



**Test Suite for the
CAX Implementor Forum
Round 21J**

October 2007 – April 2008

Release 1.0

February 11, 2008

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Contents:

1.0	Introduction	5
1.1	Functionality tested in this round	5
1.2	General test instructions for this round	6
1.3	Preliminary testing schedule	6
1.4	Copyrights on test cases.....	7
2.0	Synthetic test case specifications	7
2.1	Model T2: Cloud Of PointS GVP	7
2.1.1	Motivation	7
2.1.2	Approach	7
2.1.3	Testing instructions	7
2.1.3.1	Model construction.....	8
2.1.3.2	Statistics	8
2.2	Model GD6: Geometric Dimensioning and Tolerancing.....	10
2.2.1	Motivation	10
2.2.2	Approach	10
2.2.3	Testing Instructions.....	10
2.2.3.1	Statistics	11
2.3	Model C1 : 3D Associative Text and Special Characters.....	12
2.3.1	Motivation	12
2.3.2	Approach	12
2.3.3	Testing Instructions.....	13
2.3.3.1	Model construction.....	13
2.3.3.2	Statistics & Screenshots	14
2.4	Model W2: Wireframe Geometry in a Hybrid Model	15
2.4.1	Motivation	15
2.4.2	Approach	15
2.4.3	Testing Instructions.....	15
2.4.3.1	Model construction.....	15
2.4.3.2	Statistics	16
2.5	Model AS1: Assembly Validation Properties.....	17
2.5.1	Motivation	17

2.5.2	Approach	17
2.5.3	Testing Instructions.....	18
2.5.3.1	Construction of the AS1 model	18
2.5.3.2	Statistics	18
3.0	Production models: PM19.....	19
3.1	Motivation	19
3.2	Approach	19
3.3	Testing Instructions.....	20
3.3.1	List of available models	20
3.3.2	Results.....	20

1.0 Introduction

This document describes the suite of test cases to be used for the twenty-first round of testing of the CAx Implementor Forum (CAx-IF). The CAx-IF is a joint testing forum organized by PDES, Inc. and the ProSTEP iViP Association. The test rounds of the CAx-IF concentrate primarily on testing the interoperability and conformance of STEP processors based on AP 203 and AP 214.

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: 3D Associative Annotations including Special Characters, Geometric & Dimensional Tolerances, Cloud Of Points Validation, Wireframe Geometry, and Assembly Validation Properties.

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: 3D Associative Annotations including Special Characters, Geometric & Dimensional Tolerances, Cloud Of Points Validation, Wireframe Geometry and Assembly Validation Properties.

- 3D Associative Annotations are related to the functionality to display notes in the 3d model space. These notes are typically associated with a geometric element of the model (Associative Text). The annotations shall also include certain special characters such as a diameter symbol, represented by its Unicode string. This test is intended as preparation for GD&T presentation testing.
- Geometric & Dimensional Tolerances describes the capability to embed information about tolerances which are necessary input for the manufacturing of the part into the 3D model. The tests are currently focused on the ‘representation’ level, i.e. including the intelligent, associative information, so an importing CAD system could re-create the presentation based on this. In the current round, the scope will be extended by linear dimensions.
- The Cloud of Points validation aims for the detection of shape changes during STEP data exchange by defining a number of sampling points per face on export, and measuring their distance to the geometry created in the importing system after the exchange. The tests will be based on old production models.
- Wireframe geometry exchange has been tested in the early days of STEP data exchange and has been added to the test suite again by a participant’s request. Wireframe geometry is used as the basis for parametric design. In this round of testing, the

Wireframe geometry shall be embedded in a hybrid model, that also contains solid and surface geometry.

- Assembly Validation Properties are a new mechanism, which is derived from the “extended” ValProps. It allows for the verification of an assembly without the need to process the referenced geometry, hence focuses on large assemblies exported using the External References mechanism.
- In addition to synthetic models for the above capabilities, production models are included in this round of testing.

1.2 General test 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 CAx Implementor Forum web sites. The latest version is v1.5, dated December 2006.

Note that due to the ongoing development of CAESAR, the web-based CAx-IF Evaluation, Statistics And Results system, the way of providing native and target stats may change during this round of testing.

1.3 Preliminary testing schedule

The following schedule has been agreed on for Round21J:

Date	Action
December 6, 2007 (Thu)	Test Suite available / 1st CAx Implementor Forum conference call
ASAP	Production Models released
January 14, 2008 (Mon)	Initial STEP files and native stats due
February 8 (Fri)	STEP files and native stats frozen
February 27 (Wed)	Target stats due / 2nd conference call
March 26 (Wed)	Target stats frozen
April 2 (Wed)	Pre-release of final stats / 3rd conference call
April 7 (Mon)	Review meeting for test round
April 8 – 9 (Tue – Wed)	CAx Implementor Forum meeting, Charleston, SC

The CAx-IF meeting will take place in conjunction with the PDES, Inc. Spring Offsite, which allow for meetings with other workgroups, including the User Roundtable.

1.4 Copyrights on test cases

Not all of the production test cases which were provided by the PDES, Inc. and ProSTEP iViP member companies are fully released for any purpose. The least common denominator is that the test cases can be freely distributed among the ProSTEP iViP / PDES, Inc. Round Table participants 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 the CAx-IF testing or outside of PDES, Inc. and ProSTEP iViP.

2.0 Synthetic test case specifications

2.1 Model T2: Cloud Of PointS GVP

2.1.1 Motivation

The “Cloud Of PointS” (COPS) is a relatively new type of validation properties, intended to validate the actual shape of the model. The mechanism is based on sampling points, which are created precisely on each surface by the exporting CAD system and written into the STEP file as cartesian points. The importing system measures the distances between those sampling points and the faces and boundaries of the created geometry in order to detect any shape changes.

In case a face gets lost during translation, the sampling points can also be used as a guideline to re-create the face.

The goal is to extend the STEP file to be a self-validating archive, since in addition to the geometry it also stores the information for its validation. The main application scenario for this is long-term archiving.

2.1.2 Approach

The COPS Validation Properties will be tested according to the current Recommended Practices for Geometric Validation Properties, available CAx-IF on the web sites, under “Joint Testing Information” (dated 07-25-2007).

A more detailed presentation on this functionality provided by ITI is available in member area of the CAx-IF web sites, under “Information on Round19J of Testing”.

2.1.3 Testing instructions

Three native files are available for COPS testing in Round21J:

- A vane cluster, native UG NX
- A molding tool, native CATIA V5
- A child’s activity tray, native I-DEAS

These are the same models as used in Round20J.

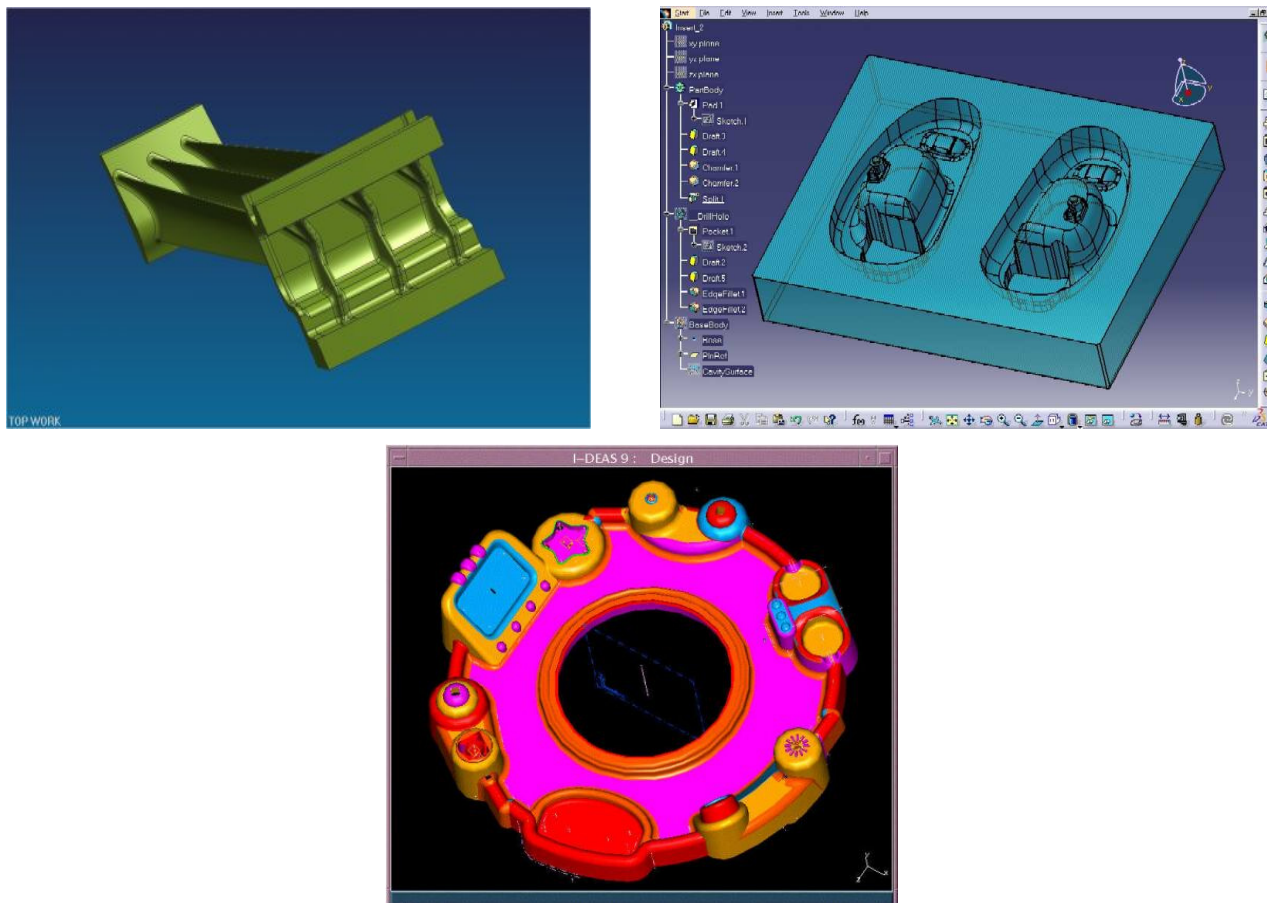


Figure 1: Shape of the T2 models (vane cluster, left, molding tool, right, activity tray, bottom)

2.1.3.1 Model construction

The vane cluster was originally used as a production model in Rounds 15J and 16J. It has been provided by Pratt & Whitney as a UG assembly. The molding tool was originally tested in Round10J, provided by Dassault Systèmes. The child's activity tray was used as a production model in Round11J, provided by ITI for I-DEAS. The native models will be made available on the CAx-IF Document Sharing Web Site.

Participants with a CATIA V5, I-DEAS or UG STEP processor should export the T2 models based on the native model, all others based on the STEP file. In any case, the highest level of validation properties supported by the exporting system shall be included in the STEP file.

2.1.3.2 Statistics

For each STEP file submitted for the T2 model, vendors must submit the corresponding native statistics to the online statistics and results database, CAESAR. To do so, log in to CAESAR, go to "Test Rounds > R21J Test Cases > T2 Data Sheet", and either fill in the web form, or upload a comma-delimited file (.csv) with the following data:

column name	description
model	The name of the test model, here: t2_c5 / t2_id / t2_ug
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
max_cops	The maximum distance between a COPS sampling point and its corresponding surface
valid_cops	pass/fail, indicates whether the target system considers the implementation of the Cloud Of PointS information valid as per 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

2.2 Model GD6: Geometric Dimensioning and Tolerancing

2.2.1 Motivation

Geometric and Dimensional Tolerances are 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 GD&T data can be used to drive downstream applications such as coordinate measuring and manufacturing

2.2.2 Approach

The functionality tested with this model is based on the Recommended Practices for GD&T Representation, available on the WikiSTEP Page:

http://www.wikistep.org/index.php/Recommended_Practices_for_the_Representation_of_GD%26T

Testing of GD&T Presentation is out of scope in Round21J.

2.2.3 Testing Instructions

In Round21J, the GD&T test cases will be a suite of “real world” models provided by CAx-IF user companies, that contain a realistic number of tolerances, with semantically correct contents. The following types of tolerances may be found in the test files:

Part Level Geometric Tolerances:

- Datum Features
- Datum Targets
- Angularity
- Circular Runout
- Concentricity
- Cylindricity
- Flatness
- Parallelism
- Perpendicularity
- Position
- Linear Profile
- Surface Profile
- Straightness
- Symmetry
- Total Runout
- Plus/Minus tolerance

Support for Modified Datum references and Modified Tolerances Composite Tolerances Pattern of Features.

The test models will be provided as native CAD parts, and be made available on the CAX-IF Document Sharing Web site. The testing procedure is the same as for Production Models.

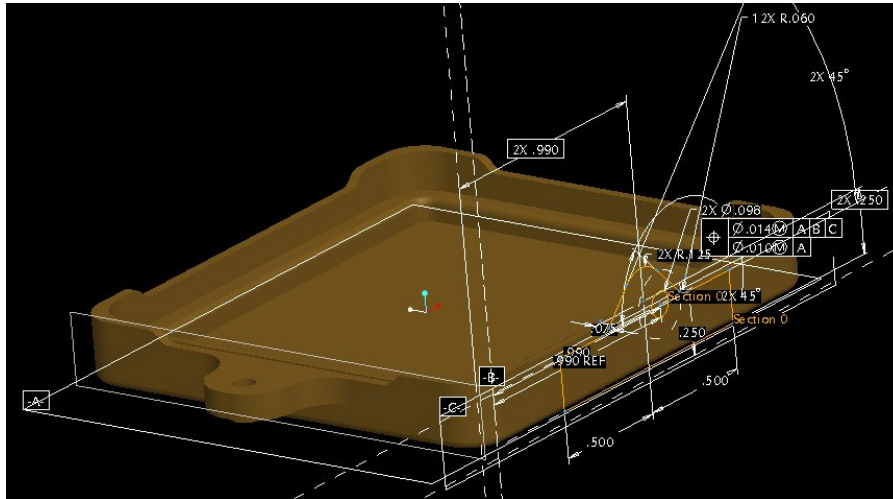


Figure 2: Example for a user-provided part with tolerances.

2.2.3.1 Test Models

The following “real-world” GD&T test models are available for Round21J, and can be downloaded from the document sharing web site, under “Round21J > GD& Test Models”:

Model name	Stats code	Native System	Remarks
Hold in Space	gd6_pe1	Pro/E	Provided by Raytheon
Merge Models	gd6_pe2	Pro/E	Provided by Raytheon
Ring	gd6_pe3	Pro/E	Provided by Raytheon
NASA Test Model	gd6_ug	UG NX	Provided by NASA
<i>to be defined in Release 1.1</i>	gd6_v51	CATIA V5	Provided by Boeing
<i>to be defined in Release 1.1</i>	gd6_v52	CATIA V5	Provided by Boeing
<i>to be defined in Release 1.1</i>	gd6_v53	CATIA V5	Provided by Boeing

2.2.3.2 Statistics

For each STEP file submitted for the GD6 model, vendors must submit the corresponding native statistics to the online statistics and results database, CAESAR. To do so, log in to CAESAR, go to “Test Rounds > R21J Test Cases > GD6 Data Sheet”, and either fill in the web form, or upload a comma-delimited file (.csv) with the following data:

column name	description
model	The name of the test model, here: gd6_<model name>
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	
model_size	model_size is the length of the space diagonal of the 3-dimensional bounding box enclosing all entities in the model. The result is the Centroid deviation divided by the model_size
dim_found	The number of dimensions processed
datum_found	The number of datums processed
tol_processed	The number of tolerances processed
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 Model C1 : 3D Associative Text and Special Characters

2.3.1 Motivation

The main objective for this test is further preparation for GD&T Presentation: Since many of the 3D Annotation modules will be re-used for GD&T Presentation, this test is also a preparation for that. In addition, the support for international characters, encoded as Unicode, will also be tested. The Unicode text should be included in one of the annotations, and in addition may be added to both product.name and product.id.

Since the focus of this test is on the functionality mentioned above, a very simple test model will be used.

2.3.2 Approach

The systems' support for associative text varies greatly. The approach discussed with the Implementor Forum allows for:

- unstyled text in the model
- styled notes in the model
- associate notes to the model

- associativity of notes visually depicted by leader curves
- special characters represented by the Unicode encoding within the annotations.

The support for this functionality inside the systems varies considerably. Further variations are introduced by the target elements to which the notes can be associated in a system.

For the test of 3D Annotation, a scenario with a styled text associated to a face and a visual depiction of this associativity by a leader curve will be implemented. Since the underlying STEP approach is modular, those systems that cannot exactly represent such a scenario are encouraged to use closest-fits, e.g. neglect the associativity when necessary.

The recommended practices for associative text are available on the CAx-IF web sites, <http://www.cax-if.org/> and <http://www.cax-if.de/>.

2.3.3 Testing Instructions

2.3.3.1 Model construction

In order to test color and text exchange without any unwanted side-effects, a very simple geometry is used. It was originally defined in Round6J and should contain:

- A cube (arbitrary dimensions and colors).

This model is also used to test the exchange of 3D annotations, for systems supporting this functionality. Recommendations to set up the text in the model:

- Include a number of annotations in the model, at least one of each of the following:
 - single-line text
 - multi-line text
 - including special characters represented by their Unicode encoding:
 - \S encoding: e.g. diameter symbol, German umlauts, French accents
 - \X2 encoding: Japanese characters. The recommended example strings are あいうえお, represented in the STEP file by '\X2\3042304430463048304A\X0\'', and the annotation "Blend R10" in Japanese as shown in Figure 3 below, represented in the STEP file by '\X2\30D630EC30F330C9\X0\ R10\'.
- Style the texts with an arbitrary color and other applicable attributes.
- The annotations should be associated to portions of the cube, e.g. a surface and an edge.
- Select an arbitrary placement of the text

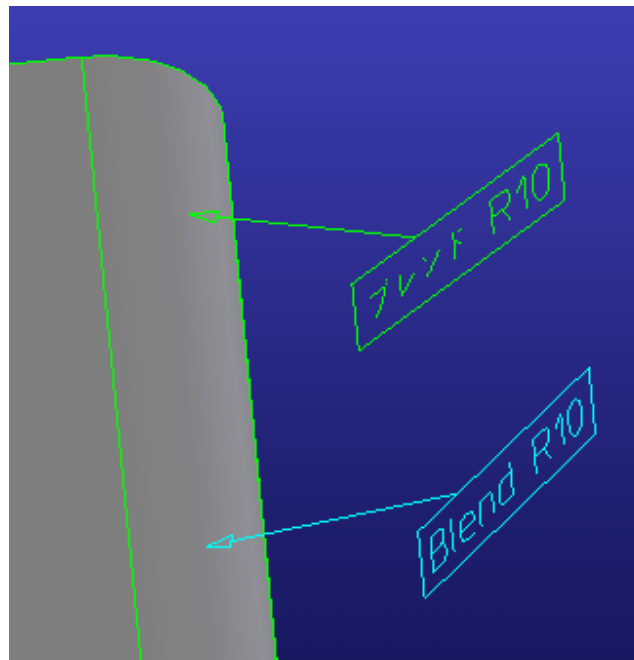


Figure 3: A section of the C1 model with a 3D Annotation

2.3.3.2 Statistics & Screenshots

For each STEP file submitted for the C1 model, vendors must submit the corresponding native **statistics** to the online statistics and results database, CAESAR. To do so, log in to CAESAR, go to “Test Rounds > R21J Test Cases > C1 Data Sheet”, and either fill in the web form, or upload a comma-delimited file (.csv) with the following data:

column name	description
model	The name of the test model, here: c1
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'
valid_txt	all/partial/none - whether the specified texts appear in the model
valid_txt_assoc	all/partial/none - whether the association of the text to the elements fo the geometric model as described above is correct
unicode	pass/fail - if Unicode characters were included in at least one of the annotations, indicates whether they were decoded and displayed correctly after import
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

Please note that due to the simplicity of the test model, no geometry statistics (volume / area / centroid) will be collected.

In order to validate the color and annotation exchange on a visual basis, vendors are asked to upload in a **screenshot** each for their native model and one for each imported C1 model to CAESAR. To do so, after having uploaded the respective statistics, go to “Test Rounds > R21J Test Cases > C1 Data Sheet”, select the row in the data table that you want to add the screenshot for, and choose “Edit existing stats” from the action menu. Then use the upload form at the bottom of the page to add a screenshot from your local hard drive. The picture shall be in either GIF, JPG or PNG format and no larger than 120kB.

2.4 Model W2: Wireframe Geometry in a Hybrid Model

2.4.1 Motivation

Wireframe is the most basic representation of geometry available in the STEP data model. It consists of various types of curves only, which may be the boundaries of a more advanced 3D representation, such as a surface or solid model. Wireframes are also used as support geometry, or may be the basis for parametric operations to create surfaces or solids.

There haven't been dedicated tests for wireframe geometry since the early days of the CAx-IF, so the test this round is basically aimed to capture the state of the art.

2.4.2 Approach

The shape representation to be used is `geometrically_bounded_wireframe_shape_representation`, using a `geometric_curve_set`. The allowable entities to be used for points and curves are defined in Part 42.

2.4.3 Testing Instructions

2.4.3.1 Model construction

The wireframe part of the model will be based on the “W1” test case defined in Round20J, for which a seed file is available in the member area of the CAx-IF web site. The basic shape of the test model is that of a balloon on a string. It contains the following class 2 entities:

- Point
- Line
- Circle
- Ellipse
- Parabola
- Hyperbola
- Bezier Curve
- B-Splines with different degrees, and one rational

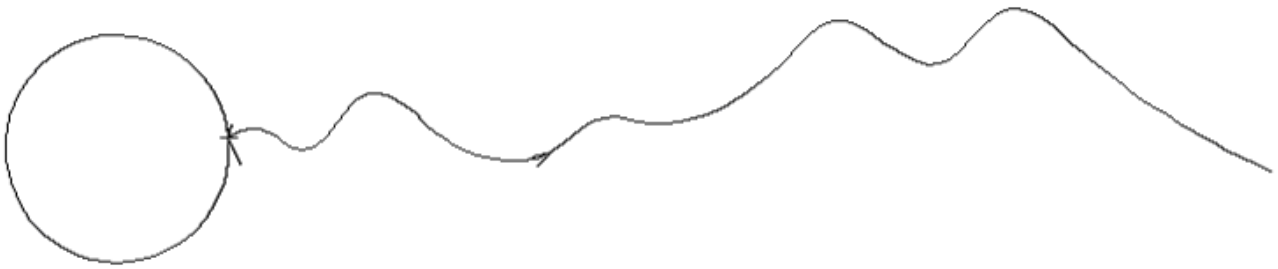


Figure 4: Layout of the W1 model
(note that the arrowhead on the curve is not part of the model)

To the wireframe portion, an arbitrary solid and a surface shall be added, to obtain configuration similar to the one shown in Figure 5 below:

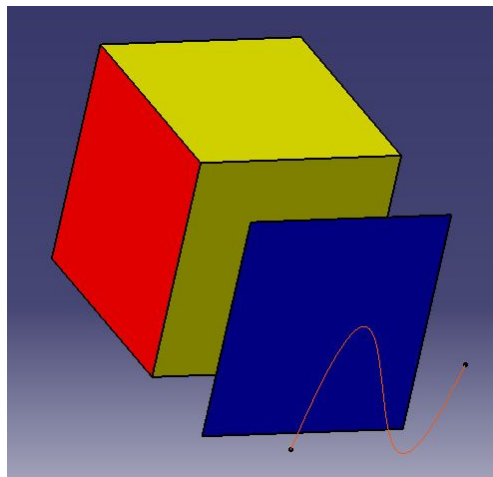


Figure 5: Example for a hybrid model containing all three classes of geometry

The tests will, however, focus on the transfer of the wireframe geometry within the hybrid model.

2.4.3.2 Statistics

For each STEP file submitted for the W1 model, vendors must submit the corresponding native **statistics** to the online statistics and results database, CAESAR. To do so, log in to CAESAR, go to “Test Rounds > R21J Test Cases > W1 Data Sheet”, and either fill in the web form, or upload a comma-delimited file (.csv) with the following data:

column name	description
model	The name of the test model, here: w2
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

curve_length	Total length of all curves in the wireframe model
cpx	Center point of the three-dimensional bounding box enclosing all geometric entities in the file
cpy	
cpz	
date	The date when the statistics were last updated (will be filled in automatically)
issues	A short statement on issues with the file

In order to validate the shape and styles (as far as applied) on a visual basis, vendors are asked to upload in a **screenshot** each for their native model and one for each imported W2 model to CAESAR. To do so, after having uploaded the respective statistics, go to “Test Rounds > R21J Test Cases > W2 Data Sheet”, select the row in the data table that you want to add the screenshot for, and choose “Edit existing stats” from the action menu. Then use the upload form at the bottom of the page to add a screenshot from your local hard drive. The picture shall be in either GIF, JPG or PNG format and no larger than 120kB.

2.5 Model AS1: Assembly Validation Properties

2.5.1 Motivation

The existing Validation Properties for assembly data, known as “ValProps II” or “Extended ValProps”, provides a suitable mechanism where geometrical data is provided along with the product structure. However, for the incremental exchange of STEP files, where the product structure might be included but the geometry of the component parts may be omitted, this approach is not applicable. Similarly, if the product structure is broken down into smaller sub-assemblies, the component data is not available in the sub-assembly files and so it is again not applicable.

The additional “Assembly Validation Properties” will provide a verification capability where geometry is not present. They will make it possible for the exchange of assembly data to be verified in two ways. The first will ensure that the number of instances found at each node is correct, while the second will ensure that the position and orientation information for each instance is correct.

2.5.2 Approach

The basic structure used in the STEP file is similar to the approach used in the Geometric Validation Properties. A draft Recommended Practice for Assembly Validation Properties is available in the member area of the CAx-IF web sites, under “Information on Round21J of Testing”.

2.5.3 Testing Instructions

The Assembly Validation Properties shall be tested using the AS1 model, adding the number of children and notional solids of dimension 10x10x10 at each node. This model is also used in the STEP file example given in the draft Recommended Practices.

2.5.3.1 Construction of the AS1 model

The AS1 model is a well-known test case within the CAX-IF. Therefore, the modeling instructions will not be listed in detail here, since most of the participants already have this model available in their systems.

Detailed modeling instructions are included in older test suite documents. Should additional information be required, please contact the facilitators (cax-test-admin-l@cax-if.org).

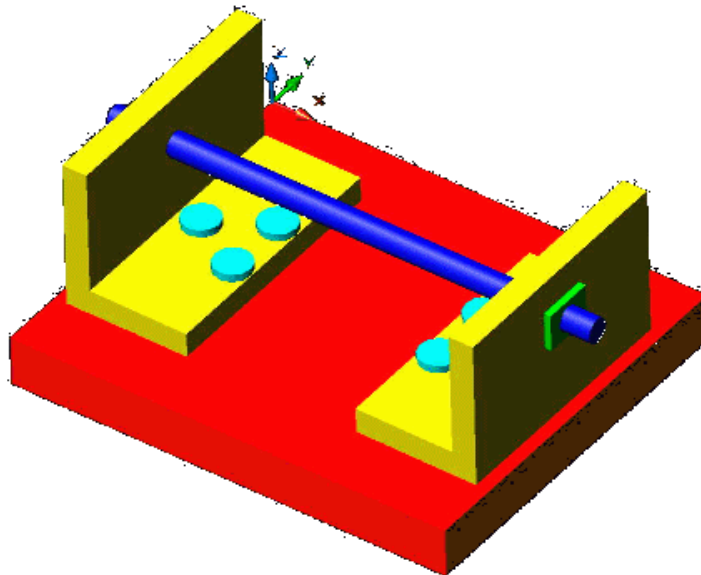


Figure 6: Shape of the AS1 model (toilet paper holder)

2.5.3.2 Statistics

For each STEP file submitted for the AS1 model, vendors must submit the corresponding native statistics to the online statistics and results database, CAESAR. To do so, log in to CAESAR, go to “Test Rounds > R21J Test Cases > AS1 Data Sheet”, and either fill in the web form, or upload a comma-delimited file (.csv) with the following data:

column name	description
model	The name of the test model, here: as1
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	
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_solds	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

3.0 Production models: PM19

3.1 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.

3.2 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 either AP214-IS or AP203e2. In order to support quality validation of the Production Model exchange, all vendors shall include the maximum level of Validation Properties they support. In addition, since Round18J, the native and target statistics will include ValProps.

All source system native models and STEP files may be analyzed for data quality by the "CADIQ" developers. STEP syntax and structure will be checked by the CAx-IF facilitators. In order to enable an end-to-end analysis of the data exchange, all vendors importing Production Model STEP files are asked to submit the resulting target model from their system along with or instead of the target statistics.

3.3 Testing Instructions

3.3.1 List of available models

Model name	Stats code	Native System	Remarks
Portable Radio	pm19_od	OneSpace Modeler	New Model in Round21J
Control Panel Assembly	pm19_ug	UG NX	New Model in Round21J

3.3.2 Results

For each STEP file submitted for the PM19 model, vendors must submit the corresponding native statistics to the online statistics and results database, CAESAR. To do so, log in to CAESAR, go to “Test Rounds > R21J Test Cases > PM19 Data Sheet”, and either fill in the web form, or upload a comma-delimited file (.csv) with the following data:

column name	description
model	The name of the test model, here: pm19_<stats code>
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
validati- on_volume	Total volume of all solids as received via the validation prop- erty capability
valid_vol	pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for valida- tion 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 valida-

	tion 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
shoveit_ok	pass/fail, indicates whether the model passed comparison of the Extended GVP (i.e. no parts/subassemblies misplaced), or failed.
valid_shoveit	pass/fail, indicates whether the target system considers the implementation of the instance information valid as per 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