Test Suite for the
CAx Implementor Forum
Round 12J

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Contents:

1.0 <u>Introduction</u>

This document describes the suite of test cases to be used for the twelfth round of testing of the CAx Implementor Forum (CAx-IF). The CAx-IF is a joint testing forum organized by PDES, Inc. and ProSTEP-iViP. The test rounds of the CAx-IF concentrate 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. 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: instance styling, geometric dimensioning and tolerancing (GD&T), AP210 and AP209 interoperability, and PDM-TDM/CAD integration.

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: solid geometry exchange, assembly instance styling, geometric dimensioning and tolerancing, AP210 and AP209 interoperability, and PDM-TDM/CAD integration.

Solid geometry exchange aims for validation and improvement of the results of the 8th Pro-STEP processor benchmark, using the same single piece part. The part should be exported in AP214-IS format in order to keep track of processor migration and interoperability with AP214-DIS.

For assembly instance styling, the objective is to be able to color instances of the same part, different colors in an assembly in order to emphasize certain parts in a given context.

The goal for GD&T is the ability to exchange tolerances for dimensions and geometry to drive downstream applications such as coordinate measuring and manufacturing.

For AP210 interoperability, the goal is to import an AP210 in order to extract the included geometry, e.g. for collision testing when putting a circuit board into its casing.

Post-processing AP209 files also mainly aims for extracting the contained geometry. The test provides the opportunity to work on the issues identified during the Round9J tests and review meeting.

PDM-TDM/CAD integration uses external references, which are a mechanism for specifying external "documents" that are associated with objects defined within a STEP file. The external documents may be digital documents such as CAD native models, STEP files, WORD documents, or NC programs, OR non-digital documents such as technical drawings on paper, or hand-written documents. With respect to the CAx-IF, external references will be used to split a single STEP file into one file containing the part identification and assembly structure

and several STEP files containing the component geometry. In Round 12J of testing, CAx vendors will be post-processing files from the PDM Implementor Forum (PDM-IF), for a joint CAx/PDM-IF testcase (see Section 2.3). In addition, the CAx vendors are asked to provide files for testing of the revised external reference 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 v1.2, dated November 2001.

1.3 Preliminary testing schedule

Date	Action
May 16, 2003	Test Suite available / 1st CAx Implementor Forum conference call
June 23	Initial STEP files and native stats due
TBD	Production Models released
July 14	STEP files and native stats frozen
August 11	Target stats due, 2nd conference call
September 8	Target stats frozen
September 15	Pre-release of final stats / 3rd conference call
September 23	Review meeting for test round
September 24-25	CAx Implementor Forum meeting, Darmstadt Germany

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 <u>Synthetic test case specifications</u>

2.1 Model B3 : Benchmark model 'torque converter housing'

2.1.1 Motivation

As a result of the presentation of the results from the ProSTEP Processor Benchmarks, it has been agreed to re-test the latest test model used there in the CAx-IF with the latest processor versions. This is the first round of testing the model from the 8th Benchmark.

Note: Those vendors who like to re-test the 'classic' validation properties functionality as tested in the previous rounds may do this informally (i.e. no stats reported) with this model.

2.1.2 Approach

No new capability involved.

2.1.3 Testing Instructions

All vendors testing this model are encouraged to export the file in **AP214-IS** format. AP214-DIS should only be used if the IS version is not yet supported.

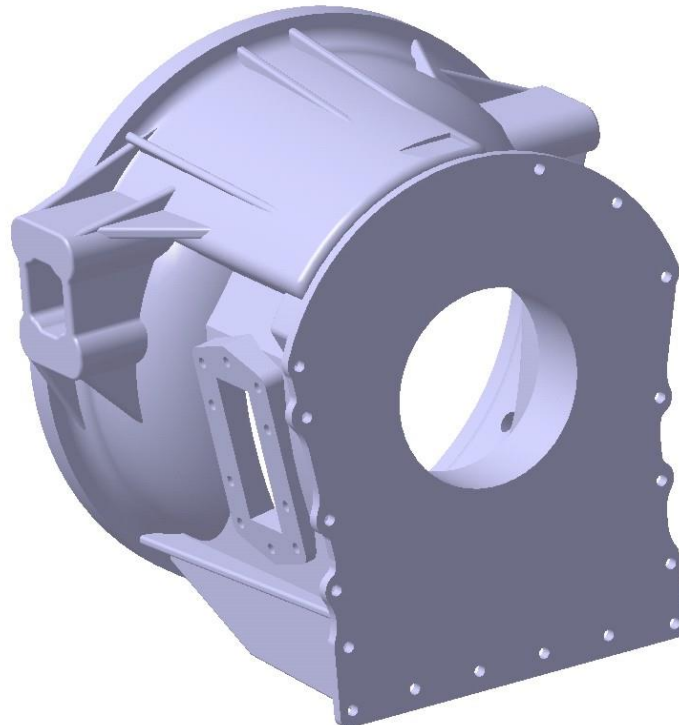#### 2.1.3.1 Construction of the benchmark model

Figure 1: Shape of the B3 model (torque converter housing)

Those vendors who participated in the ProSTEP benchmark should re-use the torque converter housing model which has been constructed for that purpose. The modeling instructions may be found in the secure area of the CAx-IF web sites, http://www.cax-if.org/secure/ and http://www.cax-if.de/secure/, under 'Information on Round12J of Testing'.

2.1.3.2 Statistics

With each STEP file submitted for the b3 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

model	*b3*
system_n	*Native system code*
system_t	*Target system code (for native stats use 'stp' for system_t)*
unit	*Units*
volume	*Total volume of all solids*
area	*Total surface area*
cx, cy, cz	*Centroid of all solids*
date	*Date submitted*
issues	*Short description of issues*

2.2 Model IS1: Assembly Instance Styling

2.2.1 Motivation

Assembly Instance Styling allows the assignment of different styles to different instances of the same part in order to emphasize this instance in a given context. For example one might want to color one instance of a bolt in a different color to point out it serves a special purpose, or one might define a certain part as being invisible because that part is of no interest in the given context but its geometry should be maintained in the model.

2.2.2 Approach

See the approach described in the 'Recommended Practices for Assembly Instance Styling', which is available from the CAx-IF web sites under 'Joint Testing Information' (http://www.cax-if.org/joint_testing_info.html and http://www.cax-if.de/joint_testing_info.html).

This document contains a STEP file example for the given test case.

Because of the complex structure in bigger assemblies, the first test of this functionality only uses the 'NAUO approach' described in the document mentioned above.

Note: Files provided in R12J should be according to the updated Release 1.1 of the Recommended Practices document.

2.2.3 Testing Instructions

2.2.3.1 Model Construction

For assembly instance styling we are using a very simple assembly which puts five instances of a solid yellow cube next to each other, as shown below in the wire frame view:
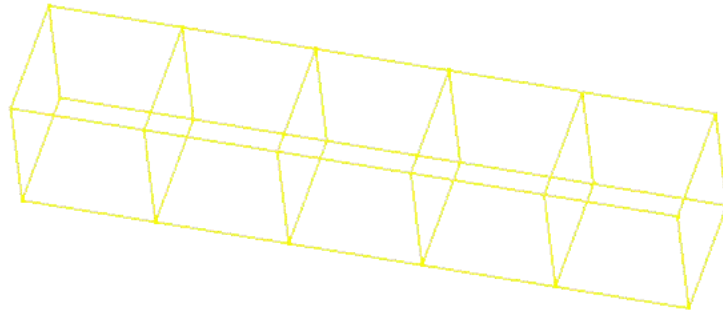
Figure 2: Wire frame view of the assembly before applying styles

Then, to two of the instances new styles are assigned. One instance is colored red, and another instance tagged as invisible. The assembly should then appear as shown below:
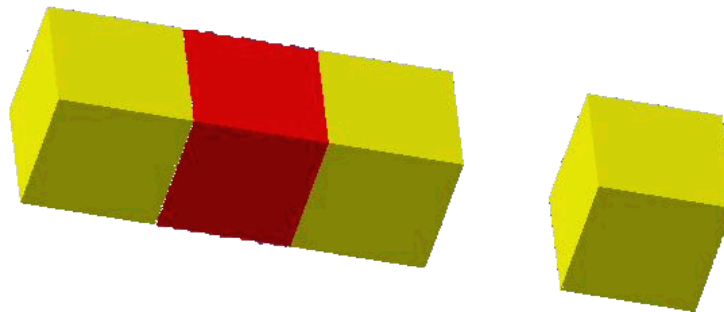
Figure 3: Shaded view of the assembly after styles have been applied to two instances

Note: Vendors participating in this test case do not need to support both coloring the instance and rendering it invisible. It is sufficient to support one of the included approached.

2.2.3.2 Statistics

With each STEP file submitted for the is1 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

Note: As we have done with previous color test cases, screenshots will be collected. Please send in meaningful screenshots for your native model (file name 'is1-(native system code)-nat.jpg/.gif) and for each imported model (file name 'is1-(native system code)-(target system code).jpg/.gif).

model	*is2*
system_n	*Native system code*
system_t	*Target system code (for native stats use 'stp' for system_t)*
unit	*Units*
volume	*Total volume of all solids*
area	*Total surface area*
cx, cy, cz	*Centroid of all solids*
base_color	*Original color assigned to the cube*
instance_-color	*Color assigned to the explicitly styled instance. If the color cannot be determined on import, please put in 'None'.* *If instance coloring is not tested, please put in 'N/A'.*
invisibility	*'Yes' – If one instance of the cube is tagged (found) as invisible* *'No' – If invisible instance cannot be determined on import* *'N/A' – If invisibility is not supported on import or export.*
date	*Date submitted*
issues	*Short description of issues*

2.3 Model XR2: Joint test case with PDM-IF

2.3.1 Motivation

This test case is an extension of the well-known AS1 or S1 model, which has been tested several times before, and it aims for CAD/PDM-TDM interaction. A major usage of external references is the splitting of product data describing assemblies into multiple files representing individual parts. The focus of the actual implementation is to deal with external representations. In the scope of this round of testing, the external representation shall be defined via STEP files.

The test case models a situation where the assembly structures are contained in one file, and the individual parts in a single file each. The file containing the assembly references the model contained in the part file.

The joint testing efforts with the PDM-IF in Round12J will include two activities:

- The PDM Implementor Forum will submit files which include managed documents. The CAX-IF vendors are asked **to import** these files, **then export** them again **('roundtrip')** and send them back to the PDM-IF in order to see which information was maintained and which was lost. The geometry (leaf node) files may not be included.

- In addition, all CAx vendors supporting External References are asked **to export** files for this test case according to the second release of the Recommended Practices for External References which will than also be passed on to the PDM-IF.

2.3.2 Approach

See the approach described in the second version of the Recommended Practices for External References, which are available from the CAx-IF web sites under 'Joint testing information' (dated November 25, 2002).

This document also contains references to relevant sections of the PDM Schema Usage Guide, available on the PDM-IF web-site (http://www.pdm-if.org/pdm_schema/).

2.3.3 Testing Instructions

Please note that system vendors that do not support the external reference mechanism should not import STEP files from this test case.

2.3.3.1 Model construction

The model which should be used as a basis for this test case is the AS1 model ('toilet paper holder'). Since this model is well known within the CAx-IF, the construction information is skipped here. If you have any questions regarding the set-up of this model, you may either have a look into the Round4J test suite available from the CAx-IF web sites, or contact the testing administrators.

The aim is to split the model into six STEP files with the following contents:

Description	STEP File name
1.: The assembly structure	xr2-(vendor code)-214.stp [e.g. xr2-tc-214.stp]
2.1: Plate Geometry	xr2-(vendor code)-plt.stp [e.g. xr2-tc-plt.stp]
2.2: L-Bracket Geometry	xr2-(vendor code)-lbr.stp [e.g. xr2-tc-lbr.stp]
2.3: Rod Geometry	xr2-(vendor code)-rod.stp [e.g. xr2-tc-rod.stp]
2.4: Nut Geometry	xr2-(vendor code)-nut.stp [e.g. xr2-tc-nut.stp]
2.5: Bolt Geometry	xr2-(vendor code)-blt.stp [e.g. xr2-tc-blt.stp]

2.3.3.2 Statistics

The statistics that must be associated which the 'root' STEP file xr2-(vendor code)-214.stp

are designed to represent the results for the following criteria and validations:

model	xr2
system_n	*Native system code*
system_t	*Target system code (for native statistics use 'stp' for system_t)*

unit	Units
solids	Number of solids
valid_sm	Pass/Fail – whether target system considers target model valid
fref_found	All – all file references for the external geometry can be found and the file node associations to model parts can be established
	Partial – some of the file references for the external geometry can be found and some of the file node association to model parts can be established
	None – no references found or associations can not be established
fref_processed	All – all referenced files can be processed to construct the overal model
	Partial - all referenced files can be processed to construct the overal model
	None – referenced files can not be processed
volume	Total volume of all solids
area	Total surface area of all solids
cx cy cz	Centroid of all solids

Note: Since there are usually no such formal statistics for the files provided from the PDM-IF, all CAx vendors post-processing these files are asked to summarize their issues and present them during the joint session with the PDM-IF at the Round12J review meeting.

2.4 Joint Test case with AP209 (EA) Group

2.4.1 Motivation

Since the number of APs used in every day data exchange is constantly increasing, the subject of AP interoperability is of growing interest. The focus of this test is on extracting the geometry (design shape) from a 209 file and converting it to an AP203 or AP214 detail/part or assembly.

2.4.2 Approach and testing instructions

AP209 file(s) should be imported, and the geometry information should then be excerpted. Of special interest is the interpretation of the product structure (design shape vs. analysis shape) as discussed during the Round9J review meeting. Only the design shape should be extracted.

2.4.2.1 Statistics

With each STEP file processed for the AP209 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

model	*ap209*
system_n	*Native system code*
system_t	*Target system code (for native stats use 'stp' for system_t)*
unit	*Units*
volume	*Total volume of all solids*
area	*Total surface area*
cx, cy, cz	*Centroid of all solids*
date	*Date submitted*
issues	*Short description of issues*

In order to help the discussion of the results with the EMT group, it may be helpful to prepare a more detailed (textual) description of the issues found, which may be sent to out via email before the meeting.

## 2.5 Test Case for Geometric Dimensioning and Tolerancing

2.5.1 Testing Instructions

1. Use inches for units.

2. Create a rectangular block at the origin with dimensions x =3, y=3, z=1.

3. Remove a 1 inch diameter through hole parallel to the Z axis centered in the block. The centerline of the hole is at (1.5, 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. Dimension the hole with a diameter dimension with a tolerance of +/- .05

8. Assign a position tolerance on the hole diameter of .05 with a Maximum Material Condition referencing Datum A, B and C in that order of precedence. See below.
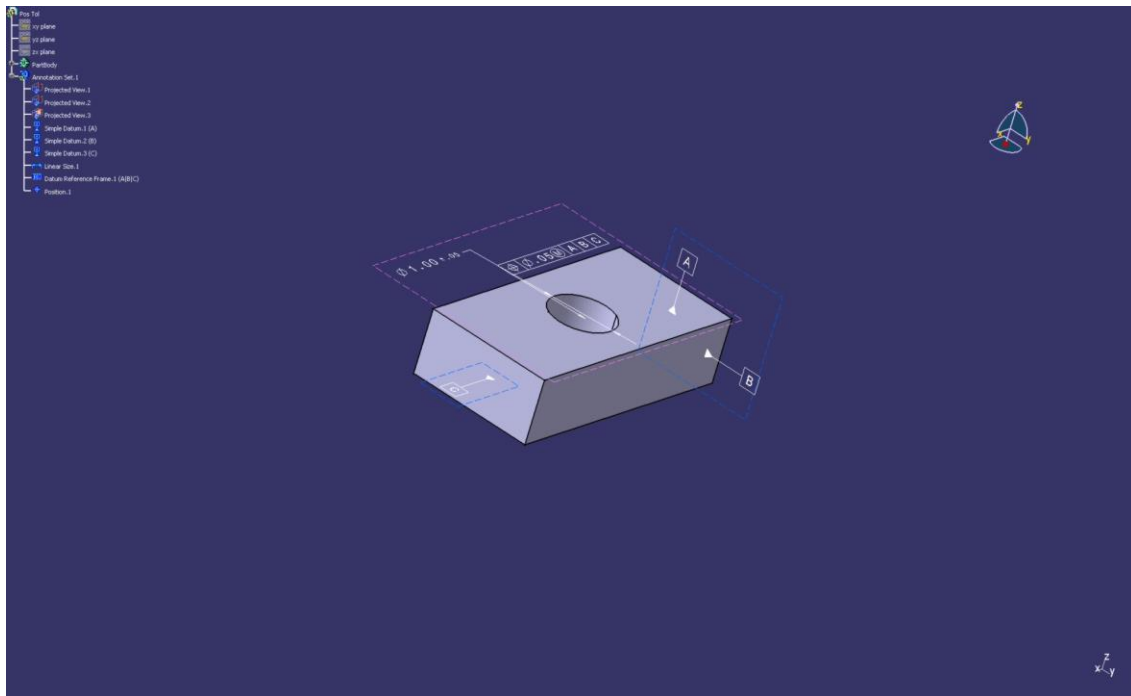
9.

10. 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 precendence.

This should create a part with a solid model, one dimensional tolerance, one position tolerance, one perpendicularity tolerance and three datums as shown below.
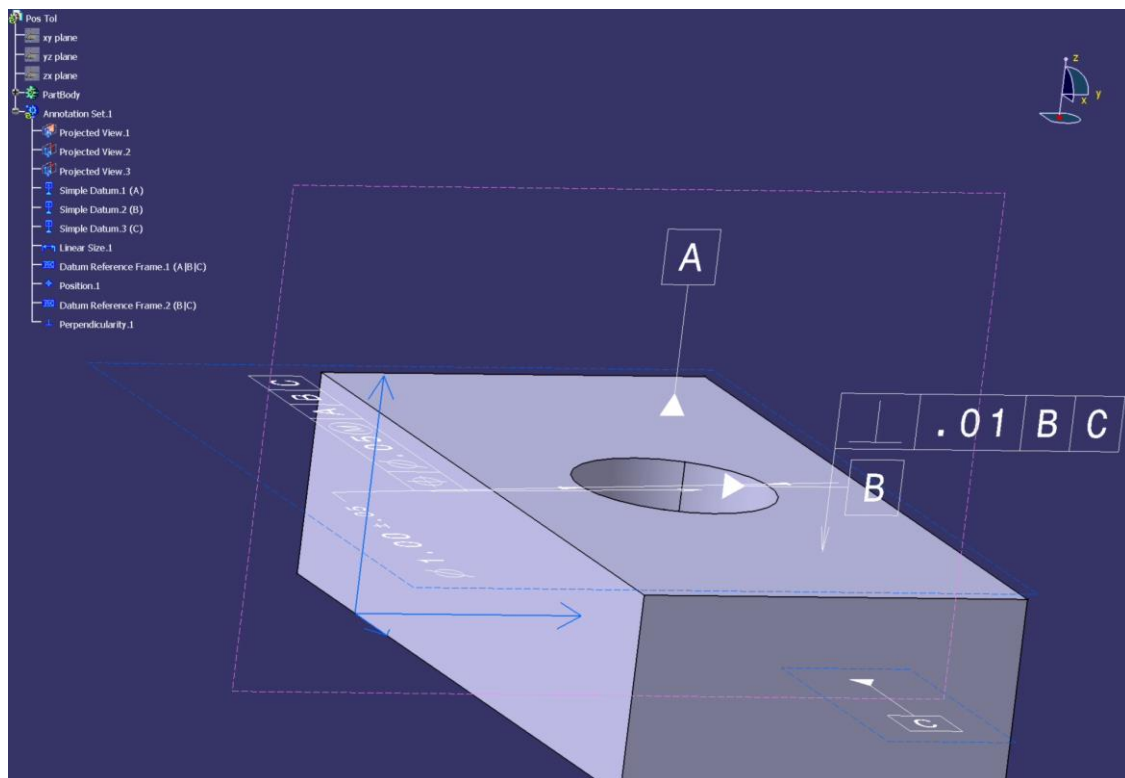
2.5.2 Statistics

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

model	*GD1*
unit	*Units*
volume	*Total volume of all solids*
area	*Total surface area of all solids*
cx, cy, cz	*Centroid of all solids*
dim_found	*The number of dimensions processed.*
datum_found	*The number of datums processed.*
tol_processed	*The number of tolerances processed.*
date	*Date submitted*
issues	*Short description of issues*

3.0 <u>Production models: PM10</u>

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 member companies and vendors have supplied these models.

3.2 Approach

STEP files provided by member companies and vendors have been analysed for quality of (solid and/or surface) geometry as well as syntax and structure. The model quality issues (if any) have been documented in a README file which accompanies the STEP files. In this round of testing production models, simple comparison of mass property data (volume, surface area, Centroid) will be used as a basis for validating success/failure of the exchange.

3.3 Testing Instructions

Detailed information on the models being tested in Round 12J will be delivered in a second release of this document as soon as the models are available.