

Solution Details - TPI 32869

Solution	32869
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Solution Actions

- Refresh Data
- Subscribe to this Solution

Title	Detailed Information Regarding Model Accuracy
Details	<div>Additional Information</div> <div><div>Description</div><div><p>This document describes the definition and use of model accuracy, which is set using #Setup, #Accuracy. This information expands on what is found in the PTC Help System. The main sections of this document are:</p><div>Accuracy Overview</div><div>Relative Accuracy</div><div>Absolute Accuracy</div><div>Modifying Accuracy: When is it necessary?</div><div>Responses to Statements Made by Pro/ENGINEER Users Regarding Accuracy</div></div><div><div>Alternate Technique</div><div><p>See Resolution below.</p></div></div><div><div>Resolution</div><div><div>Accuracy Overview</div><p>The PTC Help System states: "The Accuracy option modifies the computational accuracy of geometry calculations." This means that Accuracy gives the user the ability to control the quality of Pro/ENGINEER calculations of model geometry with respect to an exact mathematical solution.</p><p>Certain types of geometry require little computational effort to determine an exact solution, such as the geometry of a plane, cylinder, or cone. Other types of geometry, such as the intersection of two blended spline surfaces, require much more complex mathematical calculations to determine a solution. In these cases, Accuracy affects the calculations of geometry in order to achieve an acceptable level of approximation of the exact solution. Accuracy also affects the representations of the solid geometry to allow efficient memory usage, storage, and display.</p><p>Typically, a default relative accuracy of 0.0012 allows geometry to be calculated with a reasonable amount of computation and within a reasonable amount of time. Sometimes, however, specific model geometry may require that geometry calculations be sensitive to fine features or complex geometric shapes. Modification of accuracy for a model with this higher "level of detail" may be used as a last resort to assist Pro/ENGINEER in solving the model geometry.</p><p>Other important notes are:</p><div><p>Stated in equation form:</p>$A < F * s / d$<p>Where</p><p>A = recommended relative accuracy</p><p>F = a factor based on part geometry</p></div></div></div></div>

s = smallest distance which the system will consider entities to be separate

d = diagonal of box whose sides are parallel to default coordinate system axes and which just encloses the part

This relationship suggests that decreasing the value of relative accuracy for a given part increases Pro/ENGINEER's ability to measure shorter distances and finer detail in that model. Accuracy in effect determines the smallest distance between two entities (points, edges, surfaces) in which the entities are considered separate in space for geometry calculations. This provides the benefit of being able to create geometry which would otherwise not be possible due to insignificant differences in position in 3D space.

The F factor adjusts this equation to more accurately describe how the Pro/ENGINEER application code describes model geometry. It is determined by part geometry and its value is always less than or equal to 10. In the simplest case of a part consisting of a rectangular protrusion and simple extruded cuts, the value is about 10. In general, however, this factor should be considered to have a value of about 3 or less.

The diagonal of the part only increases in size. For example, if the model is cut in half, the diagonal value used does not become smaller.

To illustrate the meaning of this equation, consider the following example: With a part in the shape of a sheetmetal plate which has a largest diagonal 10 inches long and has accuracy set to the default 0.0012, the smallest edge which is still discernible is about $1/10 * 0.0012 * 10.0 \text{ in.} = .0012 \text{ inch}$. If the part accuracy is changed to 0.0001, the smallest edge can be about .0001 in. If the largest part diagonal is 1 inch and accuracy is default, then the smallest edge can be about 0.00012 in. With more complicated geometry, these values represent the lower bound of what distances can be discerned on the model. In general, the smallest distances would be about 3 times these values. Keep in mind that this smallest distance changes as features are added due to the change in the part diagonal.

Please note that the relation above is an approximation used to represent Pro/ENGINEER's mathematical solution for describing model geometry. Also, be aware that decreasing the value of accuracy typically results in both an increase in regeneration time as well as increased file size and memory usage. Generally, as more computation is required to calculate geometry, more space is required to store the additional information.

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Absolute Accuracy

Absolute accuracy can be specified for the model as an alternative to the relative accuracy method. Specifying absolute accuracy is roughly equivalent to directly setting the value for s (smallest distance) in the equation above, regardless of the size of the model. In general, relative accuracy should be used unless there are reasons to switch to absolute accuracy. Absolute accuracy should only be used when using imported features or when the absolute accuracy of two parts must be matched, such as during an assembly Merge operation. Setting the absolute accuracy of two parts to be the same will guarantee the geometry of both parts are looked at with the same accuracy.

A typical example of when to use absolute accuracy is when a small part is being merged onto a relatively large part. The small part may have some tiny geometry on it which is acceptable at the small part's relative accuracy. When this tiny geometry is merged into the large part, the large part's accuracy will not be sufficient for the new relatively extremely small geometry. By setting the absolute accuracy of the large part to match the small part, the large part will evaluate the extremely small geometry with the same accuracy as the small part.

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Modifying Accuracy: When is it necessary?

The PTC Help System states in italics "use the default accuracy until you have a reason not to do so." Despite this, accuracy may sometimes need to be modified to achieve the design intent. The PTC Help System gives the following examples which may require a change in accuracy:

1. placing a very small feature on a large part
2. intersecting (through merge or cutout) two parts of very different

- size
- 3. matching accuracy of imported geometry to its destination part
- 4. designing parts for manufacturing and mold design

Other Specific Examples of When or When Not to Modify Accuracy

Feature Creation

In certain situations adjusting accuracy will enable features to be successfully created. This typically occurs when the feature creates or intersects very detailed or tiny geometry. In general, however, it is better to save modifying accuracy as a last step after attempting other techniques for creating features, such as changing the regeneration order of the features on the part, changing the types of features on the part, or modifying/redefining features to avoid extremely detailed or tiny geometry. The decision to modify accuracy or not should be based on design intent. In some cases a small edge may be desired, so accuracy should be changed. If a small edge is not necessary, attempts should be made to avoid the edge from being created.

Absolute Accuracy Use in Pro/MOLDESIGN and Pro/CASTING

One of the few areas of Pro/ENGINEER where absolute accuracy should be set as a rule is in Pro/MOLDESIGN and Pro/CASTING, where the mold assembly is typically on the order of 3 or more times the size of the design model/reference part. When small edges on the design model are transferred onto the much larger workpiece assembly, the same relative accuracy will in general not be sufficient. Absolute accuracy should be set for the mold assembly using Select Part and selecting the reference part. All components in the assembly, with the exception of the workpiece part, should have the same absolute accuracy setting. The workpiece is an exception because no features are created on the workpiece, the surfaces and edges of the workpiece do not intersect other parts, and since workpieces are intended to not be modified so they can be used in multiple mold models.

Edge Display

The current setting of part accuracy has a direct effect on the display of edges in a model. In order to create a graphical display of a model, Pro/ENGINEER samples a certain number of locations along the length of an edge and connects these points with straight line segments. Decreasing the value of part accuracy affects this display by first creating a more accurate representation of the part geometry, then increasing the number of sampling points along the edges. In a vast majority of cases, however, there is no need to increase accuracy for this purpose. The Pro/ENGINEER command View, Model Display..., Edge/Line, Edge Quality (also accessible using the config.pro option EDGE_DISPLAY_QUALITY) more efficiently affects the display of model geometry. By changing its value from Medium to High or Very High, the number of sampling points is effectively doubled or tripled, respectively. This display option does not increase part size or regeneration time.

Mass Properties

When performing a mass properties calculation, the user has the option to enter a relative accuracy. This mass properties relative accuracy should not be confused with model relative accuracy. Mass properties accuracy affects the iterations of calculations used to determine mass properties. These iterations are based on the underlying model geometry which is affected by model accuracy. To improve mass properties results, an attempt should be made to first improve mass properties accuracy, then model accuracy only if necessary.

Responses to Statements Made by Pro/ENGINEER Users Regarding Accuracy

In 1997 a Pro/ENGINEER user on the Pro/USER Exploder newsgroup requested information from other users about when accuracy should be modified. Several other users then responded with their understanding of accuracy. Following are these statements and responses from PTC regarding the correctness of these statements:

1. user: importing Pro/E parts into Mechanica, so that Mechanica can distinguish between surfaces which are close together but have some slight offset

response: True, accuracy does effect the ability to distinguish between surfaces which are close together but have some slight offset. This distance between the surfaces can be considered the small edge distance for the model.

2. user: had to reduce accuracy to .0002 to get a x-section to display in a drawing

response: True, accuracy will sometimes help in this situation. X-sections occasionally do not display when created. Typically when this occurs, a message "Cross section may be incomplete" is displayed during creation of the x-section.

For drawing cross sections, Pro/ENGINEER internally creates a cut on the model. If this cut intersects an edge so that only a tiny portion of the edge is left to one side, then this issue will occur, and may be corrected with accuracy.

In part or assembly mode, Pro/ENGINEER internally determines the intersection of the cross section cutting plane with the model in the same manner as creating a Datum Curve using the Intr Surfs option. If this intersection does not form a closed loop of entities, the x-section may not be able to be created. This may occur, for example, when an edge almost, but does not quite, coincide with the cutting plane.

These are two examples of the types of geometry issues which may occur from the intersection of the x-section with the model. In general, it is best to attempt to modify/redefine the model or the x-section to correct this issue before attempting to modify accuracy due to the increase in regeneration and file size which generally occurs when decreasing the value of accuracy.

3. user: had to increase accuracy to create rounds, PTC AE said when rounds fail a) adjust order of rounds at corner b) adjust accuracy

response: As stated above, adjusting accuracy will sometimes aid in the creation of features. However, this should always be used as a last resort after attempting to determine the cause for being unable to create the feature and using other methods of model creation to avoid this cause. For example, several rounds can be combined into a single round feature using Advanced Round functionality with multiple sets and various transitions between the sets.

4. user: in some situations, evaluating small edges, a feature may fail unless you increase the accuracy

response: True, for reasons mentioned above. As stated above, the design intent should be considered for whether small edges are necessary or not.

5. user: change default accuracy only as a last resort, accuracy changes can affect manufacturing or assembly operations

response: True, accuracy should always be changed only as a last resort, when certain tiny geometry is required and cannot be altered with other modifications to the part. The first attempt should always be a modification to the part, for example either by creating an explicit alignment in a feature's sketch, reordering features, or recreating geometry using different types of features. Accuracy may affect manufacturing or assembly operations because some situations with these modes required components to have the same absolute accuracy. If the accuracy of one model is changed, the absolute accuracy of another model may need to be reset, for example, with merge or cutout features.

6. user: some people do use the smallest accuracy as their default

response: This is generally not a good practice, since it is an inefficient use of system resources due to longer regeneration times. This can also lead to a requirement of extremely tight relative accuracy when absolute accuracy is used for a merge or cutout type feature. As stated above, most part models do not require a modification of accuracy.

7. user: change accuracy to get small features and/or shells to regenerate--- typical problems are geom checks, shell failures, round failures on small features

response: True, for reasons mentioned above. Geom checks have a close relationship with accuracy. Some types of geom checks are given to indicate that an edge is very small to warn that the edge is on the limit of detection at the current setting of accuracy. When this geom check is encountered, the feature should be investigated to see if this edge is truly required for the part design. If possible, attempts should be made to redefine the feature to remove the tiny edge or create the feature in a different way to prevent the tiny edge from appearing. Accuracy should be modified only as a last resort.

8. user: on R18, there is an option to set accuracy to an absolute

number, such as .0001 inches (instead of a ratio of smallest feature to part diagonal of .0001, the kind of accuracy on R17)

response: See information regarding absolute accuracy above. This functionality was actually first available with Release 17.0.

9. user: changing Accuracy vital for STL file generation of larger parts (over 10"), start with Accuracy of .0003 at rapid prototyping service bureau. Recommends setting Accuracy to min. .0006, preferably .0003, before modeling. Higher Accuracy lets you select a smaller cord height when generating the STL file.

response: The last statement here is true: decreasing the value of accuracy allows the selection of smaller chord heights. As stated before, however, accuracy is relative to the size of the model so the real size of the model is generally not as important as the level of detail compared to the overall model size. With STL file generation the default relative accuracy will provide a minimum chord height which is acceptable for most applications.

STL file generation is based on the need for refinement of the triangulation of the model to a point which is an balance between time for STL generation and an accurate representation of the model geometry. As a rule, parts with small details and/or high curvature surfaces are going to require smaller chord heights to accurately triangulate the geometry, but generally the minimum chord height is sufficient.

10. user: increasing accuracy can make a part change size, by .06" in 30", if there is no overall constraint on part size

response: The statement "if there is no overall constraint on part size" is not clear, but the statement 'by .06" in 30"' can be analyzed using the equation given above:

$$A < F * s / d = 3 * .06 / 30 = 0.006$$

So, if the accuracy of the part changes by 0.006, then the part may show a difference in measurement to the order indicated, but this is very unlikely since the default accuracy is 0.0012. Changes of this magnitude should be reported to PTC Technical Support for further investigation.

11. user: increase Accuracy when making IGES files for plastic files to avoid problems at tooling vendors

response: Absolute accuracy is the recommended method for creating a desired accuracy in the IGES export file. Entering a value for absolute accuracy will control the location of points in the IGES data to within a specified tolerance. Accuracy will also affect the import of IGES data. A smaller value of part accuracy will increase the level of detail of the imported feature stored within the part.

12. user: Accuracy can be set to a lower value than .0001 by using the config.pro option accuracy_lower_bound.

response: True, the config option ACCURACY_LOWER_BOUND has an acceptable range of values of 1E-4 to 1E-6. This range of values is restricted by a config.pro option to emphasize that in the vast majority of models there is no need to set the value of relative accuracy to values this small.

13. user: parts with many boundary surfaces require an accuracy of .0001, gaps in surfaces appear if using default .0012

response: As stated earlier, accuracy is related to the size of the model, not specific feature types. These gaps may possibly be created when merging surfaces created using boundary blends. To prevent these issues when creating boundary blends, each surface should reference the edges from previous surfaces to which it will be merged, instead of the original curve the surface was based from. This serves the additional benefit of allowing automatic selection of a default surface for boundary (tangency) constraints.

14. user: increasing accuracy from .001 to .0001 increased part file size from 1.5MB to 6MB, with a corresponding increase in regeneration time

response: Yes, this is possible as stated earlier.

15. user: when sweeping helical threads, different accuracy settings will yield extreme results, ranging from missing portions of threads to unattached geometry

response: This issue has been addressed in Pro/ENGINEER Release 16.0

for newly created Advanced, Helical Sweep features. If you encounter this type of issue, contact PTC Technical Support for further investigation.

16. user: Pro/Manufacturing couldn't use a good model, no geom checks, but increasing accuracy fixed a problem with disjointed surfaces (surfaces were identified visually)

response: As stated earlier, increasing accuracy creates a more detailed and better representation of the part geometry. However, the specifics of what "couldn't use a good model" and "disjointed surfaces" mean needs to be clarified by the user to explain why accuracy would be a factor here.

17. user: use absolute accuracy option on merged parts

response: True, as stated earlier.

18. user: hotline reported that if two parts don't have the same accuracy then interference checks can miss valid interferences. Hotline said the accuracy values needed to be "close", but couldn't say how close.

response: As stated earlier, accuracy affects the representations of the model geometry. Calculation of interferences based on model geometry will therefore be affected by the current accuracy settings for the assembled components. Ideally, the absolute accuracy of the assembled components should be the same, but modifying accuracy is typically not required for accurate interference measurements.

Affected Products

Product	Pro/ENGINEER and Creo Elements/Pro
Module	GLOBAL FUNCTIONS
Reported Release	21.0
Reported Datecode	Not Available
Resolved Release	Not Available
Resolved Datecode	Not Available
Affected Client	All
Affected Server	All

Related Documents

Type	Number	Status	Description
None Available			