



**Test Suite for the
CAX Implementor Forum
Round 6J**

December 2000 – March 2001

Release 2.1

January 31st, 2001.

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1.0 Introduction

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

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 organisations PDES, Inc. and ProSTEP.

This test suite includes synthetic models for testing the following capabilities: surface geometry, model viewing, drawing organisation, solid, surface and curve colours, 3D Text annotation, extended validation properties, and PDM-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, colours, 3D text annotation/associative text, extended validation properties, model viewing, and PDM-CAD integration.

Surface models are again tested because of previous findings that indicate that this exchange capability might still need some enhancement. It has been agreed that only topologically bounded models will be exchanged.

A simple model will be used to test the exchange of solid, surface and curve colours. This will include overriding face and edge colour.

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.

The model viewing and drawing organization capability including the presentation of dimensions has already been tested in Rounds 2J, 4J and 5J. In Round6J, the model will be re-

used to test the common approach which has been agreed to during the Round5J review meeting.

PDM-CAD integration uses external references, which is 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 6J of testing, CAX vendors will be processing files from the PDM Implementor Forum (PDM-IF), for a joint CAX/PDM testcase (see Section 2.6) 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 Schedule

Date	Action
January 12 th , 2001	1 st CAX-IF Conference Call
January 26 th , 2001	Production Models released
February 2 nd , 2001	Initial STEP files and native stats due
February 16 th , 2001	STEP files and native stats frozen
February 23 rd , 2001	Target stats due, 2 nd CAX-IF Conference Call
March 2 nd , 2001	Target stats frozen
March 9 th , 2001	Pre-release of final stats
March 19 th , 2001	Review meeting for test round
March 20 th to 22 nd , 2001	CAX Implementor Forum meeting in Myrtle Beach, 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 D3 : Draughting of block with (angular) Dimensions

2.1.1 Motivation

This synthetic model represents basic draughting capability. It involves the projection of a simple 3D solid onto a view which is then placed on a sheet. The sheet is organised in a drawing. In the test of this model the test case is extended by adding linear and angular dimension information to the views.

2.1.2 Approach

See the approach described in the CAx Implementor Forum Recommended Practices for *Model Viewing, Drawing structure and Dimensions* (see http://www.cax-if.org/joint_testing_info.html and http://www.cax-if.de/joint_testing_info.html).

2.1.3 Testing Instructions

Please note that system vendors that do not support this basic draughting capability should not submit STEP files for this test case.

2.1.3.1 Model construction

The figures below indicate the construction of the draughting test case. The basic steps are:

1. Construct the solid geometry. The dimensions for the solid are given in the figure 1 below.
2. Define views of the solid and place it onto a sheet. The projection related to the views can be extracted from the figure 2.
3. Add the dimensions to the views as shown in figure 2.

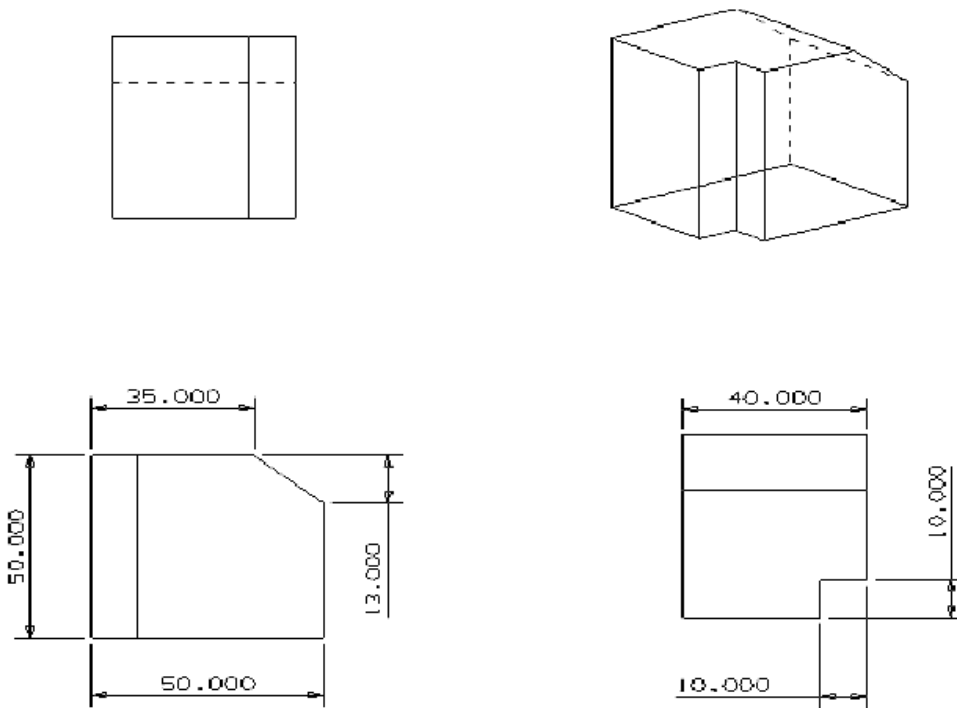


Figure 1: Dimensions for solid for d3 (dimensions in mm)

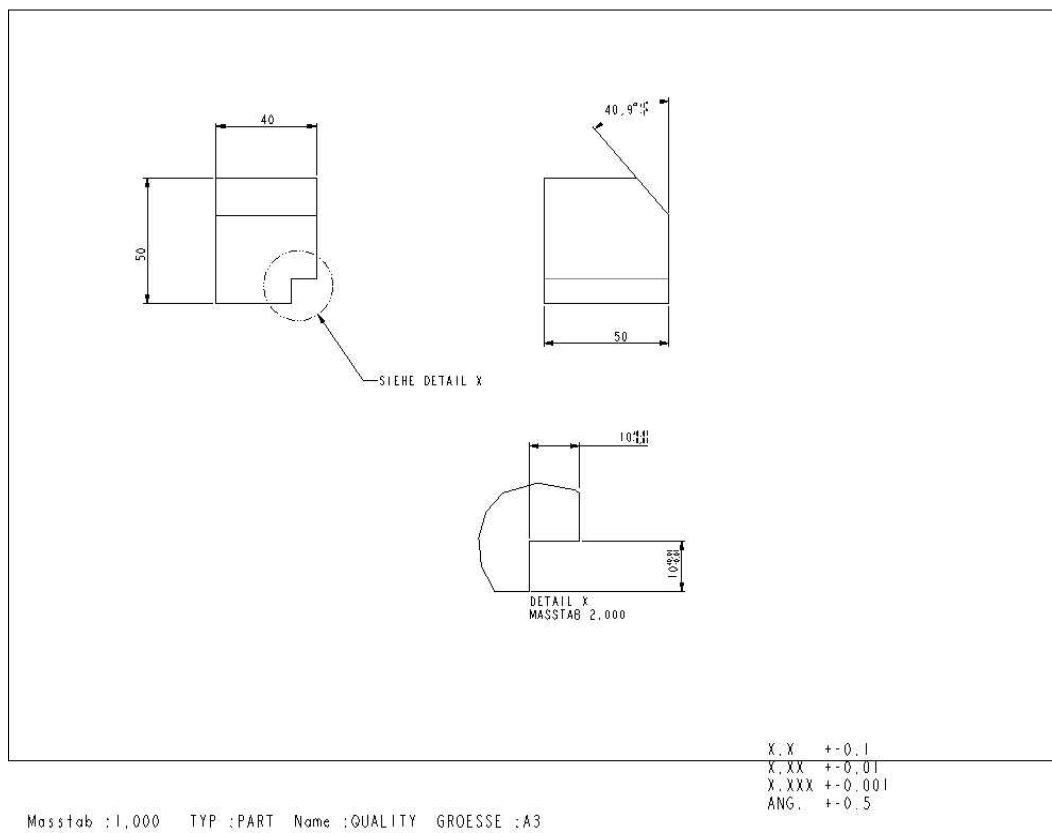


Figure 2: Views on the drawing sheet with dimensions

The layout of the views on the sheet should be indicated as above, i.e.:

- TOP and LEFT are horizontally aligned
- TOP and LEFT are placed on the top of the sheet
- The DETAIL TOP is horizontally centred
- DETAIL TOP is placed on the bottom of the sheet

The dimensions shall be added to the views as shown in figure 2.

2.1.3.2 Statistics

The statistics that must be associated with each STEP file submitted for the D2 test case are designed to represent the results for the following criteria and validations:

- Check the views: placement on the sheet and orientation
- Move the views on the sheet in order to test the association of the model to the view
- Check if the dimension text and symbology fits with the specification of the test case. Note: the dimensions are not supposed to be associative, i.e. linked with the geometrical dimensions of the solid. Tolerance information is only presented and not complemented by information in the 3D model.

model	d3
system_n	<i>Native system code</i>
system_t	<i>Target system code (for native statistics use 'stp' for system_t)</i>
views	<i>all/partial/none – whether the views appear on the sheet in the target system</i>
view_layout	<i>all/partial/none – whether the views appear with right placement and orientation in the target system</i>
pres_lin_dim	<i>all: if the presentation information of all <u>linear</u> dimensions received corresponds to the test case specifications partial: if the presentation of the <u>linear</u> dimensions is incomplete or not completely as specified in this test case none: if no <u>linear</u> dimensions are presented or all of them do not fit with the specifications</i>
pres_ang_dim	<i>all: if the presentation information of all <u>angular</u> dimensions received corresponds to the test case specifications partial: if the presentation of the <u>angular</u> dimensions is incomplete or not completely as specified in this test case none: if no <u>angular</u> dimensions are presented or all of them do not fit with the specifications</i>

valid_assoc	<i>pass/fail – whether modifications of the shape result in an appropriate update of the views (check with new dimension)</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

Note: In case a vendor (native/target) is not testing a particular functionality (e.g. pres_ang_dim) 'na' must be used as code for that statistic.

2.2 Model K1 : Surface Model

2.2.1 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, this model is tested again.

2.2.2 Approach

No new capability involved.

2.2.3 Testing Instructions

2.2.3.1 Model construction

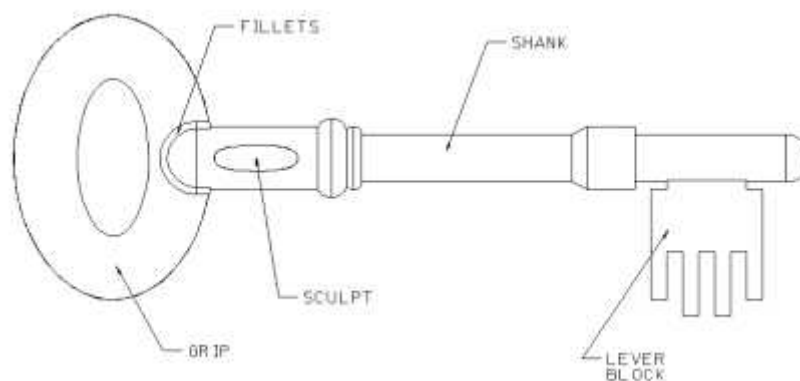


Figure 3 : Annotated shape of the k1 model.

The detailed modelling 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/> .

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.

2.2.3.2 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	<i>k1</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>
shells	<i>Number of shells in the model (not a success criteria).</i>
area	<i>Total surface area</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

2.3 Model C1 : Colours and 3D Annotation

2.3.1 Motivation

The objective of this test case is to formally test the exchange of solid, surface, curve and overriding colour as done in earlier test rounds of the CAx-IF, plus 3D annotation.

In order to eliminate any unwanted side-effects, a very simple model is used. It will contain a coloured cube, including overriding colour for the system supporting this functionality, plus a coloured surface and curve.

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

2.3.2 Approach

2.3.2.1 Presentation colours

As defined in AP214 and the Colours and Layers extension to AP203.

2.3.2.2 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/>.

2.3.3 Testing Instructions

2.3.3.1 Model construction

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

- A cube with solid colour.
- For systems supporting overriding colours:
 - An overriding face colour on one side of the cube.
 - An overriding edge colour on one edge of the cube. The edge should not belong to the coloured surface.
- A separate surface with surface colour.
- A separate curve with curve colour.

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 colour.

- The two annotations should be associated to portions of the cube, e.g. a surface and an edge.
- Select an arbitrary placement of the text

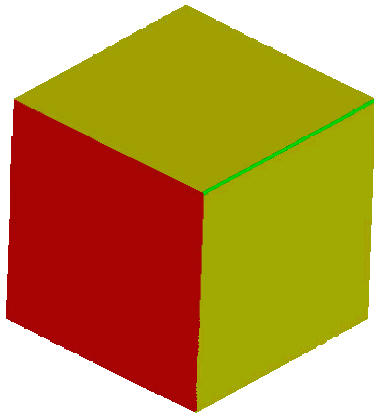


Figure 4: The cube with solid colour (yellow), overriding face colour (red) and overriding edge colour (green).

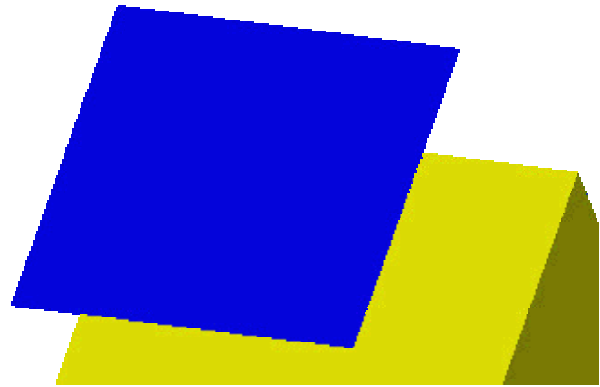


Figure 5: In addition to the cube, the test case shall contain a simple surface (blue).

Note: Overriding colours are not mandatory, but recommended for systems supporting this functionality. The colours don't necessarily need to be as shown on the figures above.

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>
unit	<i>Units</i>
volume	<i>Total volume of the solid part</i>
area	<i>Total area of all solids and surfaces in the model</i>
cx, cy, cz	<i>Centroid of the solid</i>
color_sd	<i>all/partial/none – if solid colours in the model are totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing solid colour</i>
color_f	<i>all/partial/none – if overriding face colour in the model is totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing overriding face colour</i>

color_e	<i>all/partial/none – if overriding edge colour in the model is totally correct, partially correct , or lost completely. Note: na indicates vendor is not testing overriding edge colour</i>
color_surf	<i>all/partial/none – if the colour of the extra surface in the model is totally correct, partially correct , or lost completely.</i>
color_curve	<i>all/partial/none – if the colour of the extra curve in the model is totally correct, partially correct , or lost completely.</i>
color_t1	<i>Text colour used for the single-line text.</i>
color_t2	<i>Text colour used for the multi-line text.</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>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

In order to validate the colour exchange on a visual basis, vendors are asked to send in a screenshot for their native model and one for each imported C1 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:

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 B1 : Benchmark model 'gear lever'

2.4.1 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, in order to see if the results can be improved.

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.

2.4.2 Approach

No new capability involved.

2.4.3 Testing Instructions

2.4.3.1 Construction of the benchmark model

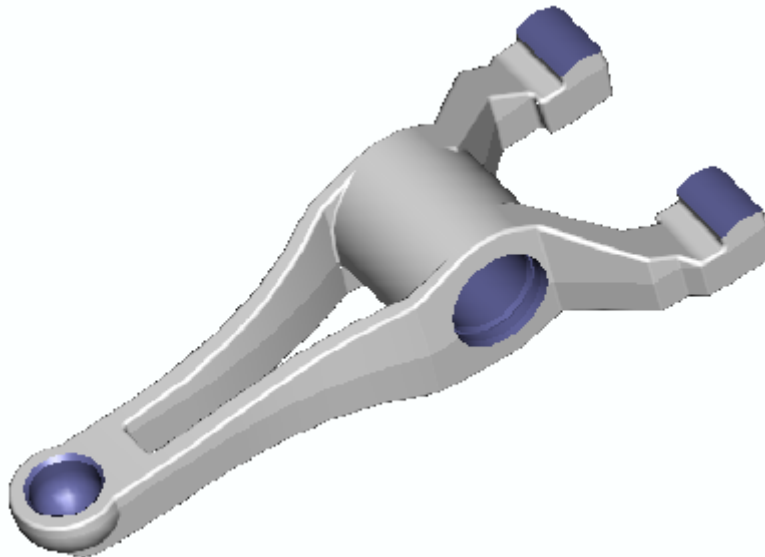


Figure 6: Shape of the B1 model (gear lever)

Those vendors who participated in the ProSTEP benchmark should re-use the gear lever model which has been constructed for that purpose. The modelling 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/>.

2.4.3.2 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	<i>b1</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>
volume	<i>Total volume of all solids</i>
area	<i>Total surface area</i>
cx, cy, cz	<i>Centroid of all solids</i>

date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

2.5 Model AS1 : Extended Validation Properties

2.5.1 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 two new fields in the statistics, which reflect if the Shove-IT information is implemented correctly and the value of the centroid of the 'Rod Assembly' in the context of its parent, the AS1 assembly.

For post-processing, a 'cobbled' file we be submitted. Vendors should trace the misplacements in the model via the VP2 information.

2.5.2 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/>.

2.5.3 Testing Instructions

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

2.5.3.1 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.

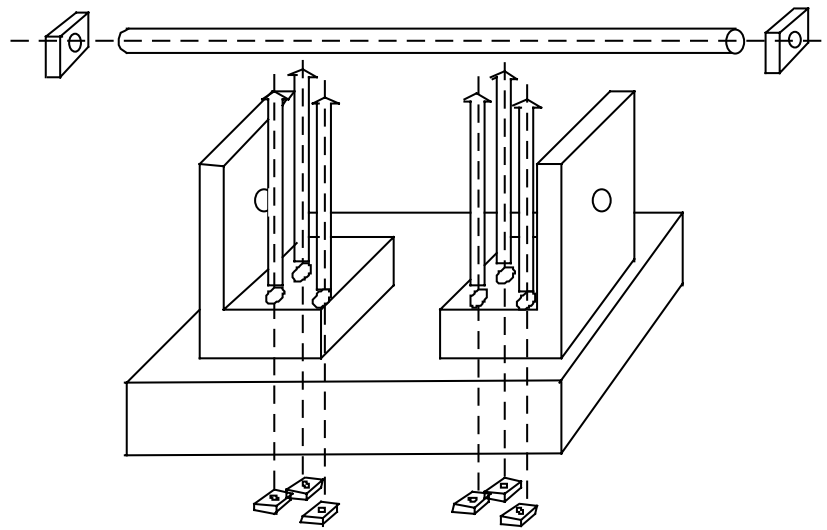


Figure 7: as1 shape

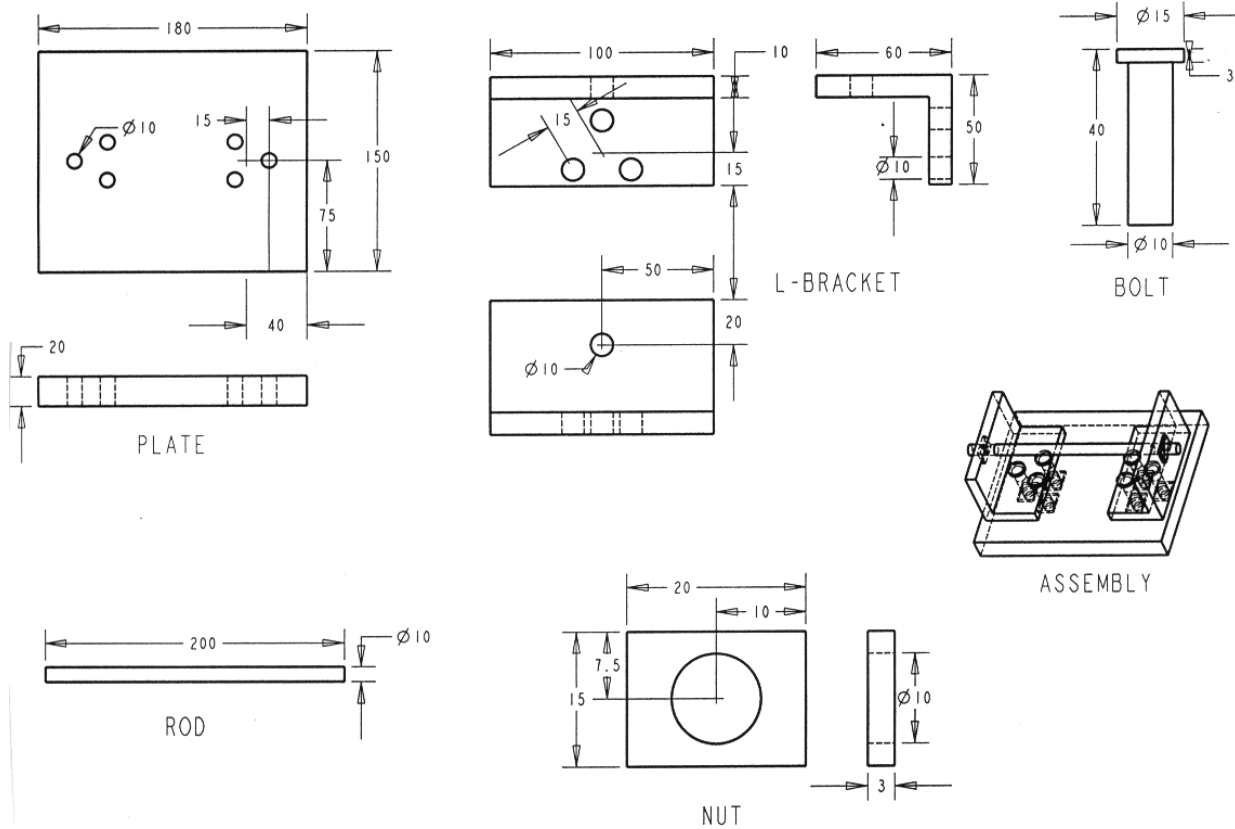


Figure 8: dimensions as1 (dimensions in mm)

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.

2.5.3.2 Statistics

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

model	<i>as1</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>
solids	<i>Number of solid instances (as opposed to components)</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	<i>Centroid of all solids (entire assembly) as received via the</i>

validation_cy validation_cz	<i>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>
lba1_cx lba1_cy lba1_cz	<i>Centroid of one instance of the 'L-Bracket assembly' with regard to its parent (AS1) as received via the extended validation property capability.</i>
lba2_cx lba2_cy lba2_cz	<i>Centroid of the other instance of the 'L-Bracket assembly' with regard to its parent (AS1) as received via the extended validation property capability.</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>

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.

2.6 Joint Testcase with PDM-IF

2.6.1 Motivation

This test case is an extension of the well-known as1 model, which has been tested several times before, and it aims for CAD-PDM 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 Round6J, 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.

2.6.2 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).

2.6.3 Testing Instructions

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

2.6.3.1 Model construction

For Round6J, 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.

2.6.3.2 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/>).

3.0 Production models: PM4

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 <prodmod_r6j.zip> containing a README file and 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)
Grinder Vise	AutoDesk Inventor 4.0	214	pm4-in-214.stp
Tommy Gun	AutoDesk Mechanical Desktop	214	pm4-ac-214.stp
Handle	Alias Studio 9.6	214	pm4-al-214.stp
Conductor Mount	Pro/E 2000i ²	214	pm4-pe-214.stp
Pump Rotor (1)	Euclid	203 <i>single file</i>	pm4-pe-203.stp
Pump Rotor (2)	Euclid	214 <i>external refs.</i>	pm4-pe-214.zip <i>unzips to 14 STEP files</i>
Hydroengine	HiCAD	214	pm4-hc-214.stp
Sifter Fork	Unigraphics 18.0	203	pm4-ug-203.stp
Drive Shaft	Unigraphics 18.0	203	pm4-ug2-203.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	<i>pm4</i>
system_n	<i>native system code (use the native system code for each model listed in the table in Section 3.3.1)</i>
system_t	<i>target system</i>
unit	<i>Units</i>

volume	<i>Total volume</i>
area	<i>Total surface area</i>
cx cy cz	<i>Centroid</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>