

TERRIFIC

Towards Enhanced Integration of Design and Production in the Factory of the Future through Isogeometric Technologies

September 1, 2011 - August 31, 2014

www.terrific-project.eu

European Community's Seventh Framework Programme
Grant Agreement 284981
Call FP7-2011-NMP-ICT-FoF

TERRIFIC and ISO 10303 STEP

Kjell Bengtsson

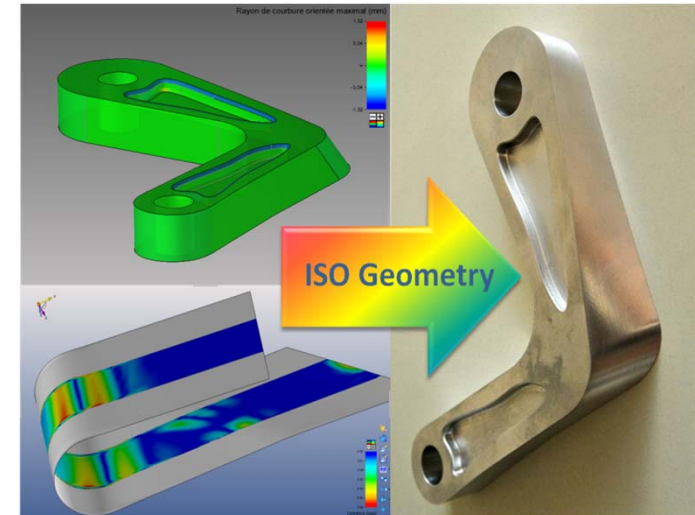
Jotne, Norway

Kjell.Bengtsson@jotne.com

www.jotne.com

Agenda

- ISO Geometry and relationships to standards: ISO 10303
- ISO 10303 and data exchange/sharing and archiving for Terrific processes
- Video on ISO 10303 PLM concepts



ISO TC 184 SC4 – ISO 10303 STEP

The big picture



ISO 10303-203

ISO 10303-214

ISO 10303-239

ISO 10303-209e2

1994



1999



2005



2012

CAD



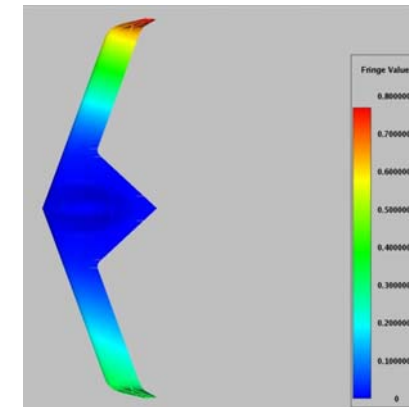
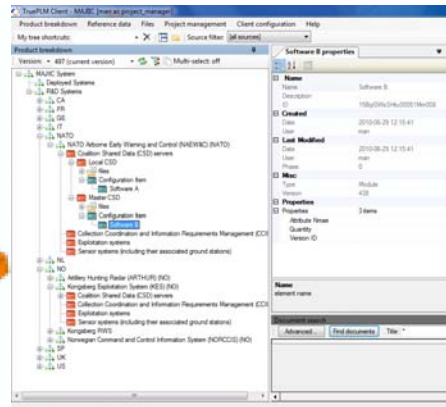
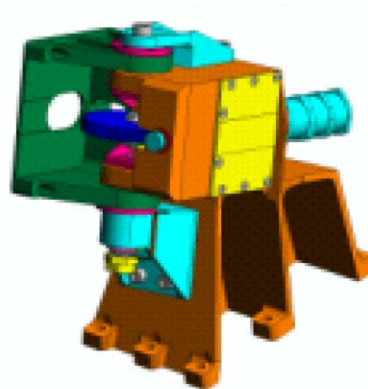
PLM



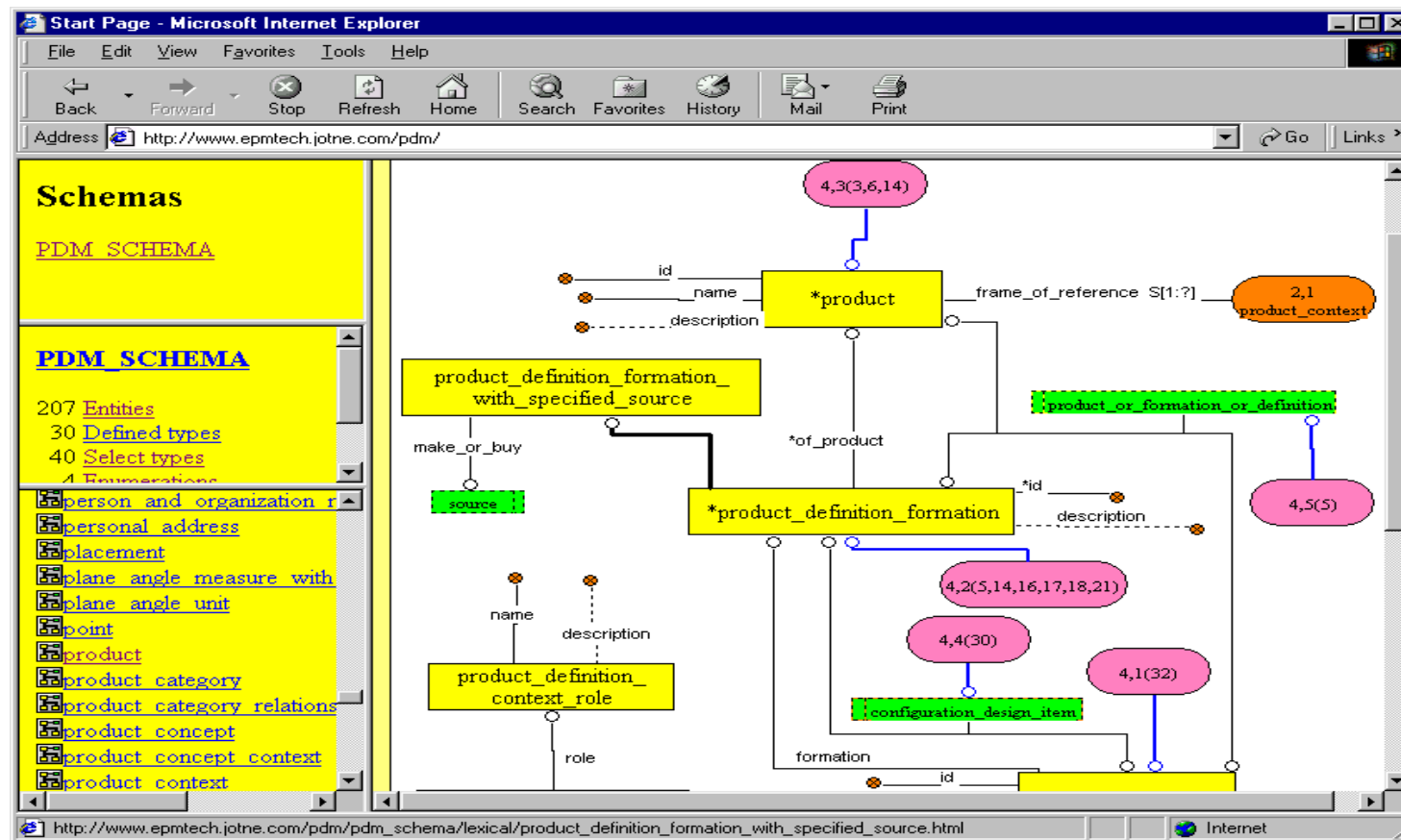
ILS



CAE-SDM

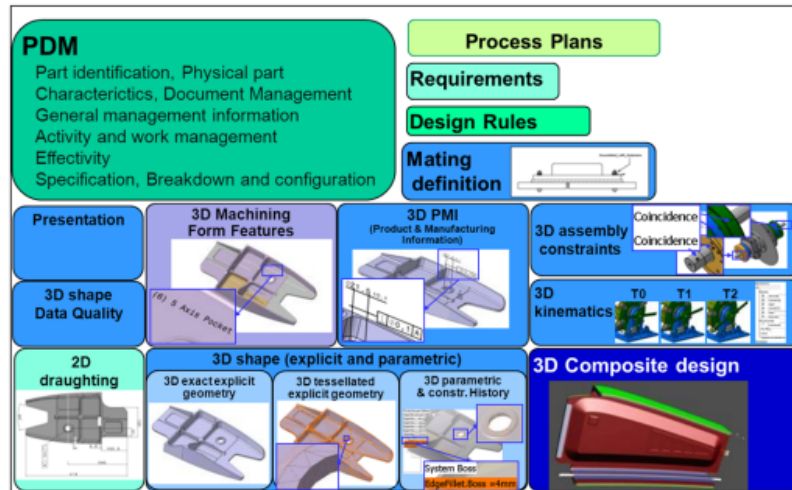
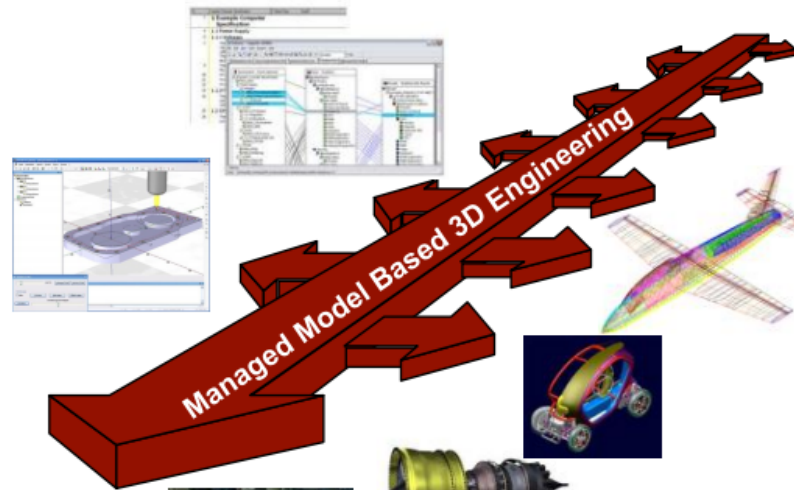


ISO 10303 consists of many parts



ISO 10303-242 for first take up

**ISO 10303 standard
STEP AP 242**
for
**Managed Model Based
3D Engineering**
For the aerospace, automotive,
& other mechanical manufacturers
and their suppliers



<http://www.ap242.org/>

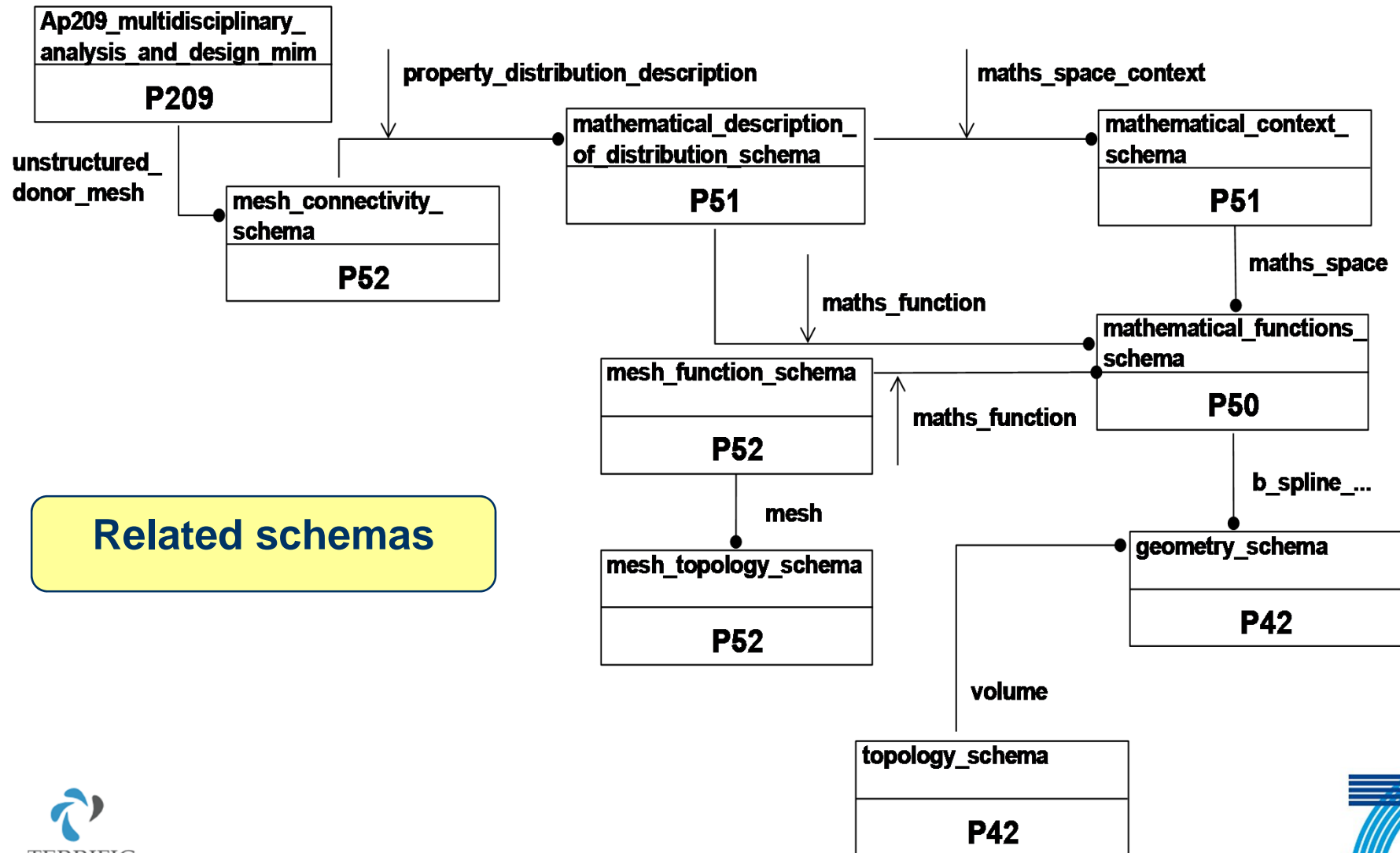
CAD/FEA representation items

- Shape
 - Trivariate volumetric representation or Boundary element method
 - Assembly of volumes
 - Isogeometry uses only splines
 - Issue with trimmed CAD-geometry
 - B-splines, NURBS or locally refined splines
- Mesh
 - isogeometric mesh uses B-splines and NURBS
- Boundary conditions
- Load fields
 - In refined versions of the shape spline space
- Solution fields
 - In refined versions of the shape spline space

Reasoning for STEP extensions (1)

- An isogeometric mesh is implicitly represented
 - B-spline surface or volume coefficients as nodes
- Part 104 is dedicated to explicit nodes and elements
 - => not appropriate for an isogeometric mesh
- Instead: Part 52
 - Mesh as B-spline surface or volume or locally refined spline surface or volume
 - But: coefficients are not interpolatory and cells are only implicitly defined
 - => `implicitly_discretized_spline_mesh` with `mesh_geometry` from P42 and `spline_mesh_function` `general_matched_mesh_connection`

Data models that has been updated

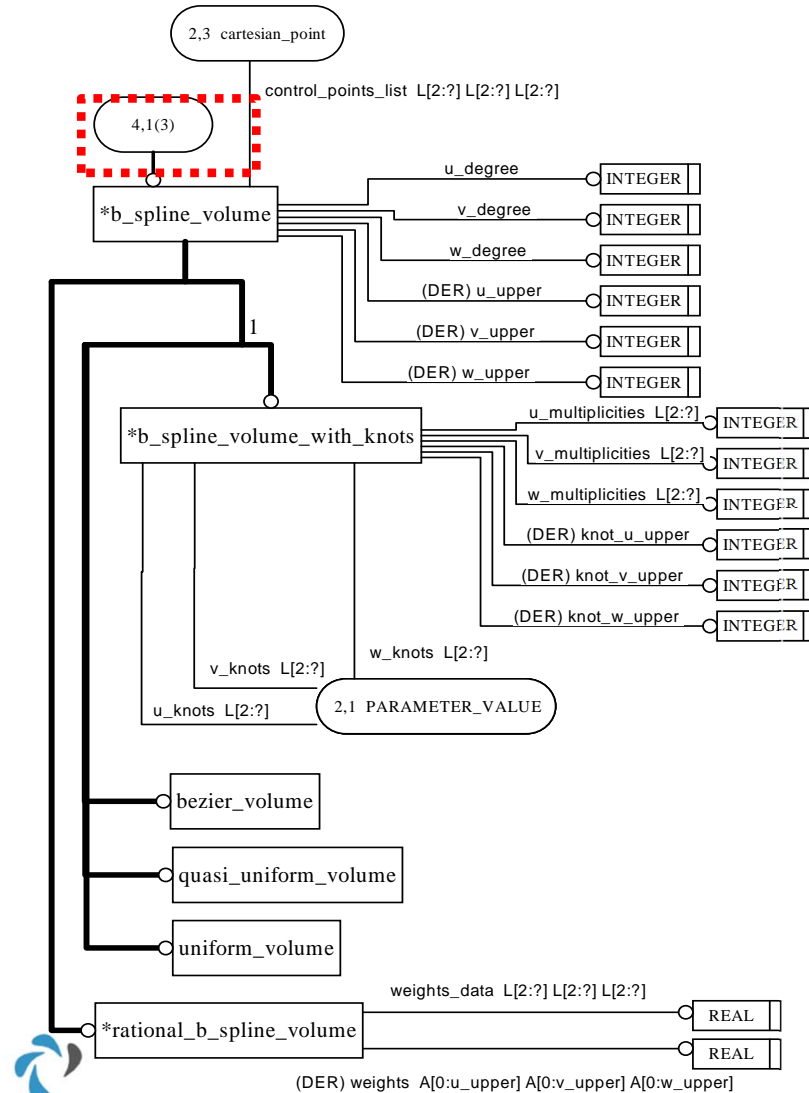


Identifies changes

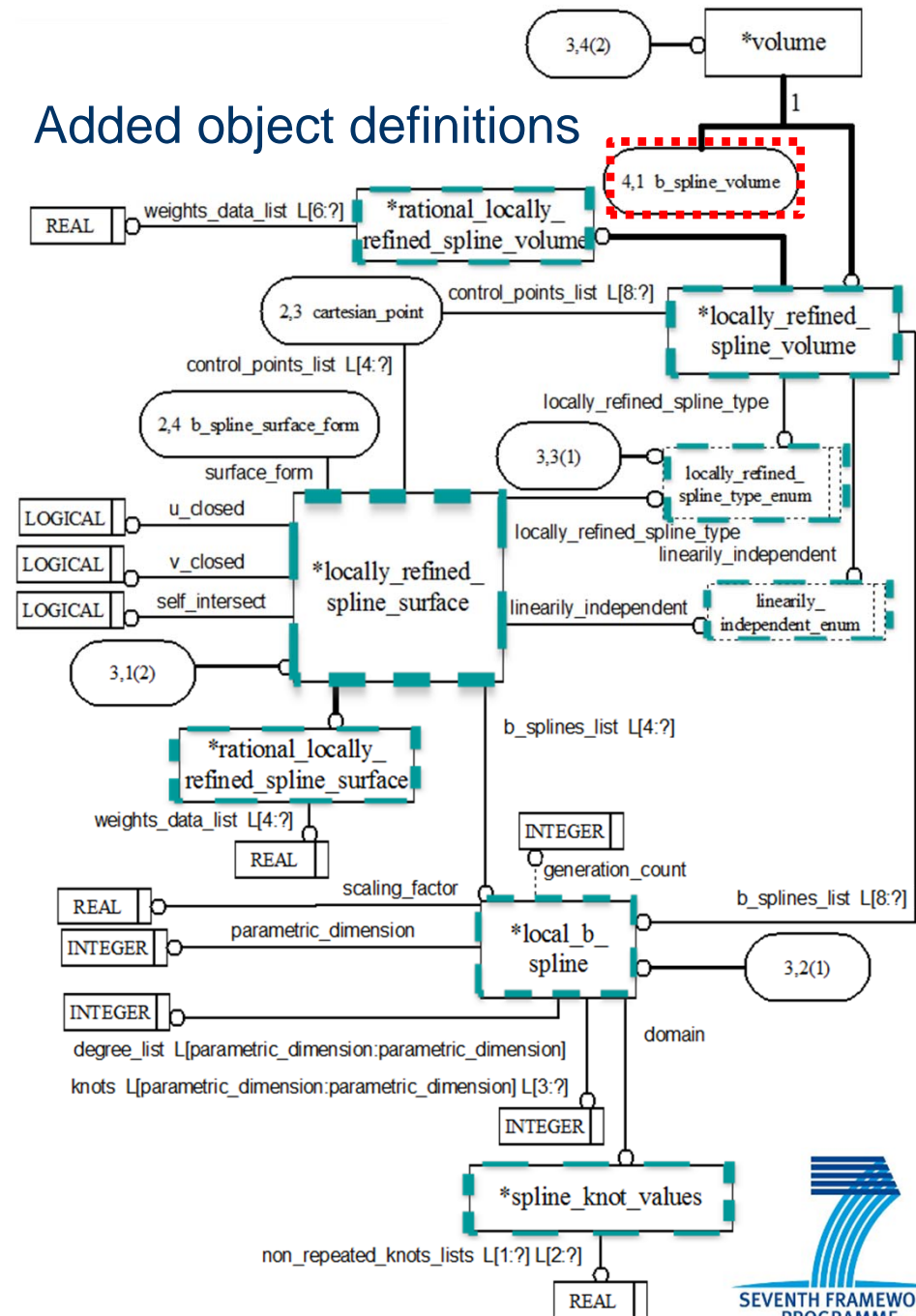
- Part 42 geometry_schema
 - Add entities locally_refined_spline_curve/_surface/_volume
 - Add entities local_b_spline
 - Add entities spline_knot_values
 - Add entities rational locally refined spline curve/_surface/_volume
- Part 42 topology_schema
 - Add entities connected_volume_set and connected_volume_sub_set
 - Add entities volume_with_faces, volume_with_shell and volume_with_parametric_boundary
- Part 50 Add entities related to local_generic_b_spline
- Part 52 mesh_function_schema, mesh_connectivity_schema, and mesh_topology_schema

Geometry_schema

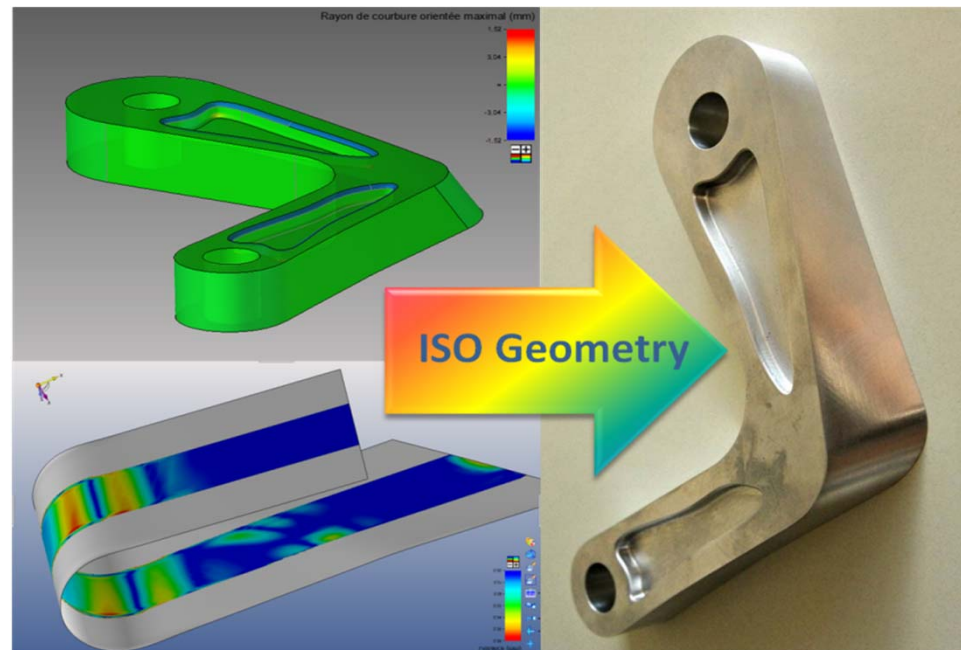
Existing data model



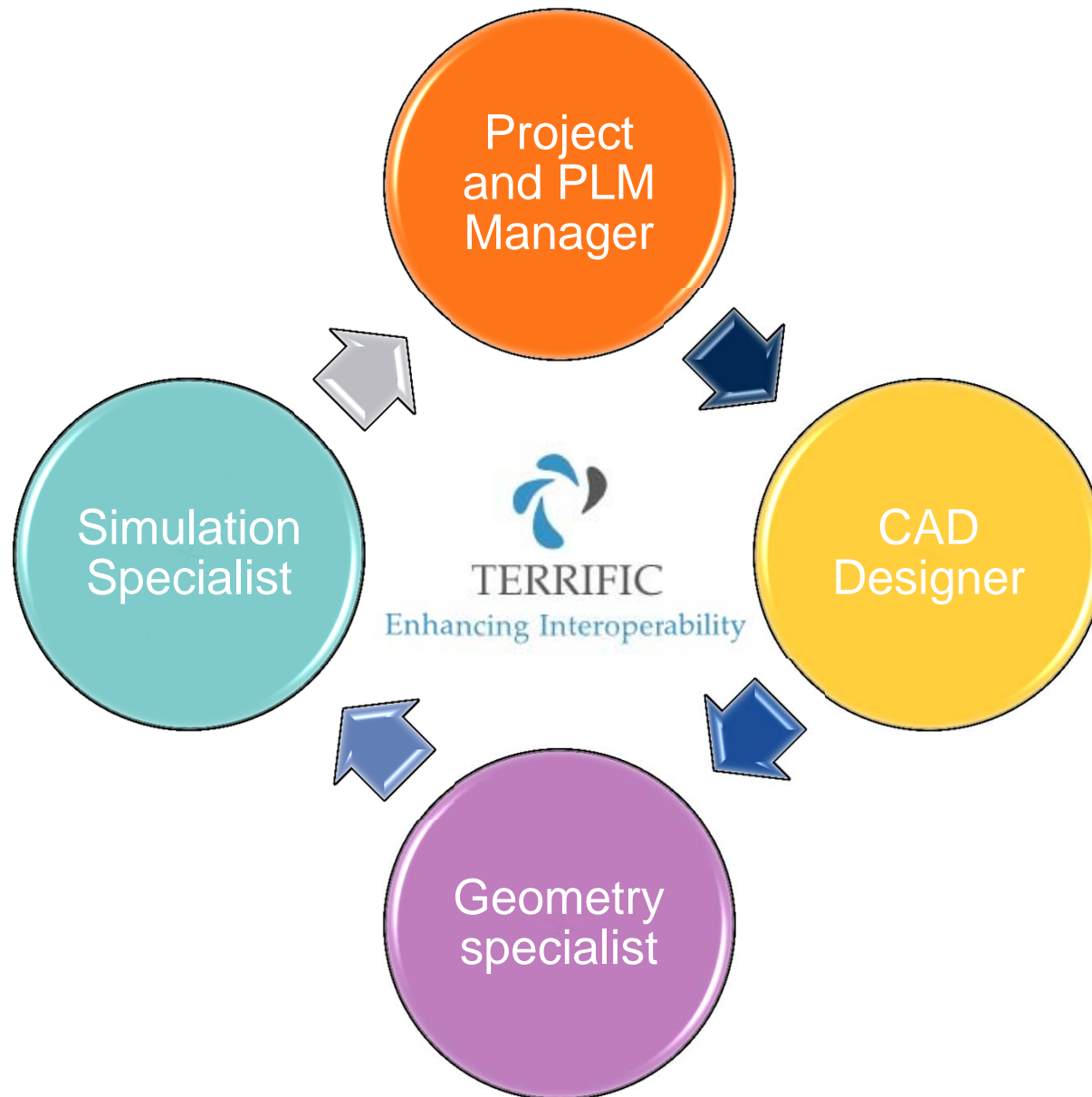
Added object definitions



TERRIFIC Integrated Demonstration and PLM Workflow



Workflow and actors



Progression through the scenario

CAD Designer develops functional 3D model



Geometry Specialist review the geometry and perform parameterization.



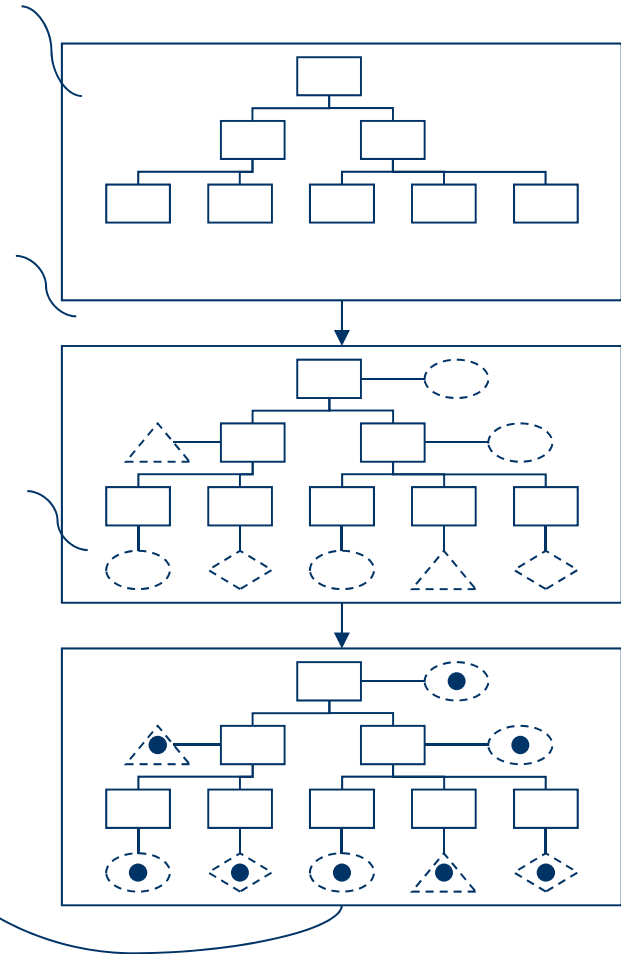
Simulation specialist creates the required input files



Simulation specialist performs simulations



Project Manager approve the simulations



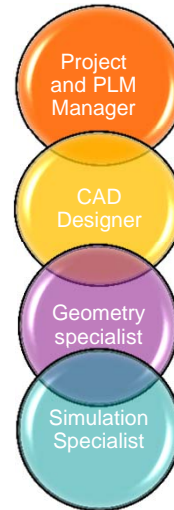
Overview

■ Participants

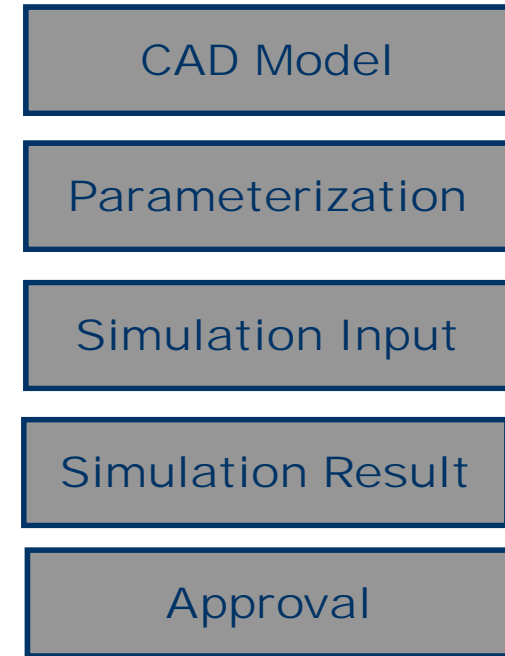
- **PLM and Project Manager**
- **CAD Designer**
- **Geometry Specialist**
- **Simulation Specialist**

■ Process

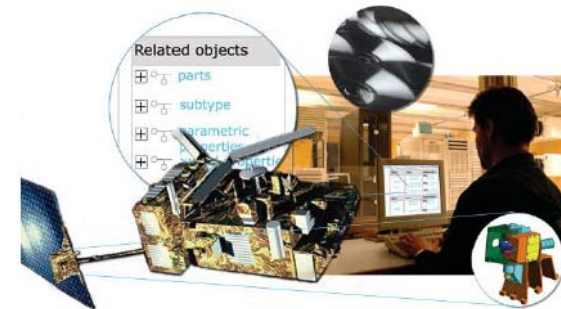
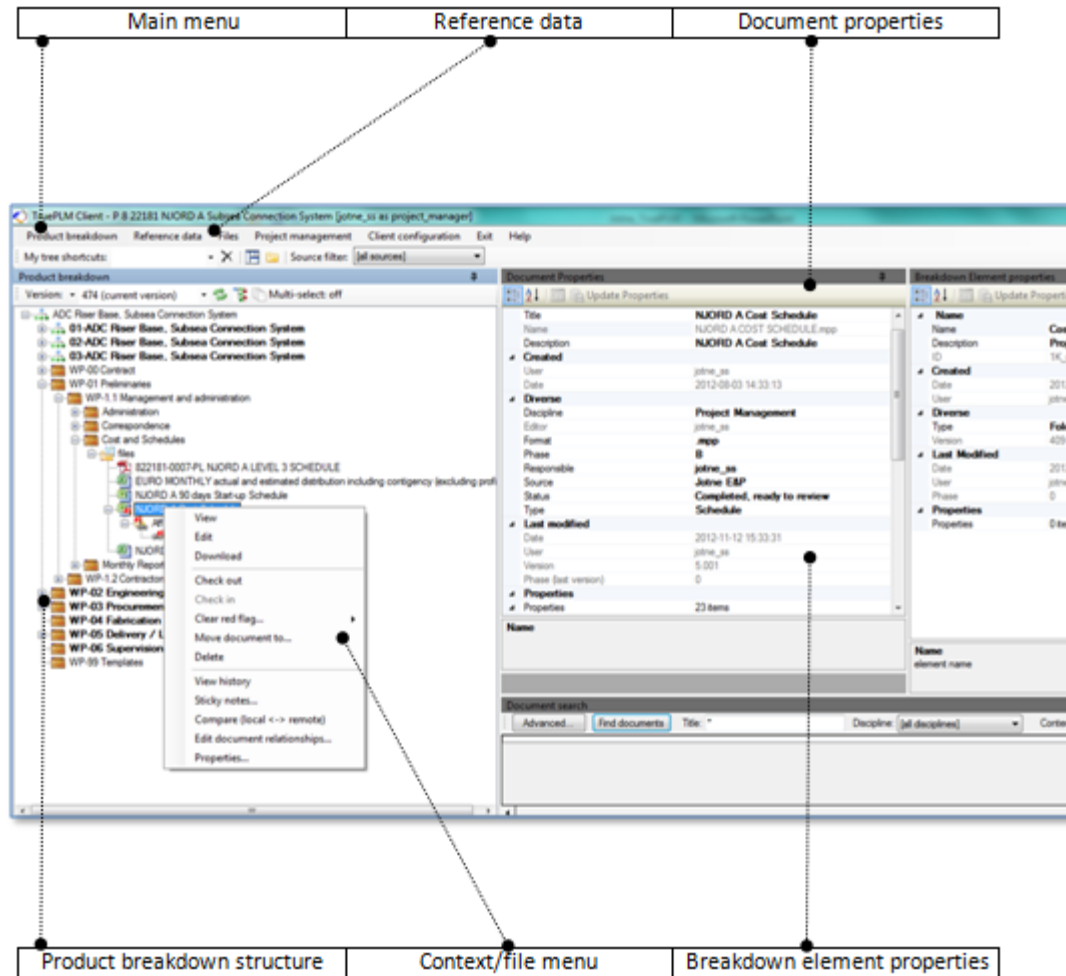
- 1) **PLM Manager set up users and access control to the project**
- 1) **Create 3D Model**
- 2) **Parameterization 1**
- 3) **Parameterization 2**
- 4) **Simulation 1 using Parameterization 1**
- 5) **Simulation 2 using Parameterization 1**
- 6) **Simulation 3 using Parameterization 2**
- 7) **Review results & approve**



Progression



What is TruePLM?



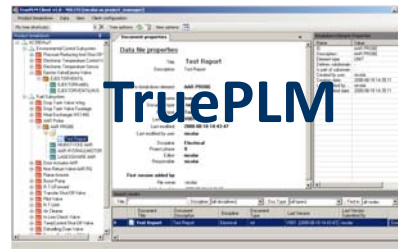
From idea to manufacturing and operations

Share, exchange and archive your PLM data

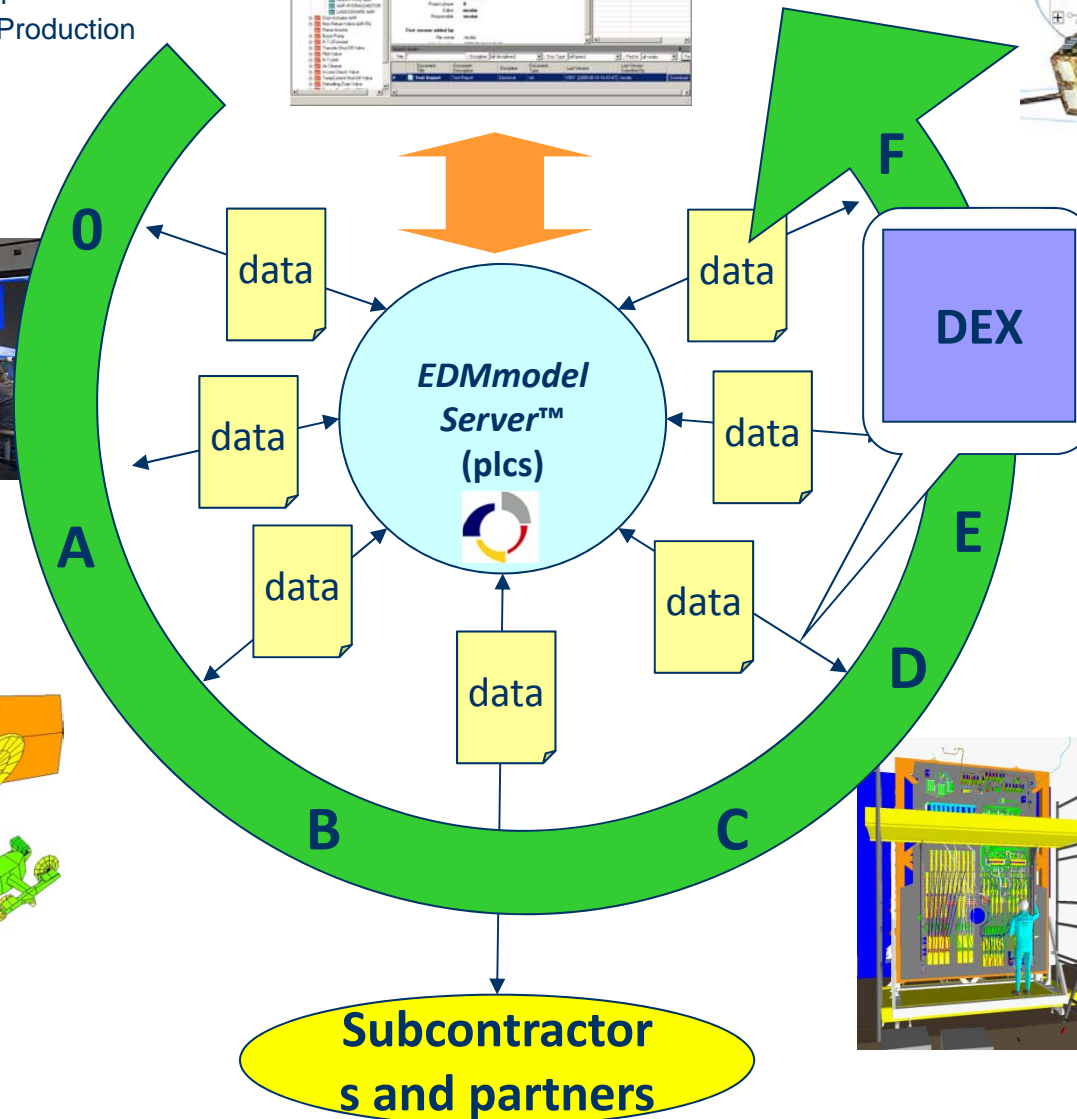
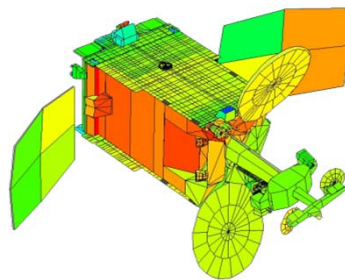
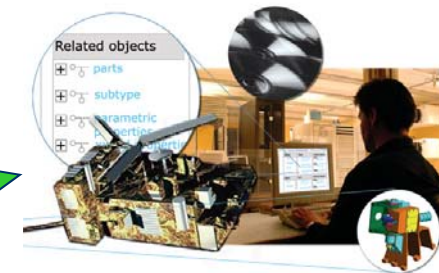


Business cases – Life-cycle support / Interoperability

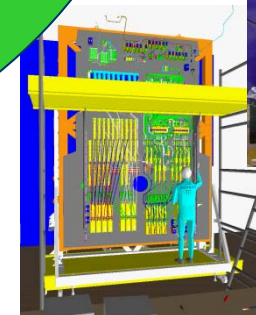
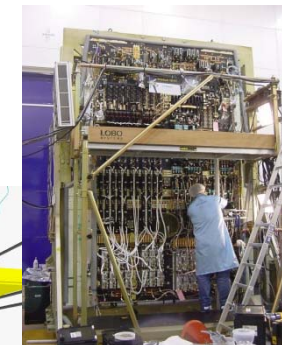
- Phase 0** Mission analysis/needs identification
- Phase A** Feasibility
- Phase B** Preliminary Definition
- Phase C** Detailed Definition
- Phase D** Qualification and Production
- Phase E** Utilization
- Phase F** Disposal



TruePLM



**Data Exchange
Specification
(PLCS)**



TERRIFIC
Enhancing Interoperability



**SEVENTH FRAMEWORK
PROGRAMME**

TruePLM main functionalities

- **Product structure tree:** TruePLM provides a product-structure-based way for sharing of project data, team collaboration and long-term archiving tools.
- **Project lifetime scope:** TruePLM system supports the project activities across all the phases from conceptual design until the end of the project.
- **Configuration control tool:** TruePLM has in built configuration control tool to manage the different versions of the product structure and data related to it
- **Presentation of product data in tree structures:** All product data sin TruePLM is always related to the product structure tree, and presented in such a tree structure
- **Versioning of data:** TruePLM system supports versioning of project data
- **Search for product data:** TruePLM supports searching of project data and project documents within the product tree
- **User access control:** Access to the TruePLM system is limited by a login system. Access to the projects and project data is limited according to the type of users and permissions required and assigned to him or her.

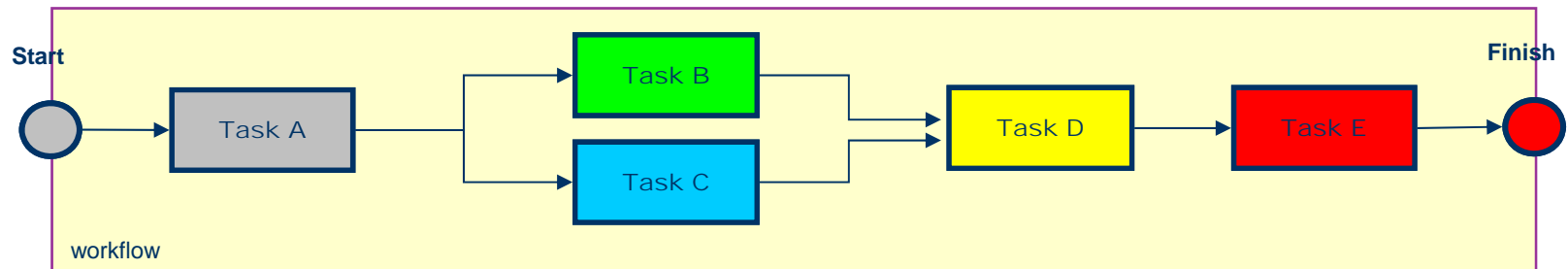
TruePLM main functionalities (2)

- **Traceability of the history of data:** *TruePLM system tracks the history of the different version submitted to the system during the development of the project*
- **Integration with specific project tools:** *TruePLM allows viewing and editing of files with specific data contents to be opened in specific application*
- **Archival of project data:** *TruePLM includes an archival system with the following capabilities:*
 - - *archival of standard representation of integrated life cycle data for space products including not only the initial phases, but also design and engineering as well as operational and logistics aspects of a space system according to ISO 10303, STEP.*
 - - *long term storage of structured space product data including referenced documents according to ISO 14721, OAIS.*
- **Project plan information:** *TruePLM stores basic information about the project plan:*
 - - *planned milestones*
 - - *scheduled events*
 - - *planned actions*

TruePLM main functionalities (3)

- **Baselines:** *TruePLM allows the creation of baselines of all or part of the project data at any moment, and also relating baselines to milestones if required*
 - *A Baseline is defined as the approved state of the product structure at a key milestone of the programme or project and provides the point of departure for further evolution of the project or programme.*
- **Project data contents:** *TruePLM allows storing of project data in form of files, including documents, CAD files, manuals, structured documents, etc.*
- **Data dependency representation:** *TruePLM allows management of dependencies between documents / data, in order to identify, check and correct the possible effect of changes in requirements or project data.*

TERRIFIC Process Status



Committed

Task has Finished, Issued Data

Published

Task has Started, Intermediate Data Exported to Other Tasks

In Progress

Task has Started, Data Available within Task

Enabled

Task Ready to Start, Input Data Available

Blocked

Task Waiting for Input Data to Become Available

TERRIFIC Workflow Definition

- Who
 - PLM and Project Manager
- Setting up project resources and PLM server
 - Logon as sys admin in TruePLM server system
 - Select predefined tasks and create activities
 - Link tasks (assign workflow order and data)
 - Assign tools, as required
 - Store workflow as notification



EXPRESS Data Manager
TruePLM™



Project
and PLM
Manager



TERRIFIC
Enhancing Interoperability



SEVENTH FRAMEWORK
PROGRAMME

PLM Manager configuration

EDMtruePLM Client v1.31.50.017 - TERRIFIC [manager as pro]

Product breakdown Reference data Files Project man

My tree shortcuts: X | | Sou

Product breakdown

Version: 32 (current version)

Breakdown

Breakdown Element properties

Name	
Name	CAD data
Description	CAD files
ID	3M6Ce0rCaHue00w14om32\$
Created	
Date	14.06.2013 10:10:12
User	manager
Last Modified	
Date	03.07.2013 10:19:09
User	caddesigner
Phase	0
Misc	
Type	Subsystem
Version	6
Properties	
Property name / Unit	0 items

Name
element name

Breakdown meta data – Properties

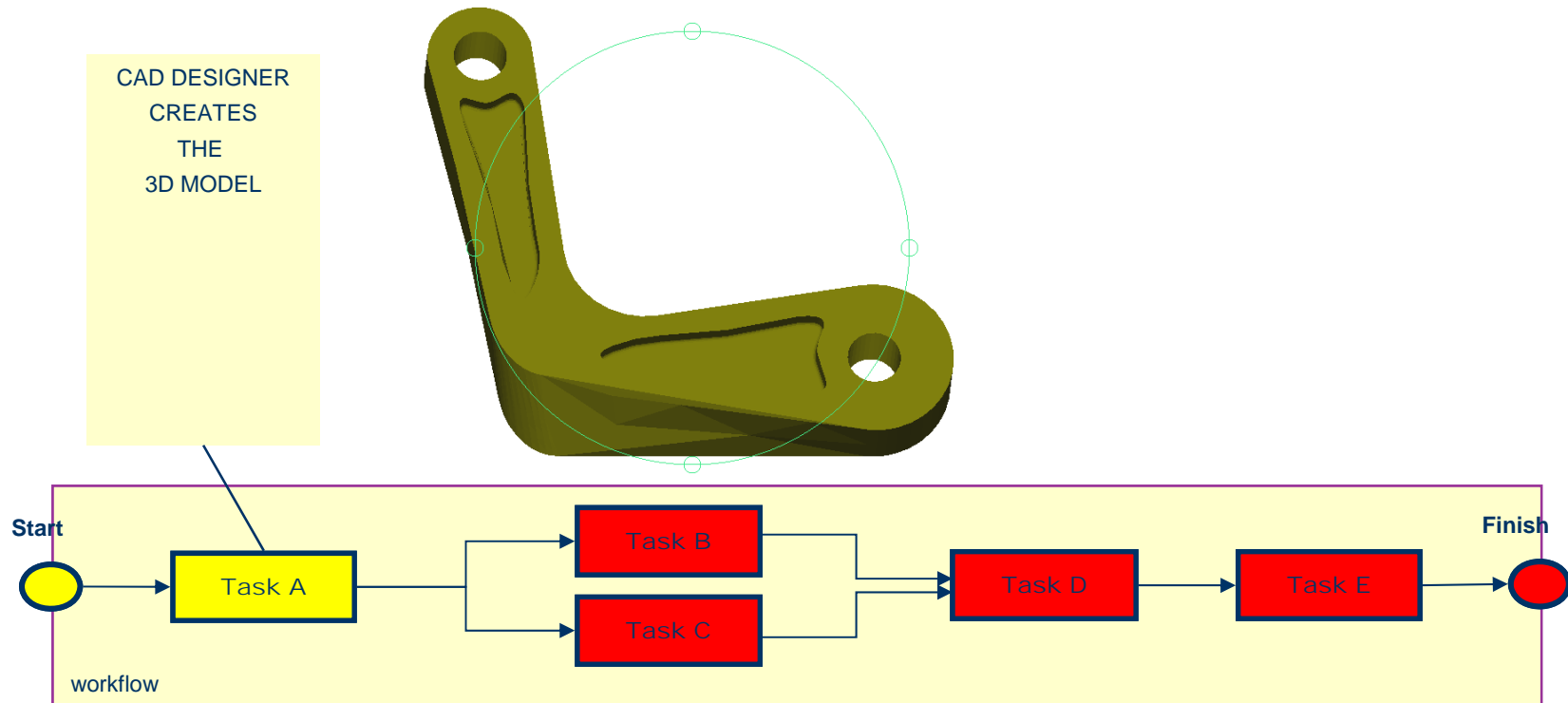
Document Properties

Update Property

Name	
Title	demonstrator_au4g_deg2.dat
Name	demonstrator_au4g_deg2.dat
Description	simulation input
Created	
User	simulationspecialist
Date	2013-09-15 10:48:04
Last modified	
Date	2013-09-15 10:48:04
User	simulationspecialist
Version	1.001
Phase (last version)	0
Misc	
Discipline	Simulation
Format	.dat
Phase	0
Responsible	simulationspecialist
Source	Internal (ESA)
Status	Draft
Type	Simulation input
User Defined Properties	
Properties	0 items

File/Document meta data – Properties

TERRIFIC Process Execution (1)



Systems for Quality analysis, Verification
validations, error and log-files

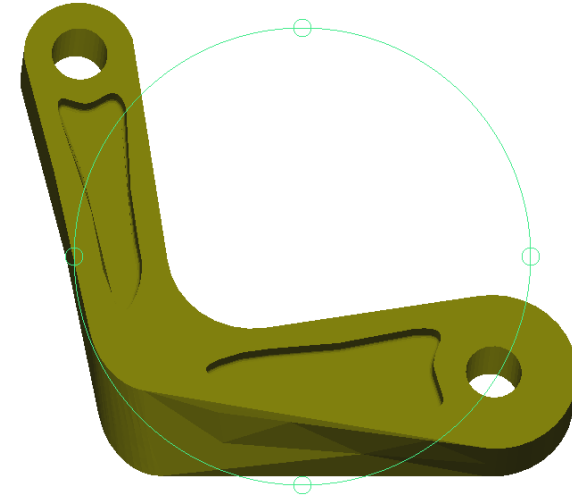
Design the model

■ Who

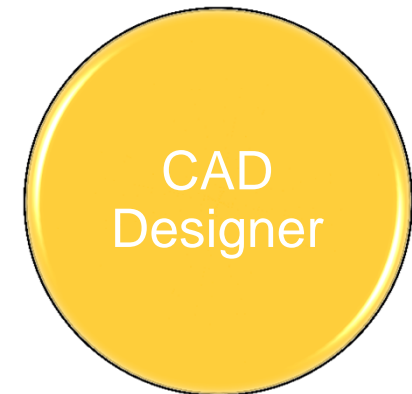
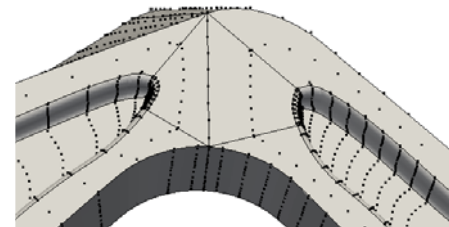
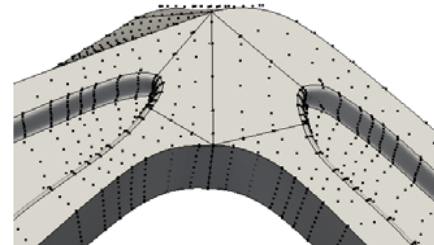
■ **CAD Designer**

■ Creates the 3D model in a CAD tool

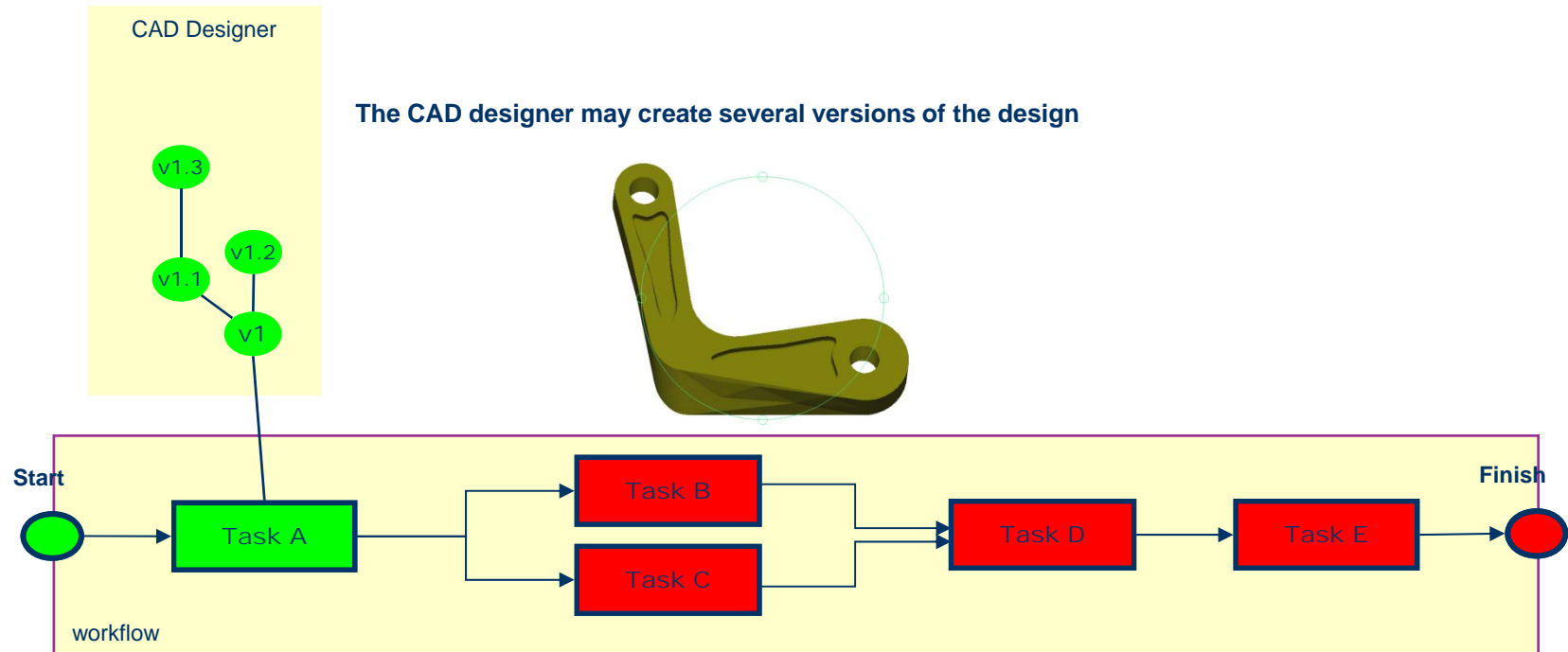
■ Using requirements to define the 3D model



Date	File name
1.7.13	DemEx6woBlends.stp
3.7.13	DemEx6woExtBlends.stp



TERRIFIC Process Execution (2)



Committed

Published

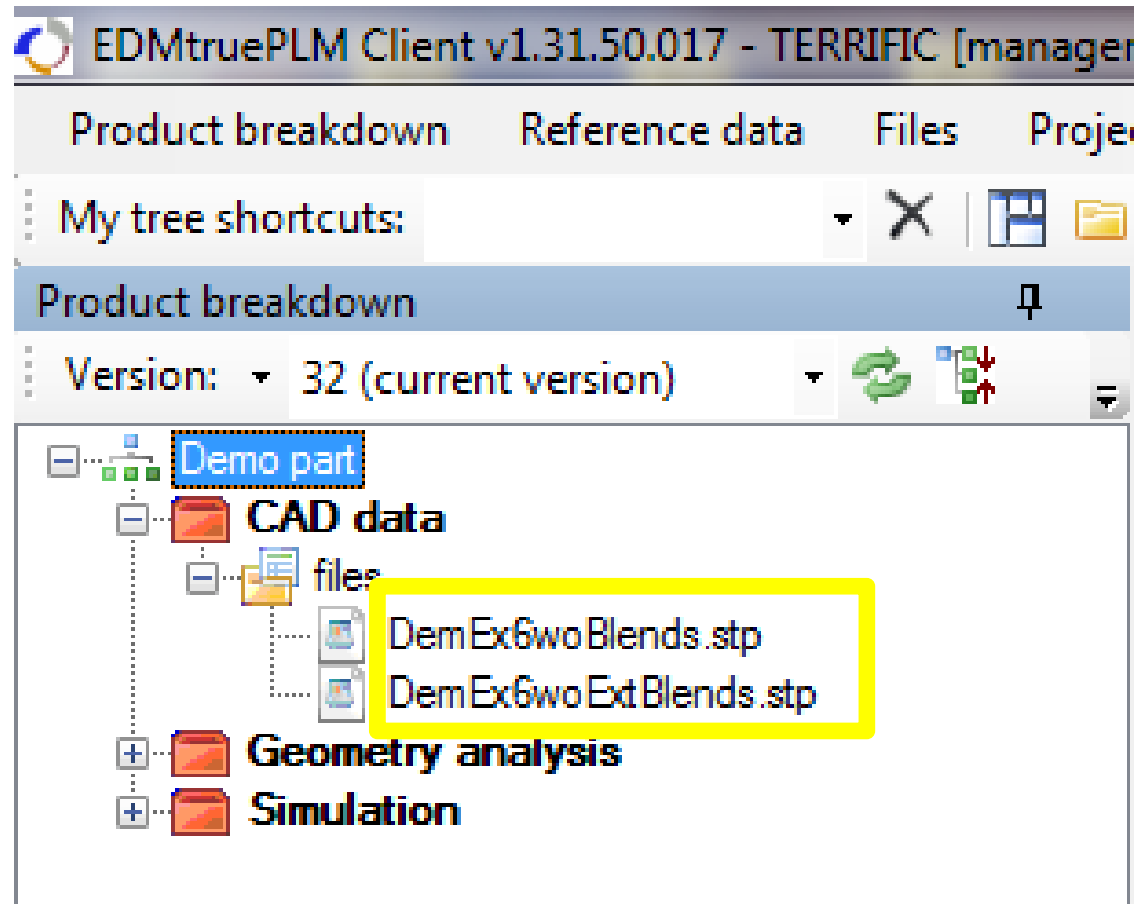
In Progress

Enabled

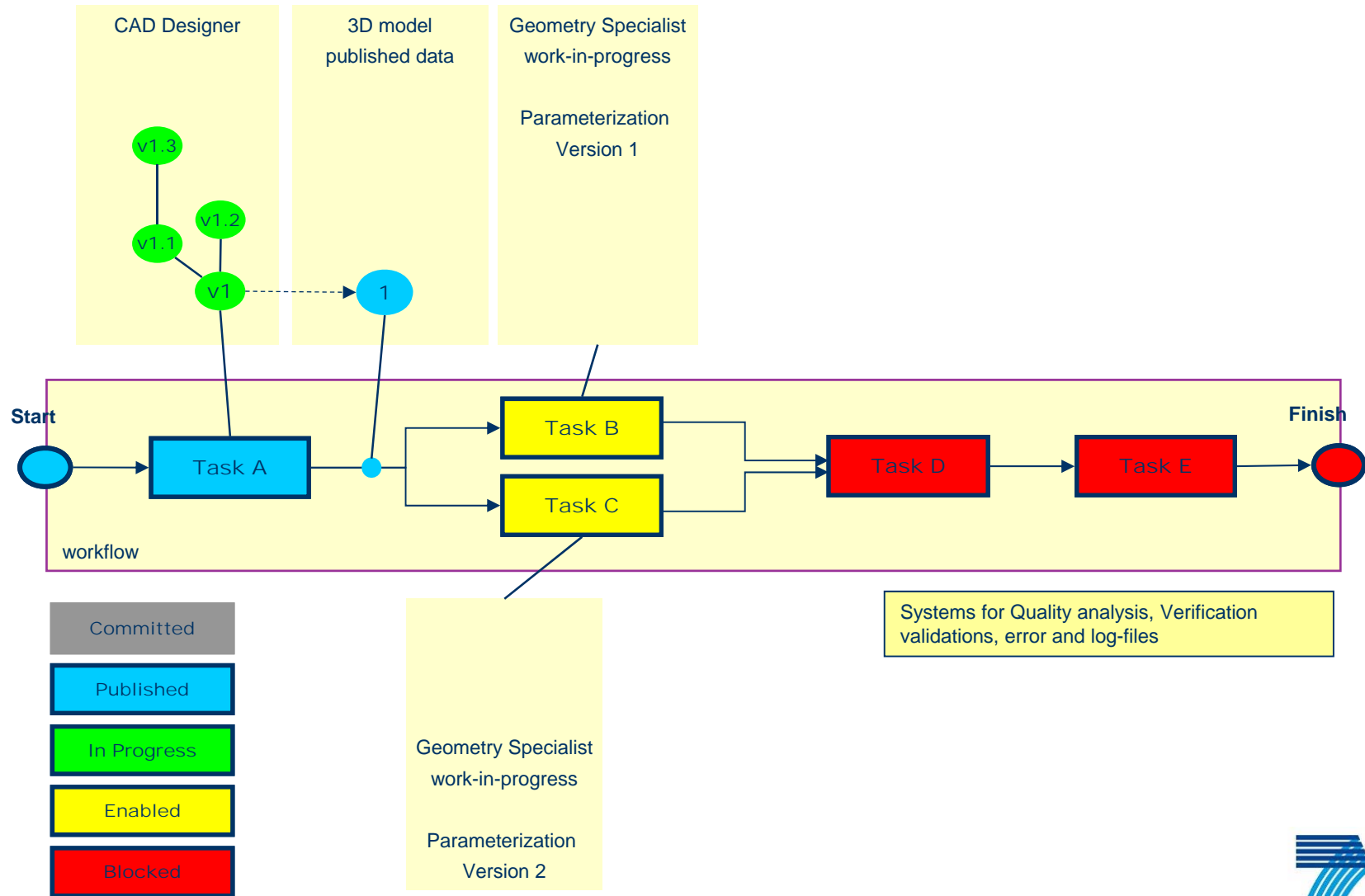
Blocked

Systems for Quality analysis, Verification
validations, error and log-files

CAD Designer output

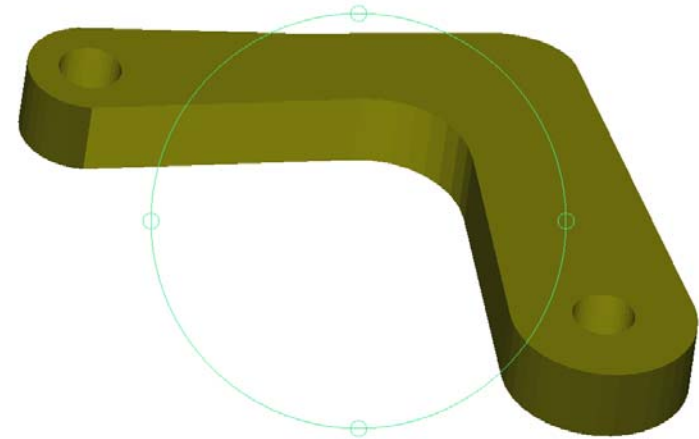


TERRIFIC Process Execution (3)



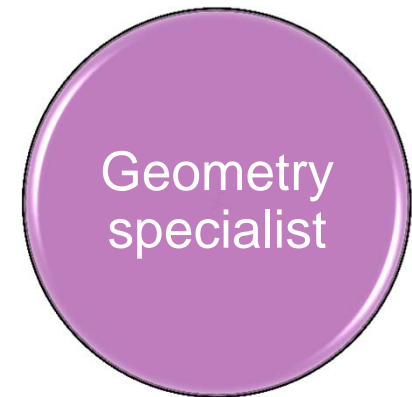
Parameterization of the model

- Who
 - **Geometry Specialist**
- Update the 3D model in GoTools
 - Refine the Geometry

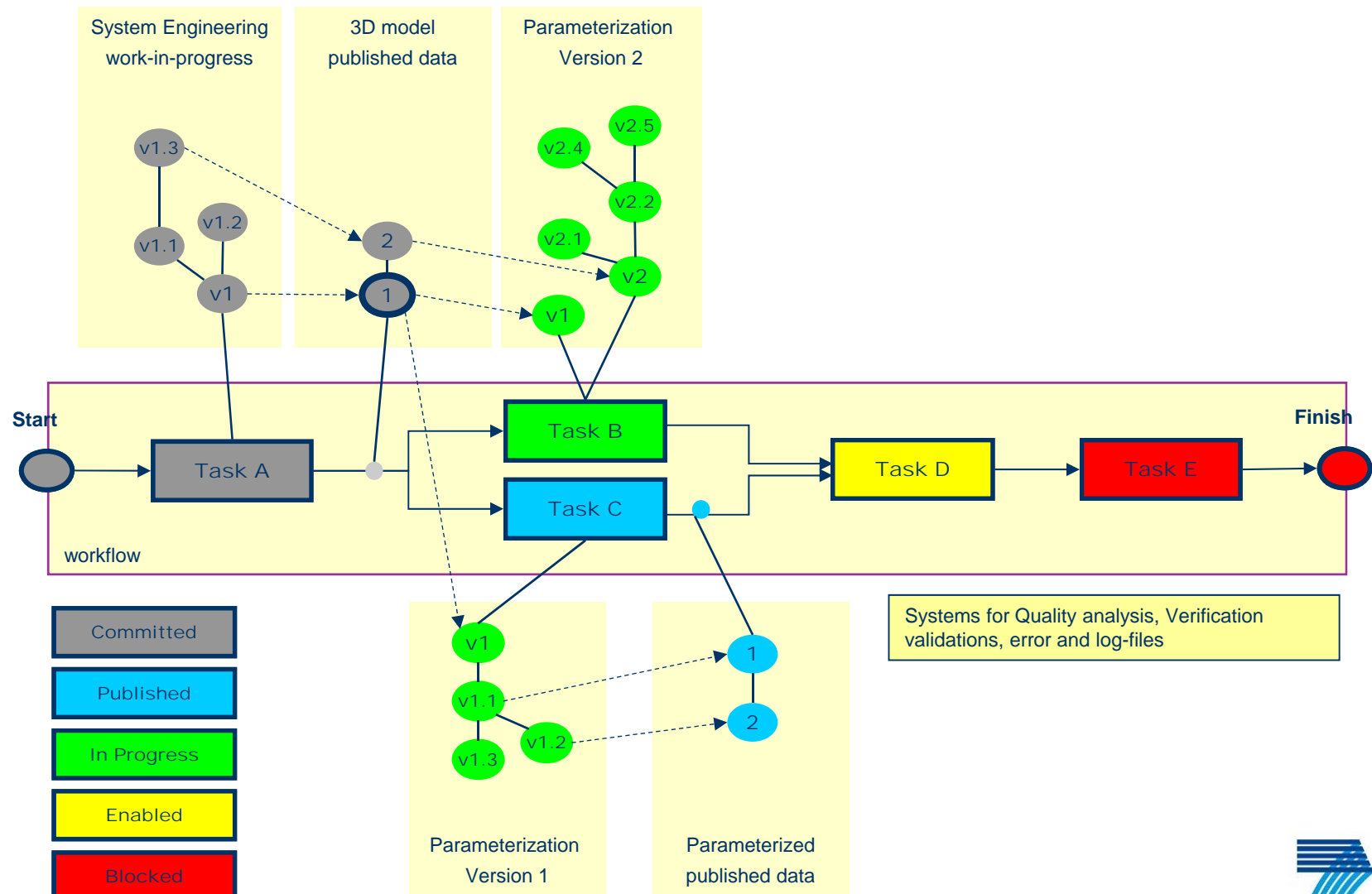


*Need graphics showing
parameterizations (*2)*

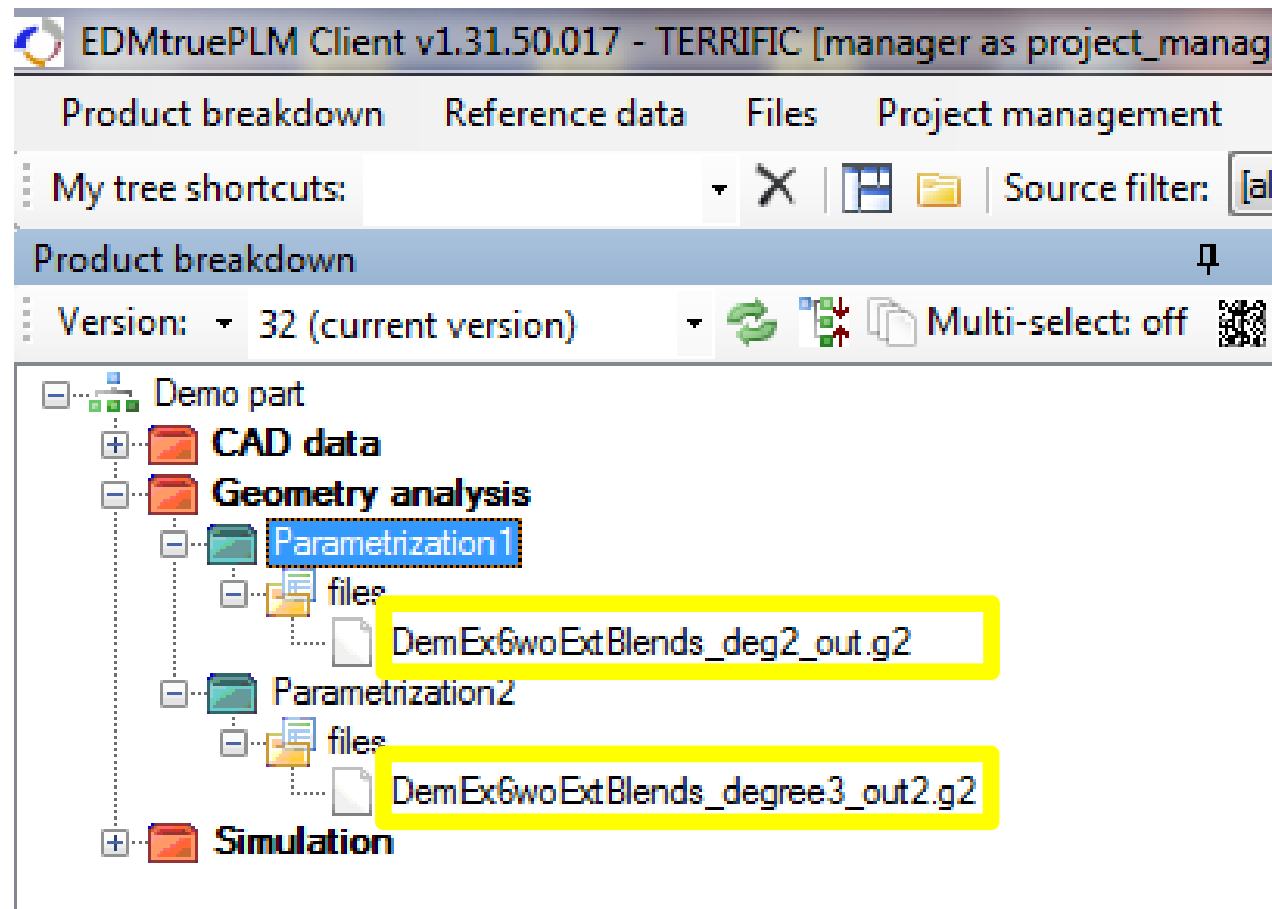
Date	File name
1.9.13	DemEx6woExtBlends_deg2_out.g2
1.11.13	DemEx6woExtBlends_degree3_out.g2



TERRIFIC Process Execution (4)



Geometry Specialist output



Perform Simulations

Who

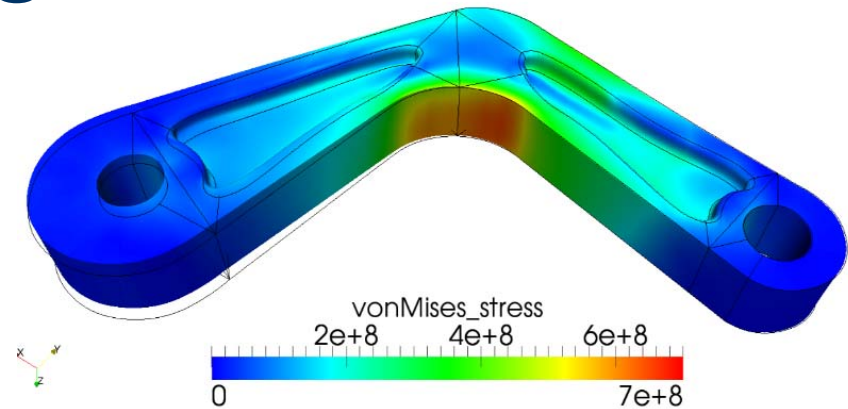
- Simulation Specialist

Creates the input files

- Collect material properties
- Define load cases
- Perform simulations

Perform Simulations

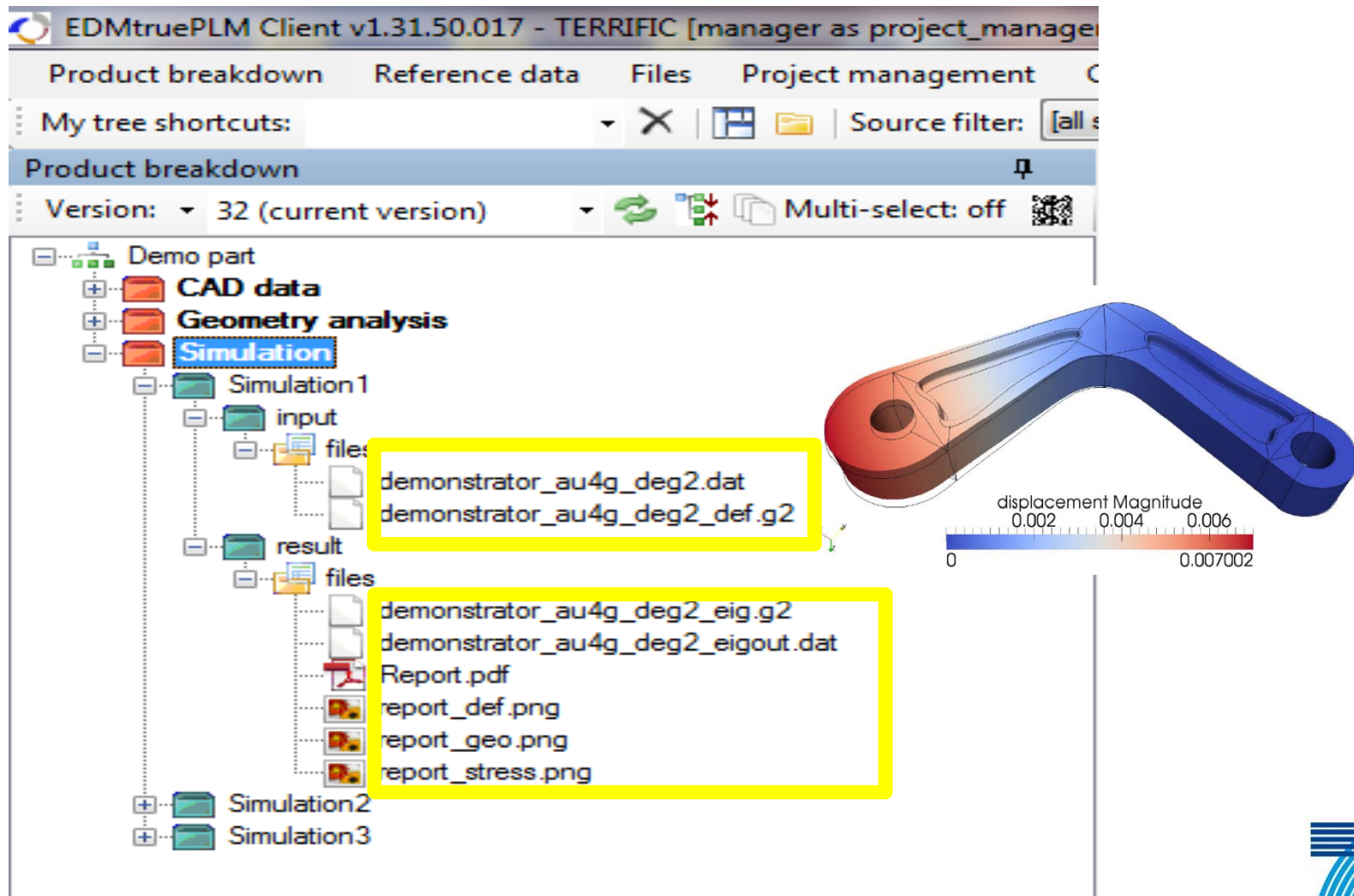
- Execute calculations



Simulation
Specialist

Need information about
load cases and
material.

Simulation Specialist output



Perform Simulations

Date	Input files	Result files	
15.9.13	(1) demonstrator_au4g_deg2.dat (2) demonstrator_au4g_deg2_def.g2		
17.9.13		(1) demonstrator_au4g_deg2_eig.g2 (2) demonstrator_au4g_deg2_eigout.dat (3) Report.pdf (4) Report_geo.png (5) Report_stress.png	
12.10.13	(1) demonstrator_au4g_deg2.dat (2) demonstrator_au4g_deg2_def.g2	(1) Report.pdf (2) report_def.png (3) Report_geo.png (4) Report_stress.png	
12.10.13		(1) Report.pdf (2) report_def.png (3) Report_geo.png (4) Report_stress.png	
3.11.13	(1) demonstrator_au4g_deg3.dat (2) demonstrator_au4g_deg3_def.g2		
5.11.13		(1) demonstrator_au4g_deg3_eig.g2 (2) demonstrator_au4g_deg3_eigout.dat (3) Report.pdf (4) report_def.png (5) Report_geo.png (6) Report_stress.png	

Simulation
Specialist

Review results

■ Who

- Project Manager

■ Project Manager


- review results and approve simulations



Project Manager Design Approval Technical Data Package

Notifications - What's new

Data Packages Management

 Edit data package

Select data package: filesFOrApproval

Add new data package

Version: 1

Create new version

Delete this version

(Select a data package and version above)

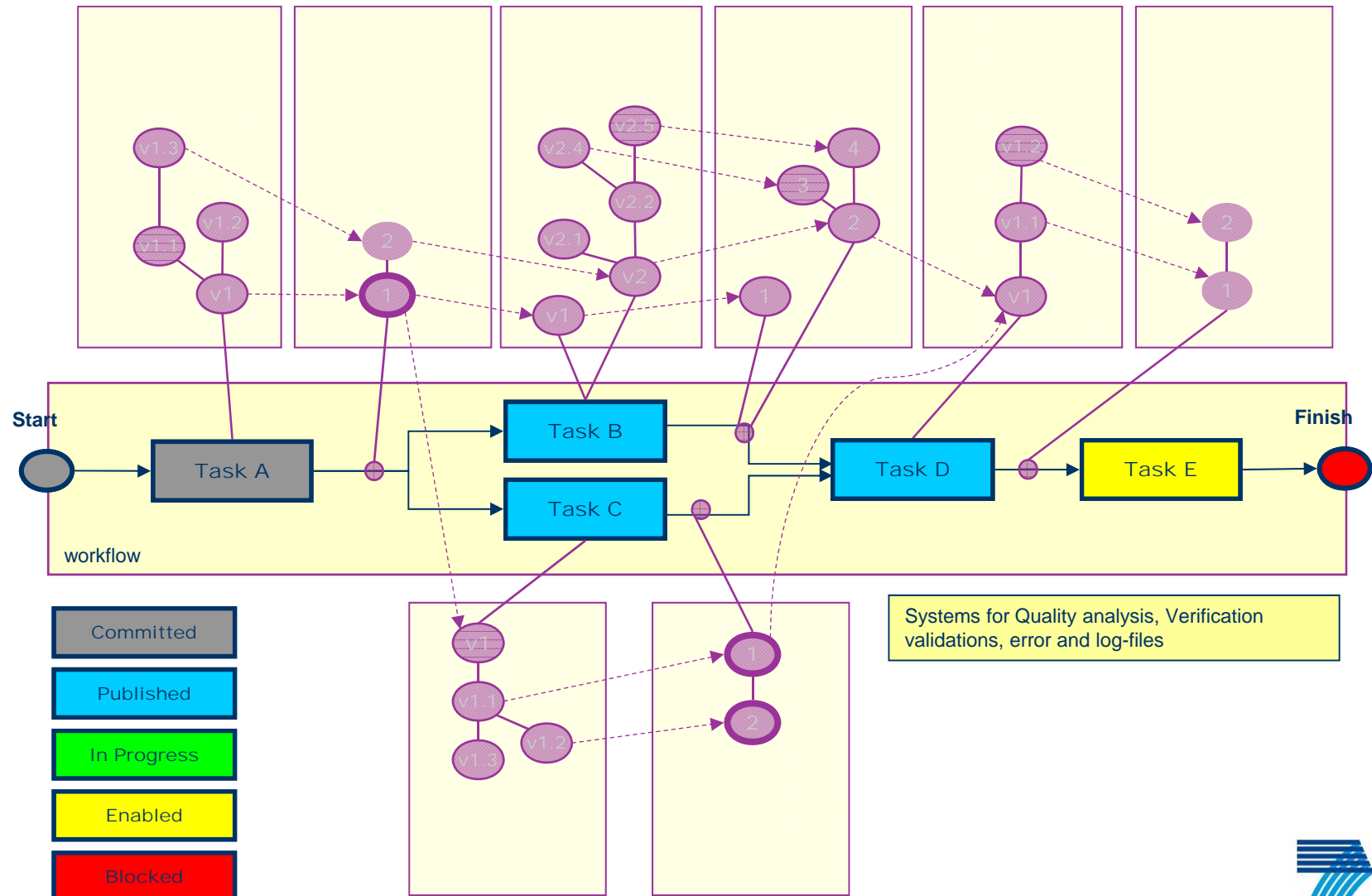
- To add a new document , drag and drop it from the product structure to the list

- Don't forget to specify the correct version of the document on the list

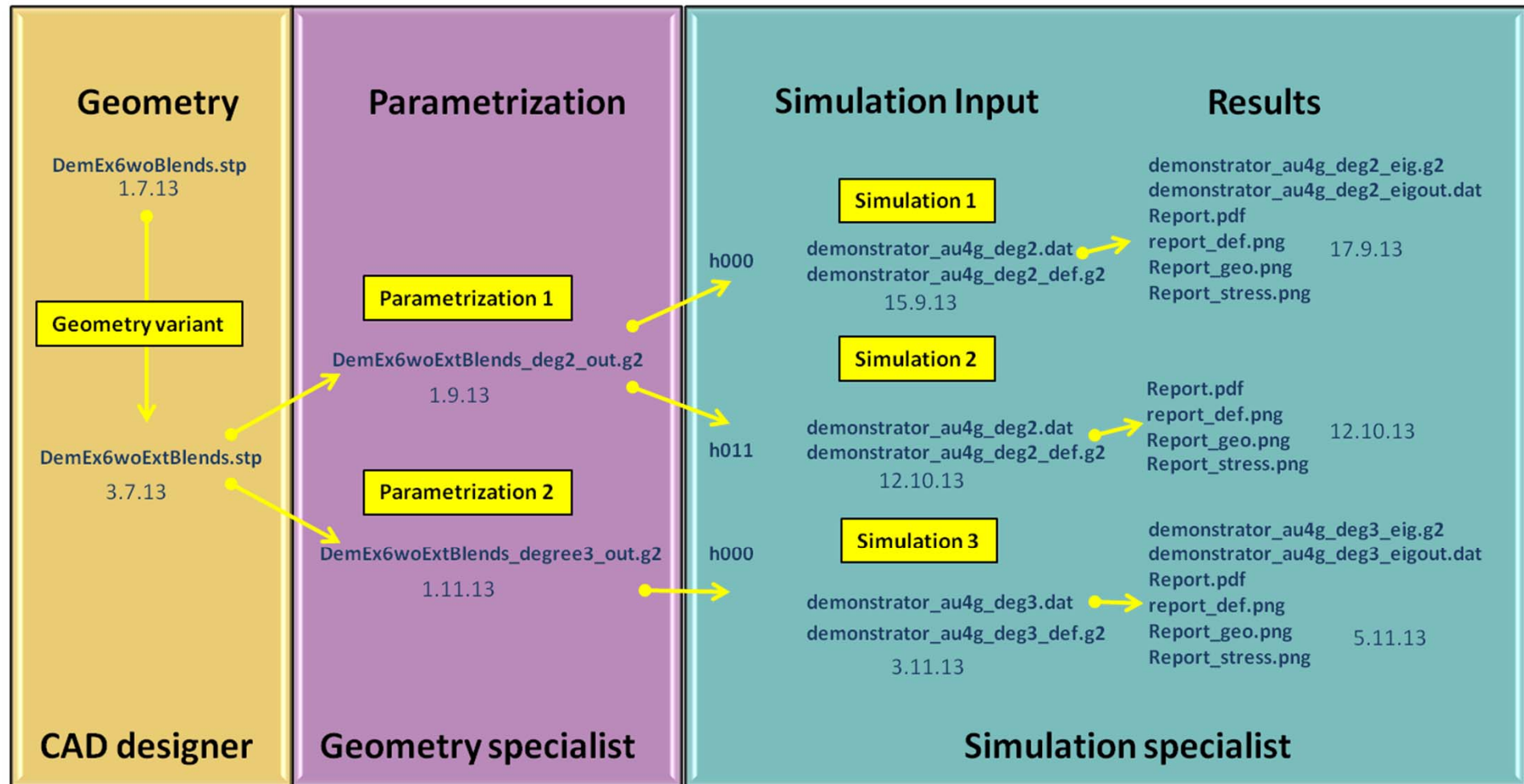
	Title	Description	Document version	Status
<input checked="" type="checkbox"/>	demonstrator_au4g_deg3_eig.g2	simulation result	1.001	Draft
<input type="checkbox"/>	demonstrator_au4g_deg3_eigout.dat	simulation result	1.001	Draft
<input type="checkbox"/>	Report.pdf	simulation result	1.001	Draft
<input type="checkbox"/>	report_def.png	simulation result	1.001	Draft
<input type="checkbox"/>	report_geo.png	simulation result	1.001	Draft
<input type="checkbox"/>	report_stress.png	simulation result	1.001	Draft

Remove selected items from list

TERRIFIC Workflow



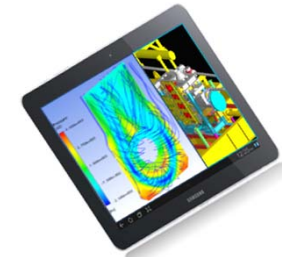
Workflow



Data inTruePLM



EXPRESS Data Manager
TruePLM™



EDMtruePLM Client v1.31.50.017 - TERRIFIC [manager as project_manager]

Product breakdown Reference data Files Project management Client configuration Exit Help

My tree shortcuts: [X] [F] [M] [S] Source filter: [all sources]

Product breakdown

Version: 32 (current version)

Notifications - What's new Scheduled events Data Packages Management

Actions

- 2013-11-01 11:45:52 [Deadline for action has been modified by geometrystylist](#) [HIDE THIS]
- 2013-11-01 11:45:30 [Deadline for action has been modified by geometrystylist](#) [HIDE THIS]
- 2013-11-01 11:45:12 [Action status has been changed by geometrystylist](#) [HIDE THIS]
- 2013-11-01 11:45:12 [Action object list was modified by geometrystylist](#) [HIDE THIS]
- 2013-09-01 11:43:12 [Action object list was modified by geometrystylist](#) [HIDE THIS]
- 2013-09-01 11:43:12 [Deadline for action has been modified by geometrystylist](#) [HIDE THIS]
- 2013-09-01 11:42:19 [Deadline for action has been modified by geometrystylist](#) [HIDE THIS]
- 2013-09-01 11:41:12 [Action object list was modified by geometrystylist](#) [HIDE THIS]
- 2013-11-05 11:39:12 [Action status has been changed by caddesigner](#) [HIDE THIS]
- 2013-09-01 10:38:14 [Deadline for action has been modified by geometrystylist](#) [HIDE THIS]
- 2013-09-01 10:37:48 [Action status has been changed by geometrystylist](#) [HIDE THIS]
- 2013-09-01 10:37:48 [Action object list was modified by geometrystylist](#) [HIDE THIS]
- 2013-07-03 10:22:33 [Deadline for action has been modified by caddesigner](#) [HIDE THIS]
- 2013-07-03 10:21:32 [Action status has been changed by caddesigner](#) [HIDE THIS]
- 2013-07-03 10:21:32 [Action object list was modified by caddesigner](#) [HIDE THIS]

Document Properties

Update Properties

Name

Title DemEx6woExtBlends_deg2
Name DemEx6woExtBlends_deg2_out
Description geometry data

Created

User geometrystylist
Date 2013-09-01 10:32:57

Last modified

Date 2013-09-01 10:32:57
User geometrystylist
Version 1.001
Phase (last version) 0

Misc

Breakdown Element properties

Update Properties

Name

Name Parametrization 1
Description Parametrization 1
ID 0tFO004k0Huu00w14om32s

Created

Date 01.09.2013 10:26:36
User geometrystylist

Last Modified

Date 01.09.2013 10:32:57
User geometrystylist
Phase 0

Misc

Type Module

Name

element name

Product breakdown tree:

- Demo part
 - CAD data
 - Geometry analysis
 - Parametrization 1
 - files
 - DemEx6woExtBlends_deg2_out.g2
 - Parametrization 2
 - files
 - DemEx6woExtBlends_degree3_out2.g2
 - Simulation
 - Simulation 1
 - input
 - demonstrator_au4g_deg2.dat
 - demonstrator_au4g_deg2_def.g2
 - result
 - files
 - demonstrator_au4g_deg2_eig.g2
 - demonstrator_au4g_deg2_eigout.dat
 - Report.pdf
 - report_def.png
 - report_geo.png
 - report_stress.png
 - Simulation 2
 - input
 - result
 - Simulation 3
 - input
 - result
 - files
 - demonstrator_au4g_deg3_eig.g2
 - demonstrator_au4g_deg3_eigout.dat
 - Report.pdf
 - report_def.png
 - report_geo.png
 - report_stress.png

Jotne



From idea to manufacturing and operations

Share, exchange and archive your PLM data



EXPRESS Data Manager
TruePLM™



Jotne

Exchange
Integration
Validation
Archival



Past

Future

Video about Interoperability



TERRIFIC

Enhancing Interoperability



**SEVENTH FRAMEWORK
PROGRAMME**