



**Test Suite for the
CAX Implementor Forum
Round 20J**

April – September 2007

Release 1.2

July 25, 2007

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1.0 Introduction

This document describes the suite of test cases to be used for the twentieth 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, and Wireframe Geometry.

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, and Wireframe Geometry.

- 3D Associative Annotations is 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.
- 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 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.

1.3 Preliminary testing schedule

The following schedule has been agreed on for Round20J:

Date	Action
April 27, 2007 (Fri)	Test Suite available / 1st CAx Implementor Forum conference call
ASAP	Production Models released
May 16 (Wed)	Initial STEP files and native stats due
June 27 (Wed)	STEP files and native stats frozen
July 18 (Wed)	Target stats due / 2nd conference call
August 29 (Wed)	Target stats frozen
September 5 (Wed)	Pre-release of final stats / 3rd conference call
September 11 (Tue)	Review meeting for test round
September 12 – 13 (Wed – Thu)	CAx Implementor Forum meeting, Darmstadt, Germany

The CAx-IF meeting will take place in conjunction with the Workshop for STEP data exchange on Thursday, which is the PROSTEP 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 kind of validation properties, intended to validate the actual shape of the model. The mechanism is based on sampling points, which are created exactly on each surface by the exporting CAD system and written into the STEP file as □centroid□ 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 12-06-2006).

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 Round20J:

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

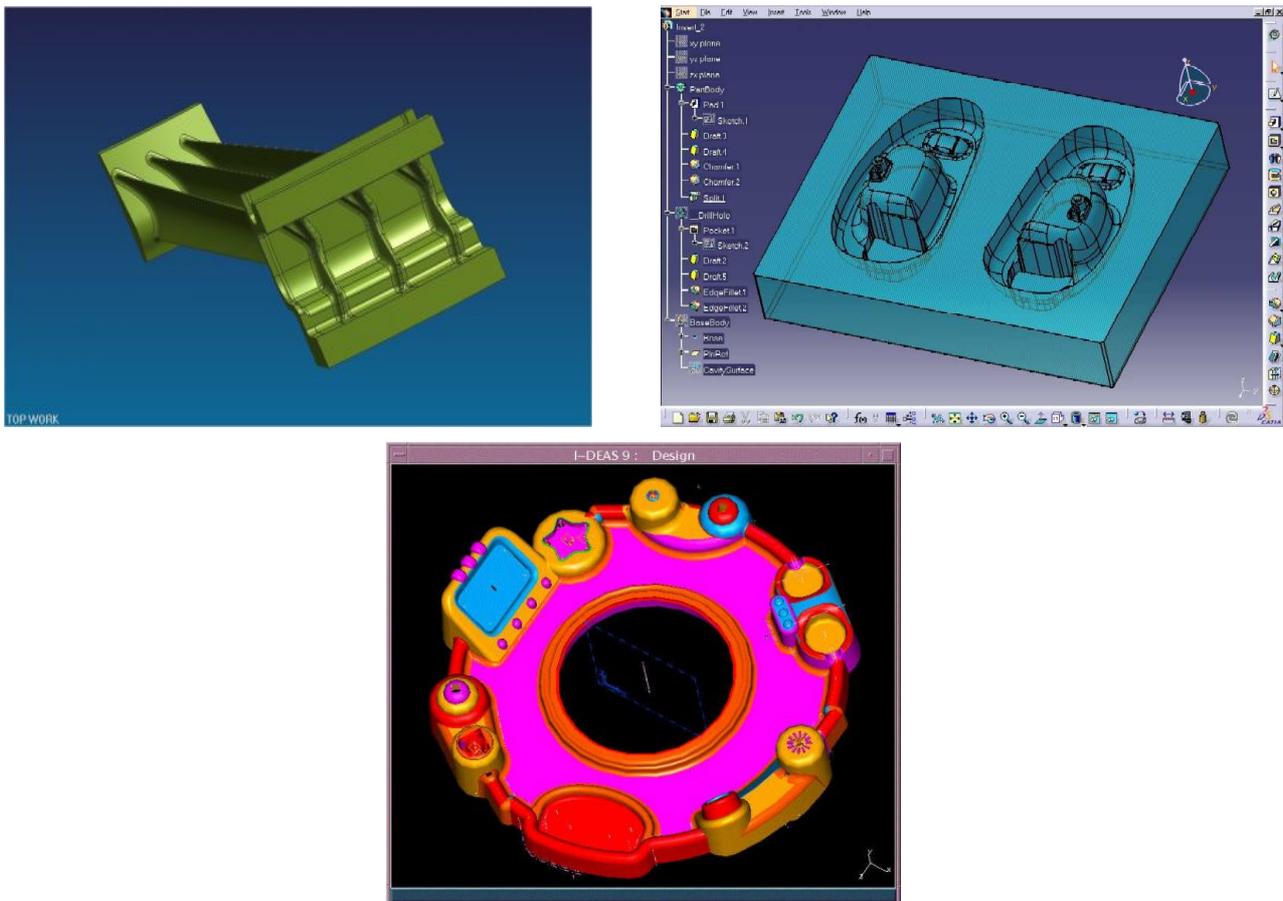


Figure 1: Shape of the T2 models (vane cluster, left, molding tool, right, activity tray, bottom)

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 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

With each STEP file submitted for the T2 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

model	<i>t2_ug / t2_c5 / t2_id</i>
system_n	<i>Native system code</i>
system_t	<i>Target system code (for native stats use 'stp' for system_t)</i>
unit	<i>Units</i>
volume	<i>Total volume of all solids</i>
validation_volume	<i>Total volume of all solids as received via the validation property capability.</i>
valid_vol	<i>pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?</i>
area	<i>Total surface area of all solids</i>
validation_area	<i>Total surface area of all solids (entire assembly) as received via the validation property capability.</i>
valid_area	<i>pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?</i>
cx cy cz	<i>Centroid of all solids</i>
validation_cx validation_cy validation_cz	<i>Centroid of all solids (entire assembly) as received via the validation property capability.</i>
valid_cent	<i>pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?</i>
cops_ok	<i>pass/fail, indicates whether the model passed comparison of the COPS GVP (i.e. no shape changes detected), or failed.</i>
valid_cops	<i>pass/fail, indicates whether the target system considers the implementation of the Cloud of PointS information valid as per recommended practices.</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

2.2 Model GD5: 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

In addition, this will be a first test of the “minimalist approach” to GD&T presentation as decided at the Round19J Review meeting, i.e. GD&T representation plus basic positioning information. Recommended Practices for this and an accordingly extended EXPRESS schema will be made available in the member area of the CAx-IF website or on the WikiSTEP page.

2.2.3 Testing Instructions

This test case is derived from the “GD2” test case used in earlier CAx-IF test rounds. Item 9 has been added to the instructions below.

1. Use inches for units.
2. Create a rectangular block at the origin with dimensions $x=4$, $y=2$, $z=1$.
3. Remove two 1 inch diameter through holes parallel to the Z axis centered in the block. The centroids of the holes are at (1, 1, 0) and (3,1,0)
4. Assign Datum plane A to the top face, i.e. the XY plane where $Z=1$.
5. Assign Datum plane B to the side face, i.e., the XZ plane where $Y=2$.
6. Assign Datum C to the end face, i.e., the YZ plane where $X=3$.
7. Assign a position tolerance to the pattern of holes diameter of .01 referencing Datum C and B in that order of precedence. See Figure 2 below.
8. Assign a perpendicularity tolerance of .01 on the top face (the same face as Datum A) referencing Datum B and Datum C in that order of precedence.
9. Add a linear dimension for the diameter of a hole (not shown on Figure 2).

This should create a part with a solid model, one dimensional tolerance, one position tolerance, one perpendicularity tolerance, three datums and one linear dimension.

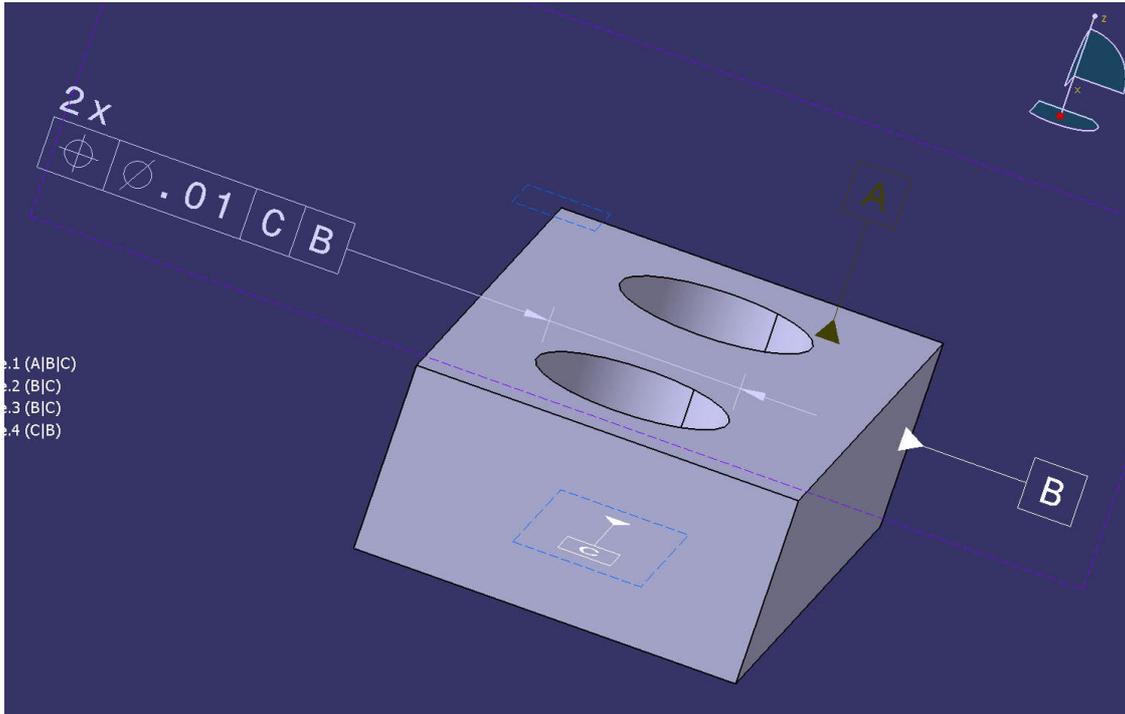


Figure 2: Shape of the GD2 model

2.2.3.1 Statistics

With each STEP file processed for the GD&T model, vendors must include a text file with the statistics in comma-delimited form (.CSV):

model	<i>gd5</i>
system_n	<i>Native system code</i>
system_t	<i>Target system code (for native stats use 'stp' for system_t)</i>
unit	<i>Units</i>
volume	<i>Total volume of all solids</i>
area	<i>Total surface area of all solids</i>
cx, cy, cz	<i>Centroid of all solids</i>
dim_found	<i>The number of dimensions processed.</i>
datum_found	<i>The number of datums processed.</i>
tol_processed	<i>The number of tolerances processed.</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

2.3 Model C1 : 3D Associative Text and Special Characters

2.3.1 Motivation

The main objectives for this test is the 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. Explicit GD&T Presentation will be tested at a later point in time.

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 annotations in the model, at least one of each of the following:
 - single-line text
 - multi-line text

- including a special character (e.g. a diameter symbol) represented by its Unicode encoding.
- 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

With each STEP file submitted for C1, vendors must include a text file with the stats in comma-delimited form (.csv):

model	<i>c1</i>
system_t	<i>Native system code</i>
system_n	<i>Target system code (for native stats use 'stp' for system_t)</i>
valid_txt	<i>all/partial/none – whether the specified texts appear in the model Note: na indicates vendor is not testing associative text</i>
valid_txt_- assoc	<i>all/partial/none – whether the association of the text to the elements of the geometric model as described above is correct Note: na indicates vendor is not testing associative text</i>
unicode	<i>pass/fail – whether Unicode characters were included in at least one of the annotations, and if they were decoded and displayed correctly after import. Note: na indicates the system does not support Unicode encoding and/or display in annotation.</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

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 send in a screenshot for their native model and one for each imported C1 to Jochen.boy@prostep.com. These pictures will then be published in the secure area of the CAx-IF web sites (<http://www.cax-if.de/secure/> and <http://www.cax-if.org/secure/>). The following naming convention is suggested:

c1-[nat]-[tgt].[type]

where [nat] is the native system code, [tgt] is the target system code (use 'native' for the screenshot of the native model), and [type] is the usual extension based on the file format (.jpg/.gif/.bmp).

2.4 Model W1: Wireframe Geometry

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

A seed file will be provided 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)

2.4.3.2 Statistics

With each STEP file submitted for W1, vendors must include a text file with the stats in comma-delimited form (.csv):

model	<i>w1</i>
system_t	<i>Native system code</i>
system_n	<i>Target system code (for native stats use 'stp' for system_t)</i>
unit	<i>Units</i>
curve_length	<i>Total length of all curves in the model</i>
cx cy cz	<i>Center point of the three-dimensional bounding box enclosing all geometric entities in the file</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

In order to validate the shape and styles (as far as applied) on a visual basis, vendors are asked to send in a screenshot for their native model and one for each imported W1 to Jochen.boy@prostep.com. These pictures will then be published in the secure area of the CAx-IF web sites (<http://www.cax-if.de/secure/> and <http://www.cax-if.org/secure/>). The following naming convention is suggested:

w1-[nat]-[tgt].[type]

where [nat] is the native system code, [tgt] is the target system code (use 'native' for the screenshot of the native model), and [type] is the usual extension based on the file format (.jpg/.gif/.bmp).

3.0 Production models: PM18

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	Native System	Remarks
Car Handle	CATIA V5	New Model in R20J
Transmission Casing Section	Pro/Engineer	Re-test from Round19J Please note the problematic areas shown in the screenshot on the document sharing web site.
Air Plenum	UG NX	New Model in R20J

3.3.2 Results

For each STEP file imported for the Production Models, vendors have to submit a text file with the statistics in comma-delimited form (.CSV):

model	<i>pm18</i>
system_n	<i>Native system code</i>
system_t	<i>Target system code (for native stats use 'stp' for system_t)</i>
unit	<i>Units</i>
volume	<i>Total volume of all solids</i>
validation_volume	<i>Total volume of all solids as received via the validation property capability.</i>
valid_vol	<i>pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?</i>
area	<i>Total surface area of all solids</i>
validation_area	<i>Total surface area of all solids (entire assembly) as received via the validation property capability.</i>
valid_area	<i>pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?</i>
cx cy cz	<i>Centroid of all solids</i>
validation_cx validation_cy validation_cz	<i>Centroid of all solids (entire assembly) as received via the validation property capability.</i>
valid_cent	<i>pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?</i>
shoveit_ok	<i>pass/fail, indicates whether the model passed comparison of the Extended GVP (i.e. no parts/subassemblies misplaced), or failed.</i>
valid_shoveit	<i>pass/fail, indicates whether the target system considers the implementation of the instance information valid as per recommended practices.</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>