Test Suite for the CAx Implementor Forum Round 3J

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1.0 Introduction

This document describes the suite of test cases to be used for the third 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 STEP processors interoperability and conformance.

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 capabilities form features (round_hole), model viewing, drawing organization, colours, 3D annotation and validation properties.

Production models are provided for solid 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 be read in by all participants

1.1 Functionality tested in this round

Functionality tested in this round relates to colors, 3D annotation/associative text, validation properties, form features, and model viewing functionality.

Colors includes the capability to assign colors to solids, assign overriding face colors, and overriding edge colors to the model

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 organisation capability has already been tested in rounds 1J and 2J.

Form features are a capability to logically mark-up portions of shape with relevance to design or manufacturing.

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 stats etc. are outlined in a separate document 'General Testing Instructions'. The general instructions can be retrieved from CAx Implementor Forum web sites.

Specifically, for this round of testing it is recommended in general to write STEP files in respect to AP214 DIS. Nevertheless vendors can send AP203 + modular extension files in.

1.3 Schedule

Date	**Action**
December 7th, 1999	CAx Implementor Forum conference call
January 15th, 2000	Production models released
February 1st, 2000	Initial STEP files and native stats due / 2nd ConCall
February 10th, 2000	STEP files and native stats frozen
February 25th, 2000	Target stats due
March 3rd, 2000	Pre-release of final stats
March 21st, 2000	Review meeting for test round in Myrtle Beach
March 22nd and 23rd, 2000	CAx Implementor Forum meeting in Myrtle Beach

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.

2.0 Synthetic test case specifications

2.1 Model d1 : draughting of block

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. As a first synthetic test for this new capability this test is kept deliberately simple.

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/ or 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 figures 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 below.

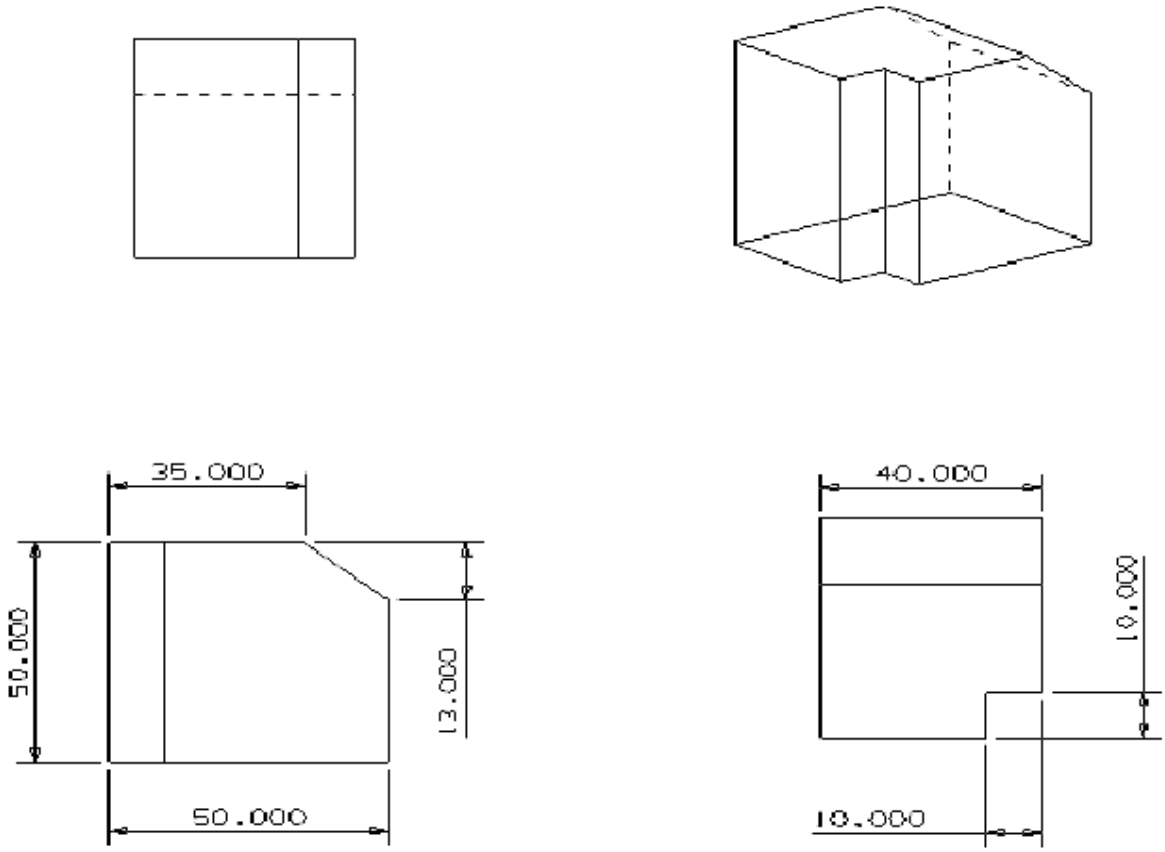

Figure 1: dimensions for solid for d1 (dimensions in mm)

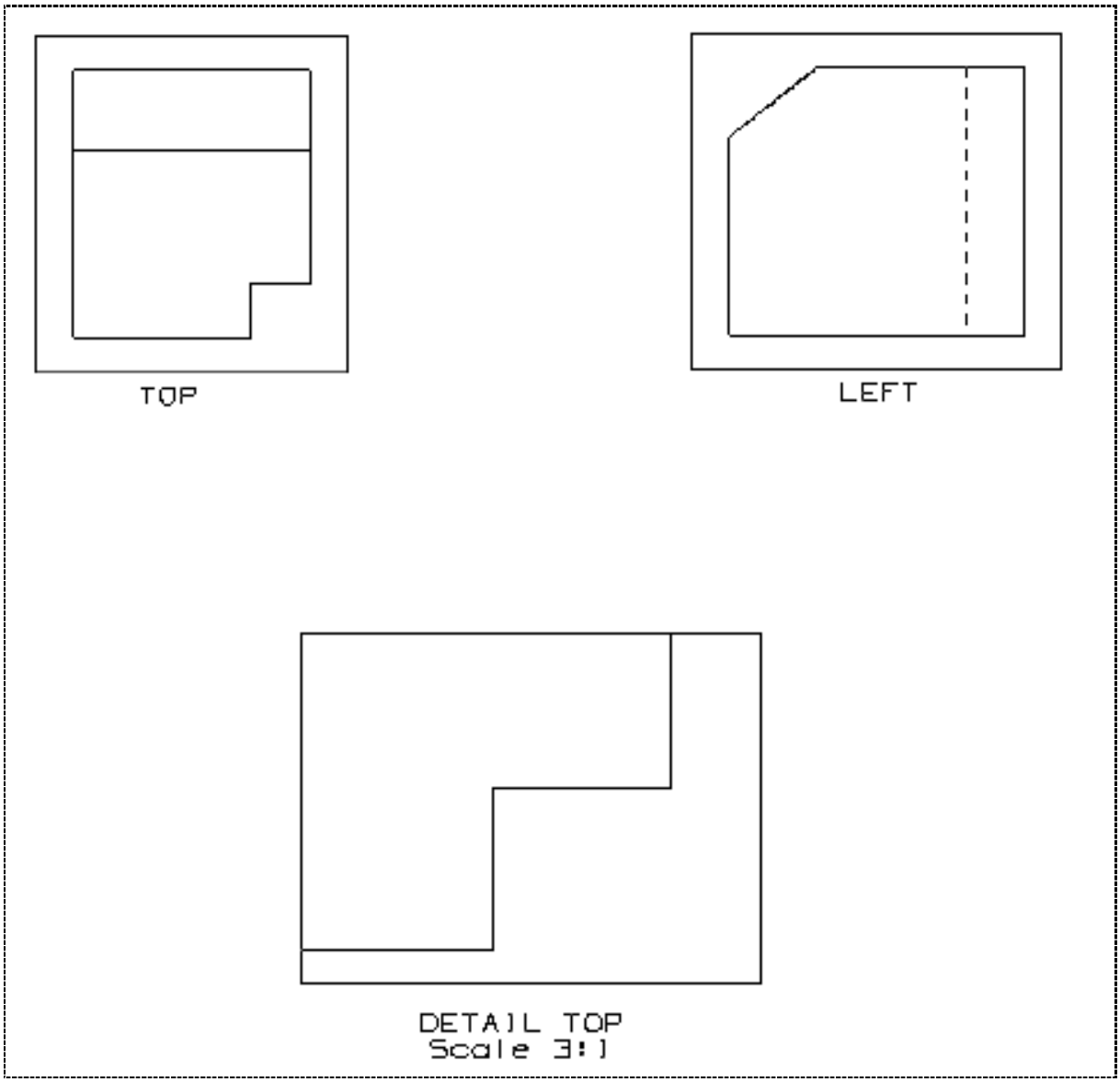

Figure 2: views on the drawing sheet

The layout of the views on the sheet should be as above indicated, 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

2.1.3.2 Statistics

The statistics that must be associated which each STEP file submitted for the d1 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
- Add any dimension to test the functionality of the drawing. A dimension shall be added in the target system in order to inspect the associativity between the shape and the presentation.

model	*d1*
system_n	*native system code*
system_t	*target system code (for native statistics use 'stp' for system_t)*
views	*all/partial/none – whether the views appear on the sheet in the target system*
view_layout	*all/partial/none – whether the views appear with right placement and orientation in the target system*
valid_associativity	*pass/fail – whether modifications of the shape result in an appropriate update of the views (check with new dimension)*
valid_sm	*pass/fail – whether target system considers target model valid*
date	*date submitted*
issues	*short description of issues*

2.2 Model as1 : Validation properties

2.2.1 Motivation

as1 is a model already known from previous testing activities of STEPnet and ProSTEP. The model is re-used to test validation properties.

2.2.2 Approach

See the approach described in the CAx Implementor Forum Recommended Practices for *Geometric Validation Properties* (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 validation properties capability should not submit STEP files for this test case.

2.2.3.1 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.

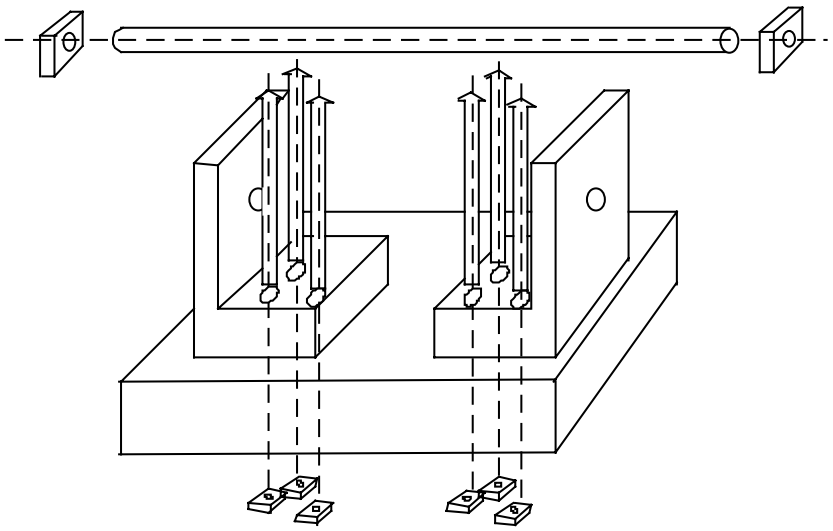

Figure 3: as1 shape

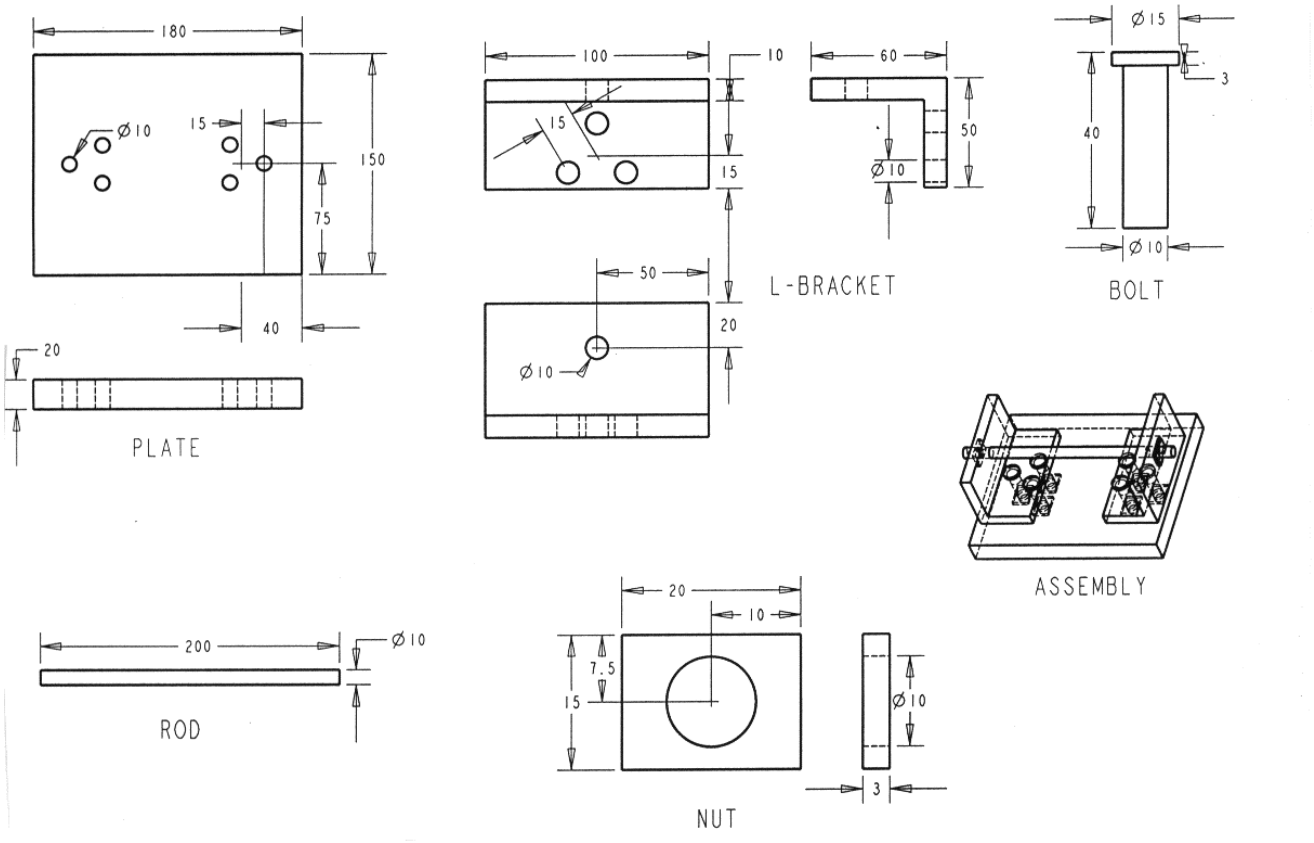

Figure 4: dimensions as1 (dimensions in mm)

Part names:

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

Validation properties

The values for the overall volume of the assembly and its centroid as well as the total surface area of the I-bracket assembly shall be computed and transferred via the STEP file. The statistics for target systems shall indicate whether these values match those computed in the target systems.

2.2.3.2 Statistics

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

model	*as1*
system_n	*native system code*
system_t	*target system code (for native statistics use 'stp' for system_t)*
unit	*Units*
solids	*number of solid instances (as opposed to components)*
valid_sm	*pass/fail – whether target system considers target model valid*
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 validation_cy validation_cz	*Centroid of all solids (entire assembly) as received via the 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?*
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.

2.3 Model s1 "space ship" : Colors and Annotation Text

2.3.1 Motivation

This synthetic model (a slightly abstracted version of an "Überraschungsei"-toy) is used to test color exchange capabilities. 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 the AP 214 recommended practices and the corresponding AP 203 application extension and thus should also be interoperable. The model as used in round 1J can be re-used.

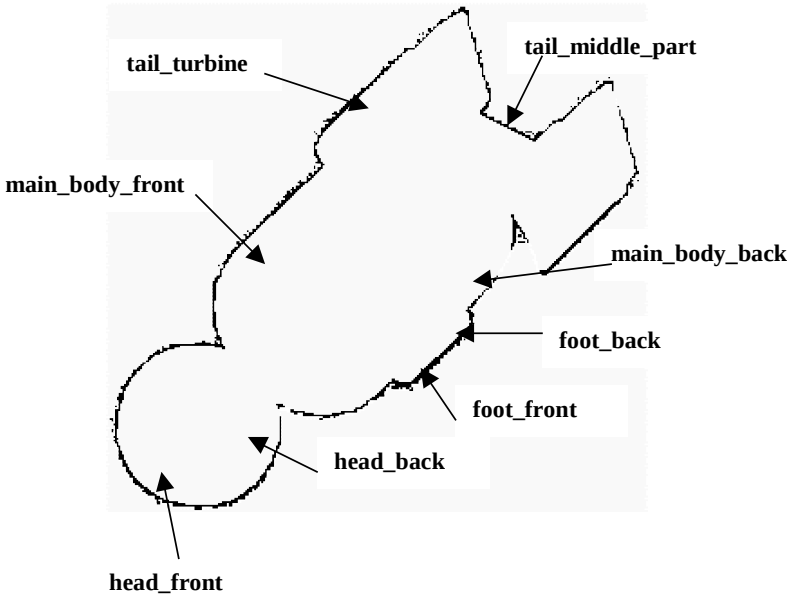

Figure 5: Annotated Shape of Space Ship s1.

2.3.2 Approach

See the approaches described in the CAx Implementor Forum Recommended Practices for *Colors and Layers and Associative Text* (see http://www.cax-if.org/public/ or http://www.cax-if.de/public/).

2.3.3 Testing instructions

Please note that system vendors that do not support associative text or colors capabilities should not submit STEP files for this test case.

2.3.3.1 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**
space_ship	*mainbody*
	head
	2x foot
	tail
head	*head_front*
	head_back
mainbody	*mainbody_front*

	mainbody_back
foot	*foot_front*
	foot_back
tail	*2 x tail_turbine*
	tail_middle_part

Presentation

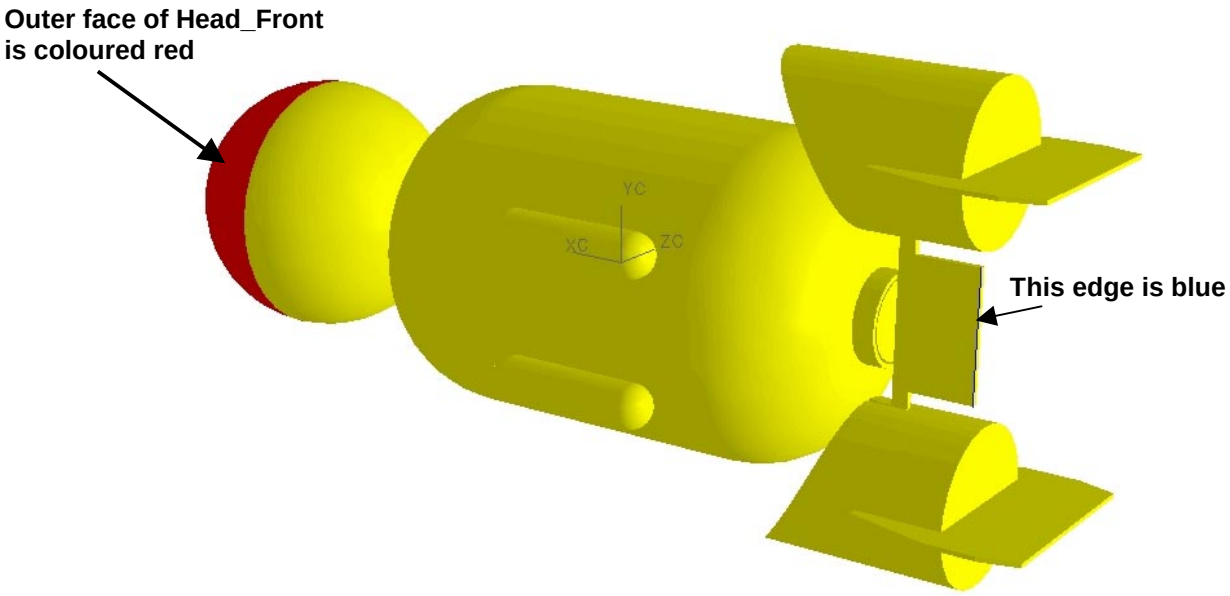

Figure 6: s1 Presentation and Text Annotation Assignment

REMARK: the annotation is part of test case.

Solid colors.

All the solids in the assembly must be colored 'yellow'.

Overriding Face color.

The outer face of the component 'head_front' as shown in Figure 6 above must be colored 'red'.

Overriding Edge color.

The edge of the component 'tail_middle_part' as shown in Figure 6 above must be colored 'blue'. An enlarged view of this section of the assembly is shown in Figure 7.

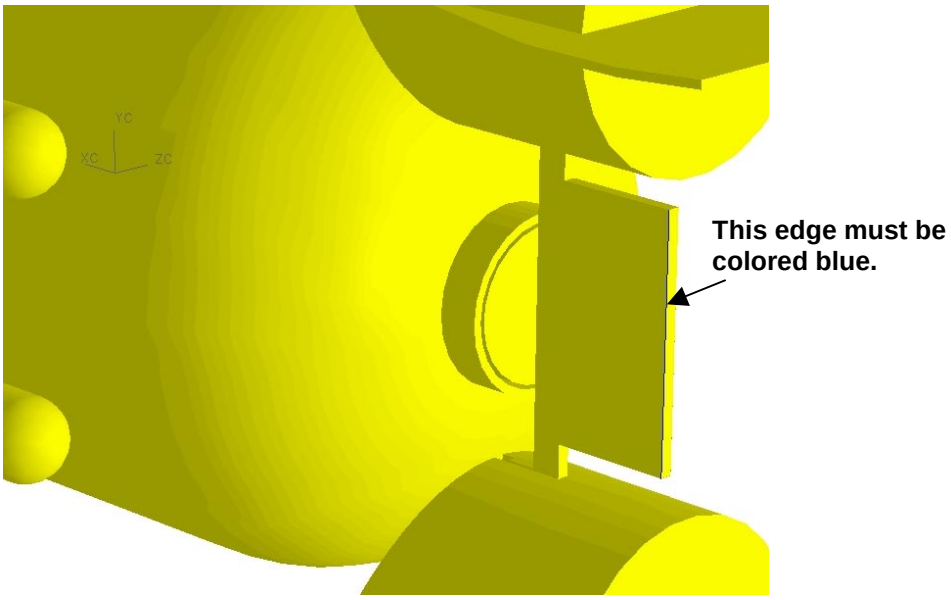

Figure 7: Enlarged View of the 'tail_middle_part' showing Overriding Edge

Annotations

Text is as shown in Figure 6. 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

2.3.3.2 Statistics

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

model	*s1*
system_n	*native system code*
system_t	*target system code (for native statistics use 'stp' for system_t)*
unit	*units*
solids	*number of solids*
volume	*total volume of all solids*

area	*total surface area of all solids*
cx cy cz	*centroid of all solids*
valid_sm	*pass/fail – whether target system considers target model valid*
color_t1	*text colour used for the annotation text "Outer face…"*
color_t2	*text colour used for the annotation text "This edge… "*
color_sd	*all/partial/none – if solid colors in the model are totally correct, partially correct, or lost completely.*
color_f	*all/partial/none – if overriding face colour in the model is totally correct, partially correct, or lost completely.*
color_e	*all/partial/none – if overriding edge colour in the model is totally correct, partially correct, or lost completely.*
valid_txt	*all/partial/none – whether the specified texts appear in the model*
valid_txt_assoc	*all/partial/none – whether the association of the text to the elements of the geometric model as described above is correct*
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.

2.4 Model f2 : Form Features

2.4.1 Motivation

This test case is specified as a first test for feature capability. It is deliberately kept simple in order to test basic functionality. In contrast to the f1 model from Round2J, a thread has been added to the 'through' hole. It does not reflect a production model.

The usage scenario for the features capability is currently focussed at the integration of the CAD/CAM process chain and the generation of STEP based data repositories including geometry associated with feature and machining information. In such business scenarios round-trips do not necessarily need to be supported.

In consequence – in contrast to usual test round practice – this test model will possibly not be read, and as well, written by all participants testing feature capability. To support this scenario the CAx-IF testing team will visually inspect the geometry with viewers and manually check the feature parameters in the files in order to assess result statistics data where not available.

2.4.2 Approach

See the approach described in the CAx Implementor Forum Recommended Practices for Form Features: *round_hole, thread and compound features*. The recommended practices are available from http://www.cax-if.org/public/ or http://www.cax-if.de/public/.

Note: The recommended practices for Form Features: thread and compound features will be made available (on the CAx IF sites) shortly.

2.4.3 Testing Instructions

Please note that systems vendors that do not support the scope of feature functionality related to this test case should not provide STEP files for it.

Since manual inspection of the files might be necessary, the participants are requested to closely follow the instructions resp. dimensions described to ease that process of checking.

2.4.3.1 Model construction

The figures below indicate the construction of the form features test case.

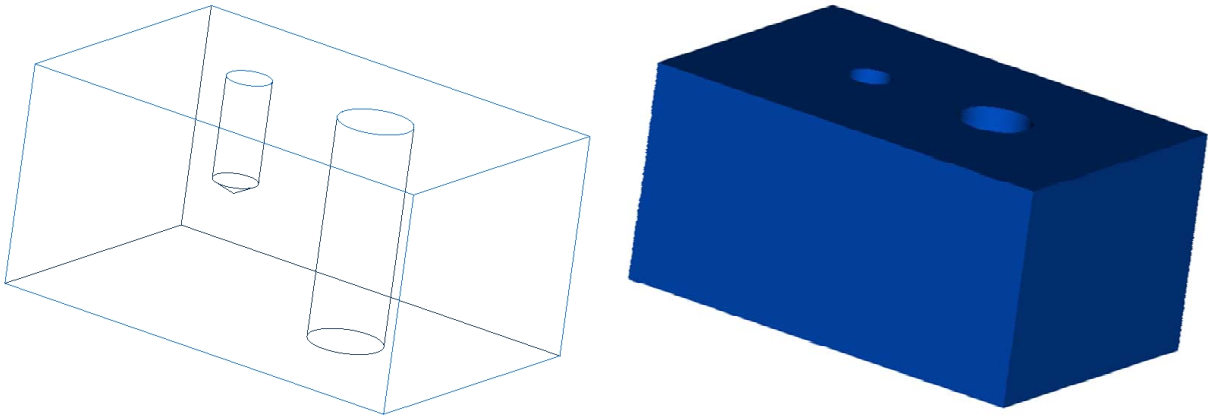

Figure 8: shape of test case with features.

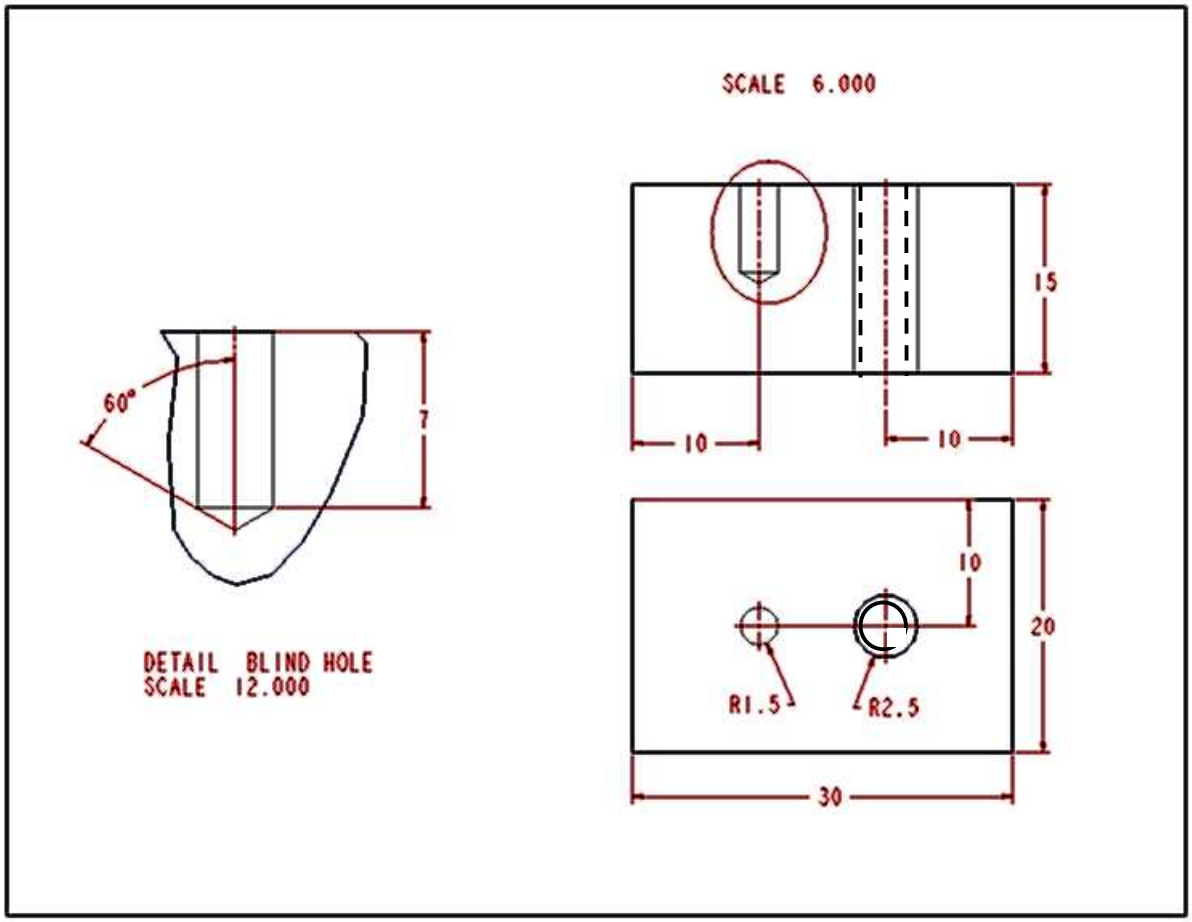

Figure 9: dimensions for f1 test case

number of threads	*(Depends on the axial unit of length of measure. For 'mm' use the REAL value* 2.0 *.)*
fit class	*'2E'*
form	*'M'*
hand	*'right'*
thread side	*'internal'*
major diameter	*(Derived from hole diameter)*
pitch diameter	*(Derived from hole diameter)*

Figure 10: Recommended values for mandatory attributes for thread specification

2.4.3.2 Statistics

The statistics that should be associated which each STEP file submitted for the f1 test case are designed to represent the results for the following criteria and validations:

- check if the identification of the geometric portions of the part shape that establishes the two round hole features is correct.
- check if explicitly defined feature parameters represent the correct values (in accordance to their geometric representation)
- check if the end conditions for the holes are represented correctly.
- check if the thread is correctly represented and assigned to the 'through' hole.
- check if the overall resulting geometry fits in the sending and receiving systems. The model deliberately uses very simple geometry, in order to isolate the feature capability testing from other side effects related to geometry testing. Nevertheless the volume shall be computed to verify if the application of the features indeed results in the anticipated solid geometry.

Model	*f2*
system_n	*native system code*
system_t	*target system code (for native statistics use 'stp' for system_t)*
unit	*Units*
Volume	*total volume of solid*
valid_sm	*pass/fail – whether target system considers target model valid*
Identification	*enter:* - *'fail', if there is no identification of the portions of geometry given /received to which the hole features relate, i.e. the boundary face / surfaces'* - *'partial', if there is an association of the feature definition to portions of geometry, but these do not fully/correctly reflect the feature geometry* - *'pass', if the given/received structure correctly identifies the hole features on the part shape* *Remark: the recommended practices currently advise to mark the removal volume that identifies the hole feature for that purpose. Systems – possibly not able to do this – might choose other reasonable approaches as e.g. identifying the face that constitutes the boundary of the hole feature. The successful exchange of such alternative solutions can also be considered as a 'pass'.*
Hole_Parame	*Enter:*

ters	- *'fail', if parameters for the implicit representation of the feature geometry (profile diameter, placement, depth, ..) are not at all given resp. correct* - *'partial', if not all of the parameters are consistently wrong / missing resp. correct* - *'pass' if the parameters for the implicit geometric representation of the hole features matches*
Thread_Parameters	*Enter:* - *'fail', if parameters for the implicit representation of the feature geometry (number of threads, form, hand, thread side, thread system,...) are not at all given resp. correct* - *'partial', if not all of the parameters are consistently wrong / missing resp. correct* - *'pass' if the parameters for the specification of the thread features matches*
end_cond	*enter:* - *'fail', the end conditions of the holes are not given/received* - *'partial', end conditions for the holes are given / received but not completely correct* - *'pass', end conditions are given / received correctly*
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.

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 automobile industry. These models have been supplied by companies and vendors.

3.2 Approach

STEP files provided by member companies and vendors have been analyzed 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 of the production models, simple comparison of mass property data (volume, surface area, CofG) 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_r3j.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	Native system code	Schema	STEP File Name (in ZIP file)
Control valve assembly	UG 15.0	ug	203	pm1-ug-203.stp
chassis	Pro/ENGINEER 2000i^2	pe	203	pm1-pe-203.stp
automobile bumper	Alias Stage 2.1	al	214 DIS	pm1-al-214.stp
cylinder head	I-DEAS MS 8B1	id	214 DIS	pm1-id-214.stp
pulley assembly	AutoCAD 2000	ac	203	pm1-ac-203.stp
Air Cylinder Assembly	AutoCAD 2000	ac2	203	pm1-ac2-203.stp
Machined part	CATIA V4.2.2	ct	203	pm1-ct-203.stp
Bracket	CATIA V4.2.2	ct2	203	pm1-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 center of gravity 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 stats. 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	*pm1*
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*
valid_sm	*pass/fail – whether target system considers target model valid*
date	*date submitted*
issues	*short description of issues*

Annex

Dimensions for s1 (space ship) shape

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

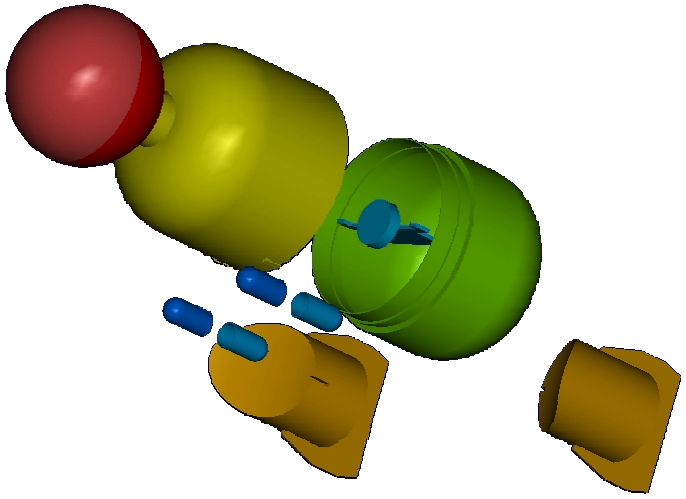

Figure 11: s1 - overview of parts of s1

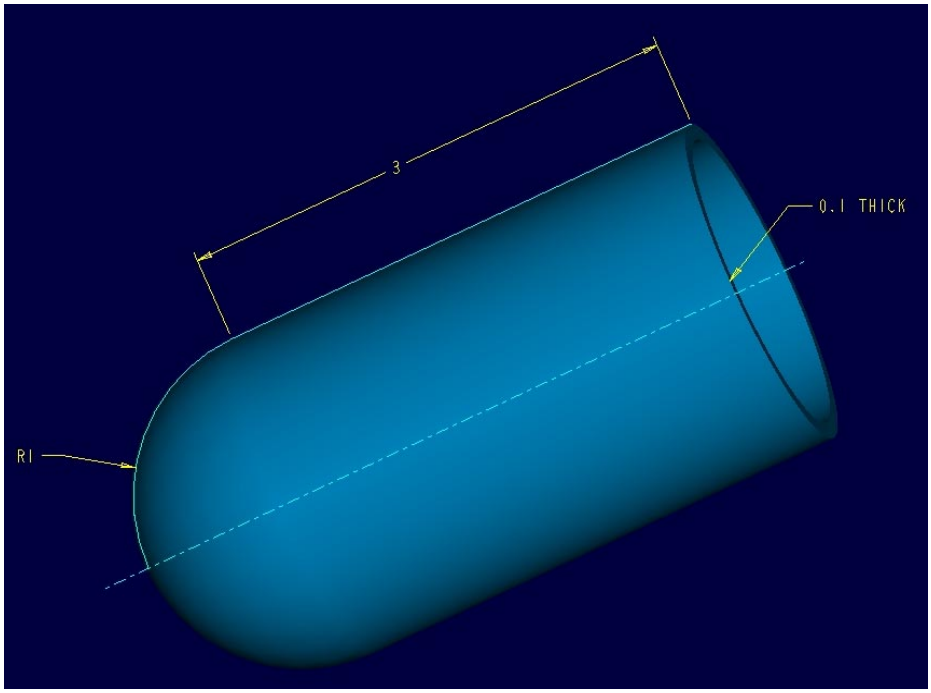

Figure 12: s1 - foot back

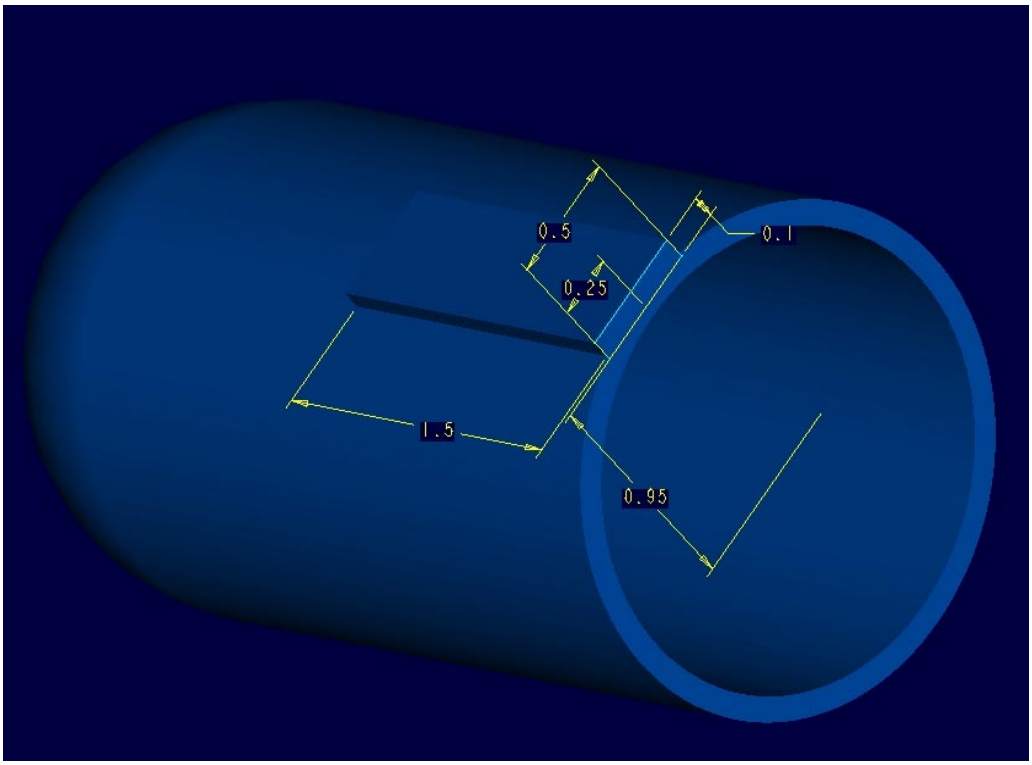

Figure 13: foot_front

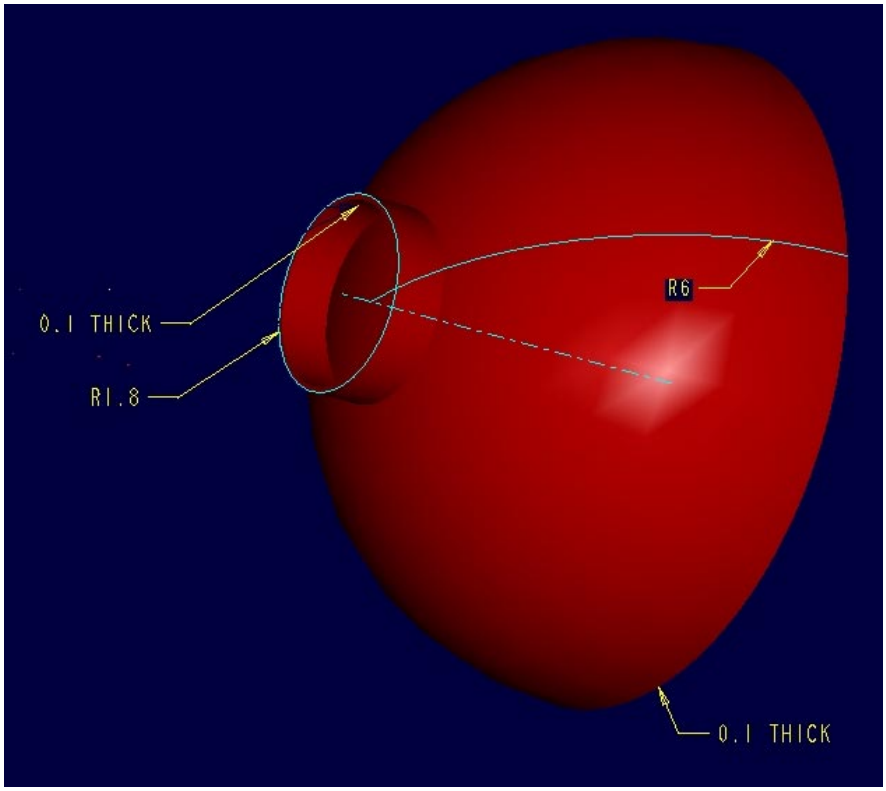

Figure 14: s1 - head_back

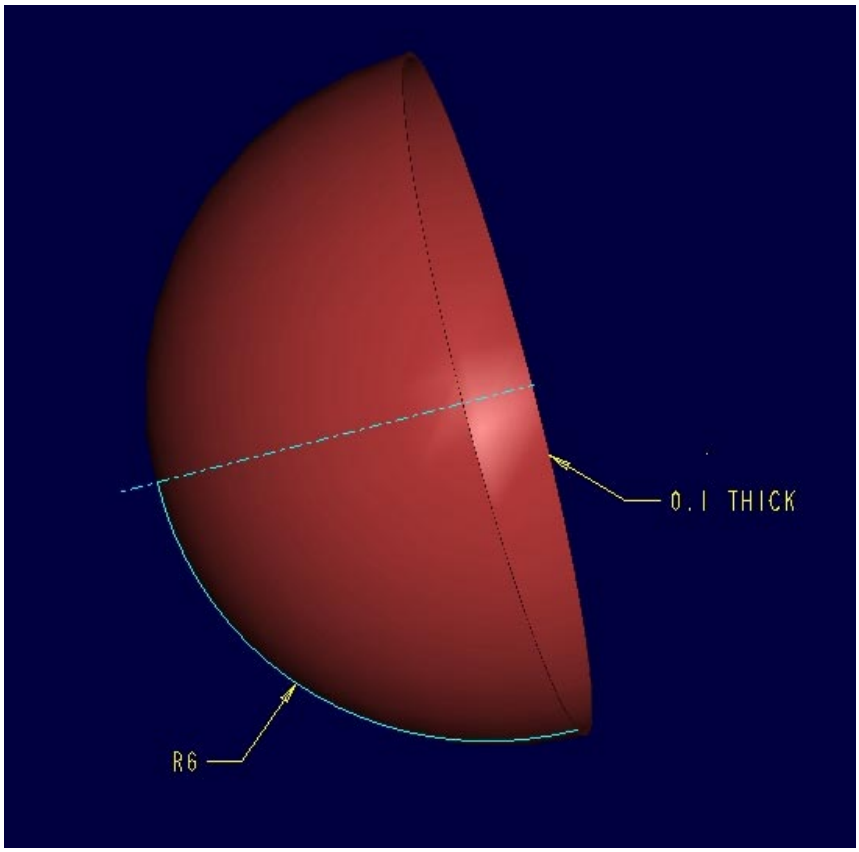

Figure 15: s1 - head_front

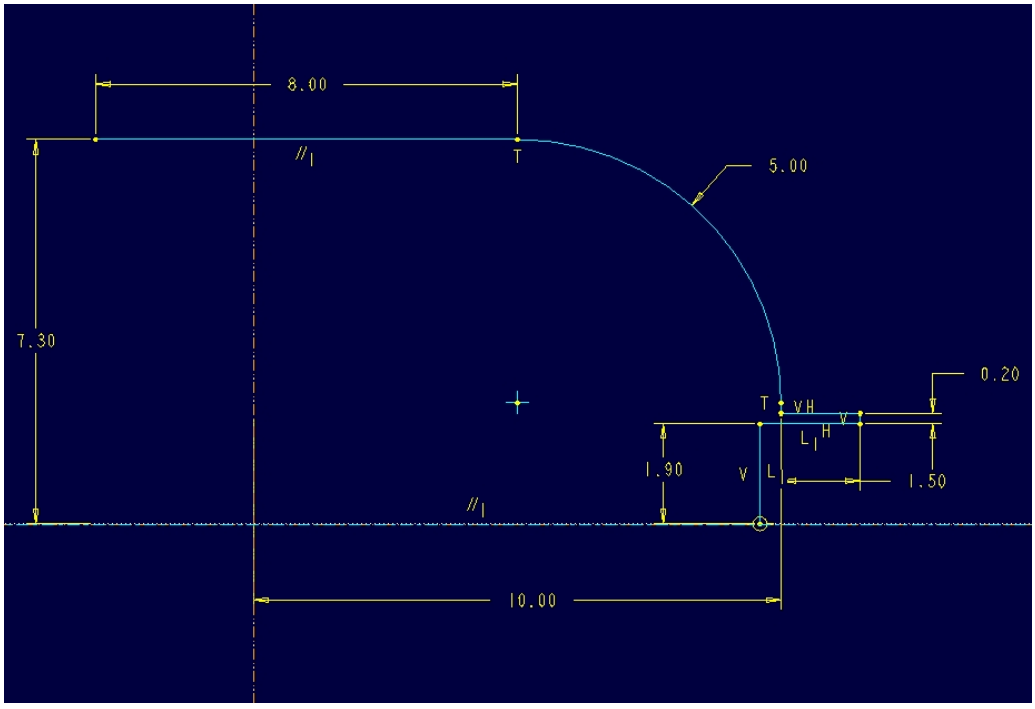

Figure 16: s1 - main_body_back

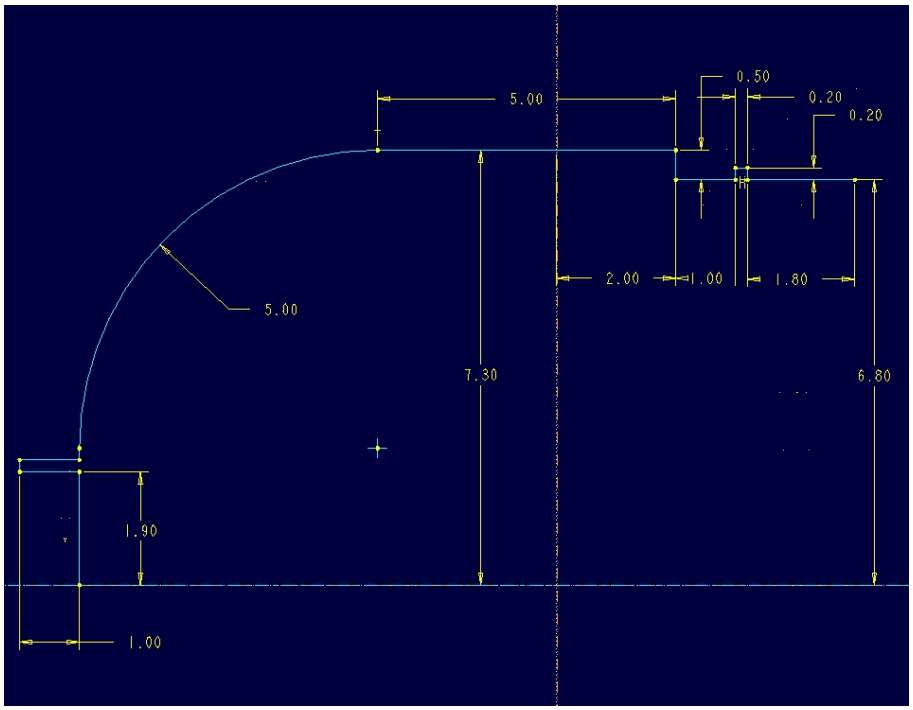

Figure 17: s1 - main_body_front

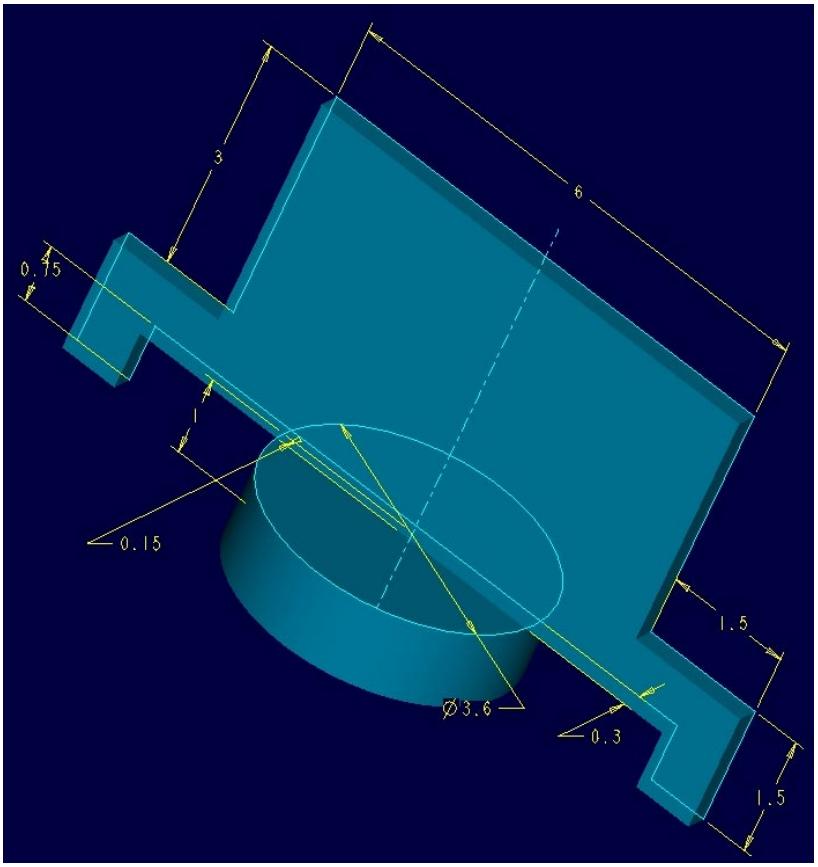

Figure 18: s1 - tail_middle_part

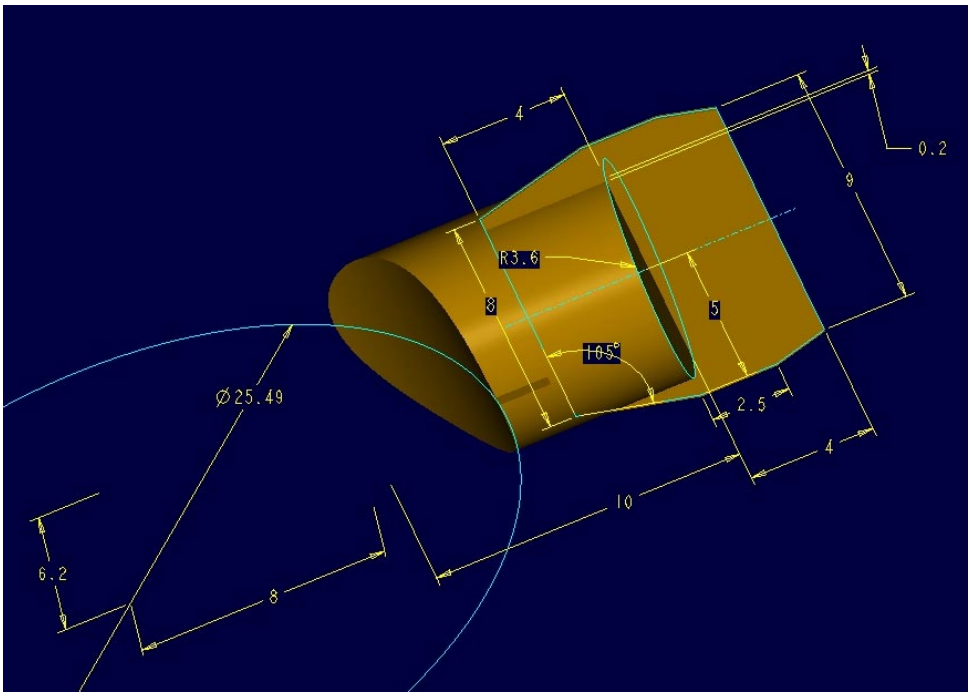

Figure 19: s1 - tail_turbine

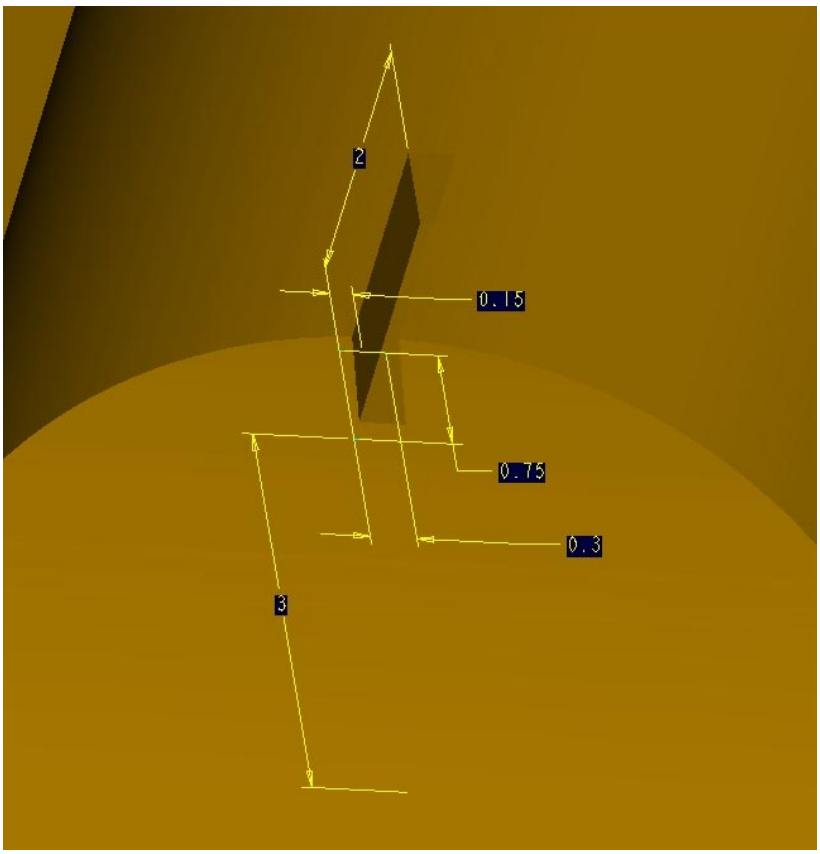

Figure 20: s1- detail nut of tail_turbine