



**Test Suite for the
CAX Implementor Forum
Round 4J**

April - July 2000

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1.0 Introduction

This document describes the suite of test cases to be used for the fourth 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 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, , model viewing, drawing organization, 3D Text annotation, validation properties, and external references.

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 preprocessed (converted to STEP files) is unique for each CAD system. After preprocessing, the resulting STEP files are then to imported/post-processed be read in by participants

1.1 Functionality tested in this round

Functionality tested in this round relates to surface geometry, 3D text annotation/associative text, validation properties, model viewing, and external references.

Surface models are again tested because of previous findings that indicate that this exchange capability might still need some enhancement.

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 model viewing and drawing organization capability including the presentation of dimensions has already been tested in Round 2J. In addition, the scope of Round 4J includes optional testing of dimensional tolerances.

External references 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. In respect to the CAx IF, external references will be used to split a single STEP file into a file containing the part identification and assembly structure and several STEP files containing the component geometry. The PDM Implementor Forum (PDM-IF) will be testing this functionality as well, by post processing these files from the CAx-IF.

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
May 3 rd , 2000	CAx Implementor Forum conference call
May 10 st , 2000	Production models released
May 24 th , 2000	Second ConCall
June 2 nd , 2000	Initial STEP files and native stats due
June 16 th , 2000	STEP files and native stats frozen
June 27 th , 2000	Target stats due/ 3 rd ConCall
July 5 th , 2000	Target stats frozen
July 11 th , 2000	Pre-release of final stats
July 25 th , 2000	Review meeting for test round in Munich
July 26 th and 27 th , 2000	CAx Implementor Forum meeting in Munich

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 d2 : Draughting of block with 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 dimension information to the views. This model has already been tested in Round2J.

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/public/> and <http://www.cax-if.de/public/>).

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.

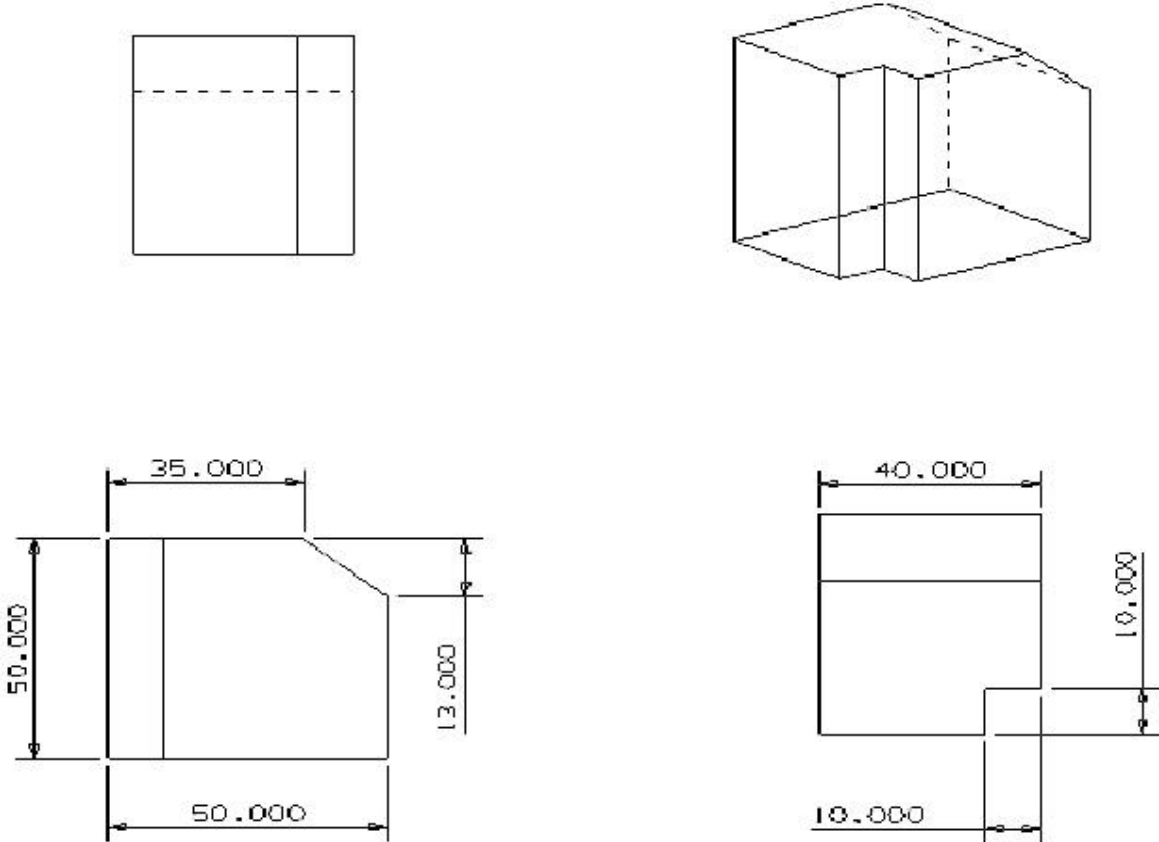


Figure 1: dimensions for solid for d2 (dimensions in mm)

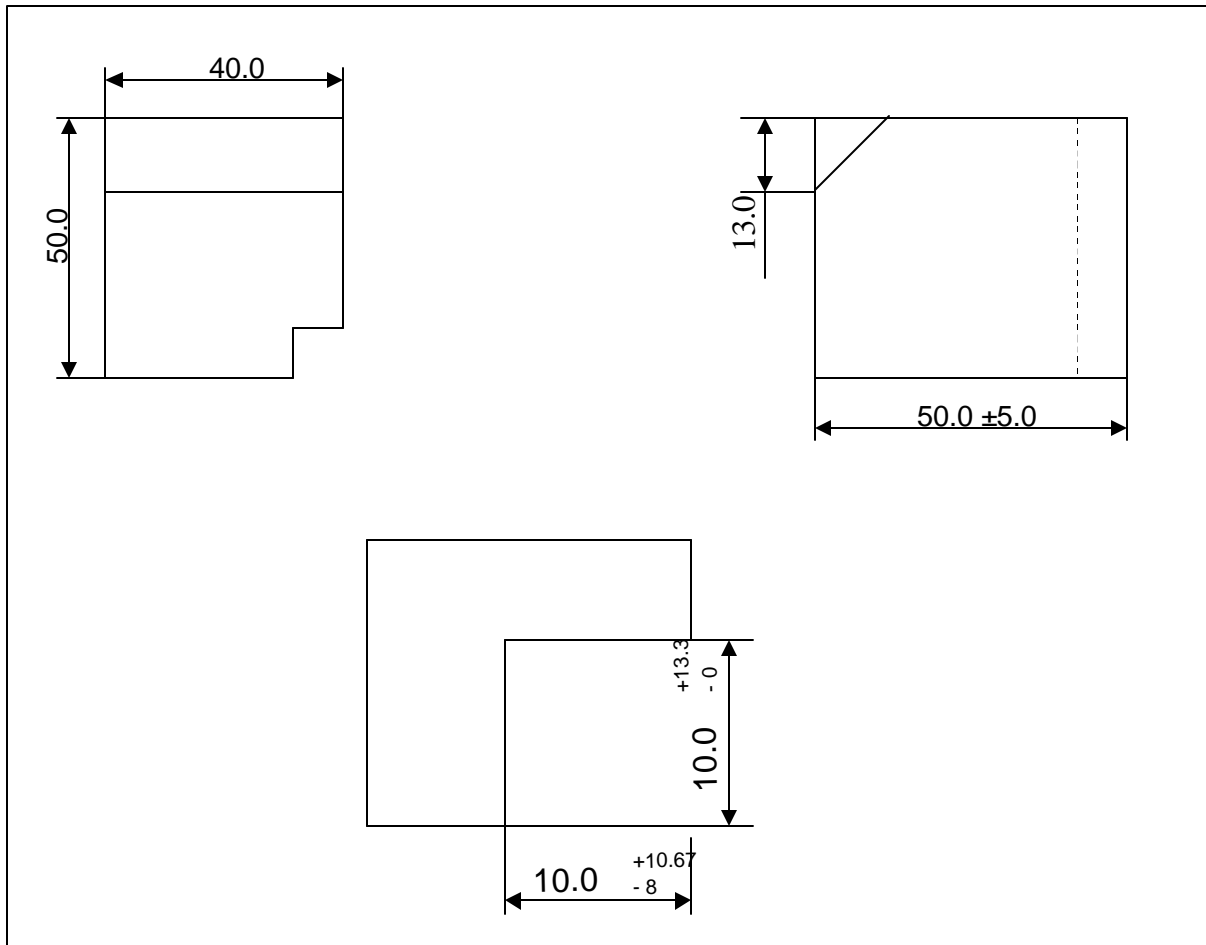


Figure 2: views on the drawing sheet with dimensions

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	d2
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_dim	<i>all: if the presentation information of all dimensions received corresponds to the test case specifications partial: if the presentation of the dimensions is incomplete or not completely as specified in this test case none: if no dimensions are presented or all of them do not fit with the specifications</i>
valid_associativity	<i>pass/fail – whether modifications of the shape result in an appropriate update of the views (check with new dimension)</i>
valid_sm	<i>pass/fail - whether target system considers target model valid</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_dim) 'na' must be used as code for that statistic.

2.2 Model s1 "space ship" : Validation Properties

2.2.1 Motivation

This synthetic model (a slightly abstracted version of an "Überraschungsei"-toy) is a model already known from previous testing activities of the CAx-IF. The model is re-used to test validation properties and 3D text annotation/text associativity. The model as used in Round3J can be re-used.

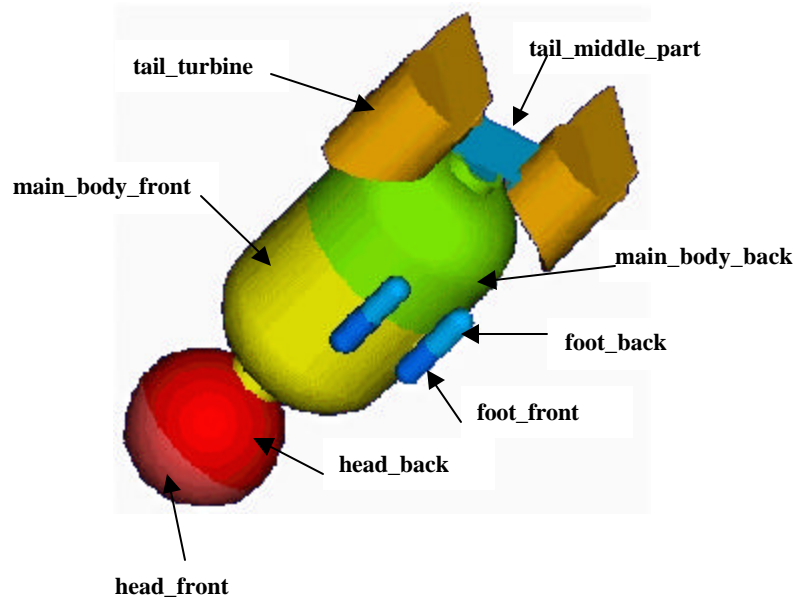


Figure 3: Annotated Shape of Space Ship s1.

2.2.2 Approach

See the approaches described in the CAx Implementor Forum Recommended Practices for *Geometric Validation Properties*, and *3D Associative Text* (see <http://www.cax-if.org/public/> or <http://www.cax-if.de/public/>).

2.2.3 Testing instructions

Please note that system vendors that do not support the validation property capability should not submit STEP files for this test case.

2.2.3.1 Construction of s1 "spaceship"

Dimensions

see *Figures given in the annex*

Assembly structure

The underlying assembly structure shall be (see figure above for part names):

Assembly	Component
<i>space_ship</i>	<i>mainbody</i> <i>head</i> <i>2x foot</i> <i>tail</i>
<i>head</i>	<i>head_front</i> <i>head_back</i>
<i>mainbody</i>	<i>mainbody_front</i>

	<i>mainbody_back</i>
<i>foot</i>	<i>foot_front</i>
	<i>foot_back</i>
<i>tail</i>	<i>2 x tail_turbine</i>
	<i>tail_middle_part</i>

Presentation

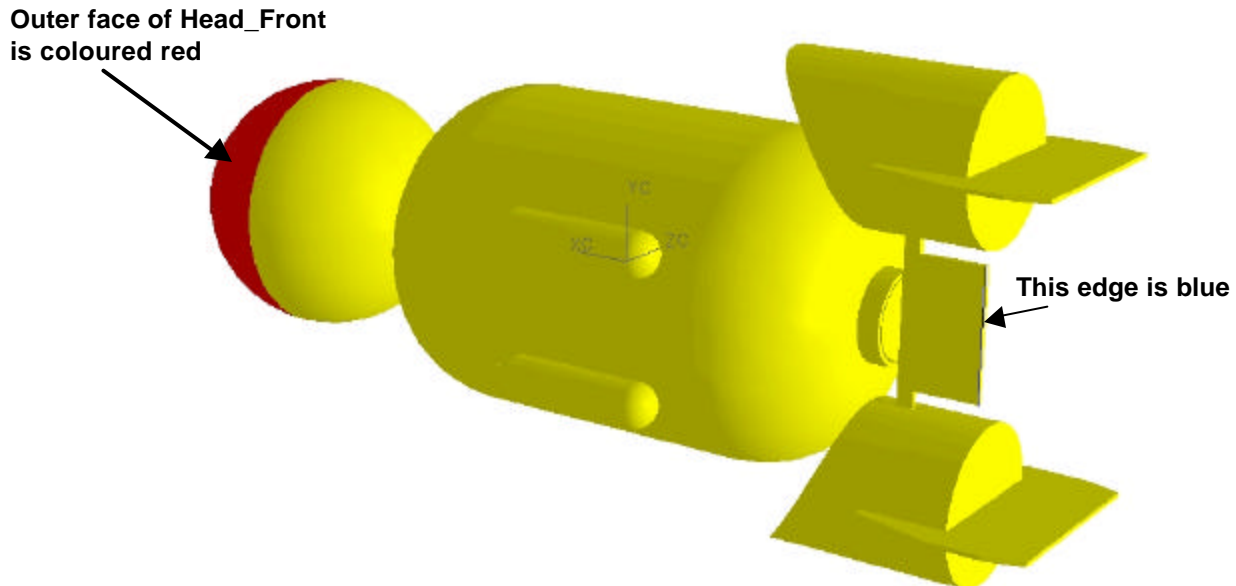


Figure 4: s1 Text Annotation Assignment

REMARK: the annotation is part of test case.

Annotations

Text is as shown in Figure 4. The following basic regulations are defined:

- style the two texts with an arbitrary colour
- associate the text "Outer face ..." to the outer face of the 'head_front'.
- associate the text "This edge ..." to the edge of the 'tail_middle_part'
- define the text "Outer face ..." as a multi-line text
- select an arbitrary placement of the text

2.2.3.2 Statistics

With each STEP file submitted for model s1 vendors must include a text file with the stats in comma-delimited form (.csv):

model	<i>s1</i>
system_n	<i>native system code</i>
system_t	<i>target system code (for native statistics use 'stp' for system_t)</i>
unit	<i>units</i>
solids	<i>number of solids</i>
valid_sm	<i>pass/fail – whether target system considers target model valid</i>
volume	<i>total volume of all solids</i>
validation_volume	<i>total volume of all solids as received via the validation property capability.</i>
valid_vol	<i>pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?</i>
area	<i>total surface area of all solids</i>
validation_area	<i>total surface area of all solids (entire assembly) as received via the validation property capability.</i>
valid_area	<i>pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?</i>
cx cy cz	<i>Centroid of all solids</i>
validation_cx validation_cy validation_cz	<i>Centroid of all solids (entire assembly) as received via the validation property capability.</i>
valid_cent	<i>pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?</i>
color_t1	<i>Text color used for the annotation text "Outer face..."</i>
color_t2	<i>Text color used for the annotation text "This edge..."</i>
valid_txt	<i>all/partial/none – whether the specified texts appear in the model</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</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.

2.2.3.3 Informal Testing of color functionality

As decided earlier we will be informally testing exchange of color with the S1 model, in this round. As initiated in round 3J of testing, we encourage those vendors who are interested in testing color to provide us with the screen captures (of native and target models) of the S1 models to visually validate the exchange of the color. The screen captures may be in either 'jpg' or 'gif' formats. The naming convention to be used is as follows:

For native model screen captures: s1-(vendor code)-nat.jpg [e.g. s1-pe-nat.jpg]

For target model screen captures: s1-(native vendor code)-(target vendor code).jpg [e.g. s1-pe-ac.jpg for autocad post-processing a PTC file]

Note: File extension may be .jpg or .gif depending on format of graphic.

2.3 Model xr1 : External references

2.3.1 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.

The PDM Implementor Forum plans on importing the resulting files in its fourth round of testing.

2.3.2 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/). A Recommended Practices for External References with annotated, relevant sections of the Usage Guide and an example file for this test case is available on the CAx-IF site (<http://www.cax-if.org/public/> and <http://www.cax-if.de/public/>).

2.3.3 Testing Instructions

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

2.3.3.1 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.

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

Description	STEP File name
1.: The assembly structure	xr1-(vendor code)-214.stp [e.g. xr1-tc-214.stp]
2.1: Plate Geometry	xr1-(vendor code)-plt.stp [e.g. xr1-tc-plt.stp]
2.2: L-Bracket Geometry	xr1-(vendor code)-lbr.stp [e.g. xr1-tc-lbr.stp]
2.3: Rod Geometry	xr1-(vendor code)-rod.stp [e.g. xr1-tc-rod.stp]
2.4: Nut Geometry	xr1-(vendor code)-nut.stp [e.g. xr1-tc-nut.stp]
2.5: Bolt Geometry	xr1-(vendor code)-blt.stp [e.g. xr1-tc-blt.stp]

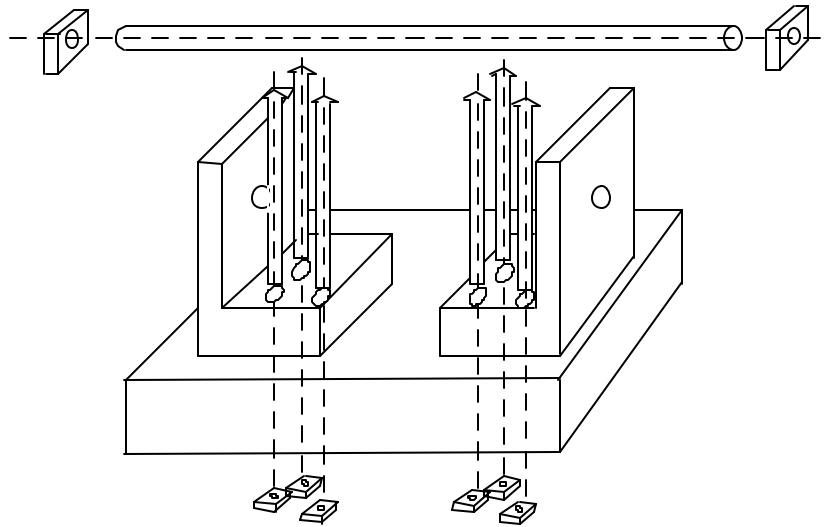


Figure 5: as1 shape

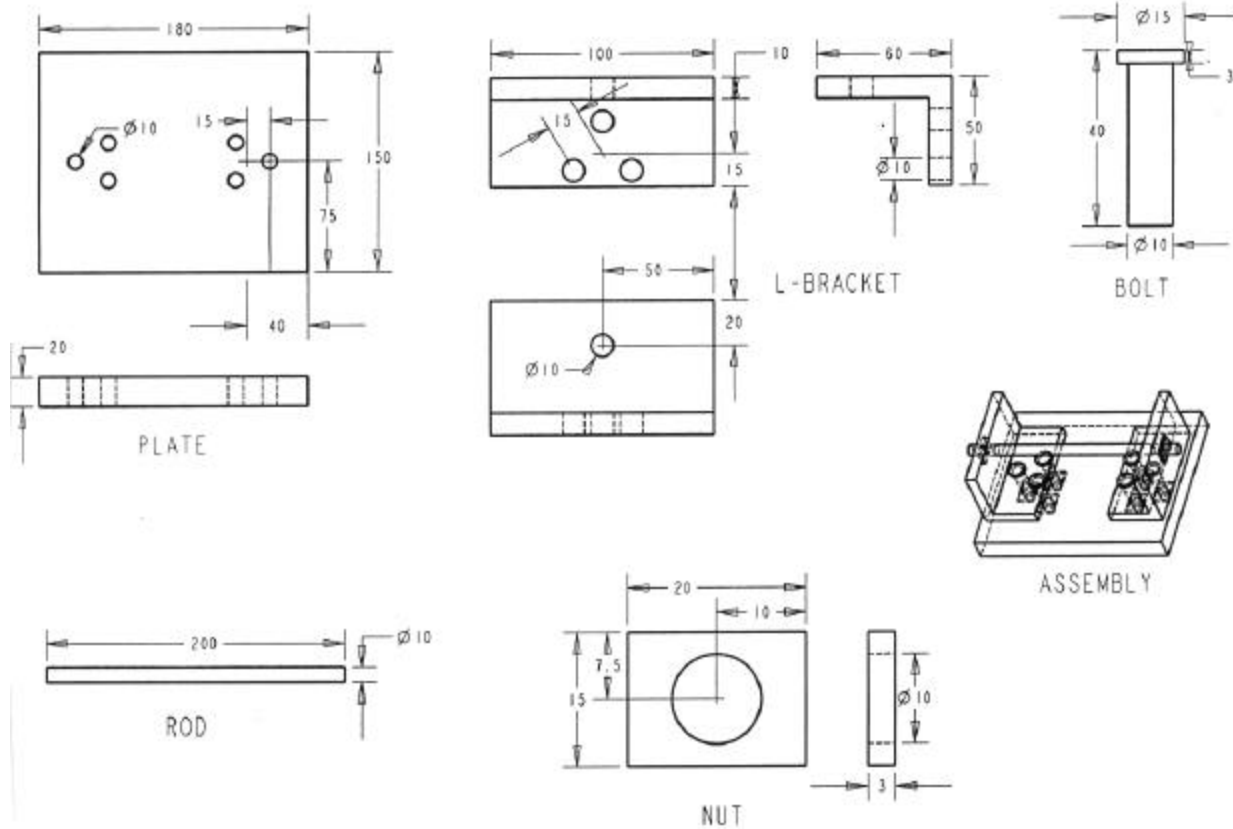


Figure 6: dimensions as1 (dimensions in mm)

Part names:

- Assembly:
 - as1
- Sub-Assemblies:
 - l-bracket assembly,
 - nut-bolt assembly,
 - rod assembly
- Components:
 - plate,
 - l-bracket,
 - bolt,
 - nut,
 - rod

2.3.3.2 Statistics

The statistics that must be associated with the 'root' STEP file xr1-(vendor code)-214.stp submitted for the xr1 test case are designed to represent the results for the following criteria and validations:

model	xr1
system_n	native system code

system_t	<i>target system code (for native statistics use 'stp' for system_t)</i>
unit	<i>Units</i>
solids	<i>number of solids</i>
valid_sm	<i>pass/fail – whether target system considers target model valid</i>
fref_found	<i>All – all file references for the external geometry can be found and the file node associations to model parts can be established</i>
	<i>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</i>
	<i>None – no references found or associations can not be established</i>
fref_processed	<i>All – all referenced files can be processed to construct the overall model</i>
	<i>Partial - all referenced files can be processed to construct the overall model</i>
	<i>None – referenced files can not be processed</i>
volume	<i>total volume of all solids</i>
area	<i>total surface area of all solids</i>
cx cy cz	<i>Centroid of all solids</i>

2.4 Model k1 : Surface Model

2.4.1 Motivation

Previous findings indicated that the exchange of surface models – geometrically bounded as well as topologically bounded – may need some enhancement. Possible side effects with newly implemented functionality caused a regression in surface model exchange capability. To study this phenomena the capability tested with the model is limited to surface model exchange written as geometrically and as well as topologically bounded.

2.4.2 Approach

No new capability involved.

2.4.3 Testing Instructions

2.4.3.1 Model construction

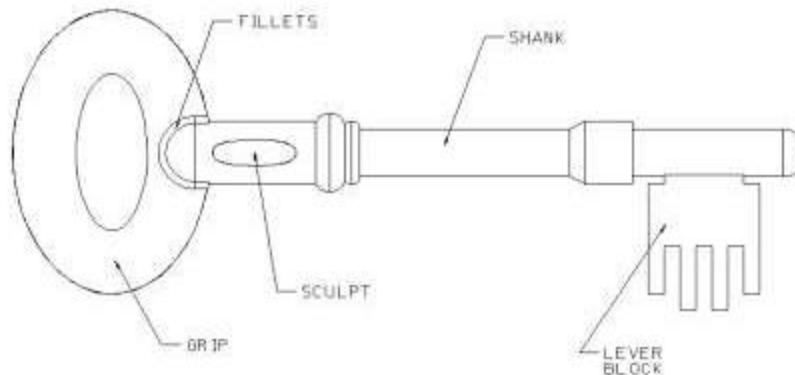


Figure 7 : Annotated shape of the k1 model.

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 step is 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.
- The last point is how two export the model: both topologically and geometrically bounded models are allowed. Vendors with systems supporting both capabilities may provide two STEP files. In order to distinguish the models, the usual naming convention is extended and it is recommended to use 'k1_top' for the topologically bounded and 'k1_geo' for the geometrically bounded version of the key as model name.

2.4.3.2 Statistics

The model may be pre-processed in two variants: topologically bounded (model: k1_top) and geometrically bounded (k1_geo).

With each STEP file submitted for k1_top and k1_geo vendors must include a text file with the stats in comma-delimited form (.csv):

model	k1_top / k1_geo
--------------	-----------------

system_n	<i>native system code</i>
system_t	<i>target system code</i>
unit	<i>Units</i>
shells	<i>Number of shells in the model (not a success criteria).</i>
area	<i>total surface area</i>
valid_sm	<i>pass/fail - whether target system considers target model valid</i>
date	<i>date submitted</i>
issues	<i>short description of issues</i>

3.0 Production models

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 of 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_r4j.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	New / Retest (Round)	Schema	STEP File Name (in ZIP file)
--------------	---------------------------	---------------------------------	---------------	---

		(Round)		(in ZIP file)
Control valve assembly	UG 16.0	Retest (R3J)	203 + gvp	pm2-ug-203.stp
Suspension Arm	Pro/ENGINEER 2000i ²	New	214 DIS	pm2-pe-214.stp
Pump Housing	Pro/ENGINEER 2000i ²	New	203	pm2-pe2-203.stp
Manifold	I-DEAS MS 8	New	203 + gvp	pm2-id-203.stp
Pump Rotor	CASCADE OL 3.0	New	214 DIS	pm2-ec-214.stp
pulley assembly	AutoCAD 2000	Retest (R3J)	214 DIS	pm2-ac-214.stp
Mountain Bike	Inventor R1	New	214 DIS	pm2-in-214.stp
Housing block	CATIA V4.2.3	New	203	pm2-ct-203.stp
Arm	CATIA V4.2.3	New	203	pm2-ct2-203.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>pm2</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>
valid_sm	<i>pass/fail – whether target system considers target model valid</i>

date	<i>date submitted</i>
issues	<i>short description of issues</i>

3.3.3 Post processing recommendations

3.3.3.1 Healing on import

In order to achieve a realistic testing scenario for production models, it is recommended that the importing system "heal" the STEP models on import if that functionality is provided in the target system.

3.3.3.2 Screen captures

Vendors are also requested to submit screen captures for the production models post processed. This will aid in issue resolution during the CAx IF Round 4J wrap-up meeting. Again, either 'jpg' or 'gif' graphic format is acceptable. The file naming convention is as follows:

pm2-(vendor code)-(target vendor code).jpg [e.g. pm2-pe2-ac.jpg]

Annex

Dimensions for s1 (space ship) shape

The following figures show the dimensions of the space ship design. Measures are given in centimetres.

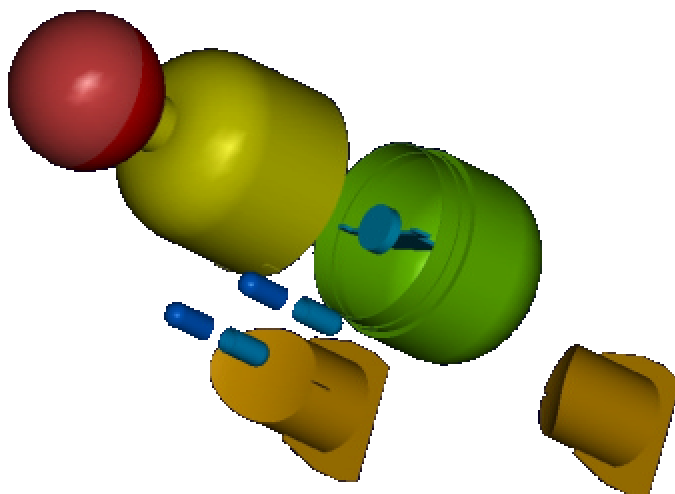


Figure 8: s1 - overview of parts of s1

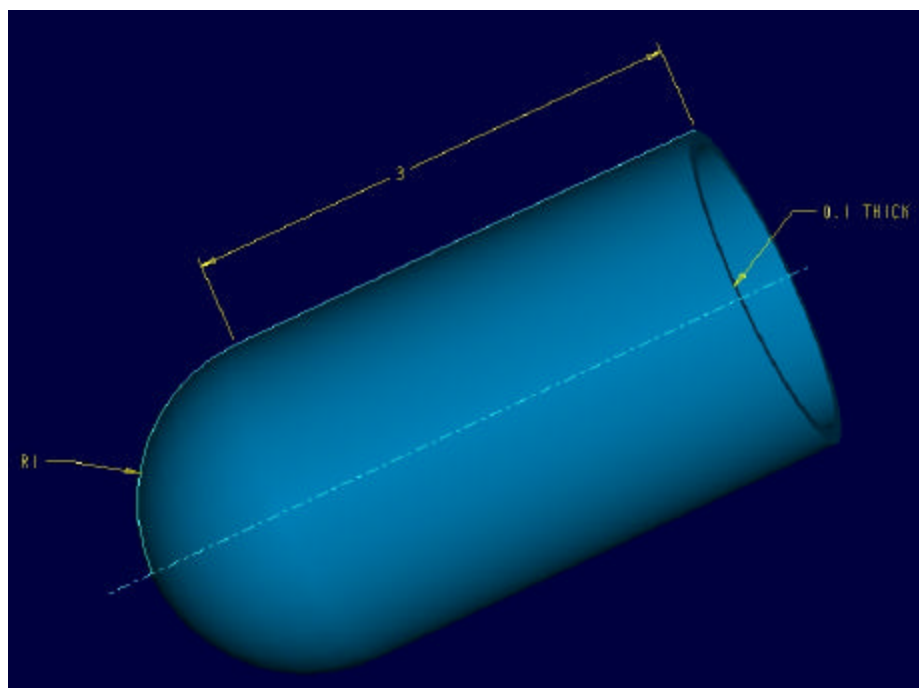


Figure 9: s1 - foot back

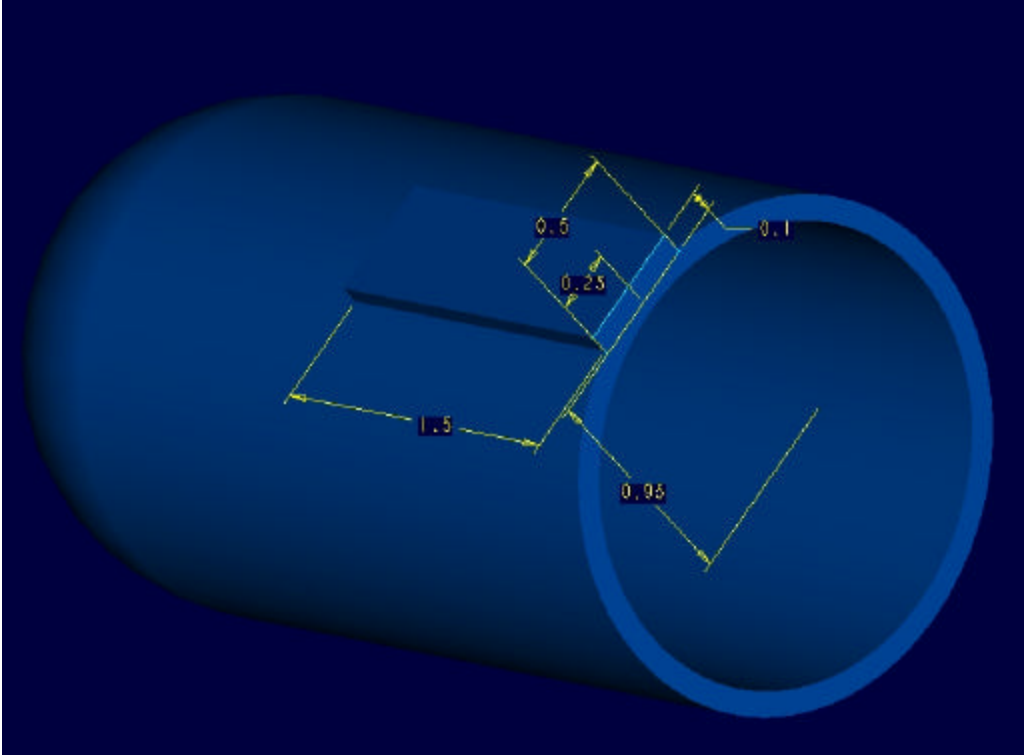


Figure 10: foot_front

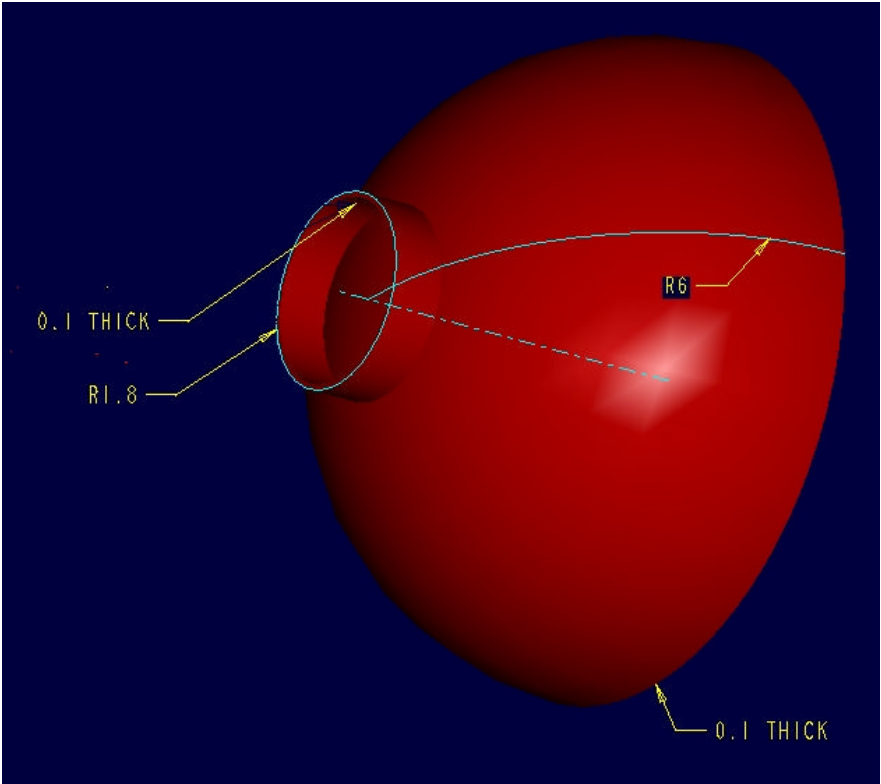


Figure 11: s1 - head_back

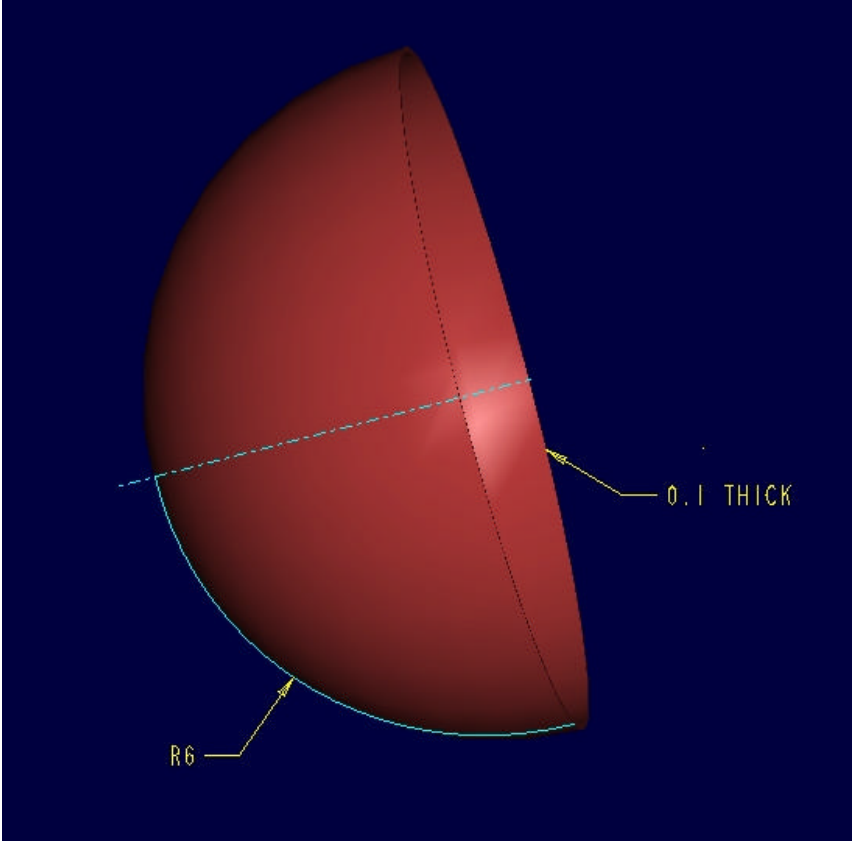


Figure 12: s1 - head_front

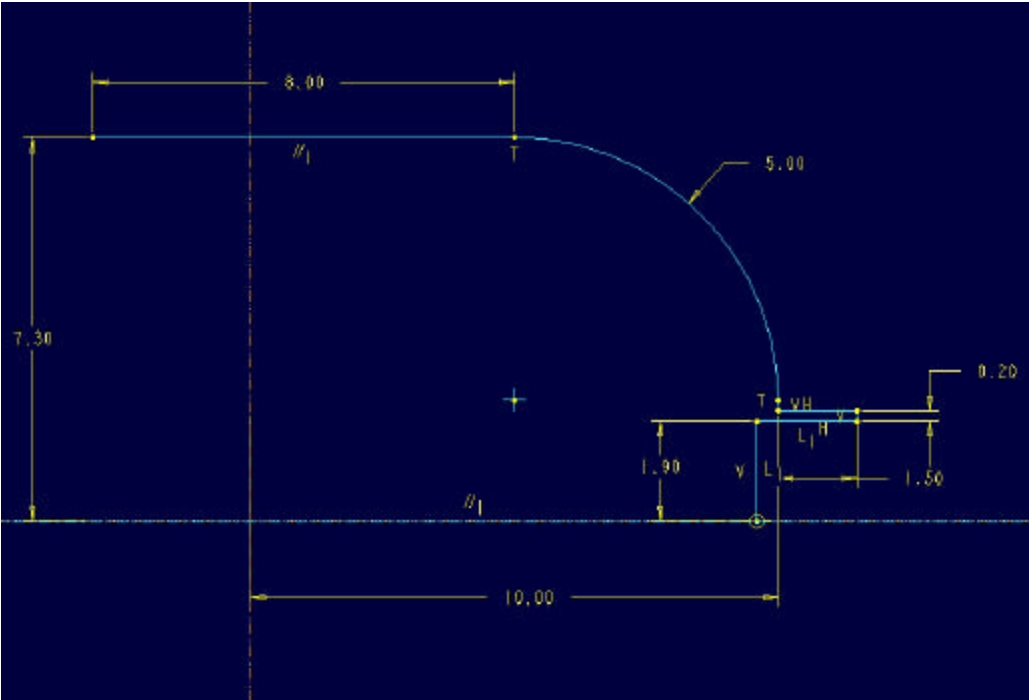


Figure 13: s1 - main_body_back

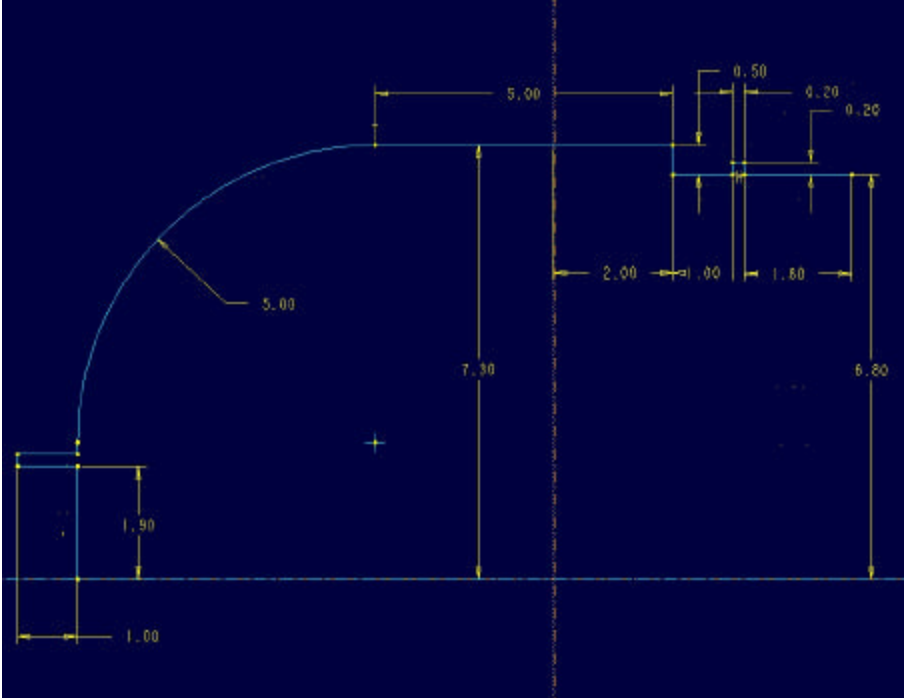


Figure 14: s1 - main_body_front

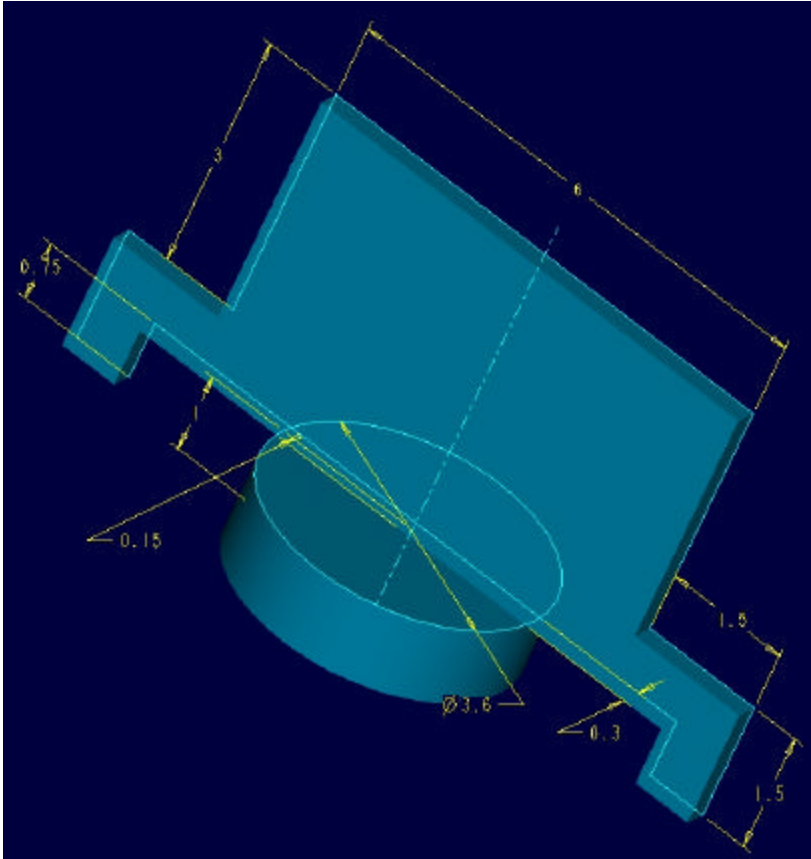


Figure 15: s1 - tail_middle_part

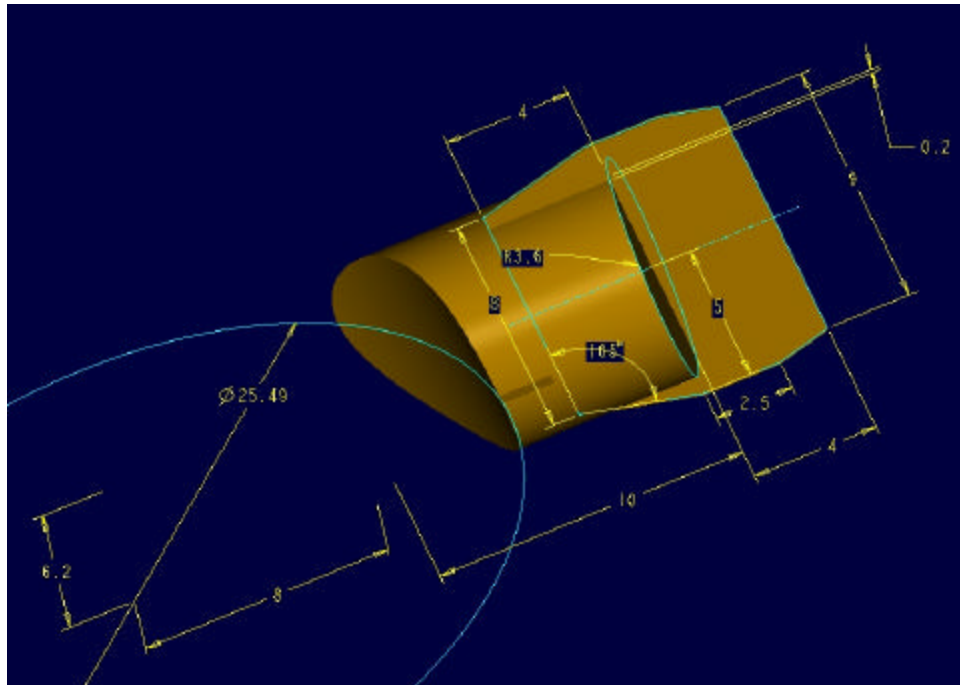


Figure 16: s1 - tail_turbine

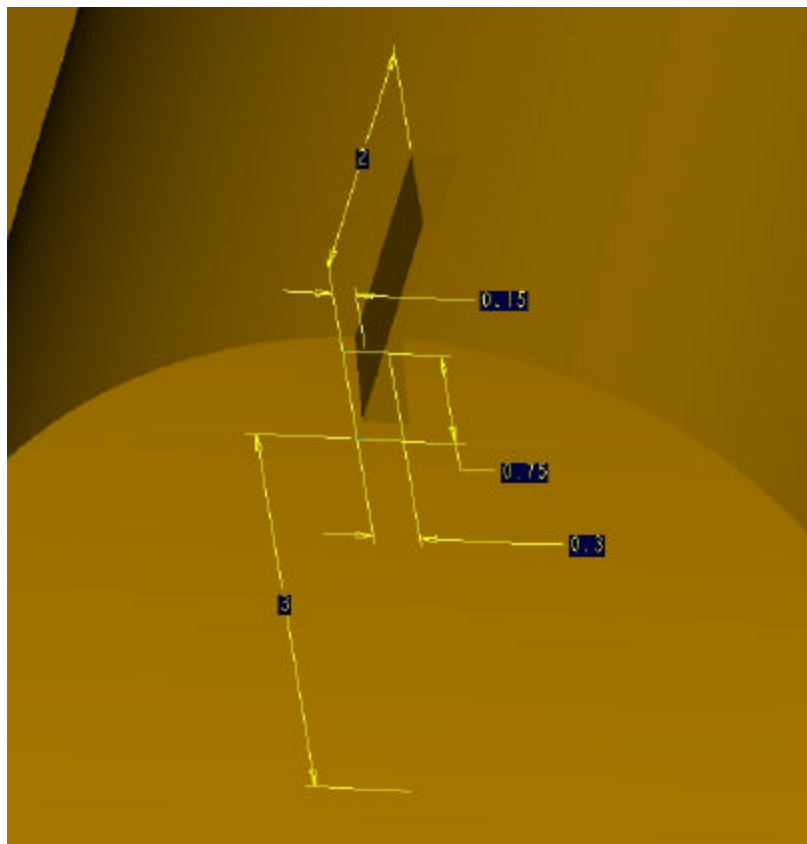


Figure 17: s1- detail nut of tail_turbine