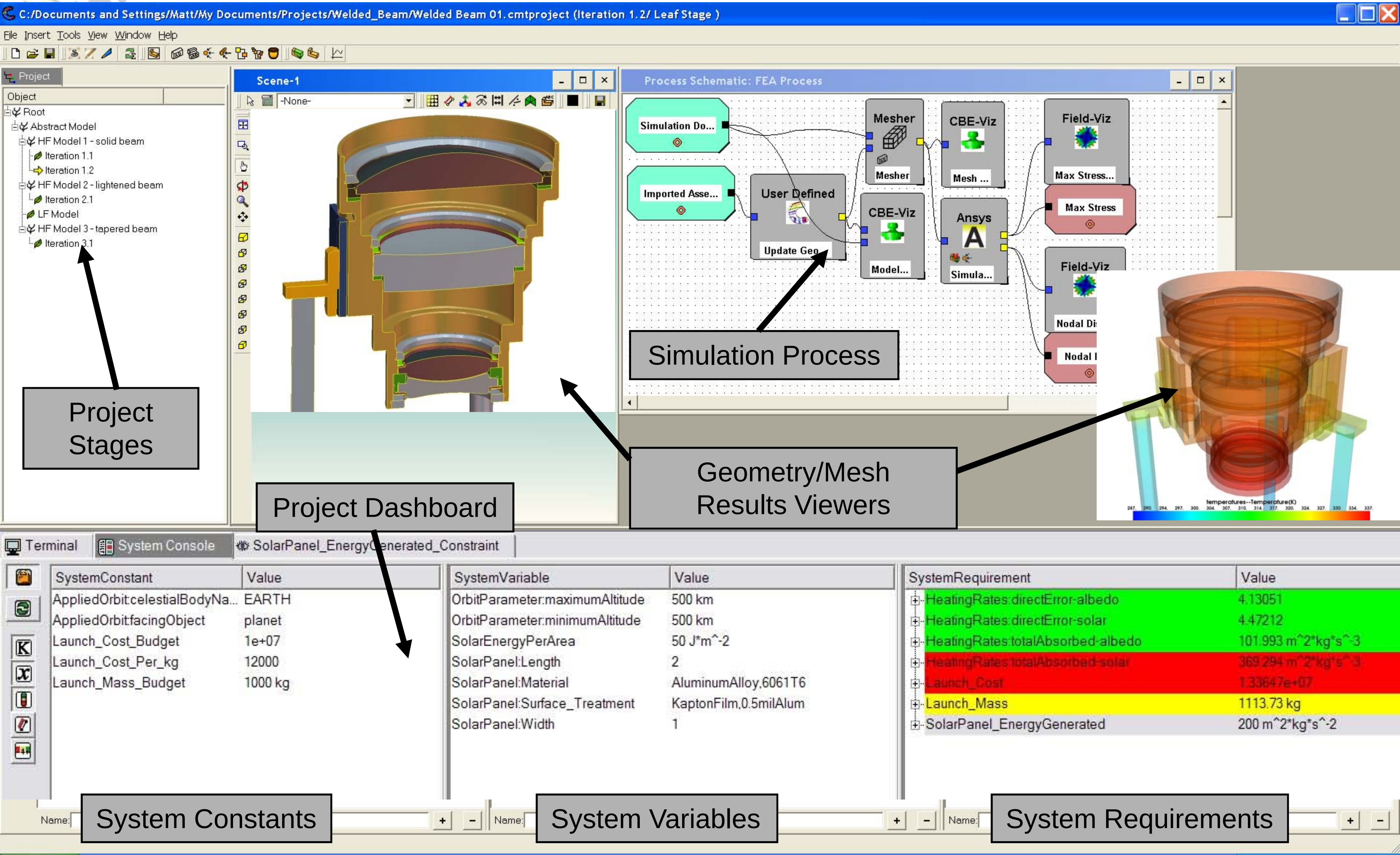
The Aerospace Corp. STOP Project

- *Goal*
  Higher fidelity STOP analysis of space flight EO sensors in shorter cycle time.
- *Pain*
  Current fragmented approach is slow, inefficient, error-prone.
- *Project Team*
  Team Lead plus optical, mechanical, structural, and thermal engineers.

Requirements to Meet Team's Goals

- Effective and efficient communication <u>and</u> management of *all* project data with *all* team members including managers.
- Single, integrated view of all the model data *(CAD, structural, thermal, optical.)*
- Earlier evaluation of more concepts, and more iterations of a concept at multiple levels of model fidelity.
- "No-wait design reviews" including requirements checking (*no simulation tool expertise needed.*)
- Use of COTS CAD and CAE tools (extensible environment for commercial and in-house tools.)

Performance Engineering Workspace



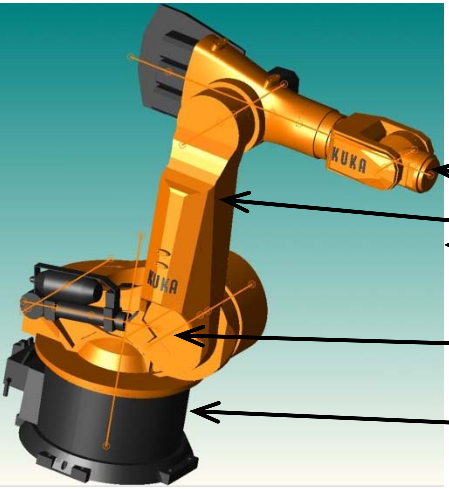
What is an Abstract Model?

- Models for Performance Simulation – the *Status Quo*
  - Models for simulation are typically geometry-centric – the engineering data is directly attached to the CAD geometry.
  - Changes to the CAD design require large amounts of manual rework to run simulations on the new design.
  - Systems Engineering models are independent of detailed CAD.

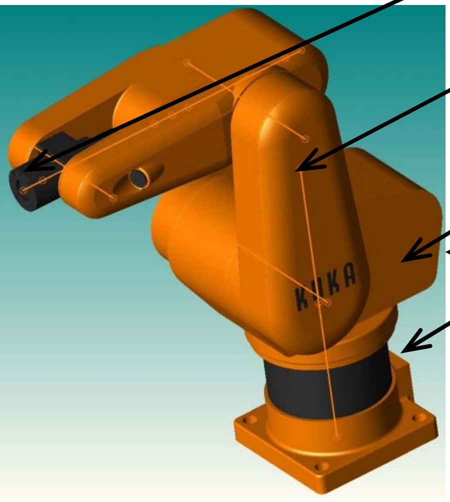
- An Abstract Model

  "A functional model of a product containing all the engineering data (performance requirements/metrics, materials, environments…) and simulation processes, ***independent of the CAD geometry or shape characteristics of the product***."

The Status Quo:
Geometry-Centric Modeling in Silos



Geometry



Engineering Data Silos

Mesher 1
Mesher 2
Abaqus
ANSYS
Nastran
Excel
MATLAB
Adams
Thermal-Desktop
CODE V
SigFit
In-House Codes

- Materials
- Surface Treatments
- Environments (Loads/BCs/…)
- Joints
- Contact and other Interactions
- Springs/dashpots/bushings/…
- Meshing rules
- Analysis rules
- Subsets of the assembly

Rework
Wasted Time
Manual Errors
Data Silos

n Processes

The Future: Integrated Abstract Modeling

Tagged Geometry

Import & Analyze

Import & Analyze

Abstract Model

Abstract Entities

Engineering Data

- Materials
- Surface Treatments
- Environments (Loads/BCs/…)
- Joints
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- Meshing rules
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- Subsets of the assembly

Simulation Processes

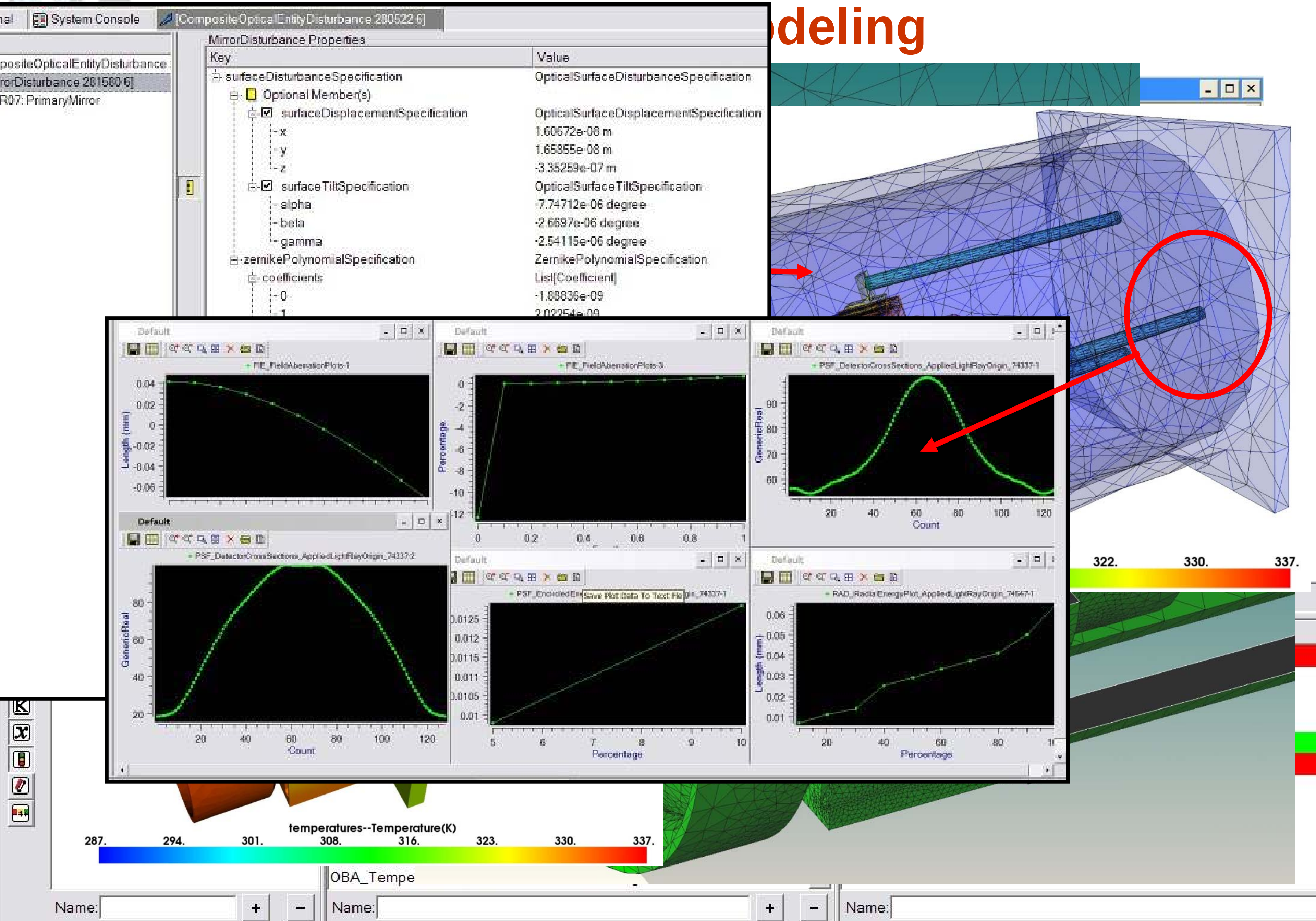
Pro/E · *SolidWorks* · *UG NX* · *Abaqus* · *ANSYS* · *Nastran* · *Mesher 1* · *Mesher 2* · *Adams* · *CODE V* · *ThermalDesktop* · *Excel* · *MATLAB*

Why Abstract Modeling?

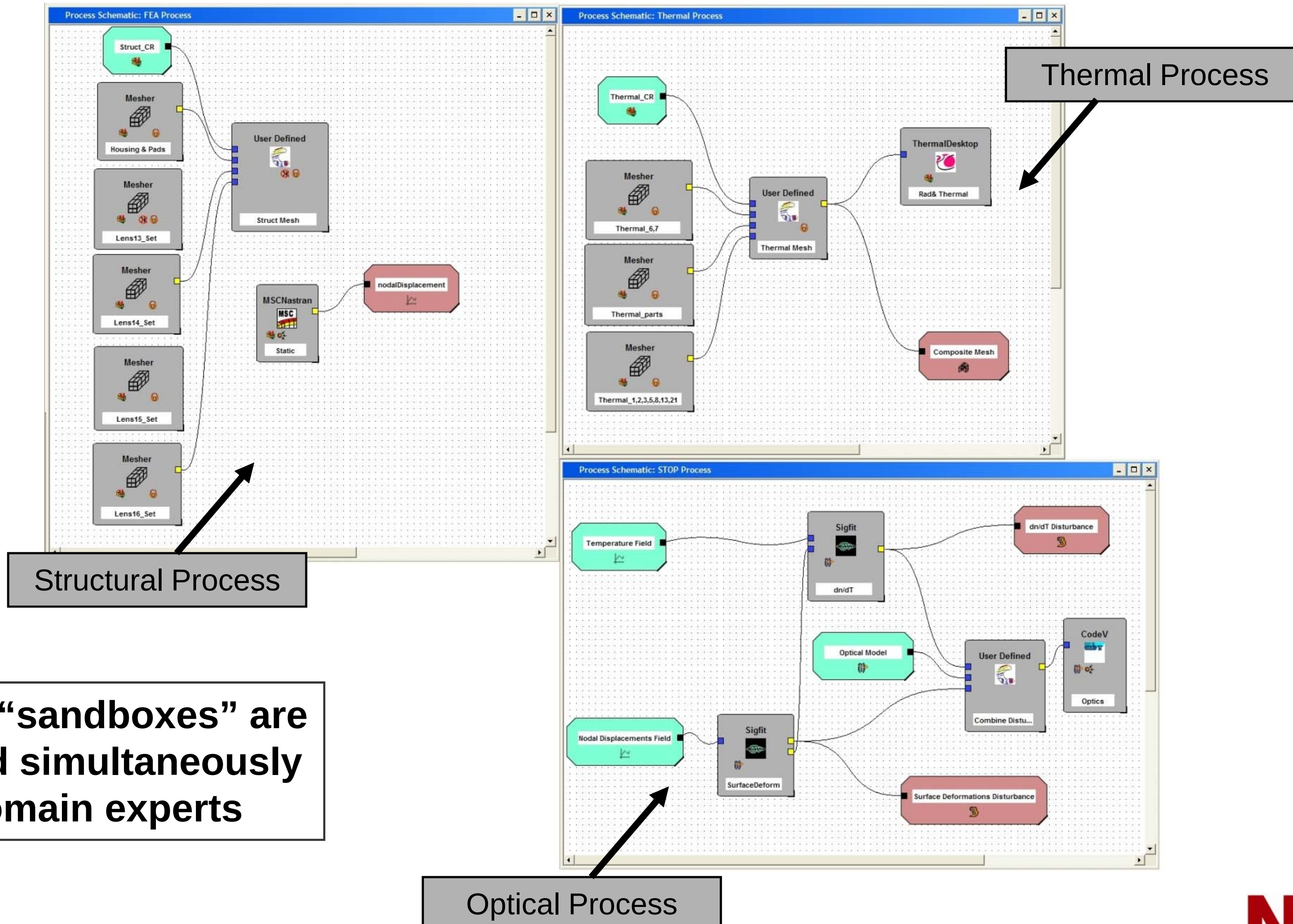
- Automatically generate the analysis model across multiple disciplines – minimize/eliminate data reentry and manual errors.
- Capture engineering “best practice” workflows abstractly, independent of the *design geometry*.
- Set up performance requirements abstractly, independent of the *design geometry*.

Bottom Line: High-fidelity, accurate simulations in a fraction of the time.

Structural/Thermal/Optical Performance
deling

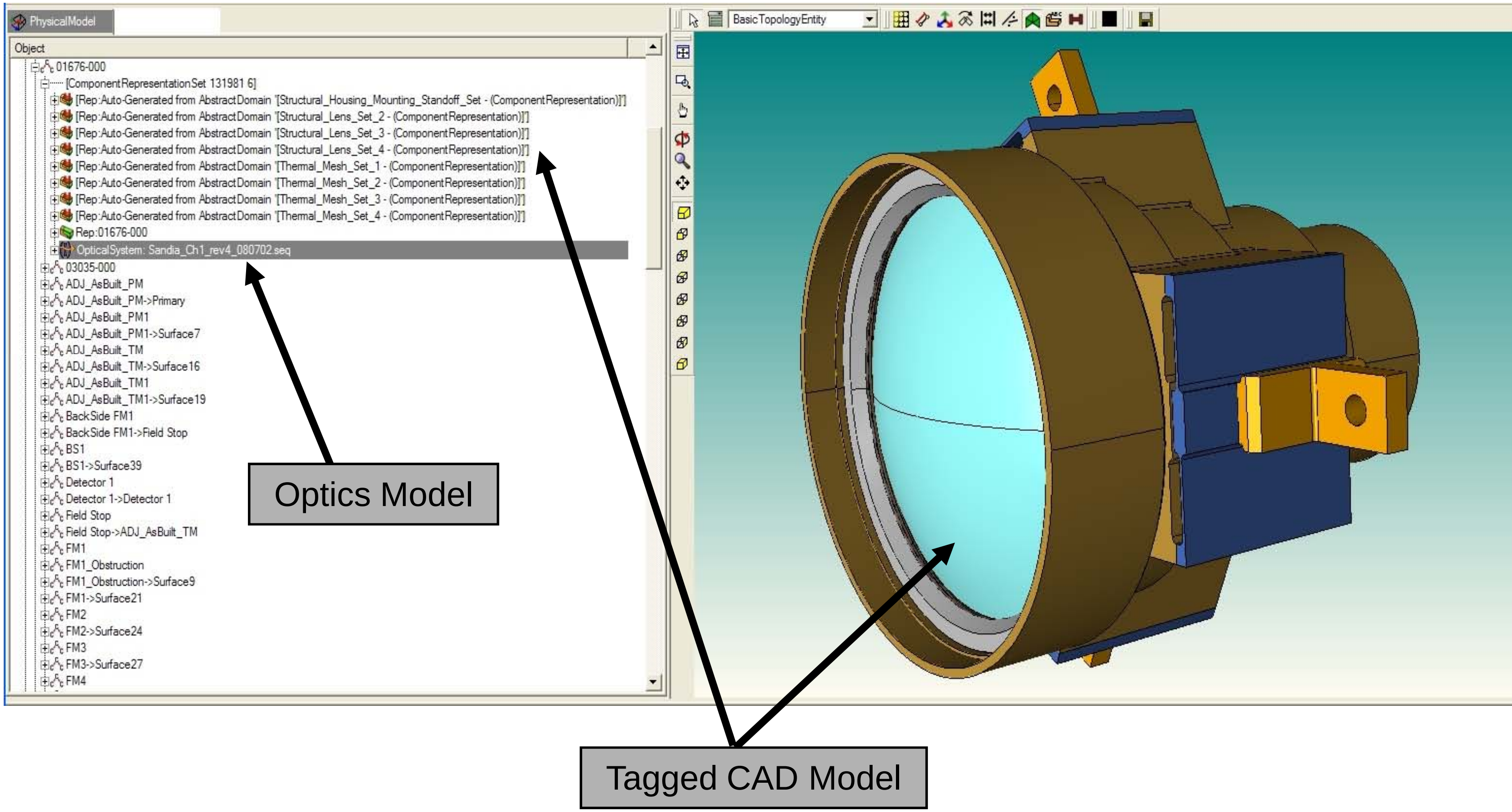


Reusable Simulation Templates: Capture/Reuse Multi-Disciplinary Processes



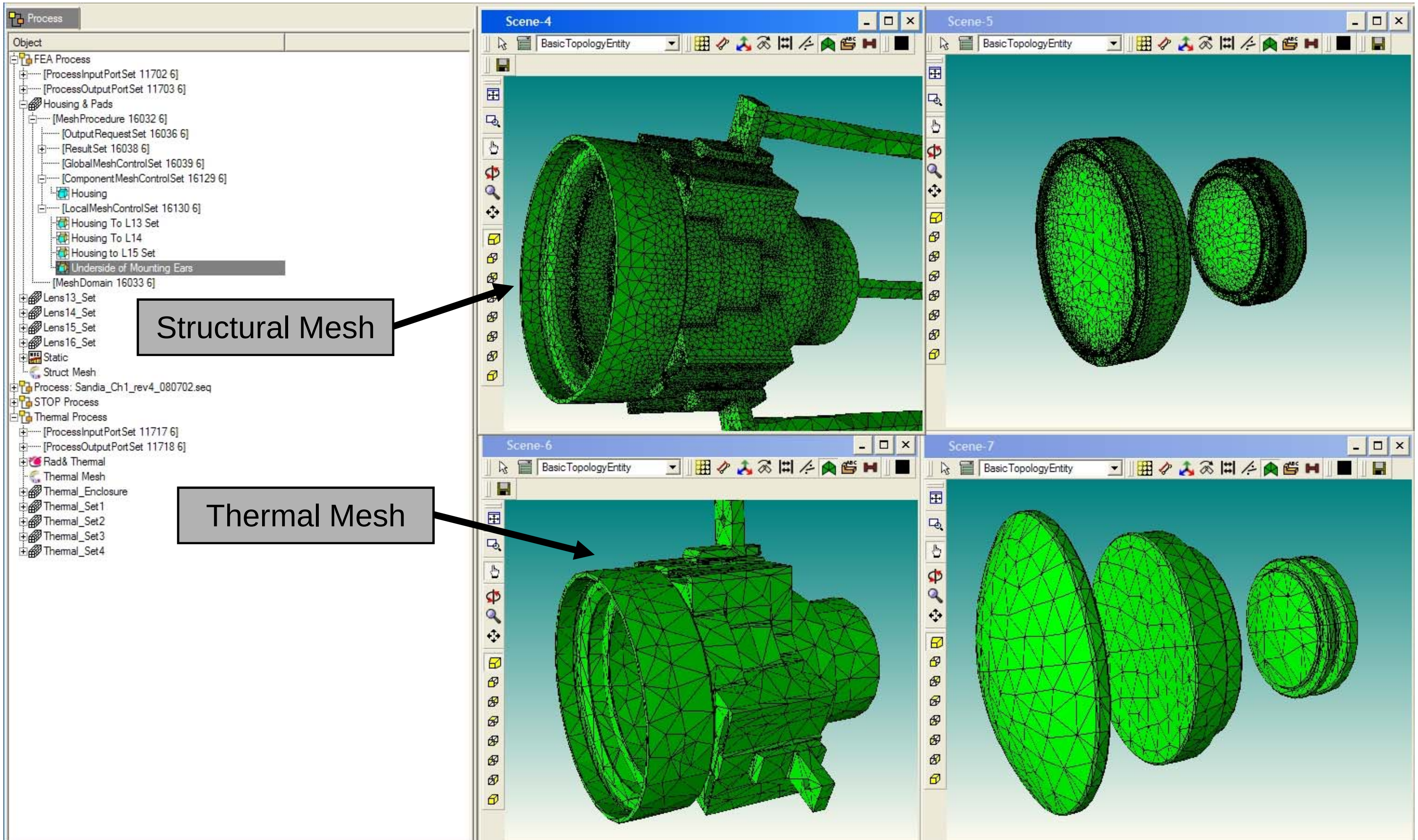
Process "sandboxes" are executed simultaneously by domain experts

Import initial CAD and Optics Models



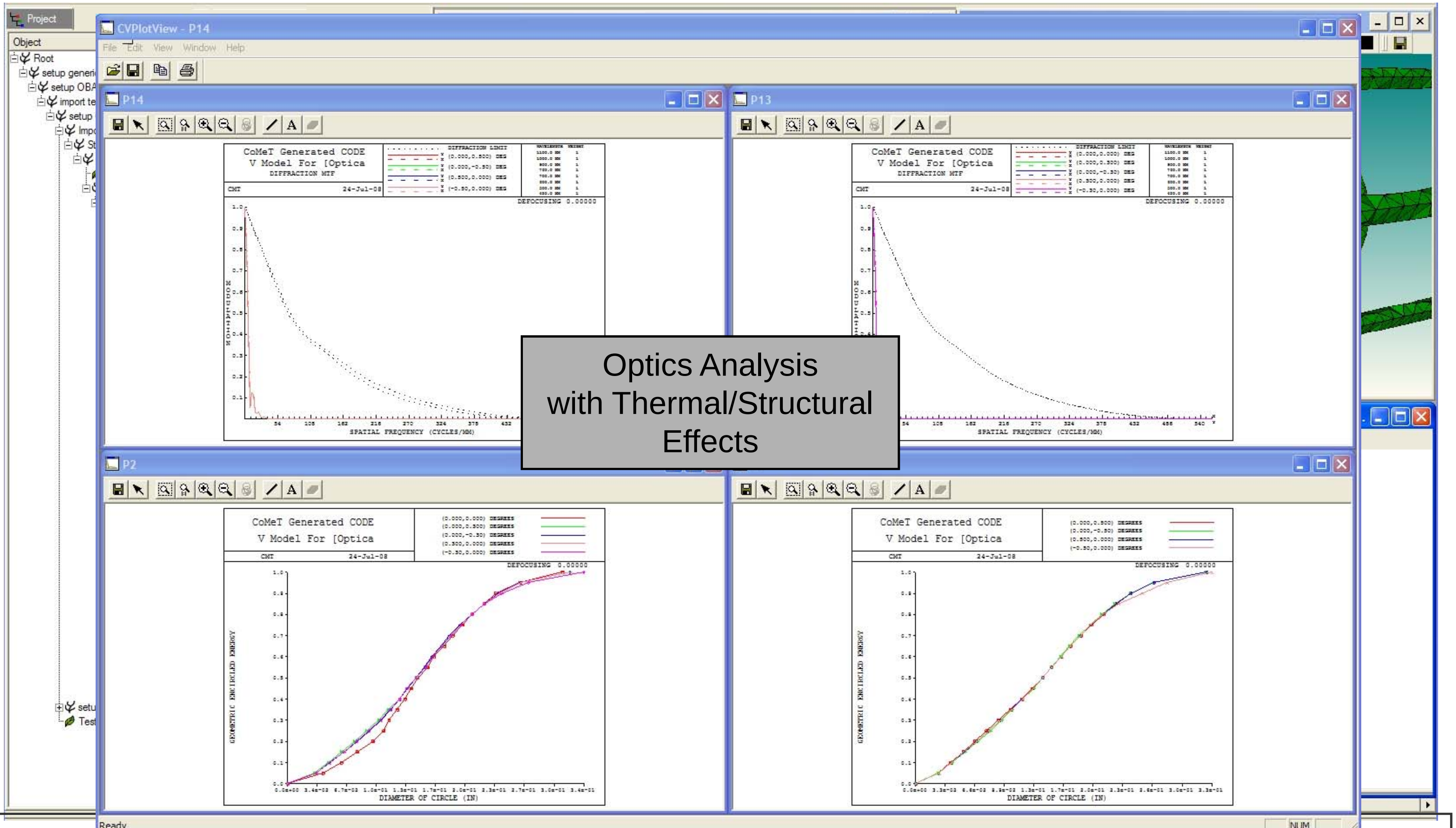
Optics and CAD models are “synchronized” when imported

Mesh the CAD Model



Automatic meshing “rules” set up in the Abstract Model resulted in significant efficiency gains during iterations

Get Optics Performance Results



Analysis "rules" (BC's, analysis controls, environments…) for each engineering domain are captured in the template

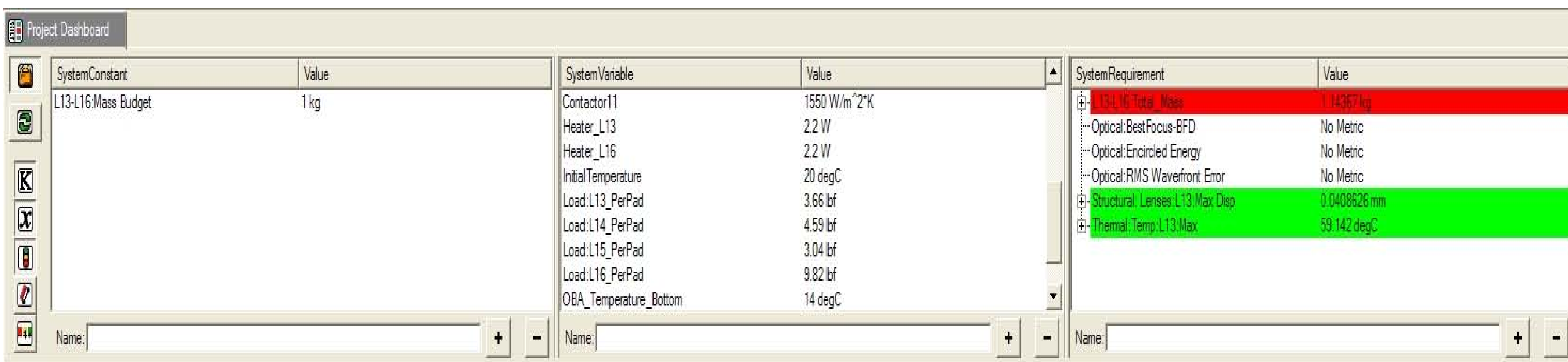
Analysis "rules" for SigFit and CODE V are captured in the template

Results are immediately available for review and downstream inputs

Use Project Dashboard for Reviews:

A Single Summary View of Product Performance

- Change system variables.
- Run simulation processes.
- Immediately review key performance data regardless of the underlying CAD and CAE tools used.
- Facilitate the concurrent engineering process and customer briefings.



STOP Project Results and Conclusions

- Performance Engineering Workspace with Abstract Modeling is enabling our team to meet its goals:
  - We developed a higher fidelity STOP model *in less than half the time compared to standard processes*.
  - The abstract modeling technique allowed us to *perform more simulations effectively*, reducing manual data entry and errors.
  - Quantitative visualization of CAD/CAE results across discipline boundaries and in one view is key to *identifying and troubleshooting interdisciplinary design issues*.
  - The integrated project environment allowed us to *capture and track all analysis data and design variations*.
  - We conducted *effective and efficient design reviews* with customers from within the software environment with no need for PP slides!

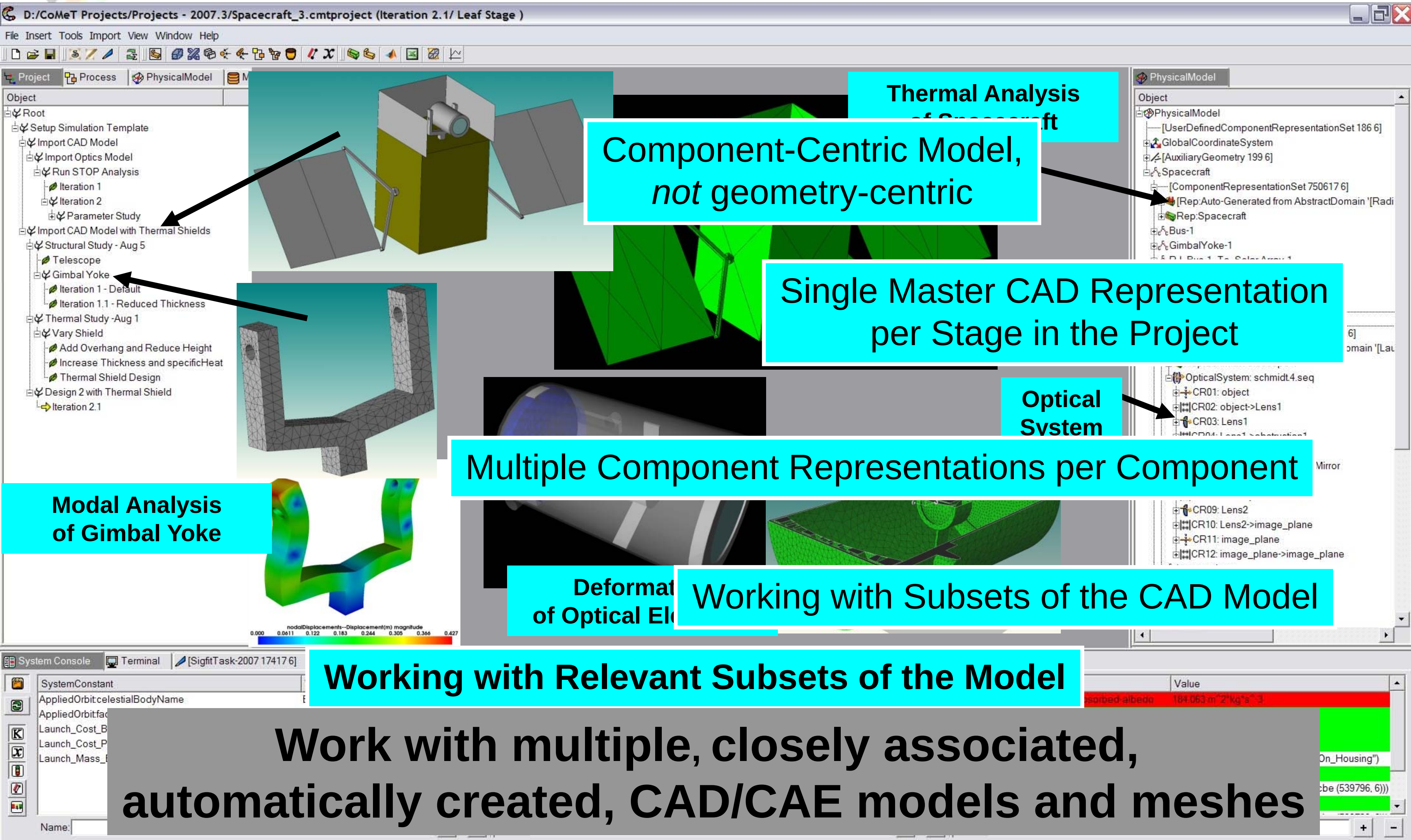
Q&A

- Any Questions?
- A detailed white paper is available on this subject.
- Please see me or a Comet representative following this presentation or during the conference to request a copy.

Webinar Q&A

- Any Questions?
- A detailed white paper is available on this subject.
- Please visit www.cometsolutions.com for more information about our performance engineering workspace and abstract modeling. Or email – malcolm.panthaki@cometsolutions.com.

Managing Multiple CAD/CAE Representations



Work with multiple, closely associated, automatically created, CAD/CAE models and meshes

Space Borne Sensor Design: Tools Environment

Comet Solutions, Inc.

MSC

Abaqus

Structural FEA

Sigmadyne

Optical Disturbances

C&R TECHNOLOGIES
Hot Engineering . . . Cool Software®

Thermal/Radiation Simulation

PTC®

CAD

OPTICAL RESEARCH ASSOCIATES

Optics Simulation

The MathWorks™
Accelerating the pace of engineering

Microsoft®

General Calculations

Comet Solutions, Inc.

Comet Solutions, Inc.

Software Approaches were Limited

- Current Choices
  - Single-vendor, integrated suites of CAE tools
  - CAE point tools with bi-directional connection to CAD models
  - CAD-embedded “light” tools
- Limitations
  - Lack of integrated environment with access to all data & tools from multiple vendors
  - Lack of ready access to data for decision-making
  - Highly inefficient process when dealing with design changes