NORDIC 2010 NAFEMS CONFERENCE

Addressing robustness in simulation models

Dr.-Ing. Stylianos SEITANIS
BETA CAE Systems, S.A.

Overview

- Identity
- Addressing Robustness
- Focal Points
- Functionality to get there faster
- Leverage the experience – extend to CAE workflows
- Discussion

BETA CAE Systems S.A.

Research & development of CAE software and mechanical engineering products studies

- Private Company
- Headquarters in Thessaloniki, GREECE
- Established in 1999
- More than 20 years in the field
- Leader in multi-disciplinary CAE pre- and post- processing
  - Innovative, high performance software
  - High quality services

Addressing Robustness

Some factors driving product development:

Consumer's standpoint

- Fit to ones aesthetic
- Perform at all times
- Affordable cost

Engineer's standpoint

- Fit to consumer's aesthetic
- Meet its performance targets at all times under its operational conditions (…and just a bit off!)
- Build at low cost

Q: *Should the endless process of design – evaluation – improvement lead to an optimum product?*

A: *NO – It should lead to a product that is ideal, i.e. an affordable product that integrates aesthetics, performance and robustness for its intended use.*

Addressing Robustness

Challenges of Automotive Industry:

- Push innovative technologies in product development
  - *Fast evaluation of different concepts and accurate understanding of relative trends in early design phases*
  - *Integrate simulation into development process*
  - *Improve confidence in simulation*
- Reduce development time and cost; reduce the number of prototypes
- Provide improvements and comply to tighter regulations for safety, environmental protection, handling and ride comfort
- Capture and maintain enterprise knowledge and expertise
  - *Identify best practices and use breakthrough technology*
  - *Deploy enterprise solutions to address simulation, methods, data, process and resources management*
- Safeguard enterprise intellectual property

Addressing Robustness

Typical automotive CAE cycles involve a number of actions. . .

CAE engineers would love to conduct robustness analysis. But, even when all other obstacles are lifted, they still have to find the time for it!

Focal Points

Q: *How do we face robustness in the context of a simulation model?*

A: *By focusing on two equally important points:*

- Provide the means to correctly build-up the models required to conduct robustness analysis
- Develop a methodology so that the process leading to the actual robustness models is itself robust

Focal Points

Q: "*Where" should we build the robustness models?*

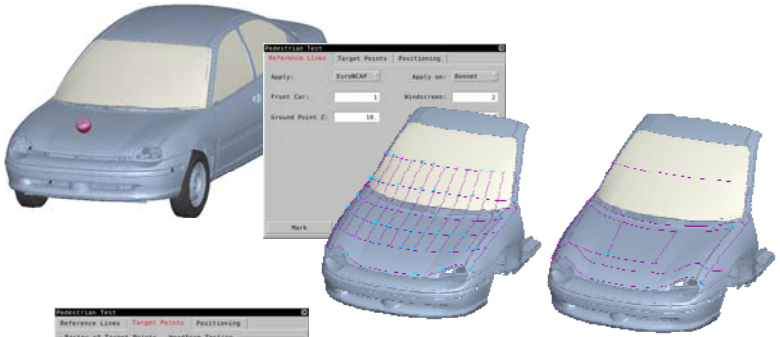
A: *In the pre-processor.*

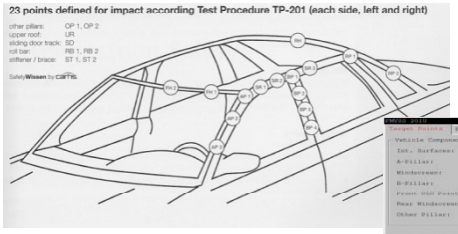
Here are some reasons why:

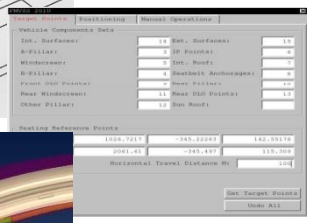
- *It is an "every day" tool; a tool that engineers know and trust*
- *It contains the FE-model in its most detail and has the integral functionality to modify it; typical (deterministic) FE-models are the basis for robustness models*
- *It can handle model updates*
- *Engineers can visualize the envelope of the input scatter and, for each sample, verify model's correctness against solver requirements*
- *It has the functionality to handle validated FE-models (e.g. dummies)*
- *It can identify interdependencies, perform model checks and fixes*
- *. . . . . .*

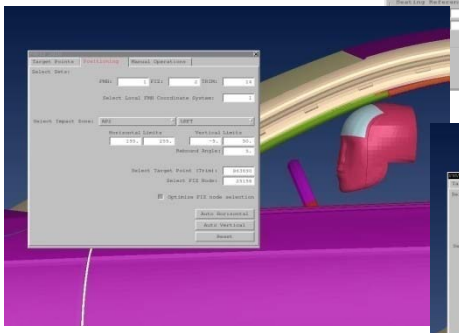
Functionality to get there faster

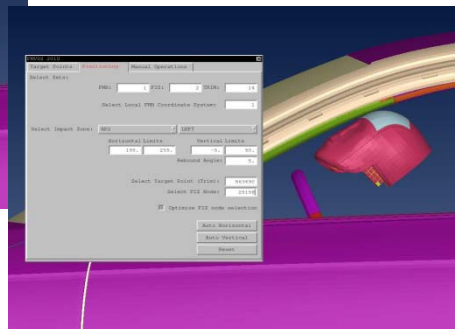
Existing capabilities for the intended discipline, especially in *positioning* for *safety*

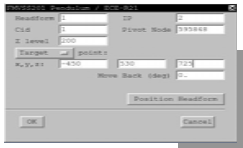


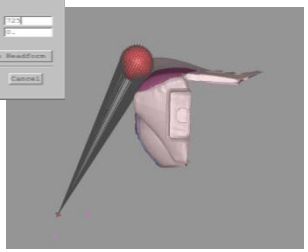






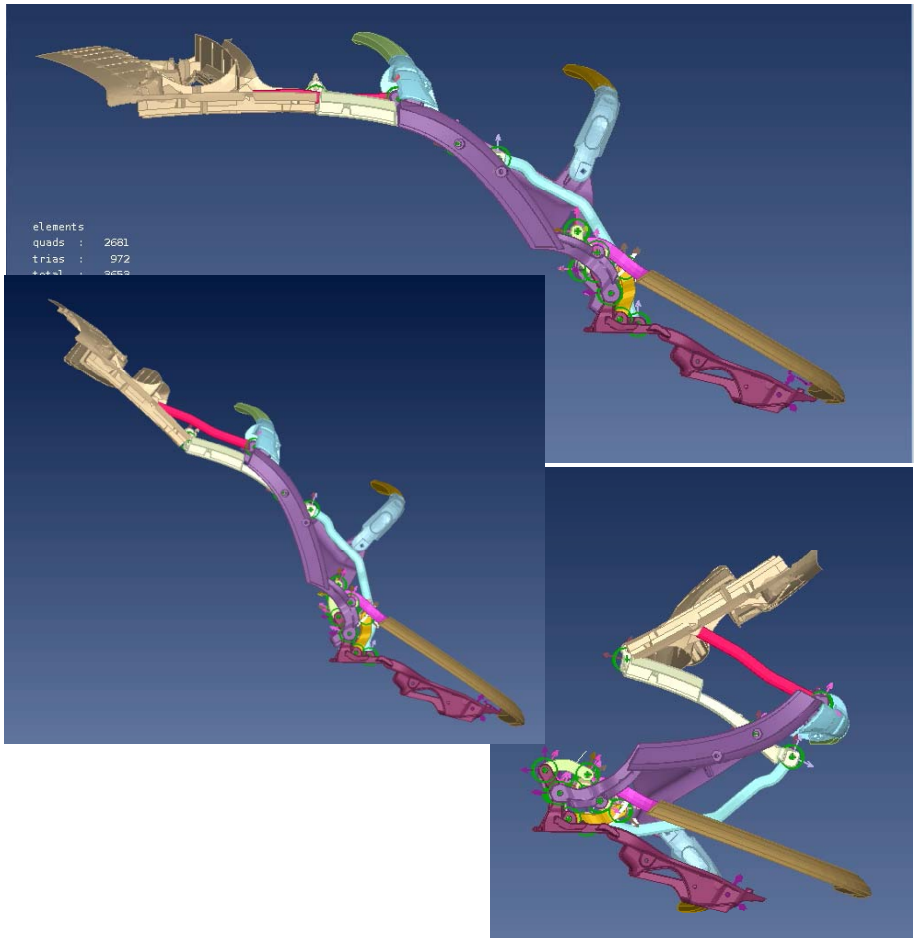


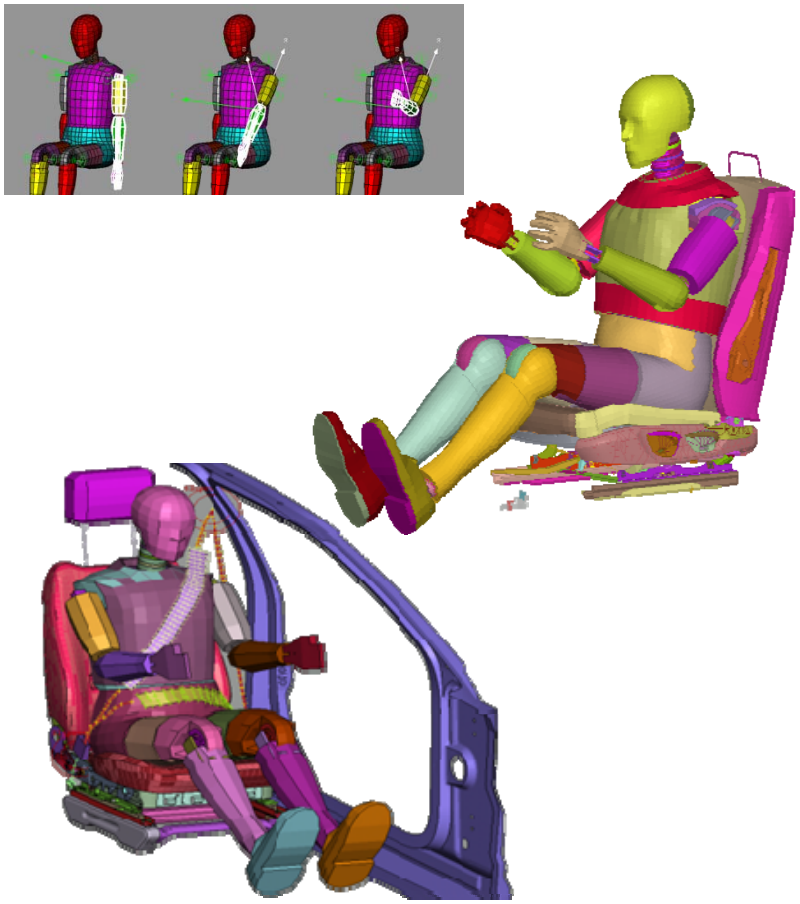




Functionality to get there faster

Extended capabilities, e.g. *kinematic tools* to handle complex mechanisms



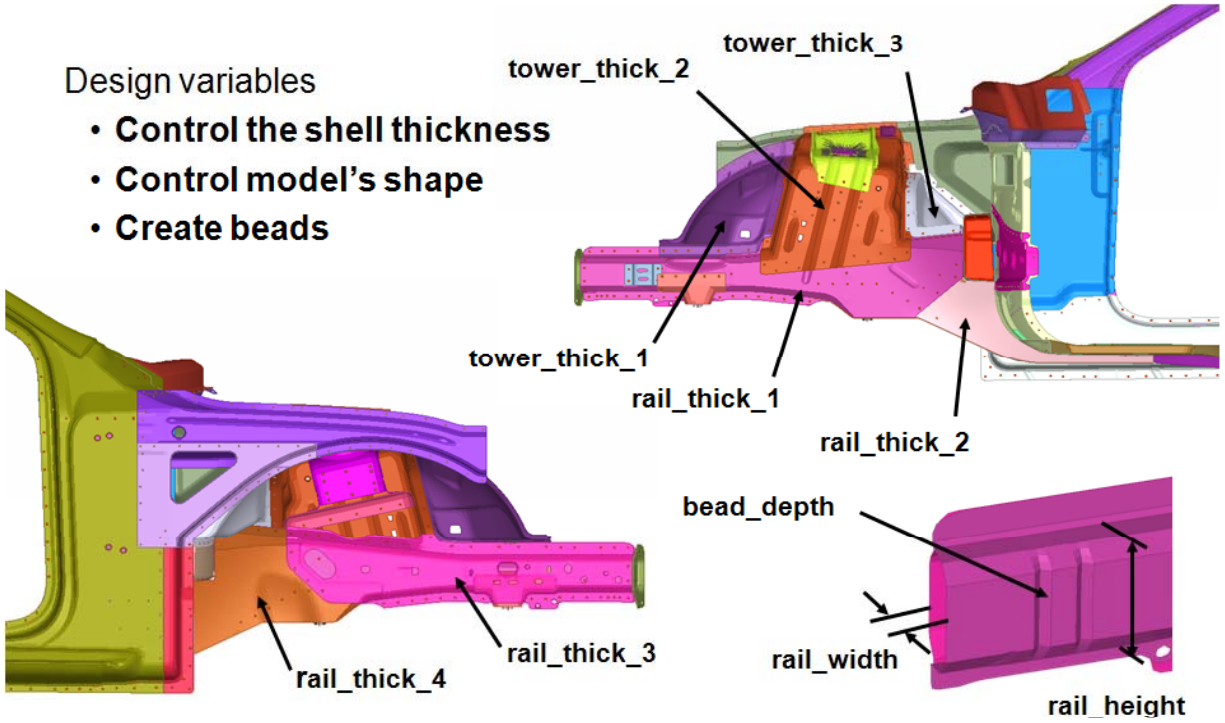


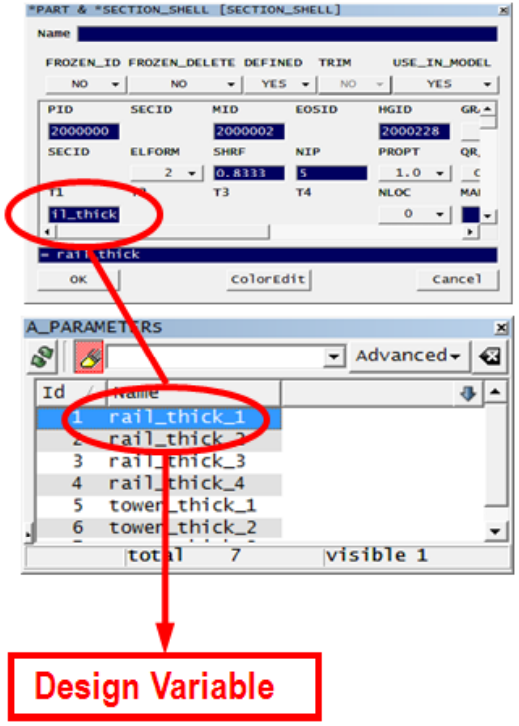
Functionality to get there faster

Capabilities to set up optimization cases

Design variables

- **Control the shell thickness**
- **Control model's shape**
- **Create beads**

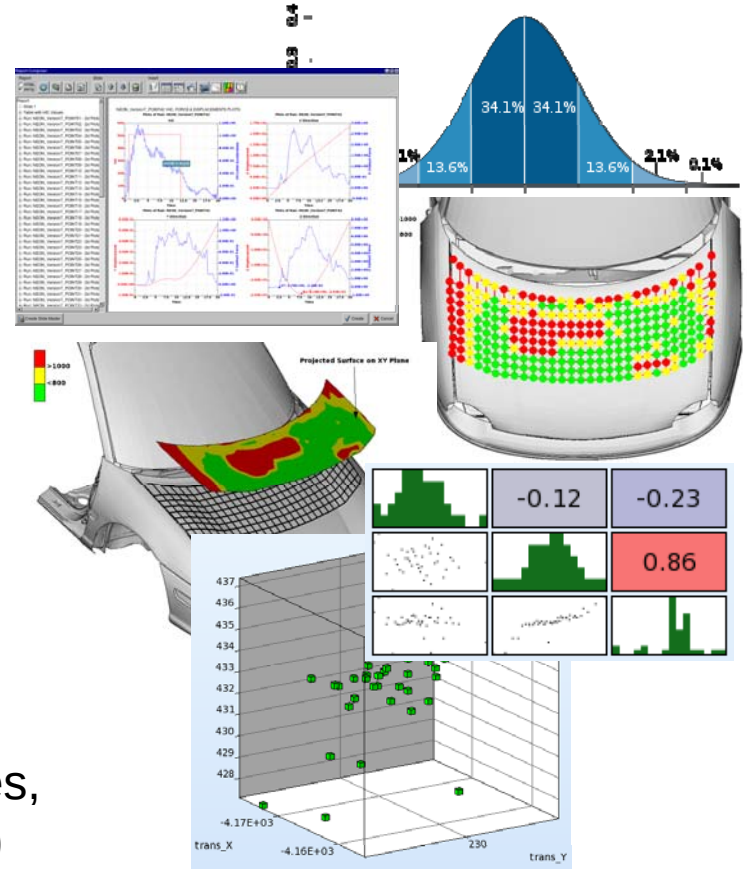




Functionality to get there faster

Inclusion of robustness analysis specifics:

- Scatter of input variables, typically in
  - *Dimensioning of passive safety systems*
  - *Material values*
  - *Positioning of crash test dummies*
  - *Loads and testing conditions*
  - *Imposed restraints*
- Assignment of distribution and correlation info to the scattering input variables, using collective experience and lab data
- Sampling methodologies
- Requested analysis results (model responses, correlation matrices, response surfaces etc.)



Output of all models that will be used for the robustness analysis, each checked and individually verified against the solver requirements

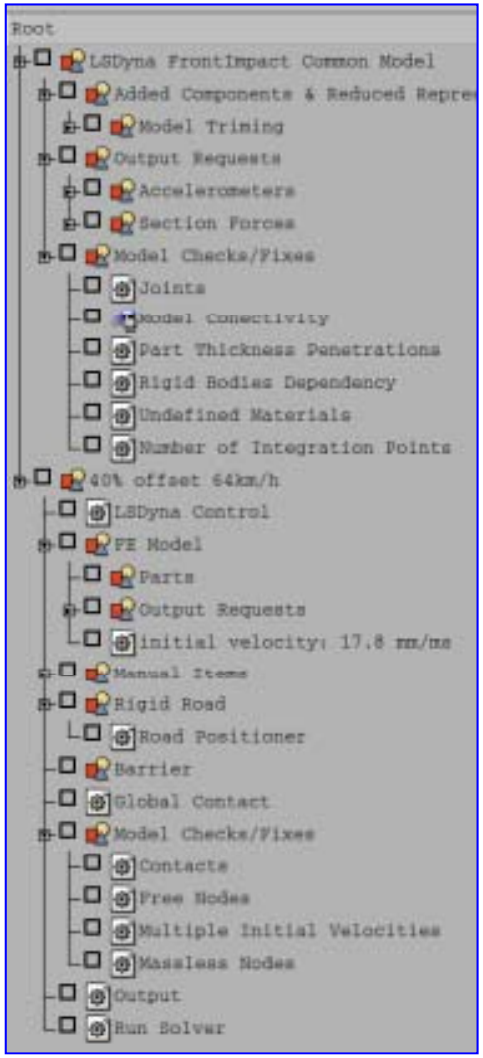
Functionality to get there faster

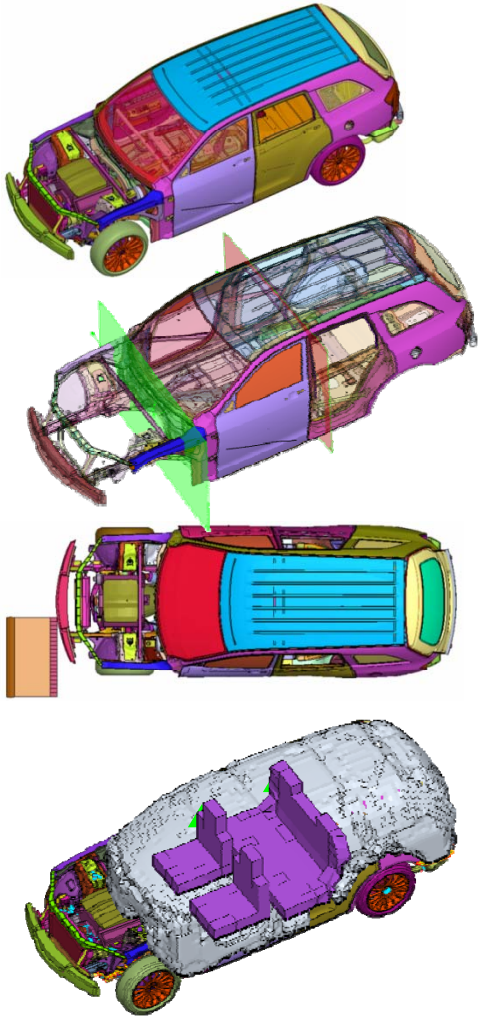
Process Automation, facilitated by:

- Template based model build-up
- Have an expert define a model build-up process
- Reflect this into a template-based, step wise structure
- Have inexperienced users follow it

Data Management systems

- *Part / sub-system data*
- *Auxiliary components*
- *Library items*
- *Text files*
- *Processes*
- *Results of past analyses*





Functionality to get there faster

Motivation

- Use the pre-processor to streamline discipline model build-up, suitable for robustness analysis

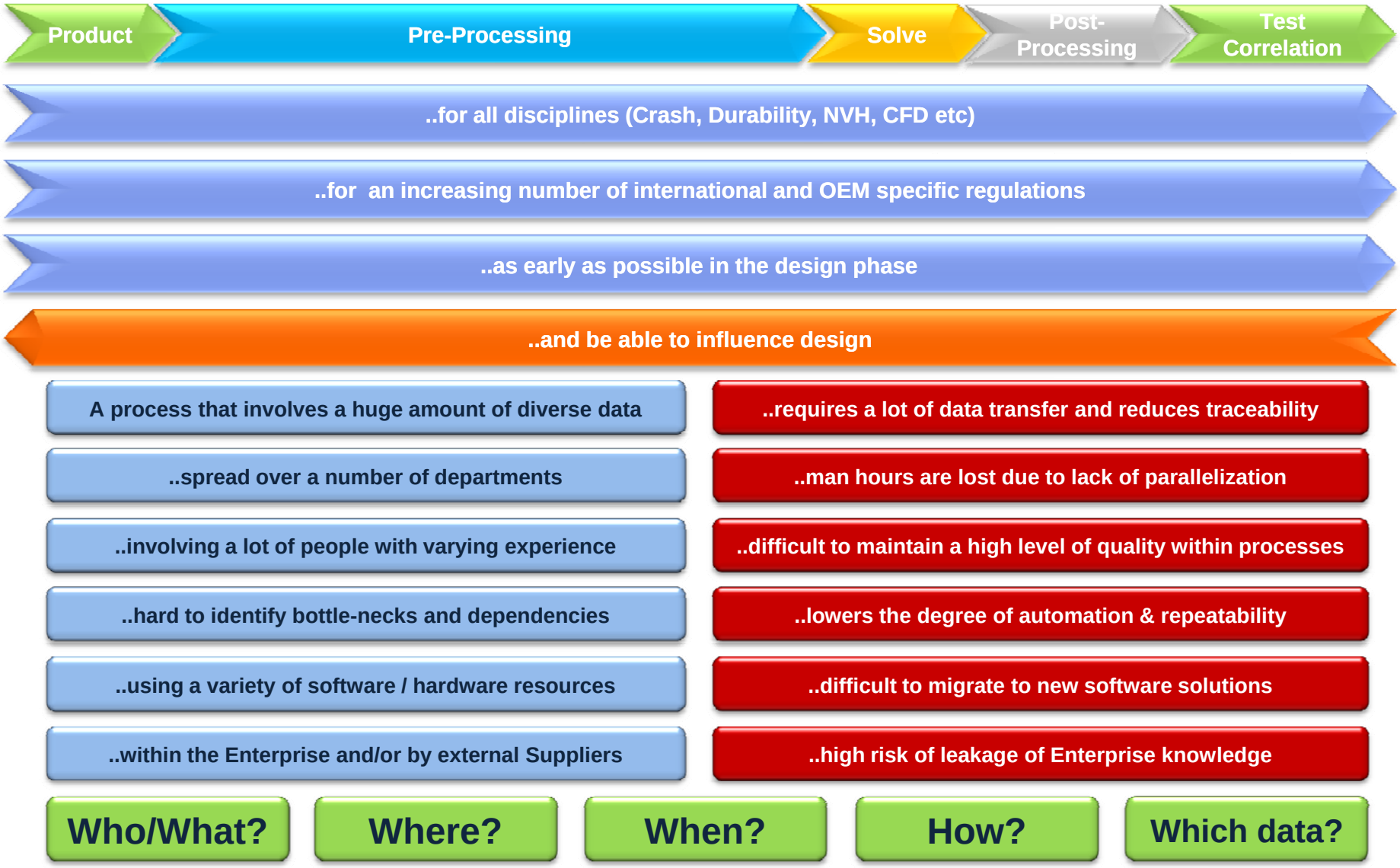
Target is to minimize or eliminate

- Difficulties and inconveniences in gathering all necessary data
- Facilitate the need of communication between engineers
- Unwanted changes caused by the incorporation of component updates at late stages of the discipline model build-up
- Dependency of the model quality upon the engineer’s expertise

Promote

- Model build-up repeatability
- Discipline model robustness
- CAE team productivity, communication and efficiency
- Decrease cost of the development effort

Leverage the experience – extend to CAE workflows



Leverage the experience – extend to CAE workflows

Product → Pre-Processing → Solve → Post-Processing → Test Correlation

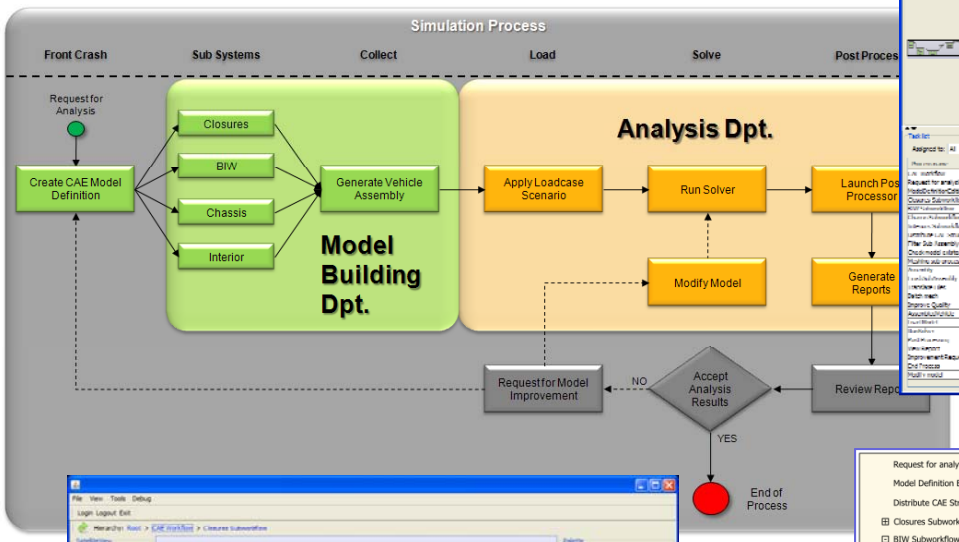
CAE workflow is a valuable Intellectual Property of the Enterprise...

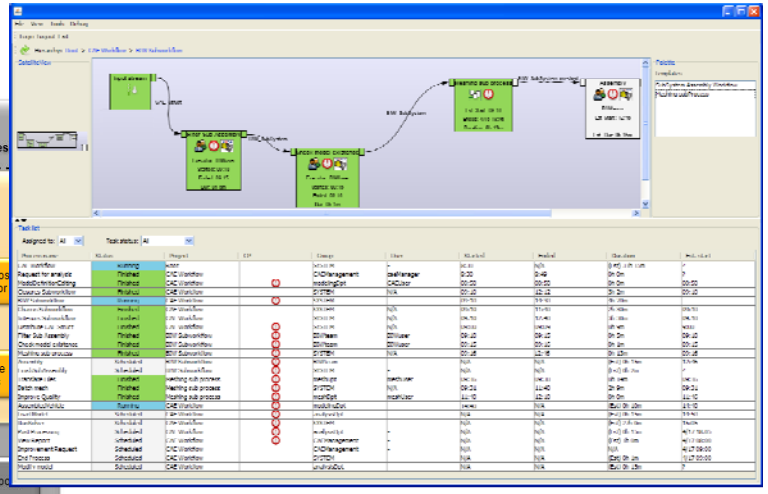
…that must be captured, continuously improved and safely deployed & executed

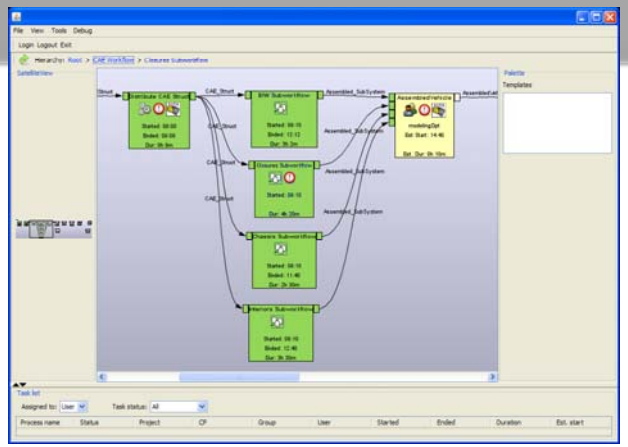
Enterprise solution to address simulation process, data & resources management

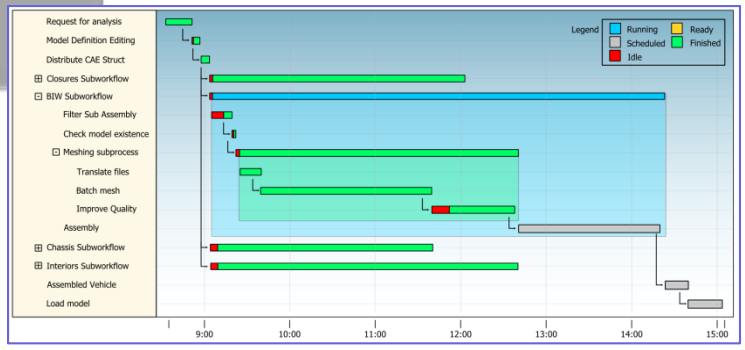
- Process
- Data
- Resources

Leverage the experience – extend to CAE workflows









Leverage the experience – extend to CAE workflows

Integration of Simulation, Process, Data and Resources management tools:

- Overall process consistency and standardization, at all levels
- Harmonization of operations within the enterprise and across suppliers
- Reduction of data redundancy
- Progress monitoring & the effective process quality management
- Repeatability of processes, even when using updated or different datasets and software tools
- Management of simulation generated intellectual property
- Increase of confidence to CAE with parallel reduction in time & cost of the overall simulation process

Increase the number of robust simulations,

increase the number of results,
increase confidence

Discussion