Test Suite for the CAx Implementor Forum Round 8J

August – October 2001

Release 2.0

September 5, 2001

Contacts:

Jochen Boy

ProSTEP GmbH

Dolivostraße 11

64293 Darmstadt/Germany

jboy@prostep.de

Phil Rosché

ATI/PDES, Inc.

5300 International Blvd.

North Charleston, SC 29418 USA

rosche@aticorp.org

Contents:

1.0 Introduction

This document describes the suite of test cases to be used for the eighth round of testing of the CAx Implementor Forum (CAx-IF). The CAx-IF is a joint group of the organizations and vendors previously engaged in the ProSTEP CAD Round Table and the PDES, Inc. STEP-net.

The test rounds of the CAx Implementor Forum continue the tradition of the Test Rallies and STEPnet activities in testing the interoperability and conformance of STEP processors.

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.

This test suite includes synthetic models for testing the following capabilities: surface geometry, surface and curve colors, 3D Text annotation, extended validation properties, 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 originated 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 participants

1.1 Functionality tested in this round

Functionality tested in this round relates to surface geometry, colors, 3D text annotation/associative text, extended validation properties, and PDM-TDM/CAD integration.

Surface models are again tested because of previous findings that indicate that this exchange capability might still need some enhancement, and to give new participants in this forum a chance to measure their improvements. It has been agreed that only topologically bounded models will be exchanged.

A simple model will be used to test the exchange of surface and curve colors.

Associative text is the capability to associate text notes in 3D model space with portions of the model.

Validation properties (in AP214 named shape_dependent_properties) is a mechanism to allow the exchange of geometric properties and their assignment to geometric representations for the purposes of data exchange validation. Considered properties are volume, surface area and centroid.

The extended functionality ('Val.Props.2') tested in this round includes instance information, i.e. the centroid of each part is stored in the context of the parent assembly, giving information on the placement of every item, including multiple instances of a single part.

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 8J of testing, CAx vendors will be processing files from the PDM Implementor Forum (PDM-IF), for a joint CAx/PDM-IF testcase (see Section 2.5) which has been defined in Round5J.

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.

1.3 Testing schedule

Date	Action
August 6th, 2001	Test Suite available / 1st CAx-IF Conference Call
August 20th	Initial STEP files and native stats due
August 27th	Production Models released
September 3rd	STEP files and native stats frozen
September 17th	Target stats due / 2nd CAx-IF Conference Call
October 1st	Target stats frozen
October 8th	Pre-release of final stats / 3rd CAx-IF Conference Call
October 16th	Review meeting for test round in Charleston, SC
October 16th to 18th	CAx Implementor Forum meeting in Charleston, SC

1.4 Copyrights on test cases

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

2.0   Synthetic test case specifications

2.1   Model K1 : Surface Model

2.1.1   Motivation

Previous findings indicated that the exchange of surface models may need some enhancement. To take into account the latest issue resolution processes in the CAx-IF, and to give new participants a chance to measure their improvements, this model is tested again.

2.1.2   Approach

No new capability involved.

2.1.3   Testing Instructions

2.1.3.1   Model construction
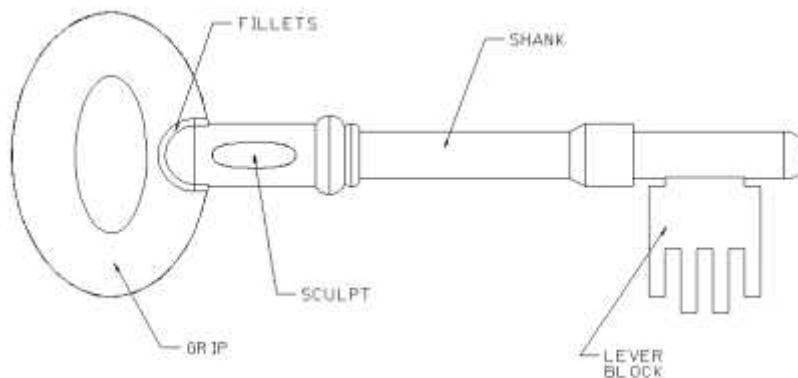
Figure 1 : Annotated shape of the k1 model.

The detailed modeling instructions are available as PDF document from the member areas of the CAx-IF web sites, http://www.cax.if.de/secure/ and http://www.cax-if.org/secure/ , under 'Information on Round4J of Testing'.

There are several degrees of freedom when implementing this test case:

▪ The first point is how two construct the model according to Theorem's test suite. There are two approaches (sweeping/revolving vs. union/intersection). Vendors may choose the approach which fits best with their system capabilities, the model should be constructed only once.

■ The next point is how to downgrade the model. It has been agreed that any number of shells is allowed. The information how many shells are used will be collected with the native stats, but will not be an exchange success criteria.

2.1.3.2 Statistics

It has been agreed, that for Round6J and future testing, only topologically bounded surface models shall be exchanged. Thus the model name is simply 'k1'.

With each STEP file submitted for k1, vendors must include a text file with the stats in comma-delimited form (.csv):

model	k1
system_n	Native system code
system_t	Target system code (for native stats use 'stp' for system_t)
unit	Units
shells	Number of shells in the model (not a success criteria).
area	Total surface area
date	Date submitted
issues	Short description of issues

2.2 Model C2 : Colors and 3D Annotation

2.2.1 Motivation

The objective of this test case is to formally test the exchange of surface and curve color as done in Round7J, plus 3D annotation.

In order to eliminate any unwanted side-effects, a very simple model is used. It will contain a colored surface and a colored curve.

This model – for the systems having implemented the annotation capability – is also used to transfer associative text. The associative text capability is fully harmonized between AP 214 and the corresponding AP 203 application extension and thus should also be interoperable.

2.2.2 Approach

2.2.2.1 Presentation colors

The assignment of the surface and curve colors shall be based on the agreement from the Round7J review meeting, which is available from the CAx-IF web sites, http://www.cax-if.org/ and http://www.cax-if.de/.

2.2.2.2 Annotation

The systems' support for associative text is strongly varying. The approach recently studied 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

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 studied. 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/.

2.2.3 Testing Instructions

2.2.3.1 Model construction

In order to test color and text exchange without any unwanted side-effects, a very simple geometry is used. The model should contain:

- A single surface with surface color.

- A separate curve with curve color.

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 two annotations in the model, one single-line text and one multi-line text.

- Style the two texts with an arbitrary color.

- The two annotations should be associated to portions of the model, e.g. the surface or an edge.

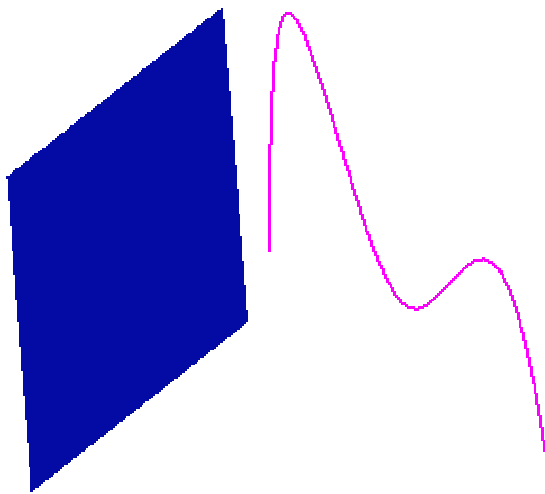- Select an arbitrary placement of the text

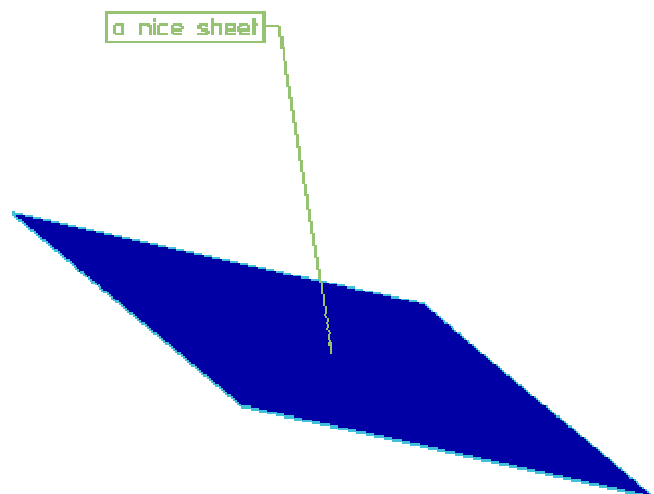*Figure 2: Example for a simple surface and a curve with different colors..*

Figure 3: For system supporting this, 3D annotations may included in and associated to the model.

Note: The colors don't necessarily need to be as shown on the figures above.

2.2.3.2 Statistics & Screenshots

With each STEP file submitted for c2, vendors must include a text file with the stats in comma-delimited form (.csv):

model	*c2*
system_n	*Native system code*
system_t	*Target system code (for native stats use 'stp' for system_t)*
unit	*Units*
area	*Total area of the surface.*
color_surf	*all/partial/none – if the color of the surface in the model is totally correct, partially correct , or lost completely.*
color_curve	*all/partial/none – if the color of the curve in the model is totally correct, partially correct , or lost completely.*
color_t1	*Text color used for the single-line text.*
color_t2	*Text color used for the multi-line text.*
valid_txt	*all/partial/none – whether the specified texts appear in the model Note: na indicates vendor is not testing associative text*
valid_txt_-assoc	*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*

date	Date submitted
issues	Short description of issues

In order to validate the color exchange on a visual basis, vendors are asked to send in a screenshot for their native model and one for each imported C2 to jboy@prostep.de. 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:

c2-[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).

2.3 Model B1 : Benchmark model 'gear lever'

2.3.1 Motivation

As a result of the presentation of the short report from the 6th ProSTEP Processor Benchmark during the Round5J review meeting, it has been agreed to re-test the model used there in the CAx-IF with the latest processor versions. This model is used again, because the Round7J results showed possible improvements.

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

2.3.2 Approach

No new capability involved.

2.3.3 Testing Instructions

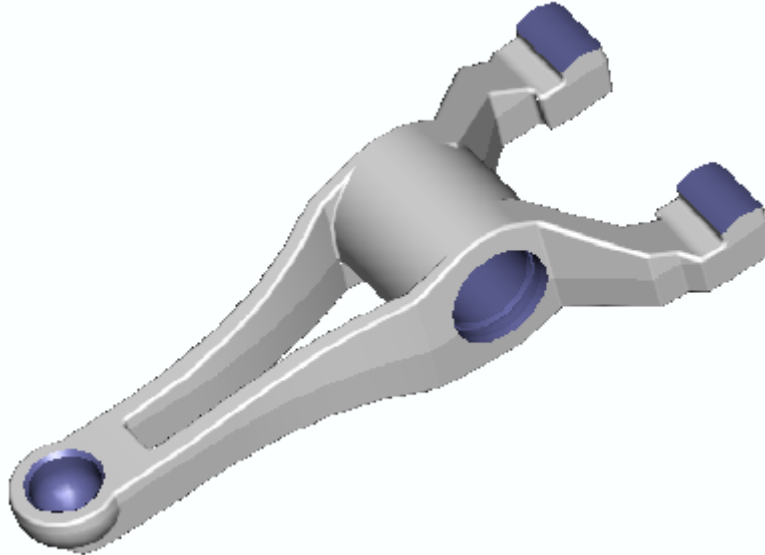### 2.3.3.1 Construction of the benchmark model

Figure 4: Shape of the B1 model (gear lever)

Those vendors who participated in the ProSTEP benchmark should re-use the gear lever 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 Round6J of Testing'.

2.3.3.2 Statistics

With each STEP file submitted for the b1 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

model	b1
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*

2.4 Model AS1 : Extended Validation Properties

2.4.1 Motivation

AS1 is a model already known from previous testing activities in the CAx-IF. The model is re-used to test the extended validation properties ('Val.Props.2') capability.

Therefore, the known VP test will be extended. There are three new fields in the statistics, which reflect if the Shove-IT information is implemented correctly and the value of the centroid of the two 'L-Bracket Assemblies' in the context of its parent, the AS1 assembly.

2.4.2 Approach

See the approach described in the CAx Implementor Forum Recommended Practices for *Geometric Validation Properties* (see http://www.cax-if.org/joint_testing_info.html or http://www.cax-if.de/joint_testing_info.html).

This approach is extended by the **Extended Validation Properties** approach, which is currently described in the presentation available from the secure areas of the CAx-IF web sites, http://www.cax-if.de/secure/ and http://www.cax-if.org/secure/, under 'Information on Round6J of Testing'.

2.4.3 Testing Instructions

Please note that system vendors that do not support the extended validation properties capability may also submit test files for this model. They are required to enter 'na' as the value for all VP2-related stats.

2.4.3.1 Model construction

Below a plot of the assembly as well as of the components is given. Note: this model may have been constructed with slightly differing dimensions in the past by some vendors. These models can also be re-used.
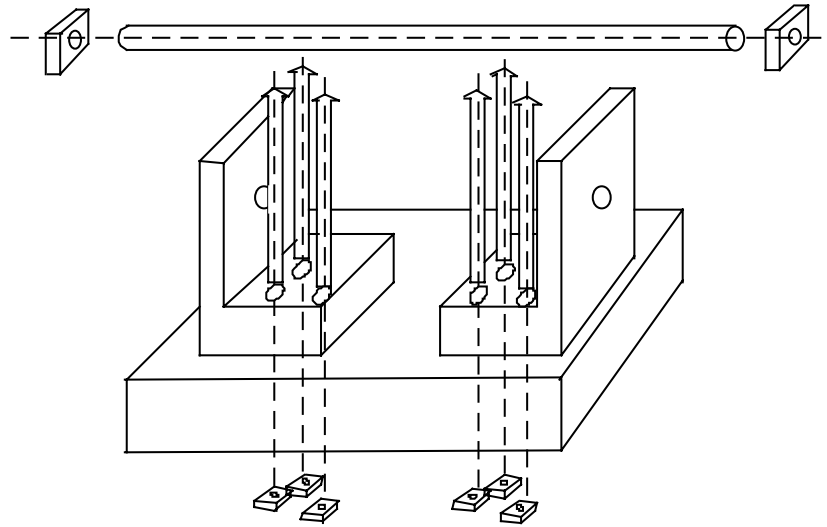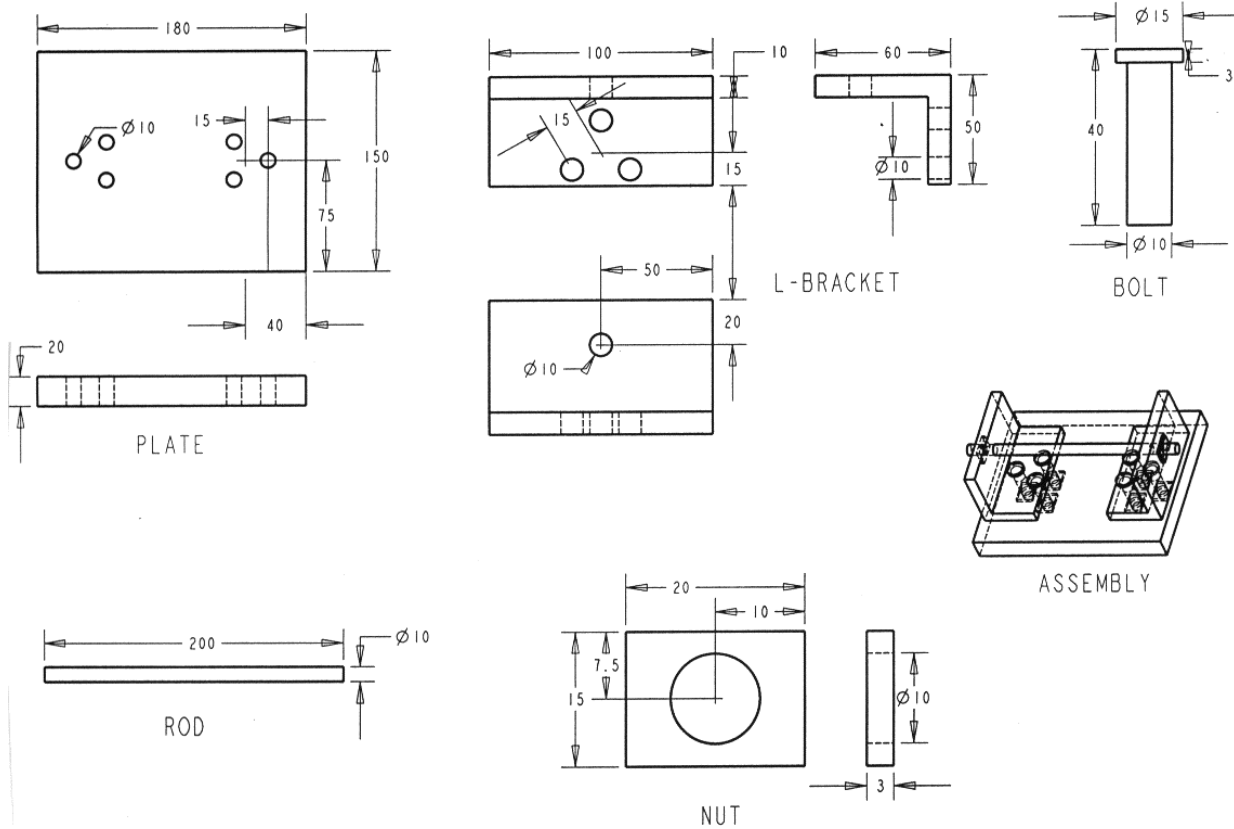
Figure 5: as1 shape

Figure 6: dimensions as1 (dimensions in mm)

Part names:

- Assembly:
  - as1

- Sub-Assemblies:
  - l-bracket assembly,
  - nut-bolt assembly,
  - rod assembly

- Components:
  - plate,
  - l-bracket,
  - bolt,
  - nut,
  - rod

Extended validation properties

The values for the overall volume of the assembly and its the total surface shall be computed and transferred via the STEP file.

In addition to this, the centroid data and Shove-IT information for the subassemblies and parts shall be transferred.

2.4.3.2 Statistics

With each STEP file submitted for model as1, vendors must include a text file with the stats in comma-delimited form (.csv):

model	*as1*
system_n	*Native system code*
system_t	*Target system code (for native stats use 'stp' for system_t)*
unit	*Units*
solids	*Number of solid instances (as opposed to components)*
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' in the STEP file as per the recommended practices for validation properties?*
cx cy cz	*Centroid of all solids*
validation_cx	*Centroid of all solids (entire assembly) as received via the*

validation_cy validation_cz	validation property capability.
valid_cent	pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?
lba1_cx lba1_cy lba1_cz	Centroid of one instance of the 'L-Bracket assembly' with regard to its parent (AS1) as received via the extended validation property capability.
lba2_cx lba2_cy lba2_cz	Centroid of the other instance of the 'L-Bracket assembly' with regard to its parent (AS1) as received via the extended validation property capability.
valid_shoveit	pass/fail, indicates whether the target system considers the implementation of the instance information valid as per recommended practices.
date	Date submitted
issues	Short description of issues

Note: In case a vendor (native/target) is not testing a particular functionality, *'na'* must be used as code for that statistic. Additionally, the CAx-IF Test Administrators will compare the values of validation properties (validation_volume, etc.) as received via the validation property capability with the actual values (volume, etc.) as reported in the statistics above. A Pass/Fail statistic will be arrived at based on the allowable deviation in values.

2.5 Joint Testcase with PDM-IF

2.5.1 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 Round8J, the PDM Implementor Forum will submit the files which will then be **imported only** by all CAx vendors testing this functionality. The geometry (leaf node) files may not be included. The CAx vendors should then report which references could be found.

2.5.2 Approach

See the approach described in the PDM Schema Usage Guide, available on the PDM-IF web-site (http://www.pdm-if.org/pdm_schema/). Recommended Practices for External References with annotated, relevant sections of the Usage is available on the CAx-IF site (http://www.cax-if.org/joint_testing_info.html and http://www.cax-if.de/joint_testing_info.html).

2.5.3 Testing Instructions

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

2.5.3.1 Model construction

For Round8J, the files will be provided by the PDM vendors, based on the test cases 'dman1', 'dman2', 'er3' and 'er4', defined in Round5J. All CAx vendors supporting external reference capability should import those files and submit the results they receive.

2.5.3.2 Statistics

There are no formal stats like in the other test cases for the joint testing. Instead, there is a catalogue of questions to be answered. The results shall be fed back directly to the PDM-IF at mario.leber@prostep.de. A template document containing the questions to be answered will be available from the secure areas of the CAx-IF web sites (http://www.cax-if.org/secure/ and http://www.cax-if.de/secure/), under 'Information on Round6J of Testing'.

2.6 Joint Testcase with AP210 Group

2.6.1 Motivation

Basis for this common testcase 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.

2.6.2 Approach and testing instructions

The AP210 file(s) should be imported an the geometry information should then be excerpted. A testcase description will be given by the AP210 group, to which all results should be fed back.

2.7 Solid Model Construction History

2.7.1 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.

Due to the tight schedule of Round8J, there will be no formal test of this functionality in this round of testing. However, all vendors planning to participate in this field in future test rounds, are encouraged to set up pilot implementations and exchange their files to perform some preliminary testing.

2.7.2 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).

2.7.3 Testing Instructions

All information on construction of the model and implementation of the construction history functionality may be found in the Implementor's Guide mentioned above.

3.0 Production models: PM6

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

3.3.1 Models Being Tested

In this round of testing, the following production models are being tested. The table below contains information on the models. A ZIP file <r8j_pm6.zip> containing the STEP files (with files names as in the table) is available from the CAx-IF sites in the secure area.

Model	Originating System	Schema	STEP File Name (in ZIP file)
Edge Connector	AutoCAD	214	pm6-ac-214.stp
Hydroengine	HiCAD	214	pm6-hc-214.stp
Oil Pan	Inventor	214	pm6-in-214.stp
Velo (Bike)	SolidDesigner	214	pm6-sd-214.stp
Yoke	Spatial	203	pm6-sh-203.stp
Drive Actuator	Theorem	203	pm6-ts-203.stp

3.3.2 Statistics

As discussed briefly in the previous section (Section 3.2, Approach), the statistics that will be associated with each production model are aimed at determining if the production models are exchanged "successfully". As in past testing, change in volume, surface area, and centroid will be used as a basis for determining "pass/fail". For each production model, a set of native statistics have been collected from the respective system vendors.

For each STEP file (production model) being tested, vendors must send in target statistics in comma-delimited form (.csv): The naming convention for target stats is explained in the 'General Testing Instructions' document available on the CAx-IF sites, under the 'Joint Testing Information' link off the CAx-IF home page.

model	pm6
system_n	Native system code (use the native system code for each model listed in the table in Section 3.3.1)
system_t	Target system
unit	Units
volume	Total volume

area	*Total surface area*
cx cy cz	*Centroid*
date	*Date submitted*
issues	*Short description of issues*

area	*Total surface area*
cx cy cz	*Centroid*
date	*Date submitted*
issues	*Short description of issues*