“30% of analysts’ time was spent seeking or providing information and a further 32% was spent in discussions or meetings.”

Source
Rolls-Royce Aero-Engines, “How analysts spend their time (HASTT)” study
Simulation Data and Process Management
Maturity Stages

Data Unmanaged
- Simulation data unmanaged, majority state of Analysts
- Access TC (PDM system) for CAD
- Keep data on local and shared drives, with no re-use

Data Archival
- Data archived (as blobs) with limited traceability and no re-use
- Customize TC (to avoid license costs) - typically driven by CAE teams with short term thinking and targeting a quick solution

Data Seamlessly Captured & Managed
- Data is organized and managed in functional blocks with traceability.
- Key simulation applications integrated – capture, manage & reuse data
- Able to automate & execute targeted discrete steps of the simulation processes

Process Management
- All simulation tools integrated – capture, manage & reuse data
- Able to execute end to end simulation processes, through discrete steps of automation.
- Collaboration across teams, disciplines, suppliers etc.

Process Automation
- Processes are fully standardized and optimized.
- Discrete steps are joined through automation and executed.
- CAE status visible – projects and tasks managed & automated

Note: A customer may have different groups or disciplines at different levels of maturity
Simulation End to End Process Data management

- Execute Simulation workflow
- Simulation Data Model
- Simulation Pedigree
- Simulation Tool Launch
- Simulation Visualization
- Structures CAE Model
- Simulation Structure Automation
Execute Simulation workflow

- Designers, simulation engineers and project managers can collaborate
- **Request for simulation** work and monitor the progress
- Review simulation tasks
- **Review simulation** work and perform signoffs
- **Control process** for Repeatability
Execute Simulation workflow

Demo

Execute Simulation workflow

Simulation Data Model

Simulation Pedigree

Simulation Tool Launch

Simulation Visualization

Structures CAE Model

Simulation Structure Automation
Execute Simulation workflow

Benefits

- Process control, standardization and collaboration
Simulation Data Model

- **Break down** simulation data to smaller manageable items
- **Promote** data reuse at all levels in the CAE process
- **Share** the data and workload to a team
- **Interact** with different CAE tools
- Relationships link CAE items for **traceability**
Simulation Data Model

Frozen CAD Mater Data
CAD Part or Assembly

Idealized geometry
De-featured
Mid surface

Meshed Model representation
FE elements
Lumped mass

Run ready Model
Boundary Conditions
Input Deck
Raw results

CAD Item
Engineering Proposal

CAD Geometry

CAE Model

CAE Analysis

CAE Results

Actionable Insight

Shared results
Reports
Images
Animations

TC_CAЕ_Source

TC_CAЕ_Source

TC_CAЕ_Source

TC_CAЕ_Defining

TC_CAЕ_Results
Simulation Data Model

**Benefits**

► Process control, standardization and collaboration

► Promotes Data reuse and shared workload
Simulation Pedigree

- Access complete **pedigree of simulation data** from requirements all the way to results
- **Traceability** for all modelling and analysis data inputs
- Relationships link data consumed and **reused by different disciplines**

Execute Simulation workflow
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Simulation Pedigree

► Process control, standardization and collaboration

► Promotes Data reuse and shared workload

► Traceability automatically captured by process and data model
Simulation Tool Launch

- Simulation tool integration allows launching and **execution of tools** on local desktops or on the server or cloud machines.
- **No coding** required.
- Simulation tools can also be executed automatically via workflows enabling **task and process automation**.

- Execute Simulation workflow
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Simulation Tool Launch
3rd Party Applications examples

Pre-Processor Integration
- Invoke a pre-processor with Product structure and CAE structure as inputs
- Batch mesh
- Import the meshes and updated CAE structure

In-house Application Integration
- Invoke an in-house application with inputs
- Interact with the in-house application
- Automatically capture the outputs

Solver & Post Processor Integration
- Initiate a workflow on an Analysis Revision
- Invoke the solver through workflow and capture outputs
- Invoke the post processor through workflow and capture the outputs

Non-FEA Tool Integration
- Invoke a numerical analysis tool
- Automatically send the inputs and capture the outputs generated by the tool
- View the results

HPC Integration
- Submit a job to the cluster
- Capture the Job ID & Monitor the job status
- Import results of the job

► Execute Simulation workflow
► Simulation Data Model
► Simulation Pedigree
► Simulation Tool Launch
► Simulation Visualization
► Structures CAE Model
► Simulation Structure Automation
Simulation Tool Launch

External Integration examples

- Execute Simulation workflow
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Demo

- Execute Simulation workflow
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- Simulation Structure Automation
Simulation Tool Launch

Benefits

► Process control, standardization and collaboration
► Promotes Data reuse and shared workload
► Traceability automatically captured by process and data model
► Integration for any CAE tool and easy automation
Simulation Visualization

- Workflow carries progress updates and results information back to the business
- Status, history and audit trail
- Multi media visualization of results
  - Reports
  - Images
  - Lightweight 3D JT contour plots
Simulation Visualization Demo

Teamcenter

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Simulation Visualization

Benefits

► Process control, standardization and collaboration
► Promotes Data reuse and shared workload
► Traceability automatically captured by process and data model
► Integration for any CAE tool and easy automation
► Actionable insight available for design decision making
Structures CAE Model

- Automatically create CAE BOM from Product BOM
- Structure mapping with simplification and automated reuse
- Efficient, controlled update of CAE assemblies as the product matures
- Full model traceability
Structures CAE Model

Product

Model

Analysis

CAE Process

CAD Assembly Structure

CAE Model Structure

CAE Analysis

CAE Results

TC_CAE_Source

TC_CAE_Defining

TC_CAE_Include

TC_CAE_Results

Related CAE Analysis (e.g. Thermal map)
Structures CAE Model

Benefits

► Process control, standardization and collaboration
► Promotes Data reuse and shared workload
► Traceability automatically captured by process and data model
► Integration for any CAE tool and easy automation
► Actionable insight available for design decision making
► Automated data reuse and easy update of large assembly models
Simulation Structure Automation

- Create simulation structures **bottoms-up** with new or existing models (during **conceptual analysis phase**)
- Create simulation structures **top down** based on the existing configured product structures (during **detailed design phase**)
- Configure simulation structures through revision rules, variant rules, effectivity etc. similar to product structures
Simulation Structure Automation

Automated generation of simulation structures from product structures based on pre-defined rules, reuse of existing models, reorganization of simulation structures

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Structures CAE Model Demo

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Simulation Structure Automation

Benefits

► Process control, standardization and collaboration
► Promotes Data reuse and shared workload
► Traceability automatically captured by process and data model
► Integration for any CAE tool and easy automation
► Actionable insight available for design decision making
► Automated data reuse and easy update of large assembly models
► Automatically create simulation structures from a product structure through a set of predefined rules
## Simulation Process Data Management

### Big Picture

<table>
<thead>
<tr>
<th>Category</th>
<th>Maturity Stage</th>
<th>Persona / Role</th>
<th>Key Responsibilities</th>
<th>Target Client</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumer</strong></td>
<td>All maturity stages</td>
<td>CAE Group Manager</td>
<td>Assign CAE resources; Review CAE results &amp; reports; Approve CAE workflows</td>
<td>Active Workspace</td>
<td>Minimal interaction with the SDM system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Program Manager / Systems Engineer / Project Lead</td>
<td>Request CAE work; Review CAE results &amp; reports; Review pedigree &amp; traceability of CAE results; Sign off on CAE workflows</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design Engineer / Manufacturing Engineer</td>
<td>Request CAE work; Review CAE results &amp; reports</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Author</strong></td>
<td>Entry point / Tactical solution</td>
<td>All Analysts</td>
<td>Execute CAE workflows; Import / Export data; Archive analysis data</td>
<td></td>
<td>Minimal training</td>
</tr>
<tr>
<td></td>
<td>Higher maturity / Strategic solution</td>
<td>Analysts focused on a CAE task (Offshore Analysts, Suppliers etc.)</td>
<td>Execute CAE task(s) prepared by Advanced Analysts; Manual Import / Export data (or) Launch Simulation tool</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher maturity / Strategic solution</td>
<td>CAE Engineer / CAE Lead Engineer / Engineering Analyst / Advanced Analyst</td>
<td>Execute CAE workflows; Perform analysis; Author CAE data; Generate CAE results &amp; reports</td>
<td>Rich Client (CAE Manager)</td>
<td>Frequent interaction with the SDM system</td>
</tr>
<tr>
<td><strong>Admin</strong></td>
<td>All maturity stages</td>
<td>CAE Methods Engineer</td>
<td>Define, standardize and support CAE workflows, methods and tools</td>
<td></td>
<td>Advanced training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CAE Administrator / Database Administrator</td>
<td>Configure CAE tools, Structure Maps, workflows; Configure CAE reports, dashboards</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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