Test Suite for the
CAx Implementor Forum
Round 11J

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Contents:

1.0 <u>Introduction</u>

This document describes the suite of test cases to be used for the eleventh 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: construction history, 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, construction history, 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 7th ProSTEP 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.

The goal for construction history is the ability to change the model in the receiving system by selecting steps in the construction of the solid model and modifying them.

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 11J of testing, CAx vendors will be processing files from the PDM Implementor Forum (PDM-IF), for a joint CAx/PDM-IF testcase (see Section 2.2) which has been defined in Round8J.

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
December 16, 2002	**Test Suite available /** **1st CAx Implementor Forum conference call**
January 13, 2003	**Initial STEP files and native stats due**
TBD	**Production Models released**
January 27	**STEP files and native stats frozen**
February 24	**Target stats due, 2nd conference call**
March 10	**Target stats frozen**
March 19	**Pre-release of final stats / 3rd conference call**
April 1	**Review meeting for test round**
April 2-3	**CAx Implementor Forum meeting,** **Everett Washington**

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 B2 : Benchmark model 'pump 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 7th 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. Due to the minor changes in AP214 CC2 and the successful test in Round9J, AP214-DIS should only be used if the IS version is not yet supported.

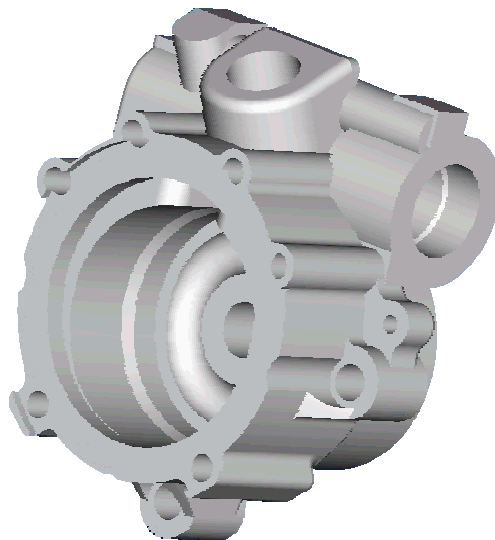#### 2.1.3.1 Construction of the benchmark model

Figure 1: Shape of the B2 model (pump housing)

Those vendors who participated in the ProSTEP benchmark should re-use the pump 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 Round9J of Testing'.

2.1.3.2 Statistics

With each STEP file submitted for the b2 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

model	*b2*
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.

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:
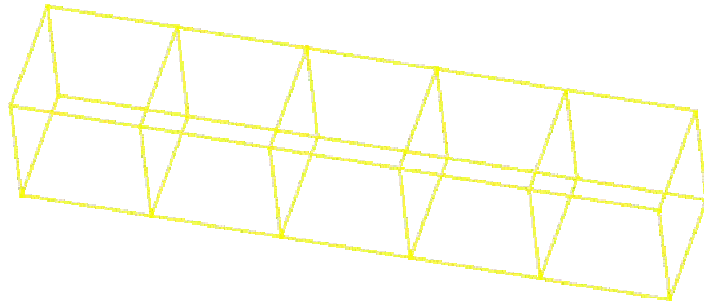
Figure 2: Wire frame view of the assembly before applying styles

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:
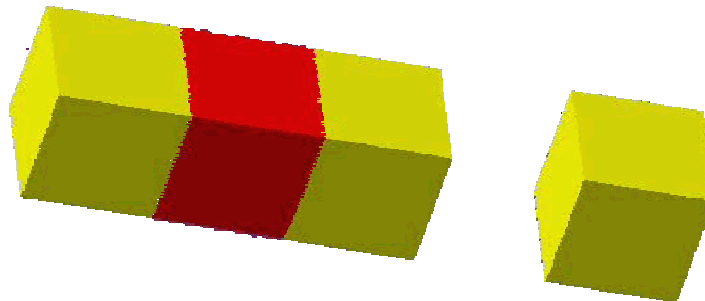
Figure 3: Shaded view of the assembly after styles have been applied to two instances

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 CH2: Solid Model Construction History

2.3.1 Motivation

Solid Model Construction History has been identified as a major field of interest in future test activities of the CAx-IF. Several aerospace, computer, and automotive companies have identified requirements to exchange solid model construction history using STEP to enable design modification in the receiving system while maintaining parametric relationships. That capability is discussed in this Implementor's Guide for Solid Model Construction History. This version includes procedural or history-based modelling constructs and operations, which can be used to extend capabilities of existing APs.

Since implementations in that field still are on a pilot level with only few vendors participating and a limited scope, it has been agreed the Construction History is not yet to be run as a full-blown CAx-IF test case. However, any vendor interested in that field is greatly welcome and encouraged to join the activities in that direction.

2.3.2 Approach

See the approach described in the 'Implementor's Guide for Solid Model Construction History', available on the CAx-IF sites (http://www.cax-if.org/joint_testing_info.html and http://www.cax-if.de/joint_testing_info.html), as well as the EXPRESS schema an the Part21 file example, also available from the above mentioned location. Any questions about testing this functionality should be directed to Dr. Bill Anderson (anderson@aticorp.org).

2.3.3 Testing Instructions

The testing instructions for construction history will be sent out seperately. The model is a simplified version of the 6th ProSTEP Benchmark model ('gear lever').

2.3.3.1 Statistics

With each STEP file processed for the CH2 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

model	*ch2*
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*
conhist	*'all' / 'partial' / 'none' of the construction history information has been successfully transferred.*
date	*Date submitted*
issues	*Short description of issues*

2.4 Model XR2: Joint test case with PDM-IF

2.4.1 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.

In **Round11J**, 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 **('round-trip')** 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.

Since there are several structural changes in the revised version of the Recommended Practices document, the CAx vendors supporting this functionality are also encouraged **to export** files for this test case according to the new structure.

2.4.2 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/).

2.4.3 Testing Instructions

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

2.4.3.1 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]

2.4.3.2 Statistics

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

submitted for the xr2 test case 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

2.5 Joint test case with AP210 (EMT) Group

2.5.1 Motivation

Basis for this common test case is the illustration of a business case, where the shape information of a circuit board should be extracted from an AP210 file and then be converted to an AP203 or AP214 detail/part or assembly, in order to use it for a build-in-test, i.e. checking for collisions when putting the circuit board into its casing, of which the geometry information is available as a STEP solid.

2.5.2 Approach and testing instructions

The AP210 file(s) should be imported and the geometry information should then be excerpted. A test case description will be given by the AP210 group.

2.5.2.1 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	*ap210*
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.

2.6 Joint Test case with AP209 (EA) Group

2.6.1 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.

2.6.2 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.

2.6.2.1 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.

2.7 Test Case for Geometric Dimensioning and Tolerancing

This material will be added at a later date.

3.0 Production models: PM8

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 11J will be delivered in a second release of this document as soon as the models are available.

3.3.1 Models being tested

A short overview of the models which have been announced until release of this document:

Model name	Originating system	File schema	Comments
Ed's Activity Tray	I-DEAS (id)		There will be two versions of this model, one NURBS and one Analytic.
Single Stroke Engine	Inventor (in)		Re-test, investigation of Centroid issue
Turbine Blade	Unigraphics (ug)		Model from R9J / R10J
Piping	CATIA V5 (ct)		New Model
Rim Section	CATIA V4 (sy, td)		New Model (5th Benchmark Model)
Mouse	CATIA V4 (sy, td)		New Model (Alternative to the above)