

PSA/BETA PARTNERSHIP FOR ASSEMBLY

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KEYWORDS –

Assembly, Automation, A-Points, Connectors

ABSTRACT –

Following PSA's decision to choose ANSA as the pre-processing tool for Nastran, Radioss and Abaqus models, BETA & PSA collaborated to identify the best methodology to generate a complete assembly of models. This new PSA assembly process and ANSA v17 have been simultaneously developed with a common target: creation of a modern, effective and efficient process and all related infrastructure.

The process handles three main modelling stages:

1. Body welding assembly

- The PLM system launches ANSA in batch mode to produce automatic meshes of parts.
- The PLM system stores meshed representations of parts together with their meta-data (attributes).
- While exporting mesh files, a "Synoptic" file is simultaneously exported, allowing automatic Body creation.
- Benefit: Spotwelds and linear connections are fixed before model creation thanks to these files.

Result is a fully automated welding assembly for Body, ready to run immediately at the beginning of model creation.

2. Bolt and other assemblies:

- Bolts are decomposed in 2 "bolt" connections: 1 "screw" + 1 "nut".
- Each bolt realization is associated to one Assembly Point (A-Point).
- A connector is automatically created between A-Points if they respect PSA-assembly criteria.

3. Application : Automated Vehicle assembly for all disciplines and configurations :

- Assembly is "prepared" subsystem by subsystem, independently from complete model and from id management.
- Inter-subsystem connectivity is based on the automatic creation of connectors.

Next step: ANSA ⇔ SimManager connector:

- To compare Body model to PLM synoptic
 - To synchronize subsystem model versions between ANSA and SimManager
-

TECHNICAL PAPER -

1. INTRODUCTION

Context

CAD tool evolution / PLM deployment

- CAD definition migrates to ENOVIA, linked to PLM solution of Dassault Systèmes.

Pre-processing tool evolution

- Pre-processing tool for Crash, NVH & Structure models migrates to ANSA.
- As ANSA offers a very good scriptability (in python language), a lot of automation tools can be developed

“Lead time” reduction

Since 2015, PSA put high priority on “lead time reduction”.

“Lead time” definition for PSA is time between frozen CAD definition and first simulation result for each milestone of a vehicle project.

- Target was to divide “Lead time” for Front crash by 2.

New process FOR Front crash model creation

1. Target of new process is to mesh individual CADs automatically as soon as they are frozen. Before official complete content, assembly can be prepared on available auto-meshes and auto-meshes can be set to target quality
2. As a consequence, when all CADs are officialised, assembly can be hardly fully prepared.
3. Once assembly preparation is ready, finalized meshes can be automatically assembled.
4. Model setup generation has been improved, too: standardization per discipline + automation tools allow a huge reduction of time for model setup.
5. This automation allows engineers to continue to spend necessary time on result analysis.

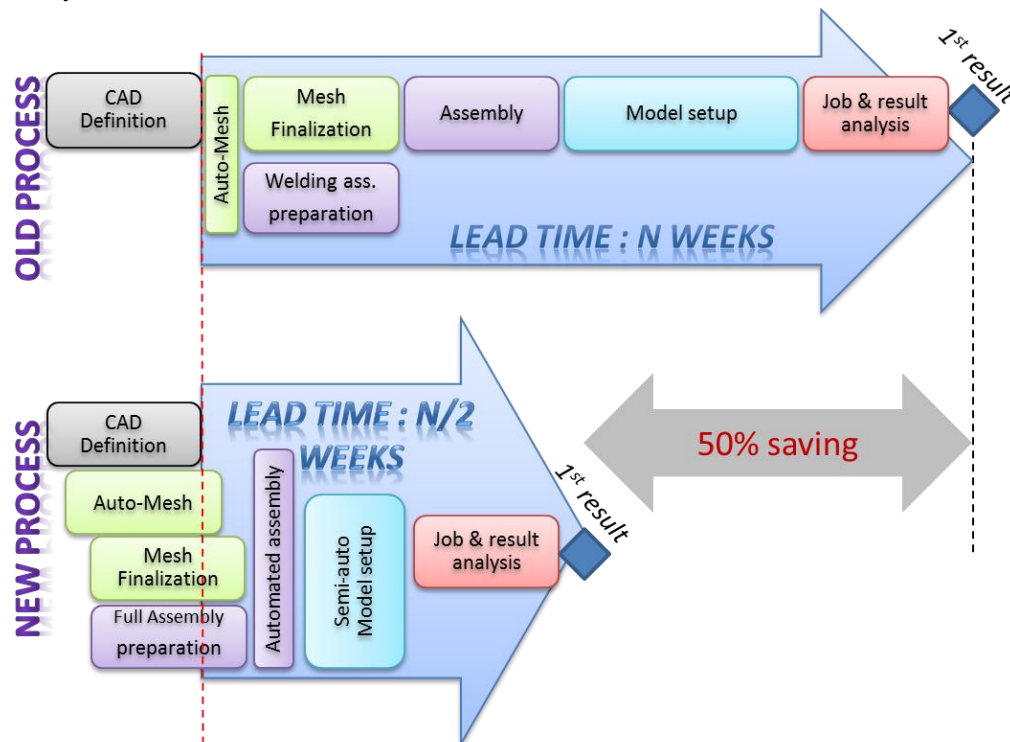


Figure 1 – Front crash model generation process

Current paper introduces first part of this process dedicated to assembly (Points 1 to 3).

2. AUTOMATED MESH

Process

Thanks to PLM System, at any time, CADs maturity is known.

- Every night, tests are done on PLM System :
- If a CAD Maturity has become “Frozen”, ANSA is run in batch mode to mesh it as follow :
 - CAD is exported simultaneously with its attributes (csv file)
 - ANSA is launched in batch mode
 - ANSA imports CAD and associated attributes
 - For metal sheets, ANSA generates mid-surface geometry
 - ANSA generates 3 different meshes : Crash / NVH & Structure
 - ANSA saves 1 file per discipline
 - Resulting files are stored in PLM system, linked to PLM-CAD

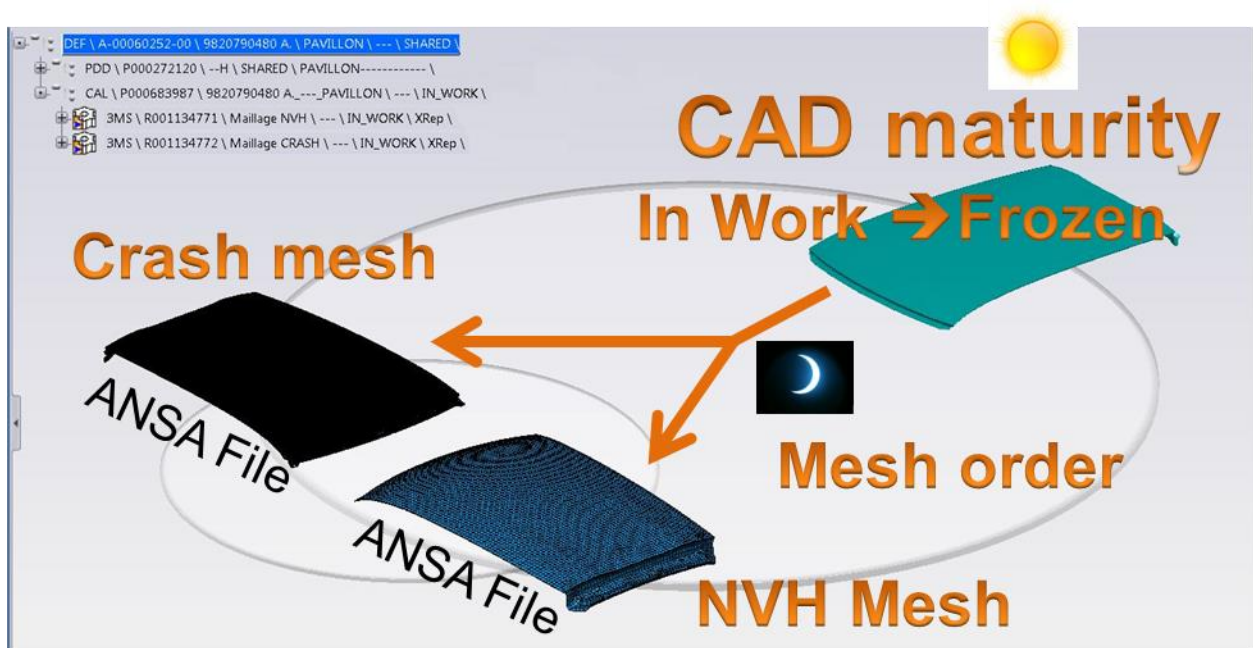


Figure 2 – PLM Mesh/CAD associativity

Mesh file content

After meshing, ANSA file is saved with a standardized name referring name of PLM object.
 Ansa file contains 2 ANSA Parts:

1. Initial geometry: This part is marked as inactive => generally, it should not be useful, but it can be used to rebuild a midsurface or a geometry detail for example
2. Mesh part :
 - a. Content : Meshed Midsurface (or meshed volume) & associated property (Thickness + Material name)
 - b. Attributes :
 - i. Useful attributes for model creation :
 1. "Code_tole" is an identifier of welded flanges ; it is used to define welded connections
 2. Decoupage_PSA is a standard code designing the part type; it is to design model organisation
 - ii. Other Attributes (PLM attributes)

The screenshot shows the ANSA Model Browser interface. The top part of the window displays a tree view with two parts:

Module Id	Name	Version	Representation	Code_tole
9824708880 A.	CLOISON_AR_LONGERON_G	P001017565_---	CRASH	1907
	CLOISON_AR_LONGERON_G_GEOMETRY	P001017565_---		1907

The bottom part of the window shows the details for the selected part, CLOISON_AR_LONGERON_G. The attributes are as follows:

Name	Value
Name	CLOISON_AR_LONGERON_G
Module Id	9824708880 A.
Version	P001017565_---
Representation	CRASH
Project	
Phase	
Study Version	0
Status	Non validated
File Type	ANSA
General	
Characteristics	
Position	
Misc	
User Attributes	
Exported_3DX_f...	CALP001201580---IN_WORK9824708880 A.---_CLO...
Part_type	Constant_thickness
Designation_EN	PARTITION_RR_SILL_LH
Symmetry	false
CAL_REF_VERSI...	P001201580_---
DEF_REF_VERSI...	A-00108317-00_---
Designation_FR	CLOISON_AR_LONGERON_G
Code_tole	1907
Decoupage_PSA	K4B01063

Annotations in the image provide additional context:

- Module ID: Official PSA Identifier of the CAD** (points to the Module Id attribute)
- Code_Tole: PSA Identifier for welding assembly** (points to the Code_tole attribute)
- Decoupage_PSA: PSA standard Code for Part type (ex: Left B-Pillar reinforcement part...)** (points to the Decoupage_PSA attribute)

Figure 3 – ANSA Mesh Part content

3. WELDING ASSEMBLY TOOLS GENERAL PRESENTATION

Download of available mesh files and synoptic with PLM:

Filtering on project, milestone, mesh objects and representation in PLM system, the user is able to select directly all meshes of current version of BIW of a project.

A single button will export all ANSA files and corresponding synoptic on user's local desktop.

Automatic creation of a body in white component: "Read synoptic":

An automated tool has been developed by Beta to import PLM synoptic, transform it in a model structure and distribute meshes on the right place.

Needed Input data:

1. Synoptic file is a csv file, containing all information about meshes and their attributes.
2. DEC_PSA file is a correspondence table between Decoupage_PSA attributes and Part Group destination in Part Manager.
3. Mesh folder(s) contain all mesh files. Name of these folders is the same as representation type. Location of this folder must be the same as synoptic file. Name of the mesh files is the same for different representation.

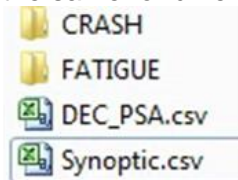


Figure 4 – Input data example

This tools works in 2 steps:

1. Model structure creation : the user selects Synoptic file, DECPSA and mesh representation

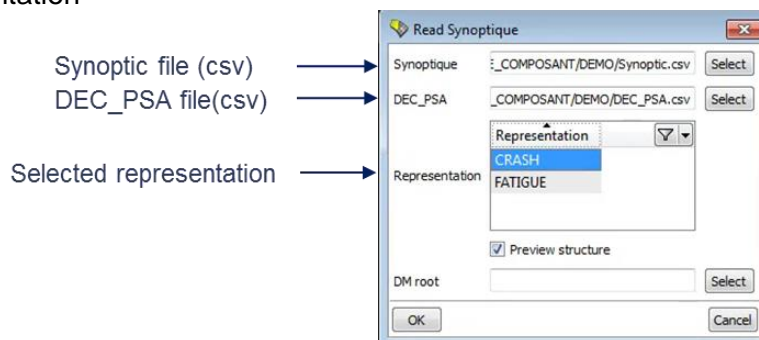


Figure 5 – "Read synoptic" interface

2. Product tree editor is automatically launched : it allows a preview of model structure before importing corresponding meshes

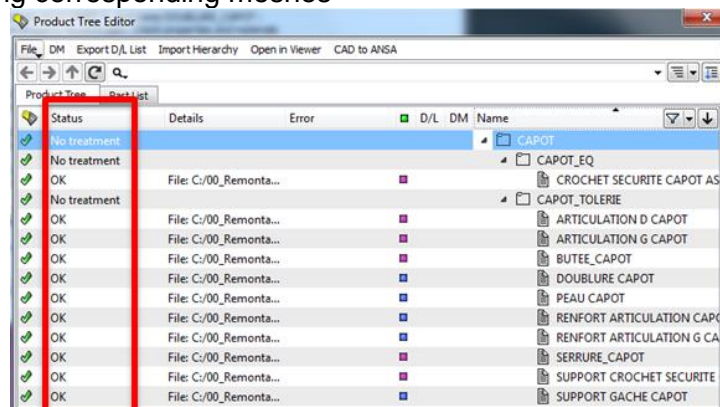


Figure 6 – "Product tree editor" preview of model structure

Import of spotweld data and linear connections

A specific tool has been developed by Beta to be able to import welding data in PSA format and transform it automatically in connections with associated attributes connectivity. If connectivity is badly defined, ANSA can try to fix it by proximity detection.

Once import is finished, these connections will be stored in a specific ANSA part.

Input data:

- Spotweld input data is usually a formatted text file containing coordinates and “Code_Tole” attributes.
- It can also be a Catia file containing Catia Points included in geometrical sets with standardized names identifying connection type of the spowelds and “code_tole” attributes of assembled parts.
- Linear connections (seamlines and adhesive lines) input data is a Catia file containing Curves included in geometrical sets with standardized names identifying connection type and “code_tole” attributes of assembled parts.

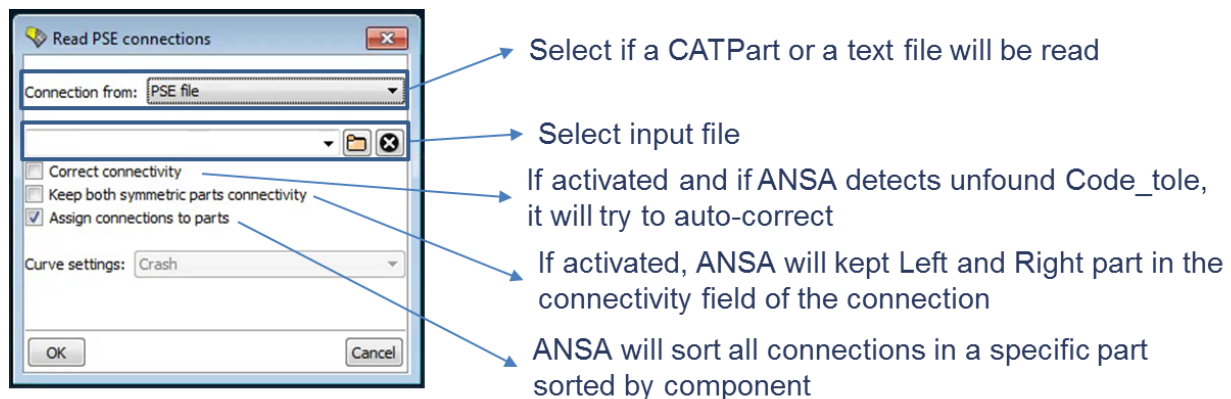


Figure 7 – “Read PSE” interface

4. WELDING ASSEMBLY PREPARATION

Based on automated mesh and welding assembly tools, an automated connection check report has been developed by PSA, based on a python script.

It allows welding designers to check welding assembly definition and connectivity throughout definition of the CAD parts, without any specific training.

Process

1. User downloads available / updated meshes during latest night (associated synoptic file will automatically be downloaded in the same time)
2. User launches ANSA and runs the script
3. User selects input data:
 - a. Downloaded meshes for reference discipline
 - b. Synoptic
 - c. Spotweld input file
 - d. Linear connections CATIA File
4. Tool automatically generates an assembled model and exports an assembly quality report
5. Additionally, other files will be stored :ANSA generated model, Connection ANSA part (ansa file),Connection input data

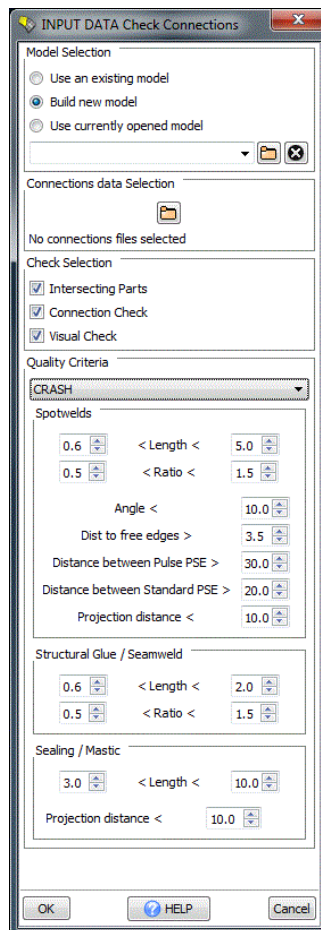


Figure 8 – “Check connections” interface

Result

Result of this tool is an Excel Workbook containing 11 tabs.

- Overview of the assembly, quality criteria and failing connections (see Fig. 9)
- Assembled and missing parts for assembly input data
- Geometrical problems (intersections) with snapshots of concerned areas (see Fig. 10)
- List of quality problems on connections (see Fig. 11)
- Pictures of each part with connected connections to allow a visual check of connectivity completion (see Fig. 12)

Compared to previous process

As this tool is fully automated and mesh is daily automatically generated, connections can be checked during project development and anticipates connectivity defaults identification.

As a consequence, welding input data can be shared immediately after last CAD definition of official milestone with an optimal quality.

Once this process is finished, automatic welding assembly can be done for all mesh types.

7 BEFORE REALITY CONFERENCE

Connection debug for		PARG_R83C_CRASH		Input Data		Cordons_PARG.CATPart		PSE_PARG.pse																																																													
<table border="1"> <caption>Quality Criteria</caption> <tr> <td rowspan="5">Spotwelds</td> <td>0,6 < Length < 2</td> </tr> <tr> <td>0,5 < Ratio < 1,5</td> </tr> <tr> <td>0 < Angle < 15</td> </tr> <tr> <td>Dist to free edge > 7</td> </tr> <tr> <td>Pulse SPWD dist 30</td> </tr> <tr> <td>Std SPWD dist 20</td> </tr> <tr> <td>Project distance 10</td> </tr> <tr> <td>Structural Glue / Seamweld</td> <td>0,5 < Length < 5</td> </tr> <tr> <td></td> <td>0,9 < Ratio < 1,1</td> </tr> <tr> <td>Sealing / Mastic</td> <td>5 < Length < 20</td> </tr> </table>										Spotwelds	0,6 < Length < 2	0,5 < Ratio < 1,5	0 < Angle < 15	Dist to free edge > 7	Pulse SPWD dist 30	Std SPWD dist 20	Project distance 10	Structural Glue / Seamweld	0,5 < Length < 5		0,9 < Ratio < 1,1	Sealing / Mastic	5 < Length < 20																																														
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Figure 9 – Overview Tab

Intersecting parts			
Part1	Part2	Capture 1	Capture 2
BRANCARD_AV_D_9674109580	BRANCARD_AV_D_9674109580		
LONGERON_INT_AV_G_AA35457474	DOUBLURE_AILE_AV_D_981920538A		

Figure 10 – Intersecting parts Tab

Failing Connections			
Connection type	Connection group	Connection number	Error type
Point PSE	9934-638	20	Projection Fail
Point PSE	9934-638	23	Projection Fail
Point PSE	715-610	35	1 Flanges : expected 2
Point PSE	715-610	36	1 Flanges : expected 2

Figure 11 – Failing connections Tab

Visual Check							
Part names	Reference	Flange cod-	Number of connection	Isometric View	Front View	Left View	Top View
RENFO_EMBO_LONG_AR_D_FB60_3.00MM	9818775280	710	Point PSE : 14 Total : 14				
APOH_LONGERONNET_INF_AR_G	9818700180	716	Point PSE : 184 Colle Structurale Choc : 4 Colle Structurale : 4 Total : 192				

Figure 12 – Visual check Tab

5. BOLTS AND OTHER ASSEMBLIES

Other assemblies are mainly Bolts; same technic is adapted for other assembly types as clips and snaps. In this document, only bolts will be presented.

Bolt representation is the result of a general reflexion on automatic assembly between Beta and PSA.

General target: automated bolt assembly

1. CAD design of parts is associated to bolt CADs, available on PLM system. These bolts (screws and nut) have specific attributes "CNX": with same technic as parts the complete content of bolts of one vehicle can be identified.

PSA target was to be able to transform them easily in bolt connections in an ANSA Model.

2. As model content depends on discipline (ex: vehicle configuration, engine variants, numerical simplification...) connectivity is not the same between all models of one project.

PSA target was to be able to build assembly of all models automatically, whatever the configuration in ANSA interface, without numbering rule.

Bolt CAD interpretation on ANSA

A Python script was developed to transform a Bolt CAD into an ANSA connection. Each connection is saved as an ANSA file, and stored in PLM system.

The result file contains an ANSA connection and a light representation of the bolt. The connection will be defined by its location, its axis and several attributes (name, diameter, washer diameter).

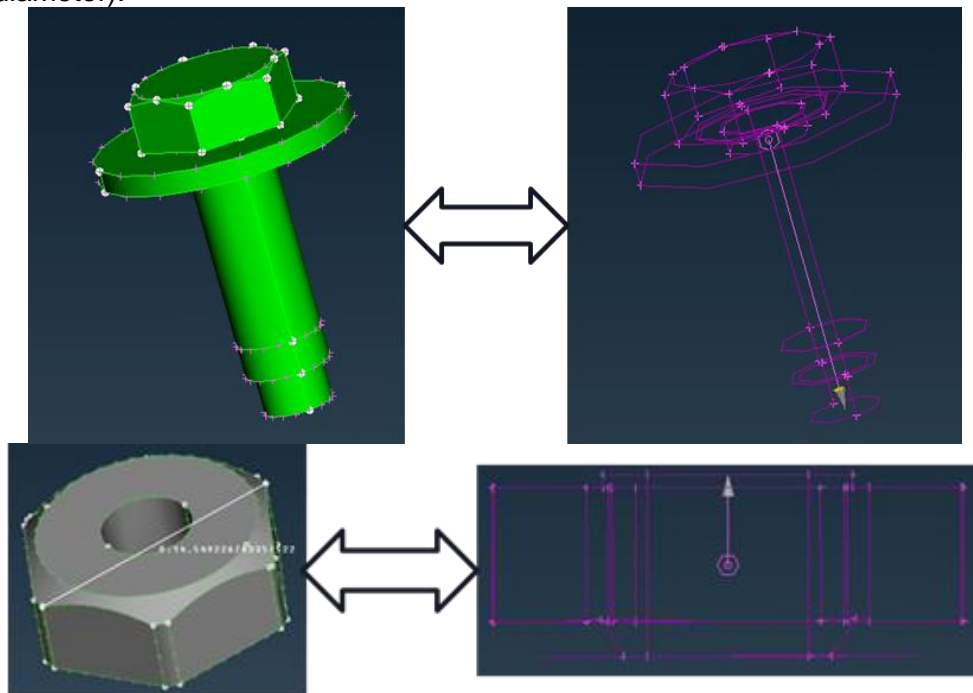


Figure 13 – Screw & Nut interpretation

Furthermore, the connection is stored in an ANSA Part. This part will also be filled with PLM attributes in order to be able using Read synoptic and PLM functions.

Bolt representation on ANSA

To allow automated assembly, whatever the configuration and discipline, every bolt is splitted in 2 connections, one for the "screw" and the other for the "pin".

By default, representation of these sub-assemblies is a Rigid Body whatever the chosen solver or discipline.

To identify screw ⇔ nut connectivity a slave node is added to connection realization, located on connection coordinates; this additional slave node is marked as an “Assembly Point” (symbolized in green on Figure 14).

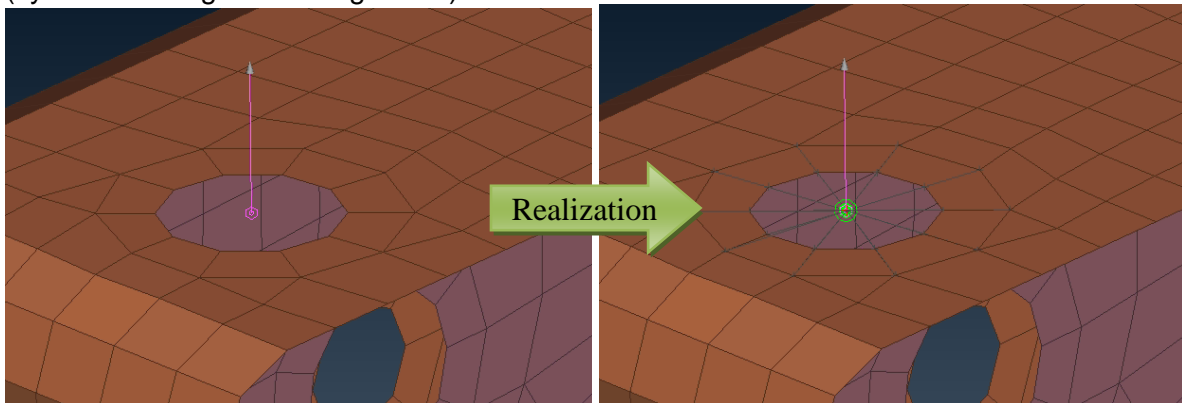


Figure 14 – “Screw” bolt realization

If a sub-assembly pair is present in the model, then 2 A-Points will be linked by a CONNECTOR.

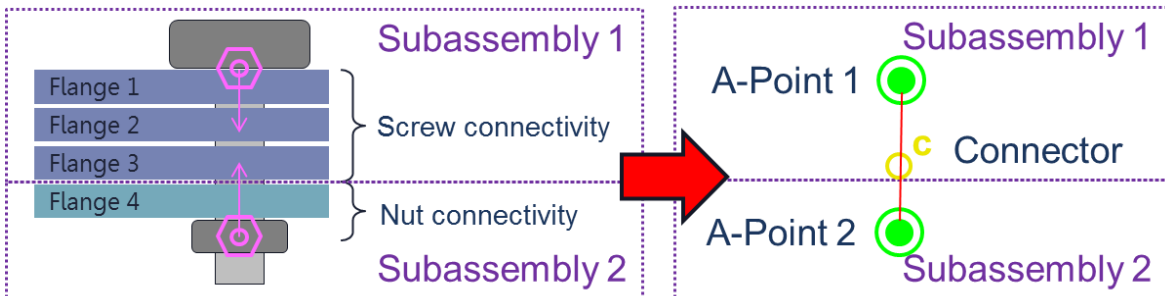


Figure 14 – “Screw” ⇔ “Pin” connector

Application: Subsystem preparation and automated assembly

Subsystem creation is systematically associated to assembly preparation. On every connecting area, a bolt connection is generated and realized with an assembly point. Then, it is stored and shared.

To create a model, all subsystems are merged in a single ANSA file.

A script automatically detects Assembly Point pairs and generates corresponding connectors.

If Assembly Points are near enough and connections are collinear (tolerances can be handled by user, too), then connectors will be created automatically.

Connector realization will be a deformable 1D element. Its properties are automatically calculated with “screw” attributes and depend on selected discipline.

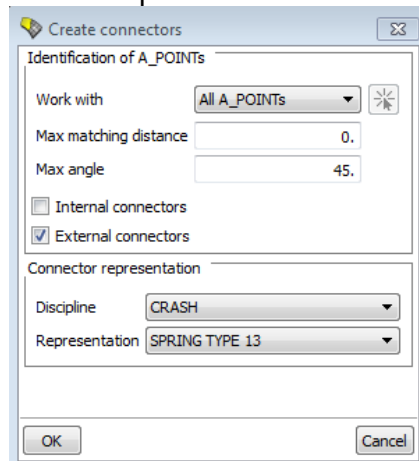


Figure 15 – “Create connector” script interface

6. NEXT STEP: ANSA / SIM MANAGER CONNECTOR

New assembling process allows PSA to share subsystems and assembly data between all models.

As PSA models validation is associated to official storage on Sim Manager (MSC Software), ongoing developments target is to create a connector between ANSA and Sim Manager.

After these developments, update status and validation status will be available on ANSA, and ANSA DM Capabilities will allow users to update subsystems and assembly data automatically.

7. CONCLUSIONS

Thanks to a strong partnership with BETA, PSA model assembly general process has been highly improved. ANSA allows PSA to anticipate input data availability for model creation and to automate assembly.

Next step will be to develop a Sim Manager / ANSA connector to insure conformity check, automatic update of subsystems and simplified official storage of ANSA models and subsystems.

REFERENCES

- (1) ANSA version 17.1.x User's Guide, BETA CAE Systems, April 2017