Test Suite for the
CAx Implementor Forum
Round 36J

March – October 2015

Release 1.1

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1   Introduction

This document describes the suite of test cases to be used for the thirty-sixth round of testing of the CAx Implementor Forum (CAx-IF). The CAx-IF is a joint testing forum, organized and facilitated by PDES, Inc., and the ProSTEP iViP Association. The test rounds of the CAx-IF concentrate primarily on testing the interoperability and compliance of STEP processors based on AP242.

The test rounds in general combine testing of synthetic and production models. Production models will in most cases be provided by the member companies of the organizations PDES, Inc. and ProSTEP iViP Association. When production models are not available from the member companies, "production-like" models will be solicited from the various CAx-IF participants.

This test suite includes synthetic models for testing the following capabilities: Product Manufacturing Information (PMI), both as Graphic Presentation and as Semantic Representation, Geometric Validation Properties, 3D Tessellated Geometry, and Assembly Structure with External References in AP242 BO Model XML format.

Production models are provided for assemblies and piece parts. The basis for the production test cases is native CAD models. Each test case therefore originates from a single CAD system, and the set of test cases to be pre-processed (converted to STEP files) is unique for each CAD system. After pre-processing, the resulting STEP files are then to be imported/post-processed/read in by the rest of the participants.

1.1   Functionality tested in this round

Functionality tested in this round relates to:

- **Product and Manufacturing Information (PMI)** describes the capability to embed information about dimensions, tolerances and other parameters which are necessary input for the manufacturing and measuring of the part from the 3D model. In Round36J, the focus will be on the two approaches for the transfer of PMI in the 3D model:

  o "Tessellated Presentation" refers to breaking down each annotation into tessellated elements as supported by AP242, and exchanging them as geometry. This preserves the exact shape of the annotation, but is human readable only. The test will include section views as well.

  o "Semantic Representation" refers to the intelligent transfer of PMI data in an associative and re-usable way. This scenario aims towards downstream usage and later modifications of the model. The data is machine-readable, but not necessarily visible in the 3D model. However, the test also includes additional presentation data, which can be linked to the corresponding PMI representation.

- **Geometric Validation Properties** is a mechanism to allow the exchange of geometric properties and their assignment to geometric representations for the purposes of data exchange validation. This includes information about volume, area, centroid, and curves. In Round36J, the focus will be on the additional validation properties for surface data, as well as on the recently agreed optimized implementation structure.

- **Tessellated Geometry** is a simplified representation for the part shape, where the geometry is not given as an exact B-Rep model, but as a collection of simple planar faces (triangles) which can be easily and efficiently created and applied in specific use cases. The scope includes the watertight tessellation format (WTF) and compressed STEP files.

- **Production Models** will be included in this round of testing, in addition to the synthetic models for the above capabilities.
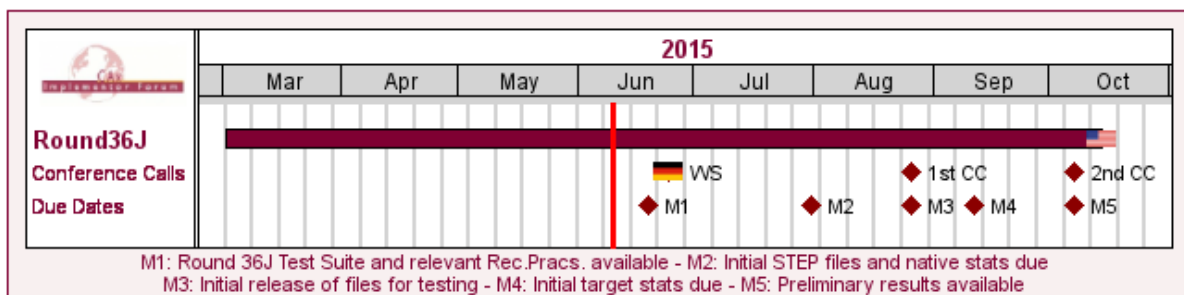
- **AP242 BO Model XML Assembly Structure** is new implementation format introduced with AP242, and the designated process format for many applications in the aerospace and automotive industries. It will be used in combination with a geometry formats matching the respective requirement. In the CAx-IF, the geometry files will be in STEP Part 21 format. The XML files will contain the assembly structure and part master information.

1.2   General testing instructions for this round

The general procedures for communication of models and statistics are outlined in a separate document 'General Testing Instructions'. The general instructions can be retrieved from the CAx Implementor Forum web sites. The latest version is v1.11, dated November 15, 2013.

1.3   Testing Schedule

The following schedule has been agreed on for Round 36J:

Date	Action
19 Jun 2015 (Fri)	Round 36J Test Suite and relevant Rec.Pracs. available
24 Jun 2015 (Wed)	CAx-IF Technical Workshop in Darmstadt, Germany
31 Jul 2015 (Fri)	Initial STEP files and native stats due
26 Aug 2015 (Wed)	1st CAx-IF Round36J Conference Call / Initial release of files for testing
11 Sep 2015 (Fri)	Initial target stats due
7 Oct 2015 (Wed)	Preliminary results available / 2nd CAx-IF Round36J Review Meeting
12 Oct 2015 (Mon) - 14 Oct 2015 (Wed)	CAx-IF Round36J Review Meeting in Albuquerque, NM, USA

Figure 1: CAx-IF Round36J Schedule

The CAx-IF Technical Workshop will be held in conjunction with a LOTAR meeting. Conference calls and web sessions will also be available.

The CAx-IF R36J Review meeting will take place in conjunction with the PDES, Inc. Fall Offsite meeting and a LOTAR workshop. In addition, conference calls and web sessions will be available for those not attending the meeting to dial in.

1.4 Copyrights on Test Cases

1.4.1 CAx-IF

None of the production test cases which were provided by the PDES, Inc. and ProSTEP iViP member companies may be publically released for any purpose. The test cases can be freely distributed among the CAx-IF members, and can be used for any purposes that are related to CAx-IF testing (i.e. testing, documentation of testing efforts), as long as a reference to the originating company is made.

The test cases must not be used for any purposes other than CAx-IF testing or outside of PDES, Inc. and ProSTEP iViP. Test cases provided by the LOTAR project for testing of specific capabilities are applicable to the same restrictions and may not be used outside LOTAR or the CAx-IF.

1.4.2 NIST

The test cases developed at the National Institute of Standards and Technology (NIST) are not subject to copyright protection and are in the public domain. NIST assumes no responsibility for the components of the test system for use by other parties and makes no guarantees, expressed or implied, about their quality, reliability, or any other characteristic. The use of the CAD systems to create the Test Models does not imply a recommendation or endorsement by NIST.

For more details, read the disclaimer at http://go.usa.gov/mGVm

2 Synthetic Test Case Specifications

2.1 Test Case SP5: Semantic PMI Representation

All information about this test case can also be viewed in CAESAR on its Information page.

2.1.1 Motivation

Product and Manufacturing Information (PMI) is required for a number of business use cases in the context of STEP data exchange. Among others, it is a prerequisite for long-term data archiving. In addition, PMI can be used to drive downstream applications such as coordinate measuring and manufacturing.

Semantic PMI Representation relates to the capability to store PMI data in the STEP file in a computer-interpretable way, so that it can be used for model redesign or downstream applications. Though the definition of the data is complete, it is by itself not visible in the 3D model.

Additional presentation capabilities are needed to display the data in a way that it is visible to the user in the 3D model. Addition of presentation is data is optional in the SP5 test case.

2.1.2 Approach

The approach to be used is described in the latest version (at least v4.0, dated October 13, 2014) of the "Recommended Practices for Representation and Presentation of PMI (AP242)", which can be found on the public CAx-IF web sites under "Joint Testing Information".

Within the PMI area, the following functionalities are in scope of Round 36J:

- Semantic PMI Representation
- Graphic PMI Presentation (Polyline or Tessellated)
- Linking of PMI Representation to Presentation

The AP242 schema to be used is the IS version (v1.36), which can be found on the public CAx-IF web sites under "Joint Testing Information".

2.1.3 Testing Instructions

The tests will be performed based on a verified set of test models, each with set of well-defined PMI elements. These models have been developed in the course of the "MBE PMI Validation and Conformance Testing" project, which has been supported by the CAx-IF in recent test rounds. The models to be used in Round 36J are from the second dataset, and will be tested for the first time.

2.1.3.1 Test Model Overview

The models are designated "FTC" ("Fully-toleranced Test Cases") and the models number 06, 08 and 09 have been selected:
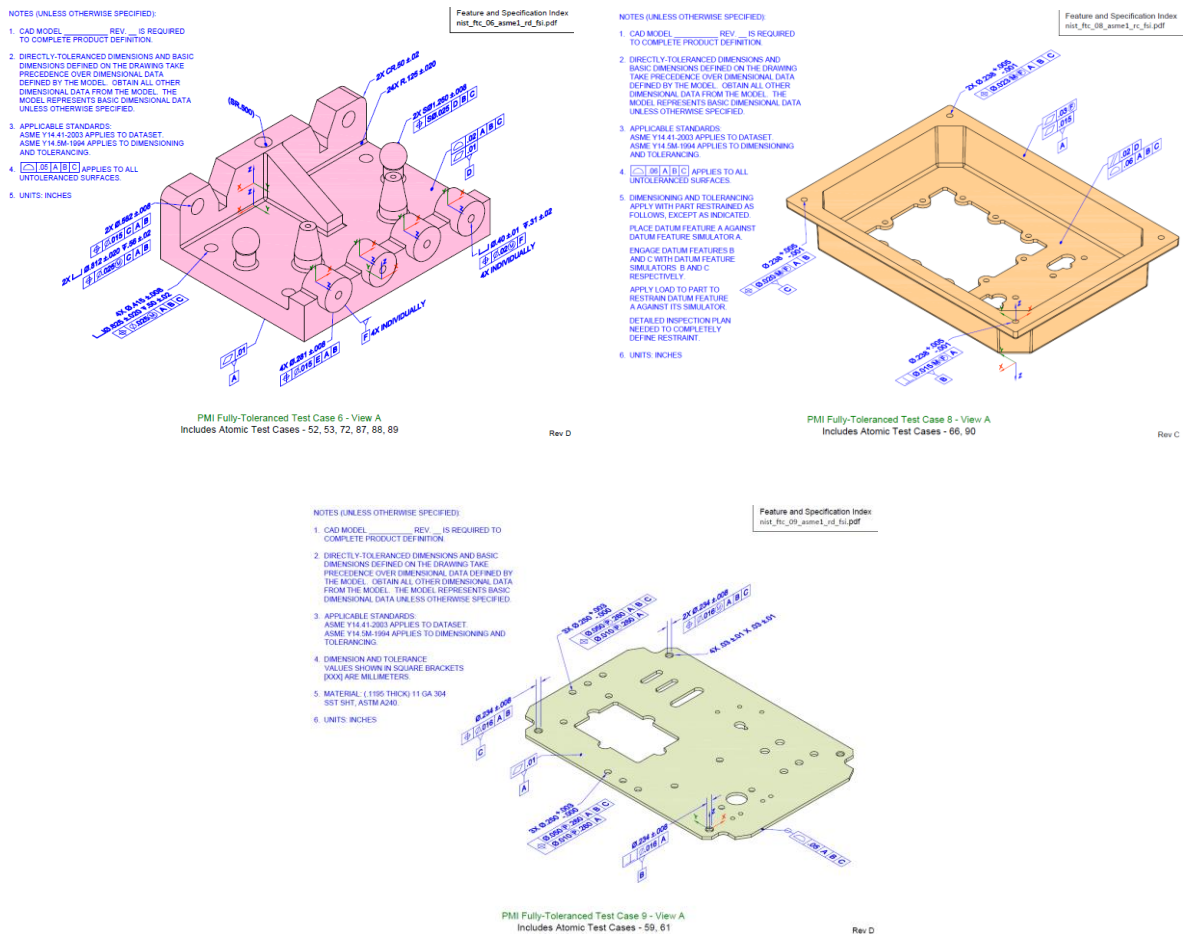
Figure 2: Illustrations of the three NIST "FTC" models to be used for SP5

2.1.3.2 Test Model Access

Each of the three test cases has been modeled natively in four different CAD systems:

- Dassault Systèmes CATIA V5-6 R2014
- PTC Creo 3.0
- Siemens NX 9.0
- Dassault Systèmes SolidWorks 2015

The native CAD files, a ZIP file with the test case definitions and geometry STEP files can be downloaded from this URL:

- http://www.nist.gov/el/msid/infotest/mbe-pmi-validation.cfm

2.1.3.3 Test Model Configuration

The following functionality shall be included in the test files provided for this round of testing, as far as it has been implemented by the CAx-IF participants and is described in the Recommended Practices:

- <u>PMI Representation</u> – the re-usable representation of PMI data should be included in all SP5 models to the extent supported by the native system.

- <u>PMI Graphic Presentation</u> – Many CAD systems require some minimal presentation information to be able to handle the PMI data in a model. There are also use cases were both PMI representation and presentation data will be included in the same file. Thus, some form of presentation information shall be included in the SP5 test case as well.

- <u>Linking PMI Representation to Presentation</u> – If a model contains PMI Representation information as well as Presentation data, it is very useful to link the corresponding elements together, so that a Representation element "knows" by which annotation it is being presented in the model. The approach to create this link is described in section 7.3 of the PMI Rec. Pracs. (v4.0).

- <u>Validation Properties</u> – All participants providing STEP files for this test case are encouraged to include validation properties as far as supported; in particular for PMI presentation and representation.

Also refer to 0 for test model translation configuration considerations.

2.1.3.4 Statistics

For each STEP file exported or imported for the SP5 test case, vendors must submit the corresponding statistics. To do so, go to the [SP5 Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described below.

Screenshots

If presentation information is contained in the test files, it shall be accompanied by corresponding screenshots. Note that CASEAR allows the addition of multiple screenshots per dataset.

Note that in order to count the GD&T elements for the statistics, per agreement during the R22J Review Meeting, the actual STEP entity types (`datum`, `datum_target`...) shall be considered.

Note that based on the Round 35J results, a new count has been added for Composite Tolerances as defined in section 6.9.9. of the PMI Rec. Pracs. (v4.0).

Note that all statistics – native and target – shall be based on the Semantic PMI Representation data only, and not take any presentation into account.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'SP5' followed by the model index; i.e. 'SP5-06', 'SP5-08', or 'SP5-09'.
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'

scope	A short designation of the scope tested in the model. In the case of SP5, recommended values are:
	  o Representation
	  o Representation + [char.-based / graphic] Presentation
	  o Representation + Linked [… / …] Presentation

dimension	The number of dimensions processed
datums	The number of datums processed
datum_targets	The number of datum targets processed
tolerances	The number of tolerances (all types combined) processed, regardless of composition
compos_tols	The number of composite tolerances processed (number of instances of geometric_tolerance_relationship per section 6.9.9. in the PMI Rec. Pracs. v4.0)
labels	The number of labels processed
pmi_graphic_pres	all/partial/none – whether the graphic PMI annotations included in the file could be processed correctly
pmi_linked_pres_rep	all/partial/none – whether the Semantic PMI Representation elements and (Graphic) PMI Presentation elements were linked correctly together.
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

2.2 Test Case TGP2: 3D Tessellated Geometry & Tessellated PMI Presentation

All information about this test case can also be viewed in CAESAR on its Information page.

2.2.1 Motivation

In addition to use cases that require a fully defined, precise, semantic definition of the part geometry and associated PMI as is the focus of the SP5 test case described above, there are also scenarios where the presentation of the data – geometry and annotations – for visual consumption is the primary goal. In such cases, a simplified and optimized version of the model is sufficient.

For this purpose, AP242 introduced a data model for tessellated geometry, which can be used for tessellated part geometry as well as for tessellated PMI presentation. These capabilities have been tested several times in past CAx-IF test rounds, though separately. In Round 35J the previously separate test case "TP3" and "TS1" were combined into one; the current round continues this scenario based on new test models.

2.2.2 Approach

The approach for 3D Tessellated Geometry is described in the corresponding draft Recommended Practices. The latest working draft (v0.5, dated March 13, 2015) can be found in the member area of the CAx-IF web sites, under "Information on Round 35J of Testing."

The approach for Tessellated PMI Presentation is described in the latest version (at least v4.0, dated October 13, 2014) of the "Recommended Practices for Representation and Presentation of PMI (AP242)", which can be found on the public CAx-IF web sites under "Joint Testing Information".

The AP242 schema to be used is the IS version (v1.36), which can be found on the public CAx-IF web sites under "Joint Testing Information".

2.2.3 Testing Instructions

The tests will be performed based on the same set of NIST FTC models as for the SP5 test case described above.

2.2.3.1 Test Model Overview

- See section 2.1.3.1 above.

2.2.3.2 Test Model Access.

- See section 2.1.3.2 above.

2.2.3.3 Test Model Configuration

The following functionality shall be included in the test file provided for this round of testing, as far as it has been implemented by the CAx-IF participants and is described in the Recommended Practices:

- <u>Tessellated Presentation</u> – include the PMI elements as tessellated annotations. Stroked, outline and filled fonts (and combinations) are allowed, as well as styling of the annotations (colors).

- <u>Definition of "Saved Views"</u> – as far as supported, include the saved views defined in the models, which contain a subset of annotations in the file, and provide a predefined position of the model in the design space.

   - All FTC models several Saved Views: FTC-06 (3), FTC-08 (4) and FTC-09 (4). In the test case definition documents, each page of the PDF document represents one Saved View.

   - For each view, a screenshot showing the model layout (displayed elements, orientation, zoom) shall be provided. **Note** that it is possible to attach several screenshots to one set of statistics in CAESAR. The name of the view shall be given as description for the screenshot.

   - Both "basic" and "advanced" view implementations are allowed

- <u>Cross-highlighting of annotations and annotated shape</u> – if supported, include in the STEP file the information necessary to maintain the association between annotations and the annotated shape elements in a way, that after import, when highlighting an annotation, the shape elements annotated by it are highlighted too, and vice versa.

- <u>PMI Validation Properties for Tessellated Presentation</u> – as far as supported, include the validation properties in the files, and evaluate these after import:

   - "Number of Segments"
   - "Tessellated Curve Length"
   - "Tessellated Curve Centre Point"
   - "Number of Facets"
   - "Tessellated Surface Area"
   - "Tessellated Surface Centre Point"
   - "Equivalent Unicode String"
   - "Affected Geometry"

Also refer to 0 for test model translation configuration considerations.

Note that for the creation of the Equivalent Unicode String, the mapping as defined by the "Unicode String Project" report (Revision J) shall be used. This document is available on the public CAx-IF homepages, under "Joint Testing Information".

Note that for the PMI validation properties, the new optimized implementation structure for validation properties can be used. This is currently defined in section 4.10 of the "Recommended Practices for Geometric and Assembly Validation Properties" (Release 4.2, dated October 9, 2014), which can be found on the public CAx-IF homepages under "Joint Testing Information".

2.2.3.4 Statistics

For each STEP file exported or imported for the TGP2 test case, vendors must submit the corresponding statistics to CAESAR. To do so, go to the [TGP2 Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

View-related Statistics

Several of the Statistics for this test case are view-related (e.g. number of annotations, positioning/scaling). The statistics cannot evaluate this for all views in the model. Hence, the idea is to select one specific (interesting) view on export and publish its name in the "Saved View" field of the statistics. It is recommended to use the first view (by name, alphabetized) in the model. Then, fill in the other view-related statistics with the values as valid for this particular view. After import, select the view with the name given in the native statistics and again provide the values valid for this view.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

Screenshots

For each Saved View in the model, provide one screenshot, which illustrates the layout (displayed geometry and annotation, model orientation, and zoom factor). Give the name of the view as the description of the screenshot.

Note that in order to count the PMI elements for the statistics, per agreement during the Round 22J Review Meeting, the names of the `tessellated_geometric_set` shall be considered.

See section "Indicating the Presented PMI Type" in the PMI Recommended Practices for details.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'TGP2' followed by the model index; i.e. 'TGP2-06', 'TGP2-08', or 'TGP2-09'.
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
dimension	The number of dimensions processed

datums	The number of datums processed
datum_targets	The number of datum targets processed
tolerances	The number of tolerances processed
labels	The number of labels processed
saved_view	The name of the Saved View which is the basis for the view-related statistics
view_annot	The number of annotations included in the specified saved view.
view_pos	pass/fail, whether the model orientation and zoom factor stored for the Saved View could be restored successfully.
highlight	all/partial/none – whether the cross-highlighting for annotations and annotated shape elements works correctly
tess_pmi_area	all/partial/none – whether the surface area of the Tessellated PMI annotations was validated successfully for all, some or none of the given annotations.
tess_pmi_clength	all/partial/none – whether the total length of segments per Tessellated PMI annotation was validated successfully for all, some or none of the given annotations.
tess_pmi_c	all/partial/none – whether the centroids of the Tessellated PMI annotations were validated successfully for all, some or none of the given annotations.
eq_unicode	all/partial/none - if the encoding of the equivalent Unicode string was correct for all, some or none of the given annotations.
valid_tess_vp	pass/fail, is the instantiation of the validation properties for Tessellated Geometry in the STEP file per the recommended practices?
affected_geo	all/partial/none – whether the affected geometry could be validated correctly for all, some or none of the PMI statements in the model.
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

2.3 Test Case B4: Geometric Validation Properties

All information about this test case can also be viewed in CAESAR on its Information page.

2.3.1 Motivation

Geometric Validation Properties are one of the most important and successful capabilities of STEP, which distinguishes it from other neutral exchange formats. The properties allow for the validation of the imported data based on key characteristics calculated by the native system and stored in the STEP file, which are then compared against the results computed for the imported model in the target system.

These key values typically are total volume, total surface area and centroid of the model. Based on recent test experiences and refined use cases, it was agreed to separate these values for the different classes of geometry (solids, independent surfaces, and independent curves) that can be found in a model. "Independent" means that these do not take part in the definition of a higher-class topological element, i.e. an independent curve is not an edge of a surface (it may be part of a wireframe model), and an independent surface is not a face of a solid (it may be part of an open or closed shell).

While the Geometric Validation Properties for Independent Curves have been tested several times now, the values for Independent Surfaces are new and hence shall be tested using a suitable hybrid model.

2.3.2 Approach

For the validation properties, the approaches as described in the "Recommended Practices for Geometric and Assembly Validation Properties", version 4.3, dated July 16, 2015, shall be used, in particular:

- GVP for Solid Geometry, section 4.6

- GVP for Surface Geometry, section 4.7 (new)

- GVP for Curve / Wireframe Geometry, section 4.8

- Bounding Box, section 4.10

- Combining Validation Properties for Efficient Implementation, section 4.11

This document is available in the member area of the CAx-IF homepages, under "Information on Round 36J of Testing".

2.3.3 Testing Instructions

In Round 36J, the model from the previous rounds will be reused. It has been provided by Audi and has been designed for interoperability tests and has been used, among other occasions, in the 2013 JT Application Benchmark facilitated by ProSTEP iViP and VDA.

The model contains:

- The part shape as solid geometry

- The part shape as surface geometry (occupying the same space)
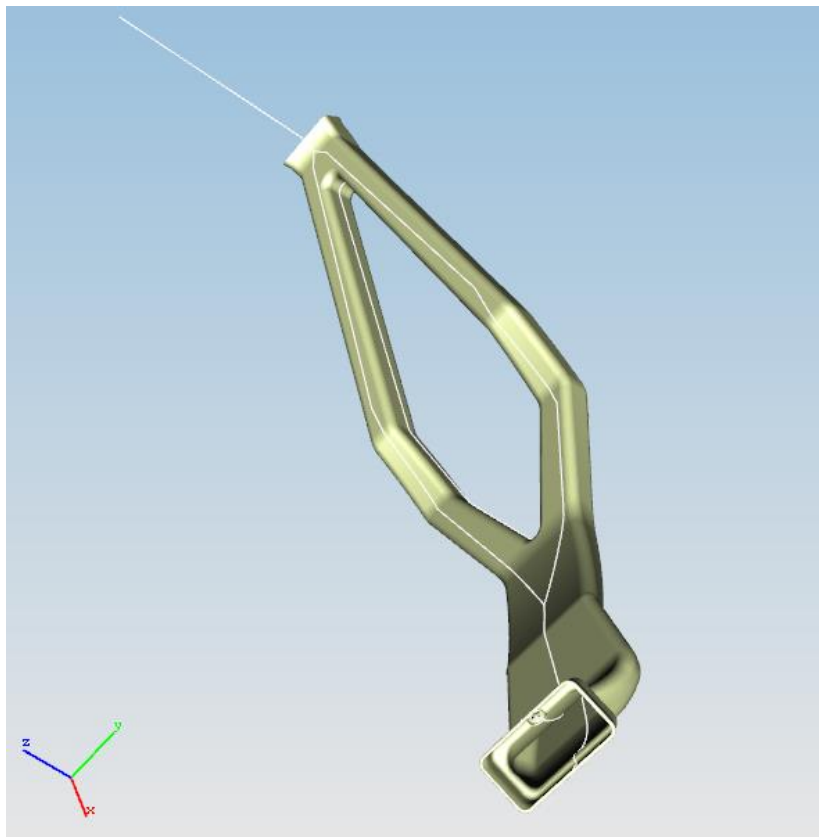
- Additional Wireframe geometry

Figure 3: Illustration of the B4 Model

Note that since in Round 35J, the exchange of (composite) curves in particular created some issues, this will be a special testing focus this round.

2.3.3.1 Construction of the Model

The model is provided in the following formats:

- CATIA V5 R19 (*.CATPart)

- Creo (*.prt.1)

- NX (*.prt)

- ACIS (*.sat)

The native files are combined into a ZIP archive, which is available from the member area of the CAx-IF homepages, under "Information on Round34J of Testing".

2.3.3.2 Statistics

For each STEP file exported or imported for the B4 test case, vendors must submit the corresponding statistics. To do so, go to the [B4 Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec.Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'B4'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
unit	The unit the model is designed in
volume	Total volume of all solids
validation_volume	Total volume of all solids as received via the validation property capability
valid_vol	pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?
area	Total surface area of all solids
validation_area	Total surface area of all solids in the model, as received via the validation property capability
valid_area	pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?
cx	Centroid of the model
cy	
cz	
validation_cx	Centroid of the model (entire assembly) as received via the validation property capability
validation_cy	

column name	description
validation_cz	
valid_cent	pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?
surface_area	Total area of all independent surfaces in the model
validation_sfarea	Total area of all independent surfaces in the model, as received via the validation property capability
valid_surface_a	pass/fail, is the instantiation of the validation property 'independent surface area' in the STEP file as per the recommended practices for validation properties?
surface_centroidx	Combined Centroid of all independent surfaces in the model
surface_centroidy	
surface_centroidz	
validation_sfcentroidx	Combined Centroid of all independent surfaces in the model, as received via the validation property capability
validation_sfcentroidy	
validation_sfcentroidz	
valid_surface_c	pass/fail, is the instantiation of the validation property 'independent surface centroid' in the STEP file as per the recommended practices for validation properties?
curve_length	Total length of all (independent) curves in the model
validation_clength	Total length of all independent curves in the model, as received via the validation property capability
valid_curve_l	pass/fail, is the instantiation of the validation property 'curve length' in the STEP file as per the recommended practices for validation properties?
curve_centroidx	Combined Centroid of all independent curves in the model
curve_centroidy	
curve_centroidz	
validation_ccentroidx	Combined Centroid of all independent curves in the model, as received via the validation property capability
validation_ccentroidy	
validation_ccentroidz	
valid_curve_c	pass/fail, is the instantiation of the validation property 'independent curve centroid' in the STEP file as per the recommended practices for validation properties?
bbox_minx	The (min X, min Y, min Z) corner point of the Bounding Box (per GVP RP v3.3 or later)
bbox_miny	
bbox_minz	
bbox_maxx	The (max X, max Y, max Z) corner point of the Bounding Box (per GVP RP v3.3 or later)
bbox_maxy	
bbox_maxz	
valid_bbox	pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

2.4 Test Case S1: AP242 BO Model XML Assembly with Tessellated Geometry

All information about this test case can also be viewed in CAESAR on its Information page.

2.4.1 Motivation

The exchange of assembly structures with external references to geometry files is a long-used concept in the STEP multiverse, which has proven its value and stability in many business use cases. In the CAx-IF context, so far all files of such a package (structure and geometry) were provided as STEP Part 21 files.

Now AP242 provides a Business Object (BO) Model, which is a comprehensive data model with an XML representation, and was designed with the use case of combined use with other formats in mind. The user community hence requests support of this new format for the established use case of assembly data exchange.

AP242 BO Model XML is the designated standard process format for the automotive and aerospace industries and will be used together with various standardized and proprietary geometry file formats, depending on the actual use case. This also includes tessellated formats. External References and 3D Tessellated Geometry, which are capabilities that have been tested many times in the CAx-IF already, but always separately. In Round 35J, they were combined into a consolidated test case, which will be re-used this round.

2.4.2 Approach

The following schemas and documents shall be used for this test:

- *AP242 IS Business Object Model XML*, dated May 5, 2014 [R34J]

- *AP242 IS Longform Schema (v1.36)*, dated May 22, 2014 [JTI]

- *Recommended Practices for AP242 Business Object Model XML Assembly Structure*, version 1.00, dated February 13, 2015 [JTI]

  o Note that a set of example XML files is available as well, based on AS1 [R35J].

- *Recommended Practices for 3D Tessellated Geometry*, version 0.5, dated March 13, 2015 [R35J]

- *Recommended Practices for STEP File Compression*, version 1.1, dated November 21, 2013 [JTI]

The documents can be found in the following locations, as indicated:

- [JTI] – Public CAx-IF Homepage, "Joint Testing Information"

- [R34J] – CAx-IF Member Area, "Information on Round 34J of Testing"

- [R35J] – CAx-IF Member Area, "Information on Round 35J of Testing"

Each set of files (structure + geometry files) shall be provided as a ZIP package containing:

- For the component part geometry files:

  o A compressed AP242 Part 21 file (*.stpZ) with a tessellated representation of the part geometry

  o Vendors who do not support 3D tessellated geometry in their implementations may provide the part geometry as "classic" STEP B-Rep data (*.stp).

- For the assembly structure:

  o One AP242 BO Model XML file ("all-in-one" approach), or

  o Multiple AP242 BO Model XML files ("nested" approach) – see section 9.2 in the Recommended Practices for AP242 BO Model XML Assembly Structure.

2.4.3 Testing Instructions

The test model that will be used for this test is the well-known "S1" model ("spaceship").

For those vendors who do not have the S1 model at hand, modelling instructions can be found in the Round5J Test Suite document (v2.0), which can be found on the "Joint Testing Information" pages of the CAx-IF web sites, dated October 4th, 2000.
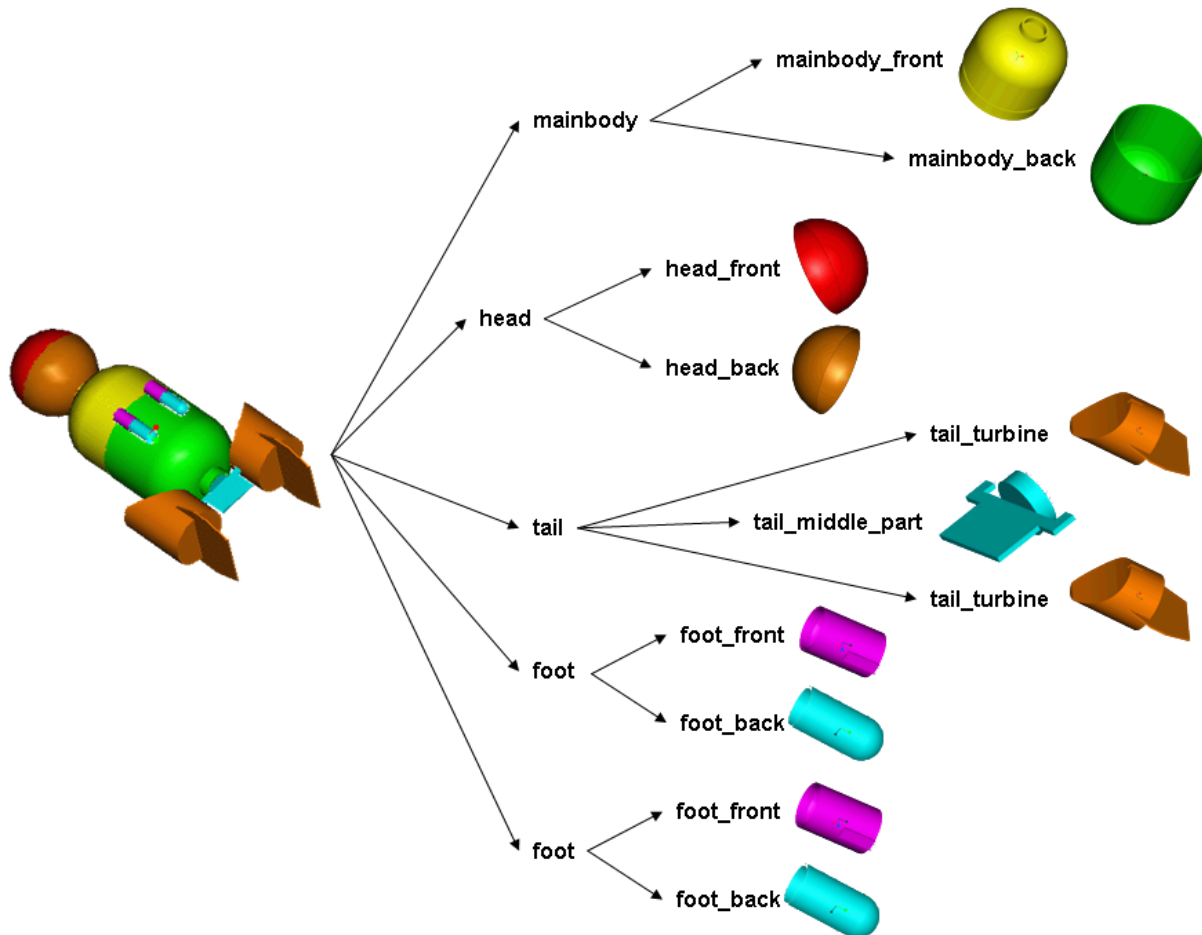

Figure 4: Shape and Structure of the S1 model (spaceship)

The aim of this test is to correctly transfer the assembly structure based on AP242 BO Model XML files, using either the "all-in-one" or the "nested" approach, and referencing tessellated parts.

Since transfer of the S1 geometry itself can safely be considered stable, there will be no geometry-related statistics. The evaluation will focus on completeness and correctness of the assembly structure and the external references.

2.4.4 Statistics

For each STEP file exported or imported for the S1 test case, vendors must submit the corresponding statistics to CAESAR. To do so, go to the [S1 Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'S1'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
fref_found	all/partial/none - indicates if all, some or none of the references to the external files can be found in the assembly structure file(s), and if they are correctly associated with the respective nodes in the assembly structure.
fref_processed	all/partial/none - indicates if all, some or none of the referenced files were be processed correctly to successfully construct the overall model.
assem_struct	pass/fail - if the model structure (assembly tree) was transferred correctly, i.e. no nodes have been added or removed, and all elements are on the correct hierarchical level.
assem_place	all/partial/none - whether the placement of assembly components is correct
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

2.5 Test Case CO1: Composite Materials

A test case for composite materials will be added in a later version of this document.

3 Production Models

3.1 Test Case PM30

All information about this test case can also be viewed in CAESAR on its Information page.

3.1.1 Motivation

In an attempt to test the STEP processors on real world models, the CAx Implementor Forum will be testing production parts in this round and future rounds of CAx-IF testing. These production models are characteristic for components and assemblies that are encountered in the aerospace and automotive industries. PDES, Inc. and ProSTEP iViP member companies and vendors have supplied these models. As they may contain data about current products of these companies, all native and STEP files related to these models have to be handled confidentially and their use is strictly limited to the CAx-IF activities.

3.1.2 Approach

Testing of Production Models focuses mainly on data quality, not on specific functionalities. Assemblies should therefore be exported as a single STEP file. The file format should be AP242 IS (schema version 1.36). In order to support quality validation of the Production Model exchange, all vendors shall include the maximum level of Validation Properties they support, and report them in the statistics. PMI may be included as Polyline Presentation, if defined in the native models.

3.1.3 Testing Instructions

The native models as provided by the user companies should be exported to STEP by all participants who maintain a STEP processor for the respective CAD system. The native models are available on the CAx-IF File Repository in the member area. Once there, browse to the sub-folder "Round 36J > Production Models".

3.1.4 List of available models

Model name	Stats code	Native System	Remarks
70721769-1_MBE	PM30-1769	NX	Provided by Honeywell Contains PMI
827-9999-903	PM30-903	NX 8.5	Provided by Rockwell Collins Contains PMI
827-9999-904	PM30-904	NX 8.5	Provided by Rockwell Collins Contains PMI

Note: The models provided by Rockwell Collins will show a "company proprietary information" note. They have been released for CAx-IF testing, under the restrictions given in section 1.4 above (copyright on test cases).
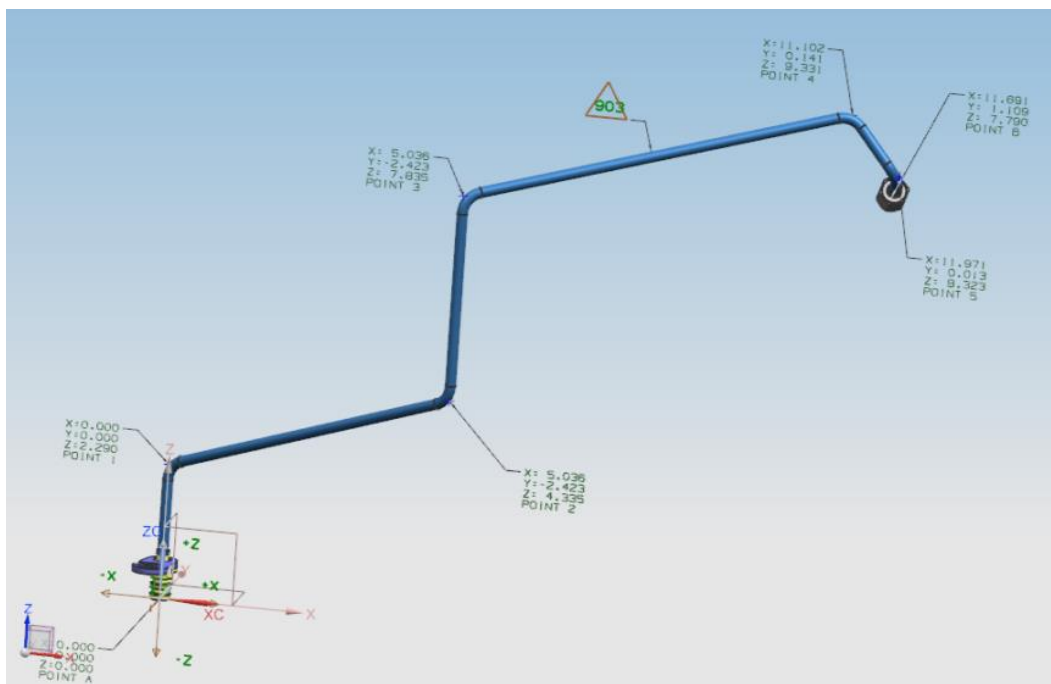

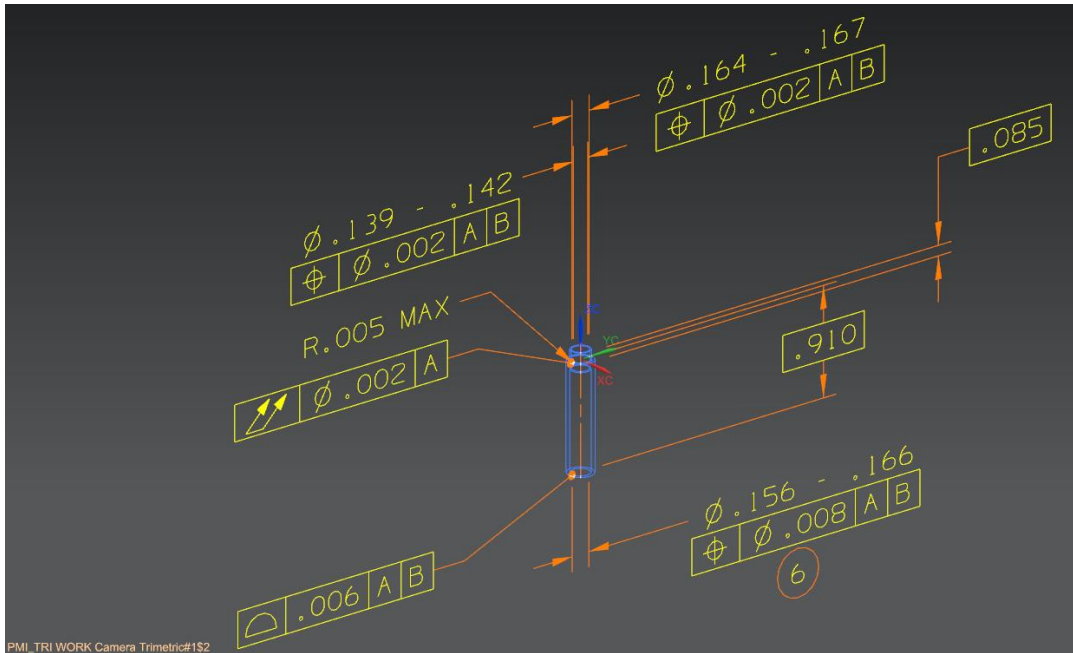*Figure 5: Illustration of PM30-1769*
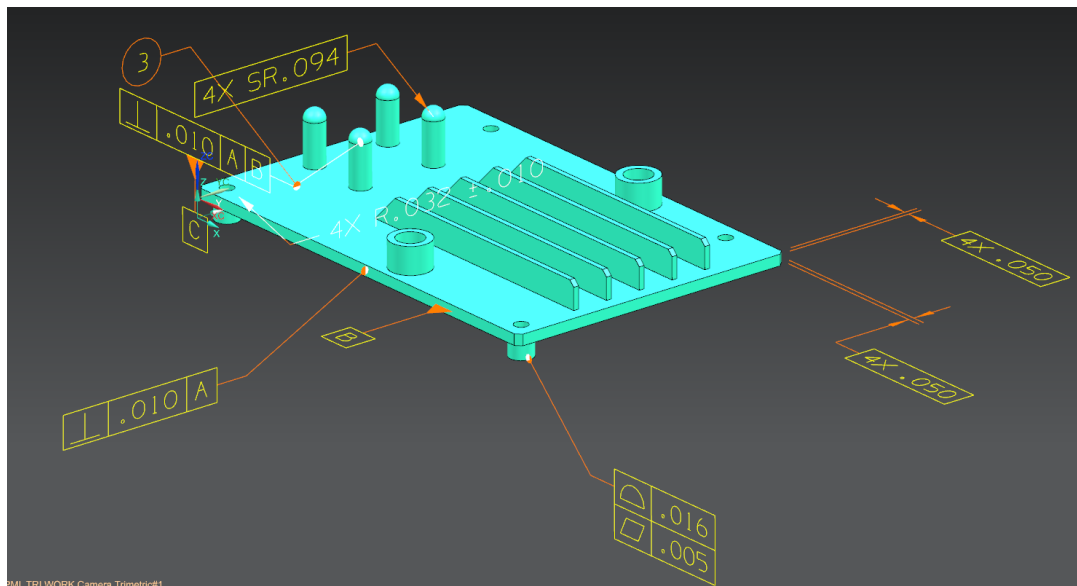
Figure 6: Illustration of PM30-903

Figure 7: Illustration of PM30-904

3.1.5 Statistics

For each STEP file exported or imported for the PM30 test cases, vendors must submit the corresponding statistics. To do so, go to the [PM30 Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a file, report the results found after processing the file as described below:

Data Sheet Columns

column name	description
model	The name of the test model, here: 'PM30'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
unit	The unit the model is designed in
volume	Total volume of all solids
validation_volume	Total volume of all solids as received via the validation property capability
valid_vol	pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?
area	Total surface area of all solids
validation_area	Total surface area of all solids (entire assembly), as received via the validation property capability
valid_area	pass/fail, is the instantiation of the validation property 'area' the STEP file as per the recommended practices for validation properties?
cx	Centroid of all solids
cy	
cz	
validation_cx	Centroid of all solids (entire assembly) as received via the validation property capability
validation_cy	
validation_cz	
valid_cent	pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?
model_size	model_size is the length of the space diagonal of the 3dimensional bounding box enclosing all entities in the model. The result is the Centroid deviation divided by the model_size
dimension	The number of dimensions processed
datums	The number of datums processed
datum_targets	The number of datum targets processed
tolerances	The number of tolerances processed
labels	The number of labels processed
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4   STEP File Library Update

Now that AP242 is released as an International Standard, the public CAx-IF STEP File Library (http://www.cax-if.de/library/ and http://www.cax-if.org/library/ respectively) needs to be updated. Hence, in the context of Round 36J, a number of additional test models have been defined with the goal of collecting "clean" STEP files based on AP242 IS and the latest applicable Recommended Practices.

The files that are currently available in the library are based on outdated schema versions – in particular the AP203e2 files posted there are based on an earlier development versions of AP203e2, and hence fail validation against the current schema.

For each test model, 2-3 (sets of) files will be selected and made publicly available on the library page, together with the corresponding native statistics and screenshots. The goal is to have at least one AP242 file for each test case, plus additional AP203e2 and/or AP214e3 files for the legacy capabilities.

To avoid confusion with the regular Round 36J test cases, the test cases for the STEP file library have designations starting with "L-".

Testing in the CAx-IF is typically based on development code and beta versions of the involved tools. Consequently, files and results stay within our group. For the STEP library, the files will – after approval – obviously be published, accessible for everyone on the internet. Hence, anyone providing files for the STEP file library is welcome to use a stable release of their products supporting the respective capabilities.

4.1   Test Case L_MS: Model Styling

All information about this test case can also be viewed in CAESAR on its Information page.

4.1.1   Motivation

The transfer of Solid Color and Overriding Face/Edge Color is one of the oldest functionalities tested in the CAx-IF. It has been tested since Round1J, and thus should be provided in the public STEP file library by a number of STEP processors.

The model is a non-assembled single solid model having a color assigned to the solid, for the inner face of the hollow shaft an overriding face color is specified and the edges limiting the drilled holes have another color assigned.

4.1.2   Approach

Test files shall be based on:

- AP203e2, AP214e3, AP242 IS
- Recommended Practices for Model Styling & Organization, v1.4 (Jan. 23, 2014)

Mandatory STEP file content:

- Solid B-Rep Geometry
- Solid Color
- Overriding Face Color

Optional additional STEP file content:

- Overriding Edge Color

4.1.3   Testing Instructions

The model used for this test is the old "IO1" ("flange") test model. For those vendors who do not have the IO1 model, modelling instructions can be found in the Round2J Test Suite document (v2.0; August 31, 1999), which can be found on the "Joint Testing Information" pages of the CAx-IF web sites.

Colors shall be assigned as follows:

- solid color: yellow

- overriding color for contact face: red

- overriding color for profile boundaries: blue

Any annotations (3D Text) contained in the original models shall NOT be exported.
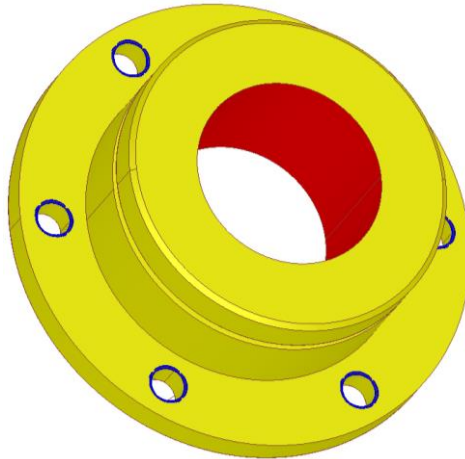

Figure 8: Illustration (shape & colors) of L_MS

4.1.4 Statistics

For each STEP file exported or imported for the L_MS test case, vendors must submit the corresponding statistics. To do so, go to the [L_MS Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a file, report the results found after processing the file as described below:

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L_MS'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
unit	The unit the model is designed in
volume	Total volume of all solids
area	Total surface area of all solids
cx	Centroid of all solids
cy	
cz	
color_sd	all/partial/none – if the color of the solid in the model is totally correct, partially correct, or lost completely.

color_f	all/partial/none - if overriding face color in the model is totally correct, partially correct, or lost completely
color_e	all/partial/none - if overriding edge color in the model is totally correct, partially correct, or lost completely
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4.2 Test Case L_SG: Supplemental Geometry

All information about this test case can also be viewed in CAESAR on its Information page.

4.2.1 Motivation

When designing a part in a CAD system, geometrical elements are often created that do not belong to the actual, i.e. manufactured, shape of the part, but are used to either create other geometric shapes, or to relate additional information about the part.

The main business applications for this capability are the transfer of reference elements for PMI information, such as cutting planes and center lines, and named axis placements as tool targets for machining applications.

4.2.2 Approach

Test files shall be based on:

- AP203e2, AP214e3, AP242 IS
- Recommended Practices for Supplemental Geometry, v1.0 (November 1, 2011)

4.2.3 Testing Instructions

The transfer of supplemental geometry will be tested using a simple test model (see below). The following elements shall be included:

- The center line for the cylindrical hole through the part
- A reference plane at the upper end of the truncated cone, its face normal parallel to the center line of the hole
- Four named axis placements along the outer top edge of the part

Note that when comparing the results, supplemental geometry elements may look differently in different CAD systems (e.g. bounded vs. unbounded plane). The essential criterion is whether they are correctly identified as supplemental geometry in the target system.

4.2.3.1 Construction of the L-SG model
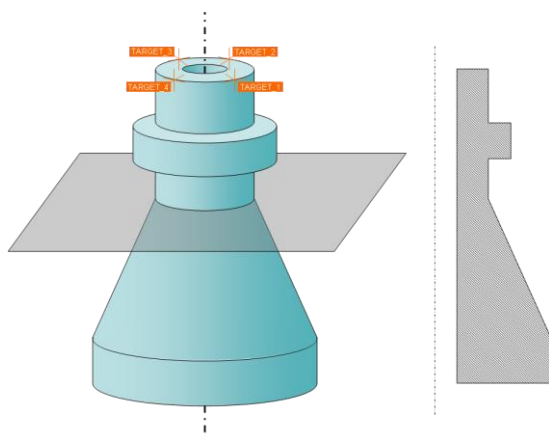
Dimensions for the part are arbitrary; suggested values are height 15cm, base diameter 10cm and tip diameter 5cm

Figure 9: Illustration of L_SG

4.2.3.2 Statistics

For each STEP file exported or imported for the L_SG test case, vendors must submit the corresponding statistics. To do so, go to the [L_SG Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value, or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec.Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L_SG'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
center_line	pass/fail, if the center line was found in the STEP file and correctly displayed in the CAD system.
ref_plane	pass/fail, if the reference plane was found in the STEP file and correctly displayed in the CAD system.
tool_tgt	pass/fail, if the named axis placements (tool targets) were found in the STEP file and correctly displayed in the CAD system or identified in the product structure.
valid_supp_geo	pass/fail, whether the implementation of the Supplemental Geometry elements in the STEP file is as defined in the recommended practices.
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4.3 Test Case L_ER: External References

All information about this test case can also be viewed in CAESAR on its Information page.

4.3.1 Motivation

External references are an important mechanism for many applications. They allow for exchanging the assembly structure separate from the model geometry, so it can be easily managed by PDM systems. Also, the geometry can be included in different formats, including native CAD files. In order to manage large assemblies, the structure information can be split into several files, which is referred to as nested external references.

4.3.2 Approach

Test files shall be based on:

- AP2032e2, AP214e3, AP242 IS

- Recommended Practices for External (Element) Reference, v3.1 (Jan. 20, 2014)

4.3.3 Testing Instructions

The External References shall be tested using the well-known AS1 model. This model will be split up into a set of STEP files:

- One structure STEP file containing only the complete assembly structure for basic external references, or

- One structure STEP file per level of the assembly structure, i.e. each containing one node of the assembly tree and its immediate children, for nested external references,

- Plus one geometry STEP file for each component part used in the S1 model.
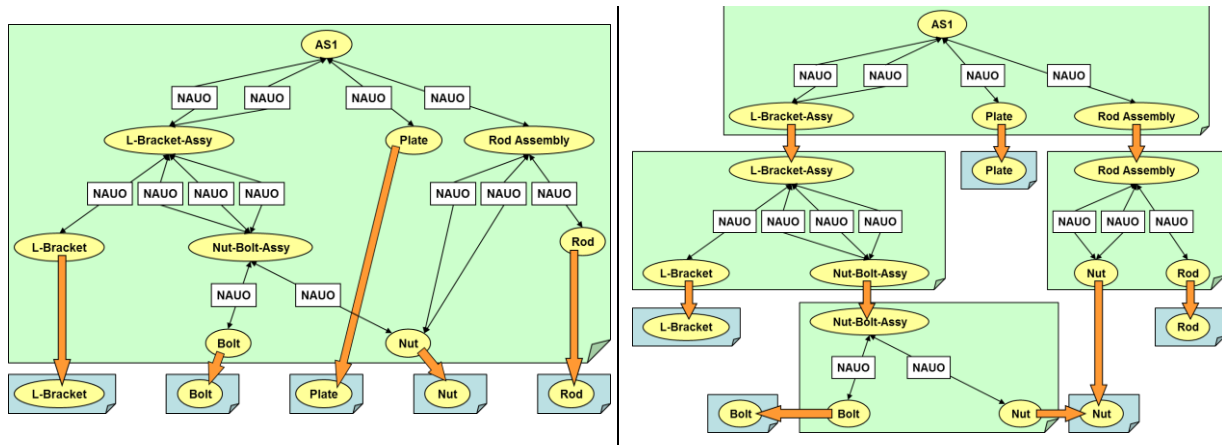
Figure 10: File structure with one structure file (left) and in the nested case (right)

4.3.3.1 Construction of the L_ER model

For those vendors who do not have the AS1 model at hand, modelling instructions can be found in the Round8J Test Suite document (v2.0; September 5, 2001), which can be found on the "Joint Testing Information" pages of the CAx-IF web sites.

Figure 11: Illustration of the L_ER Model

4.3.3.2 Statistics

For each STEP file exported or imported for the L_ER test case, vendors must submit the corresponding statistics. To do so, go to the [L_ER Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

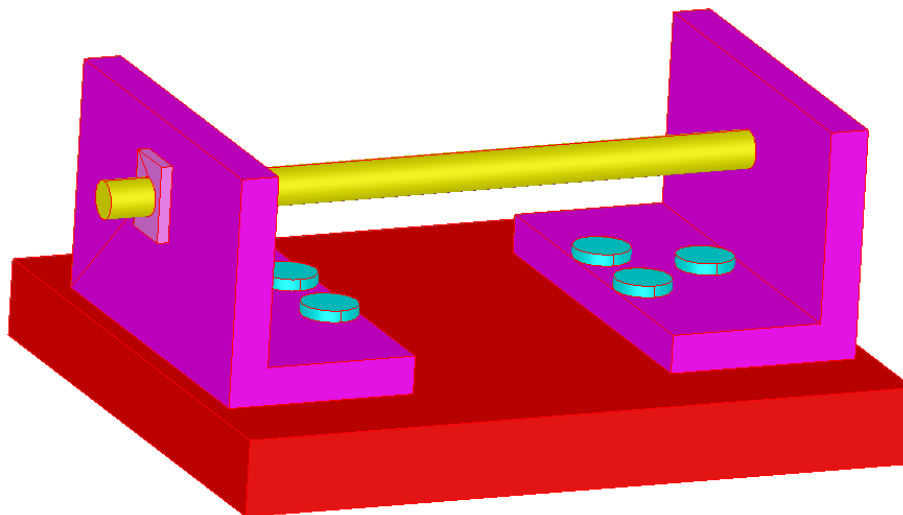When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a file, report the results found after processing the file as described below:

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L_ER'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
unit	The unit the model is designed in
volume	Total volume of all solids
area	Total surface area of all solids
cx	Centroid of all solids
cy	
cz	
fref_found	all/partial/none - indicates if all, some or none of the file references for the external geometry can be found the file node associations to the external geometry can be established
fref_processed	all/partial/none - indicates if all, some or none of the referenced files can be processed to construct the overall model
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4.4 Test Case L_UDA: User Defined Attributes

All information about this test case can also be viewed in CAESAR on its Information page.

4.4.1 Motivation

Most CAD systems allow the user to add user-defined attributes in the form of key-value pairs to a part or shape. These carry information which cannot be derived from the geometry, such as material costs, but is of relevance to downstream processes or for archiving purposes.

4.4.2 Approach

Test files shall be based on:

- AP2032e2, AP214e3, AP242 IS

- Recommended Practices for User Defined Attributes, v1.4 (Jul. 20, 2015)

User Defined Attributes can be attached to either a single part, an instance of a component in an assembly, or a geometric element of its shape. Each attribute can be descriptive (i.e. the value is a text string) or numeric (with or without unit). Attributes and attribute values can also be grouped together.

Validation Properties for User Defined Attributes can be given by creating a count of how many attributes are attached, where in the model structure – i.e. at the part/product level or various classes of geometric elements – and by creating a count of the major attribute type classes (string, integer, real, boolean). The two sums have to match in the end.

4.4.3 Testing Instructions

The User Defined Attributes will be tested using the well-known as AS1 model (see section 4.3.3.1 above).

4.4.3.1 User Defined Attribute Population

The following attributes shall be used in the L_UDA test. All attribute types should be contained in the model and attached in the file structure where meaningful for the originating system.

- To one of the faces of the 'plate' part, add a descriptive attribute (see section 6.3 in the Recommended Practices):
    - Name: 'Surface Finish'
    - Description: 'Anodize per specification MIL-A-8625, Type I'

- To the two instances of the L-bracket assembly, add a value attribute each (see section 6.2 in the Recommended Practices):
    - Name: 'asm_step'
    - Values: 1 and 2 respectively
    - **Note:** according to the Recommended Practices, use `integer_representation_item` in AP203e2 and AP242 to transfer this value. In AP214, use a `count_measure` (which requires the values to be real, i.e. 1.0 and 2.0 respectively)

- To the 'plate' part, add a measure attribute (see section 6.1 in the Recommended Practices):
    - Name: 'weight'
    - Unit: kilograms (kg) or pounds (lbs)
    - Value: <calculated weight of component preferred but generic value can be provided if necessary>

It is allowable to add additional information to each of the attributes (see section 7.4 in the Recommended Practices).

In addition, Validation Properties for the UDA shall be included; giving the following values (see section 8 in the Rec. Pracs.):

- the number of UDAs per model element type
- the number of UDAs per attribute type class

4.4.3.2 Statistics

For each STEP file exported or imported for the L_UDA test case, vendors must submit the corresponding statistics. To do so, go to the [L_UDA Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support'

(meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L_UDA'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
face_attr	pass/fail, have the User Defined Attributes at the solid/surface level been processed correctly?
instance_attr	pass/fail, have the User Defined Attributes at the assembly component instance level been processed correctly?
part_attr	pass/fail, have the User Defined Attributes at the part/product level been processed correctly?
valid_attr	pass/fail, is the instantiation of the User Defined Attributes as per the Recommended Practices?
uda_part_vp	pass/fail, has the number of User Defined Attributes at the Part/Product level been processed correctly? This includes UDA VP at assembly component instances and for groups of UDA.
uda_geo_vp	pass/fail, has the number of User Defined Attributes at the Geometry level been processed correctly?
uda_type_vp	pass/fail, has the number of User Defined Attributes per attribute type class (booelan/integer/real/string) been processed correctly?
uda_group	pass/fail, have the groups of attributes and values been processed correctly?
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4.5 Test Case L_TG: 3D Tessellated Geometry

All information about this test case can also be viewed in CAESAR on its Information page.

4.5.1 Motivation

The known scenarios for exchanging tessellated geometry in STEP include explicit representation of 3D composite part shape, where the semantic definition renders a stack of faces and not a solid, or simplified geometric definition where a fully defined B-Rep model is not needed.

Since especially large and complex geometry typically results in large STEP files, the tessellated geometry files are typically exchanged as compressed STEP files with the file extension *.stpZ.

4.5.2 Approach

Test files shall be based on:

- AP242 IS

- Recommended Practices for 3D Tessellated Geometry, v0.5 (March 13, 2015)

- Recommended Practices for STEP File Compressions, v1.1 (Nov. 21, 2013)

- Recommended Practices for Geometric and Assembly Validation Properties, v4.3 (Jul. 16, 2015)

The Tessellated Validation Properties shall be computed and stored in the STEP file <u>at the part level for each component</u> in the S1 assembly. They shall not be accumulated at assembly level. Instead, it was agreed to use the TVP in combination with the Assembly Validation Properties.

4.5.3 Testing Instructions

The well-known S1 model ("spaceship") will be used to test the transfer of 3D Tessellated Geometry in STEP.

4.5.3.1 Construction of the Model

This test case has been used in a number of previous CAx-IF test rounds, therefore the modeling instructions are not repeated here. If a vendor would like to participate in this test case and does not yet have the model, the construction information can be found in the Test Suite for Round 5J, available in the "Joint Testing Information" area of the CAx-IF web site.

Validation properties for 3D Tessellated Geometry shall be added as far as supported.

The STEP Files for the L_TG test case shall be submitted as compressed STEP files (*.stpZ) if supported.
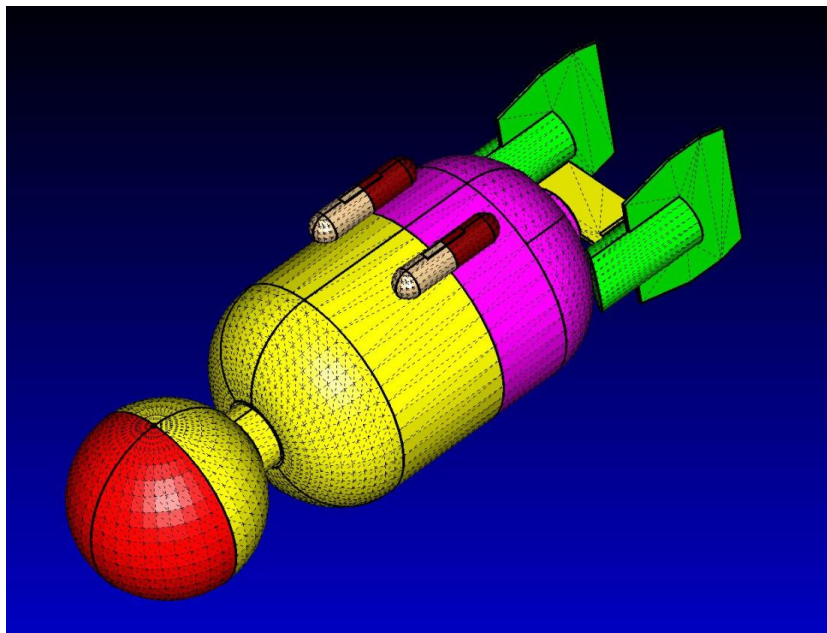

Figure 12: Illustration of the tessellated S1 model with triangle outlines

4.5.4 Statistics

For each (compressed) STEP file exported or imported for the L_TG test case, vendors must submit the corresponding statistics. To do so, go to the [L_TG Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L_TG'
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
match_tess_vp	all/partial/none, whether the Tessellated Validation Properties at part-level match for all, some, or none of the components in the assembly.
valid_tess_vp	pass/fail, is the instantiation of the validation properties for Tessellated Geomtry in the STEP file as per the recommended practices?
children	pass/fail, indicates whether the number of children for each node in the assembly tree matches the AVP value given in the STEP file
valid_child	pass/fail, is the instantiation of the validation property 'number of children' in the STEP file as per the recommended practices for validation properties?
notional_solids	all/partial/none, whether the position of all, some or none of the assembly components in the model could be validated through the 'notional solids' AVP.
valid_notion	pass/fail, is the instantiation of the validation property 'notional solids' in the STEP file as per the recommended practices for validation properties?
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4.6 Test Case L-PP: PMI Polyline Presentation

All information about this test case can also be viewed in CAESAR on its Information page.

4.6.1 Motivation

Product Manufacturing Information is required for a number of business use cases in the context of STEP data exchange. Among others, they are a prerequisite for long-term data archiving. In addition, the PMI can be used to drive downstream applications such as coordinate measuring and manufacturing.

For documentation and long-term archiving purposes, the Polyline Presentation approach was suggested and developed by the LOTAR project group. It presents the PMI within the 3D model, broken down into lines and arcs, so that is looks exactly as generated by the native system.

4.6.2 Approach

Within the "Polyline Presentation" area, the following functionalities are in scope for the STEP file library:

- Polylines presenting stroked, outlined and filled fonts

- Saved Views

- PMI Validation Properties for Polyline Presentation

The files shall be in either AP203 Ed.2, AP214 Ed.3 or AP242 IS format.

Applicable Recommended Practices:

- For AP203e2 and AP214e3 files: "Recommended Practices for PMI Polyline Presentation (AP2093/AP214)"; version 2.3, dated Oct. 14, 2013

- For AP242 files: "Recommended Practices for PMI Representation & Presentation (AP242)"; version 4.0, dated Oct. 14, 2013

4.6.3 Testing Instructions

The files for the library will be based on three models from the NIST MBE PMI Validation Project's first data set, which was last updated in December 2014. These models are available in several native formats and have been thoroughly tested and improved to ensure good data quality.

4.6.3.1 Test Models

The CAD models can be downloaded from:

- http://www.nist.gov/el/msid/infotest/mbe-pmi-validation.cfm

The models chosen for the library are three of the so-called "complex test cases" (CTC), namely CTC-01, CTC-02 and CTC-05.
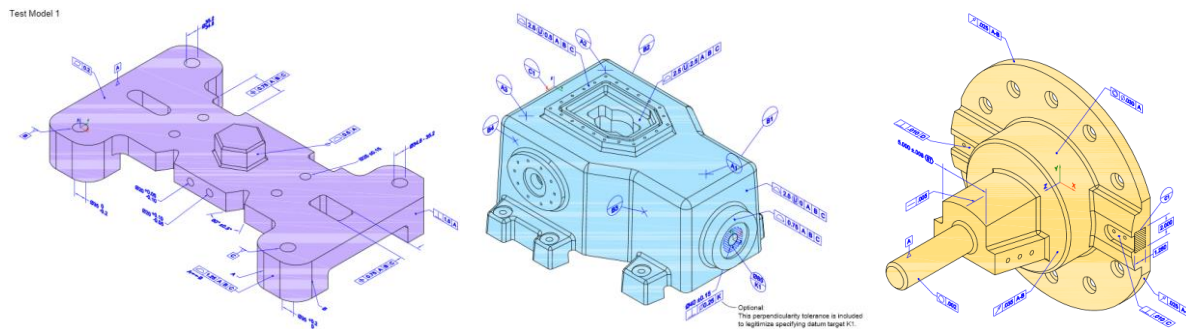

Figure 13: Illustrations of CTC-01 (left), CTC-02 (middle) and CTC-05 (right)

4.6.3.2 Test Model Configuration

The following functionality shall be included in the test files provided for the STEP file library, as far as it has been implemented by the CAx-IF participants and is described in the Recommended Practices:

- Polyline Presentation – include the PMI elements as Polyline annotations. Stroked, outlined and filled fonts (and combinations) are allowed, as well as styling of the annotations (colors). The type of Polylines used (3D or Filled) shall be stated in the "scope" field of the statistics.

- Definition of "Saved Views" – as far as supported, include the Saved Views defined in the test case descriptions in the STEP file. In the PDF file for each test case, each page represents one Saved View (one in CTC-01, three in CTC-02 and two in CTC-05).

- Cross-highlighting of annotations and annotated shape – if supported, include in the STEP file the information necessary to maintain the association between annotations and the annotated shape elements in a way, that after import, when highlighting an annotation, the shape elements annotated by it are highlighted too, and vice versa.

- PMI Validation Properties for Polylines – if supported, include the validation properties in the files, and evaluate these after import:
    - "Total Number of Annotations per File"
    - "Total Number of Views per File"

- o "Number of Annotations per Saved View"

- o "Polyline Curve Length"

- o "Polyline Centroid"

- o "Equivalent Unicode String"

- o "Affected Geometry"

Note that for the creation of the Equivalent Unicode String, the mapping as defined by the "Unicode String Project" report (Revision J) shall be used.

Also refer to 0 for test model translation configuration considerations.

4.6.3.3 Statistics

For each STEP file exported or imported for the L_PP test case, vendors must submit the corresponding statistics to CAESAR. To do so, go to the [L_PP Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

View-related Statistics

Several of the Statistics for this test case are view-related (e.g. number of annotations, positioning/scaling). The statistics cannot evaluate this for all views in the model. Hence, the idea is to select one specific (interesting) view on export and publish its name in the "Saved View" field of the statistics. Then, fill in the other view-related statistics with the values as valid for this particular view. After import, select the view with the name given in the native statistics and again provide the values valid for this view.

Screenshots

For each Saved View in the model, provide one screenshot that illustrates the layout (displayed geometry and annotation, model orientation, and zoom factor). Give the name of the view as the description of the screenshot.

Note that in order to count the PMI elements for the statistics, as per agreement during the Round 22J Review Meeting, the names of the `geometric_curve_sets` shall be considered.

See section "Indicating the Presented PMI Type" in the applicable Recommended Practices for details.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L_PP' followed by the model index; i.e. 'L_PP5-01', 'L_PP-02', or 'L_PP-05'.
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'

column name	description
scope	Short designation for the contents of the model as defined in the Test Suite (stroked / outlined / filled font, or combinations thereof). This is for information only; there will be no results for this field.
dimension	The number of dimensions processed
datums	The number of datums processed
datum_targets	The number of datum targets processed
tolerances	The number of tolerances processed
labels	The number of labels processed
saved_view	The name of the Saved View which is the basis for the view-related statistics
view_annot	The number of annotations included in the specified saved view.
view_pos	pass/fail, whether the model orientation and zoom factor stored for the Saved View could be restored successfully.
highlight	all/partial/none – whether the cross-highlighting for annotations and annotated shape elements works correctly
poly_length	all/partial/none – whether the lengths of the Polyline annotation was validated successfully for all, some or none of the given annotations.
poly_cent	all/partial/none – whether the positioning of the Polyline annotation was validated successfully for all, some or none of the given annotations.
eq_unicode	all/partial/none - if the encoding of the equivalent Unicode string was correct for all, some or none of the given annotations.
affected_geo	all/partial/none – whether the affected geometry could be validated correctly for all, some or none of the PMI statements in the model.
valid_poly_vp	pass/fail, is the instantiation of the Polyline-related validation properties in the STEP file as per the PMI recommended practices?
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4.7   Test Case L_TP: PMI Tessellated Presentation

All information about this test case can also be viewed in CAESAR on its Information page.

4.7.1 Motivation

Based on the PMI Polyline Presentation approach (see section 4.6 above), it was proposed to use the new data model for 3D Tessellated Geometry available in AP242 for a more efficient implementation of graphic PMI annotations, especially in the case of filled characters.

4.7.2 Approach

The files have to be in AP242 IS format (schema version 1.36)

Applicable Recommended Practices:

- Recommended Practices for PMI Representation & Presentation (AP242); version 4.0, dated Oct. 14, 2013

4.7.3 Testing Instructions

Refer to the L_PP Test Model for a detailed definition of the test models to be used.

CAx Implementor Forum
Round 36J Test Suite
Version 1.1, July 20, 2015

4.7.3.1 Test Model Configuration

The following functionality shall be included in the test files provided for the STEP file library, as far as it has been implemented by the CAx-IF participants and is described in the Recommended Practices:

- <u>Tessellated Presentation</u> – include the PMI elements as tessellated annotations. Stroked, outlined and filled fonts (and combinations) are allowed, as well as styling of the annotations (colors).

- <u>Definition of "Saved Views"</u> – as far as supported, include the Saved Views defined in the test case descriptions in the STEP file. In the PDF file for each test case, each page represents one Saved View (one in CTC-01, three in CTC-02 and two in CTC-05).

- <u>Cross-highlighting of annotations and annotated shape</u> – if supported, include in the STEP file the information necessary to maintain the association between annotations and the annotated shape elements in a way, that after import, when highlighting an annotation, the shape elements annotated by it are highlighted too, and vice versa.

- <u>PMI Validation Properties for Polylines</u> – if supported, include the validation properties in the files, and evaluate these after import:
  - "Total Number of Annotations per File"
  - "Total Number of Views per File"
  - "Number of Annotations per Saved View"
  - "Tessellated Number of Segments"
  - "Tessellated Curve Length"
  - "Tessellated Curve Centroid"
  - "Tessellated Number of Facets"
  - "Tessellated Surface Area"
  - "Tessellated Surface Centroid"
  - "Equivalent Unicode String"
  - "Affected Geometry"

  Note that for the creation of the Equivalent Unicode String, the mapping as defined by the "Unicode String Project" report (Revision J) shall be used.

Also refer to 0 for test model translation configuration considerations.

4.7.3.2 Statistics

For each STEP file exported or imported for the L_TP test case, vendors must submit the corresponding statistics to CAESAR. To do so, go to the [L_TP Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described in the table below.

View-related Statistics

Several of the Statistics for this test case are view-related (e.g. number of annotations, positioning/scaling). The statistics cannot evaluate this for all views in the model. Hence, the idea is to select one specific (interesting) view on export and publish its name in the "Saved View" field of the statistics. Then, fill in the other view-related statistics with the values as valid for this particular view. After import, select the view with the name given in the native statistics and again provide the values valid for this view.

Screenshots

For each Saved View in the model, provide one screenshot that illustrates the layout (displayed geometry and annotation, model orientation, and zoom factor). Give the name of the view as the description of the screenshot.

Note that in order to count the PMI elements for the statistics, as per agreement during the Round 22J Review Meeting, the names of the `tessellated_geometric_set` shall be considered. See section "Indicating the Presented PMI Type" in the PMI Recommended Practices for details.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L_TP' followed by the model index; i.e. 'L_TP5-01', 'L_TP-02', or 'L_TP-05'.
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
dimension	The number of dimensions processed
datums	The number of datums processed
datum_targets	The number of datum targets processed
tolerances	The number of tolerances processed
labels	The number of labels processed
saved_view	The name of the Saved View which is the basis for the view-related statistics
view_annot	The number of annotations included in the specified saved view.
view_pos	pass/fail, whether the model orientation and zoom factor stored for the Saved View could be restored successfully.
highlight	all/partial/none – whether the cross-highlighting for annotations and annotated shape elements works correctly
tess_pmi_area	all/partial/none – whether the surface area of the Tessellated PMI annotations was validated successfully for all, some or none of the given annotations.
tess_pmi_clength	all/partial/none – whether the total length of segments per Tessellated PMI annotation was validated successfully for all, some or none of the given annotations.
tess_pmi_c	all/partial/none – whether the centroids of the Tessellated PMI annotations were validated successfully for all, some or none of the given annotations.
eq_unicode	all/partial/none - if the encoding of the equivalent Unicode string was correct for all, some or none of the given annotations.
valid_tess_vp	pass/fail, is the instantiation of the validation properties for Tessellated Geometry in the STEP file as per the recommended practices?

affected_geo	all/partial/none – whether the affected geometry could be validated correctly for all, some or none of the PMI statements in the model.
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

4.8 Test Case L_SP Semantic PMI Representation

All information about this test case can also be viewed in CAESAR on its Information page.

4.8.1 Motivation

Semantic PMI Representation relates to the capability to store PMI data in the STEP file in a computer-interpretable way, so that it can be used for model redesign or downstream applications. Though the definition of the data is complete, it is by itself not visible in the 3D model.

Additional presentation capabilities are needed to display the data in a way that it is visible to the user in the 3D model. Addition of presentation is data is optional in the L_SP test case.

4.8.2 Approach

The approach to be used is described in the latest version (at least v4.0, dated October 13, 2014) of the "Recommended Practices for Representation and Presentation of PMI (AP242)", which can be found on the public CAx-IF web sites under "Joint Testing Information".

Within the PMI area, the following functionalities are in scope for the STEP file library:

- Semantic PMI Representation
- Graphic PMI Presentation (Polyline or Tessellated)
- Linking of PMI Representation to Presentation

The AP242 schema to be used is the IS version (v1.36), which can be found on the public CAx-IF web sites under "Joint Testing Information".

4.8.3 Testing Instructions

Refer to the L-PP Test Model for a detailed definition of the test models to be used.

Note that these are not the same as for the regular Round 36J test case, SP5 (see 2.1).

4.8.3.1 Test Model Configuration

The following functionality shall be included in the test files provided for this round of testing, as far as it has been implemented by the CAx-IF participants and is described in the Recommended Practices:

- PMI Representation – the re-usable representation of PMI data should be included in all L_SP models to the extent supported by the native system.

- PMI Graphic Presentation – Many CAD systems require some minimal presentation information to be able to handle the PMI data in a model. There are also use cases were both PMI representation and presentation data will be included in the same file. Thus, some form of presentation information shall be included in the L_SP test case as well.

- Linking PMI Representation to Presentation – If a model contains PMI Representation information as well as Presentation data, it is very useful to link the corresponding elements together, so that a Representation element "knows" by which annotation it is being presented in the model. The approach to create this link is described in section 7.3 of the PMI Rec.Pracs. (v4.0).

- Validation Properties – All participants providing STEP files for this test case are encouraged to include validation properties as far as supported; in particular for PMI presentation and representation.

Also refer to 0 for test model translation configuration considerations.

4.8.3.2 Statistics

For each STEP file exported or imported for the L_SP test case, vendors must submit the corresponding statistics. To do so, go to the [L_SP Data Sheet], and either fill in the web form, or upload a comma-delimited file (.csv) with the data as listed below.

Native Statistics

When exporting a STEP file, report what data importing systems should expect to find. For numeric statistics, enter the respective value or 'na' if not supported. For other statistics, select either 'full support' (i.e. test case and Rec. Pracs. definitions are fulfilled), 'limited support' (meaning the implementation does not meet all criteria and issues may be expected on import), or 'na' if not supported.

Target Statistics

When importing a STEP file, report the results found after processing the file as described below.

Screenshots

If presentation information is contained in the test files, it shall be accompanied by corresponding screenshots. Note that CASEAR allows the addition of multiple screenshots per dataset.

Note that in order to count the GD&T elements for the statistics, per agreement during the R22J Review Meeting, the actual STEP entity types (datum, datum_target...) shall be considered.

Note that all statistics – native and target – shall be based on the Semantic PMI Representation data only, and not take any presentation into account.

Data Sheet Columns

column name	description
model	The name of the test model, here: 'L-SP' followed by the model index; i.e. 'L-SP-01', 'L-SP-02', or 'L-SP-05'.
system_n	The system code of the CAD system creating the STEP file
system_t	The system code of the CAD system importing the STEP file. For native stats, enter 'stp'
scope	A short designation of the scope tested in the model. In the case of L-SP, recommended values are: ○ Representation ○ Representation + [char.-based / graphic] Presentation ○ Representation + Linked [… / …] Presentation
dimension	The number of dimensions processed
datums	The number of datums processed
datum_targets	The number of datum targets processed
tolerances	The number of tolerances processed
compos_tols	The number of composite tolerances processed (number of instances of geometric_tolerance_relationship per section 6.9.9. in the PMI Rec. Pracs. v4.0)

labels	The number of labels processed
pmi_graphic_pres	all/partial/none – whether the graphic PMI annotations included in the file could be processed correctly
pmi_linked_pres_rep	all/partial/none – whether the Semantic PMI Representation elements and (Graphic) PMI Presentation elements were linked correctly together.
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

Annex A   NIST Model Translation Configuration Considerations

Based on data translation issues identified in the NIST Phase 2 project (requiring multiple dataset submission iterations to resolve), the following translator configuration considerations have been derived for the PMI-related test cases (SP5, TGP2, L-PP, L-TP and L-SP) in Round 36J:

- Include annotations, coordinate systems, model properties, and PMI views

- Include supplemental geometry (non-solid surfaces, curves, points)

- Preserve annotation associations with both product and supplemental geometry

- Preserve annotation semantic PMI properties
    - Clearly point out if these are intentionally not translated

- Preserve annotation text
    - Creo should be configured to display dimension tolerances (tol_display on)
    - Do not drop leading zeros or add trailing zeros

- Preserve annotation units
    - NIST CTC 01, 02 and 04 models are defined in millimeters
    - NIST CTC 03 and 05 models are defined in inches

- Preserve display names of annotations and coordinate systems
    - Point out if you use NX 9 or newer since this will change some of the annotation names (see Figure 14 below)

- Preserve display colors of product geometry, supplemental geometry, and annotations

- Preserve view-specific visibility of annotations, coordinate systems, and supplemental geometry

- Preserve view frustum (orientation and zoom level) definition

- Do not export extraneous information
    - Only CATIA Captures (not Views) should be exported to STEP Saved Views
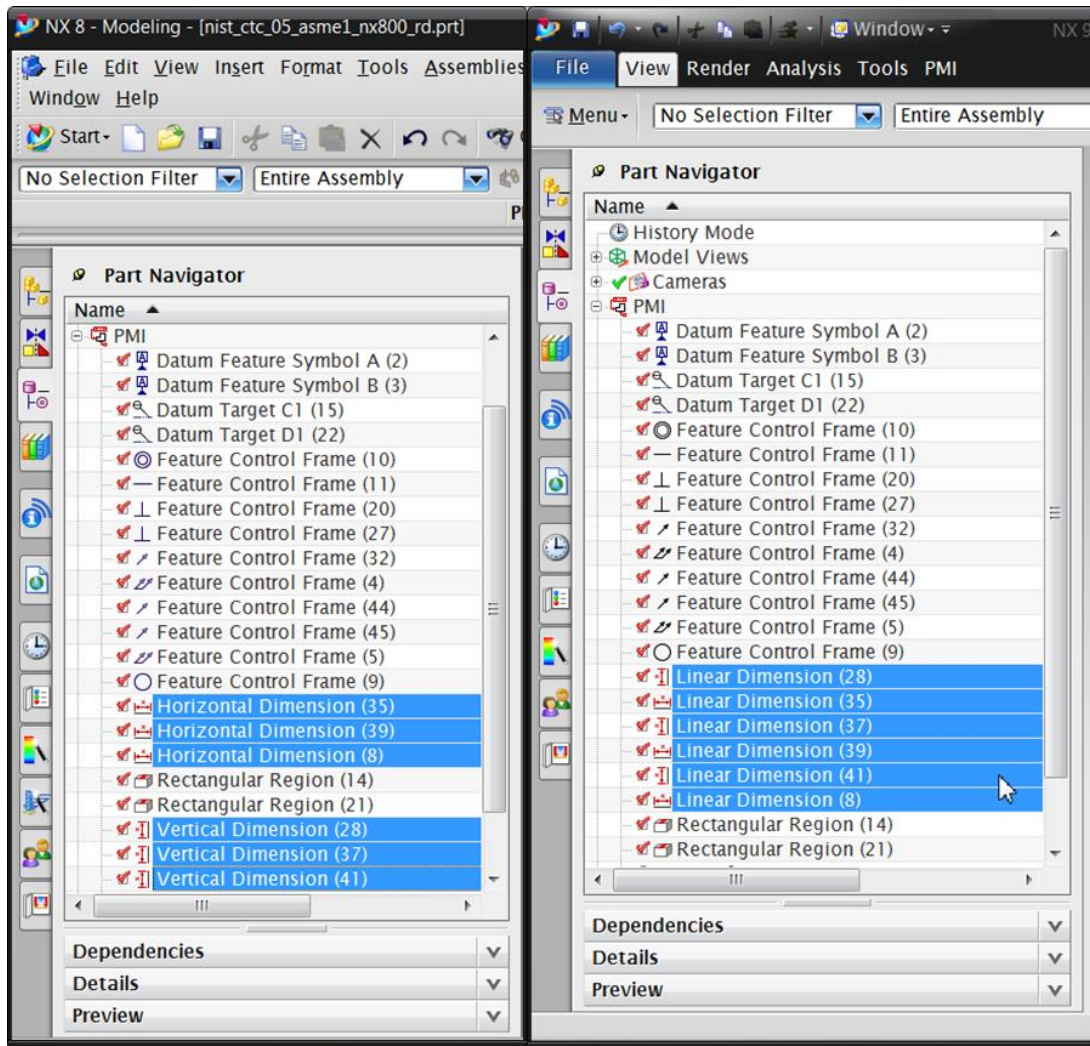   - Creo sketch dimensions should only be included when visible in a Combined View

Figure 14: NX 8 vs. NX 9 Dimension Display Names