For Pro/Files Magazine, Summer 2003

John Randazzo

Jell-Molds and Cookie-cutters: Shrinkwrap isn't just for leftovers anymore

By John Randazzo

Note: Items in red indicate corresponding graphics

It takes some time to develop your ideas from napkin sketches to detailed Pro/E assemblies. That's the beginning of many a great thing, which ought to result in fabrication and a happy boss. However, sometimes you don't need the entire assembly with all of the bells and whistles. Perhaps you are running a computational fluid dynamics analysis and all you need is a negative of your assembly. Possibly you are designing packaging for a product, and need some nicely conforming foam to protect the device. Or maybe you just want a "light" version to use in continued work. But just how best to get that "bare-bones" version? You can use your "selective suppression" and prune that model tree down to the trunk. You can, of course, start from the beginning, using what you can. However, there is another way. The unobtanium for your complex part blues is Shrinkwrap. **(raw_assembly.tif, raw_assembly_exploded.tif)**

Shall I Interest You in a Flavor?

So what is Shrinkwrap all about? For those of you who may not know about it, Shrinkwrap is a type of data structure that can manifest itself as a feature or model. It is cleverly covered up, almost hidden, and doesn't get the press or widespread use of a solid or surface. The shrinkwrap feature is located under the data sharing submenu of the feature menu. The shrinkwrap feature, as described by PTC, is "a collection of surfaces and datum features of a model that represents the exterior of the model". The advantages and applications of the shrinkwrap feature are in the creation of minimal memory guzzling representations of assemblies. These can be used to represent subassemblies in parent assemblies, and can handle control of dependency issues, geometry represented, and additional references through the use of the shrinkwrap feature options. The shrinkwrap model is an option available under the "save as" umbrella. Its function, as described by PTC, is to "share data with internal and external design groups and improve performance in large assembly design". Some of the benefits of the shrinkwrap model include being able to represent complex assemblies with a single, lightweight part that protects design intent and parametric data, and the ability to improve performance of large assembly modeling in the area of less load time. The proper-scale models can be saved as IGES, STEP, and VRML (for fly-throughs).

Opting for Shrinkwrap Options

Just how do you customize your flavor of shrinkwrap to achieve your purpose? By tailoring the options, of course! When you go to create your shrinkwrap, the first option you are presented with pops right out at you, prompting you for the quality level of the shrinkwrap. The level that you pick will control how well the shrinkwrap "wraps" to the original, and its range is from 1 to 10. The increase in quality comes at a cost of longer creation time and a larger file size (though it is still MUCH smaller than the assembly it represents). The next item to determine (and a key one for these techniques), is whether or not to use the auto hole filling. Unlike what the name describes, the auto hole fill option will fill in cuts as well as holes, as long as they penetrate the entire wall thickness where they occur (so pockets need not apply). Once you have made the initial dialogue box disappear, you are presented with the remainder of the shrinkwrap elements. Of these, this author finds the "include datums", and "geom dependency" to be the most relevant for this discussion. *Include datums* will allow you to select datum planes, points, axes, and coordinate systems to bring over with the shrinkwrap. This capability is why when the new component is created, as shown later on, the first feature is created as opposed to creating the

default datums. The *Geom. Dependency* element will determine whether or not your shrinkwrap is continually associative to its parent geometry. Usually the way to go here is to make it dependent, so that changes are carried downstream. **(swrap_fill_solid.tif, swrap_fill_wireframe.tif, swrap_nofill_solid.tif, swrap_nofill_wireframe.tif)**

Shrinkwrap for CFD

Whether you are doing external or internal flow analysis, CFD, or computational fluid dynamics, programs require a part or assembly negative in order to perform the analyses. This part represents either the fluid flowing around your part or assembly in external flow, or the fluid that flows through your part or assembly in internal flow (also known as the "wetted volume"). This geometry can most easily be considered a "jell-o mold" of the part or assembly and can easily be created through the use of Shrinkwrap. In the proposed technique, we will first use shrinkwrap to create a "skin" of the model to be analyzed. Next, the skin will be turned into a solid model. The resulting part is one that captures the design for analysis without the laborious effort of selecting and suppressing geometry. There is also one more added advantage, depending on what CFD program you use. Some CFD programs are able to operate on the native Pro/E geometry. This means that if the raw geometry changes (e.g. a set of holes or a chamfer are added), a simple regeneration of the assembly will produce an up-to-date shrinkwrap and resulting solid "for-analysis" model. The final step in preparation for CFD depends on whether or not you are doing external or internal analysis. If external analysis the goal, the shrinkwrap part is assembled to the larger control volume and subsequently cut out from it by utilizing the cutout command located under the advanced utilities in assembly mode. If internal analysis is your enlightened state, you can utilize shrinkwrap for creating the wetted volume only in certain cases. Here, you will use the subtraction of a "hole" and "no-hole" shrinkwrap to create the part that represents the fluid.

Shrinkwrap for packaging

The next scenario involves packaging for finished products. Often times, whether for concern over transit damage or just for a purely aesthetic look, equipment is packaged in a carrying case and surrounded by foam. Foam cutouts can be an easily done on primitive geometry, but become a more difficult task with shelled electronics enclosures or free-flowing geometry. However, through the magic of shrinkwrap, once again the seemingly difficult is rendered a simple task. The technique to be used us the same as with CFD, but the considerations here are different. Once the solid is created, the shrinkwrap part is modified for desired use. For example, to build in clearances, new features can be built upon the shrinkwrap through extruded and revolved solids. With proper design intent captured, these can also update with a changed model. As a final step for the desired use, the shrinkwrap part is assembled to the encapsulating foam in the desired location and orientation and cut out by once again using the cut-out command located under the advanced utilities menu in assembly mode.

Wrapping It Up

As has been observed, shrinkwrap is quite a powerful and multi-functional tool. Not all of the uses for this nearly hidden wonder have probably been documented, meaning that there are new areas where shrinkwrap may work for you. Hopefully, this little overview and focus on two specific uses will not shrink your mind, but rather expand it and set your creativity ablaze as Wildfire roars on.

Tip #1: Creating the Shrinkwrap

In Assembly Mode:

If the model to be shrinkwrapped is only a part, assemble it into an assembly.

1) Select *Component -> Create -> Part.* **(new_component.tif)**
2) Name the new component as prompted.
3) In the Create Options box, choose *Create first feature.* **(create_options.tif)**
4) Select *Data Sharing -> Shrinkwrap* from the cascading menus. **(swrap_menu_cascade.tif)**
5) Select the quality level of the shrinkwrap and whether or not hole-filling will be used. **(swrap_attribs.tif)**
6) Choose the *Include Datums* element and *Define.* **(swrap_elements.tif)**
7) Select the + icon, select the type of item to be added, choose the item(s) to be added, and choose *Done Sel.* When you have finished selecting items, choose *Ok.* **(misc_refs.tif)**
8) Choose the *Feat Dependency* element and *Define.*
9) Select *Dependent* or *Independent* and choose *Ok.* **(feat_dependency.tif)**
10) Choose *OK* in the shrinkwrap elements box to create the shrinkwrap.

Tip #2: Creating a Solid From a Shrinkwrap

1) Open up the Shrinkwrap component in part mode.
2) Inspect the Shrinkwrap part in wireframe. You will see items in purple and items in yellow. The items in yellow indicate interfaces between unattached geometry. These must be attached before a solid can be created. **(swrap_fill_wireframe.tif)**
3) Select *Feature -> Create -> Surface -> Merge.* **(merge.tif)**
4) Choose the two quilts to be merged (the purple items on either side of the yellow interface), and choose *join* and *side1*. Repeat this for all of the places where yellow geometry exists. When all are done, select the green checkmark icon to continue. **(merge_elements.tif)**
5) Select *Feature -> Create -> Solid -> Protrusion -> Use Quilt* **(create_prot.tif and (use_quilt.tif))**
6) Select the quilt and choose *Side 1* for the material side. **(use_quilt_opts.tif)**
7) Select the green checkmark to continue.

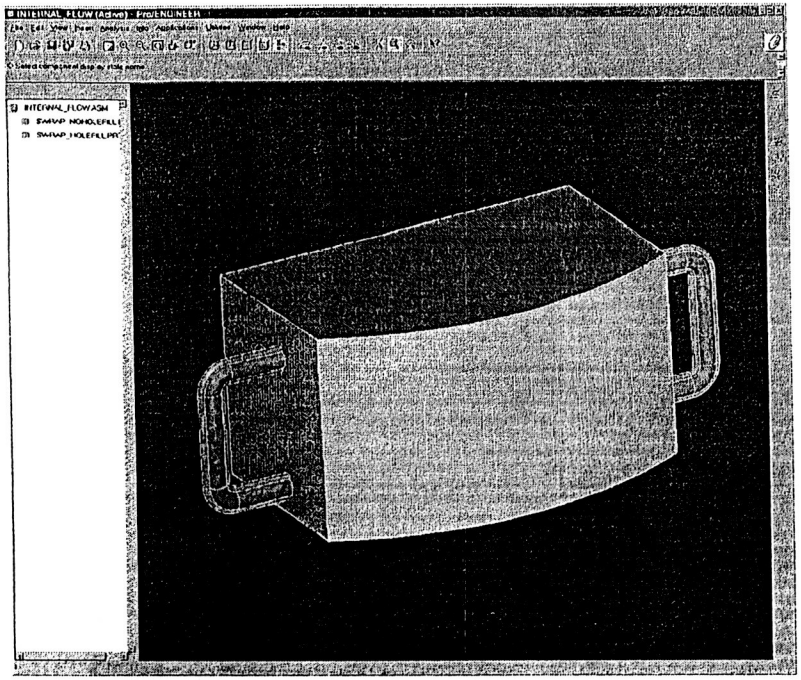
Tip #3: Shrinkwrap for External Flow Analysis or Foam Cutouts

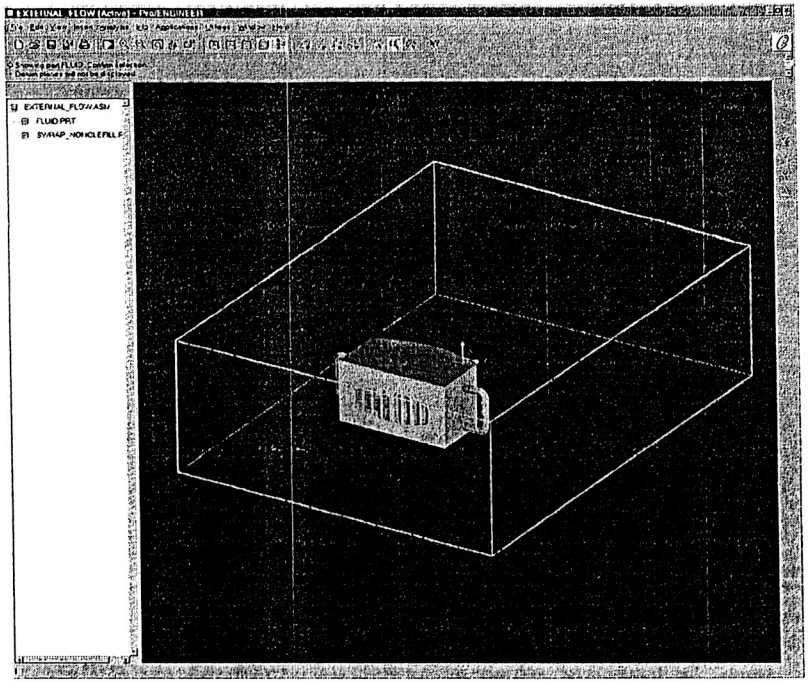
1) Create a new part that will represent the volume of fluid that surrounds the object (or the encapsulating foam), and the shrinkwrap part that represents your assembly. Follow the guidelines as established by your CFD software company and conventional methodology to correctly size the volume. If doing packaging, be sure to add any desired features to the shrinkwrap part before continuing. One additional note: more often than not, you will want an auto-hole-fill shrinkwrap part for packaging cutouts, but may want either version for an external flow analysis (no-hole filling for flow-through items). **(modified_swrap.tif)**
2) Create a new assembly, and assemble both the control volume part (or foam if doing packaging) and the shrinkwrap part of your assembly. If multiple parts are to be done, assemble the multiple occurrences. **(foam_assembled.tif, external_flow_assembled.tif)**
3) Select *Component -> Adv Utils -> Cut Out.* **(comp_cutout.tif)**
4) Select the parts to perform the cutouts to (the fluid part or encapsulating foam) and choose *Done Sel.*
5) Select the parts to use as the cutouts to (the shrinkwrap part(s)) and choose *Done Sel -> Done.* When prompted about supporting associative placement for the

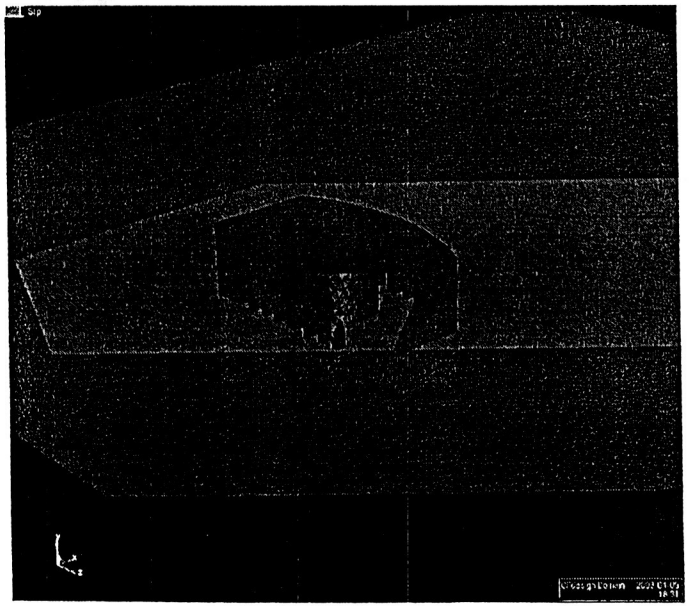
feature, click yes. At this point the cutout feature is created in the foam or fluid volume. Now the assembly can be used for the analysis (if the cutout part is suppressed) or the part itself can be used. **(foam_cutout.tif, fluid_nomesh_ext.tif, external_flow_meshed.tif)**

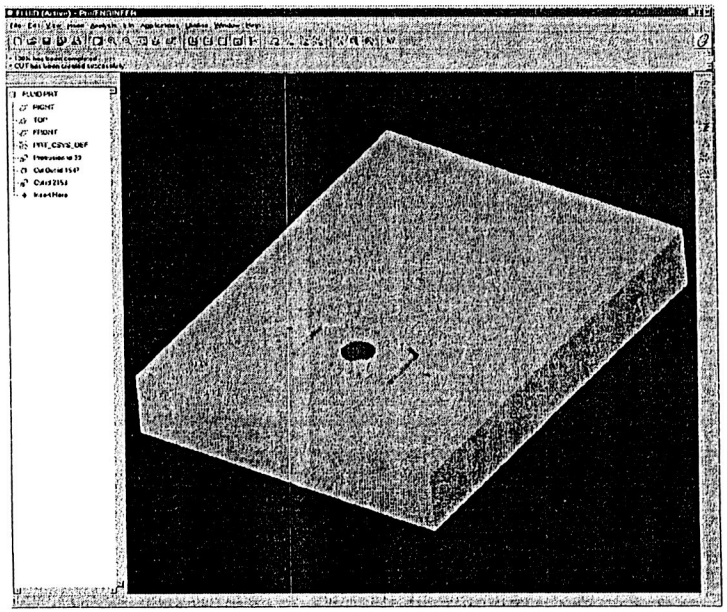
Tip #4: Shrinkwrap for Internal Flow Analysis

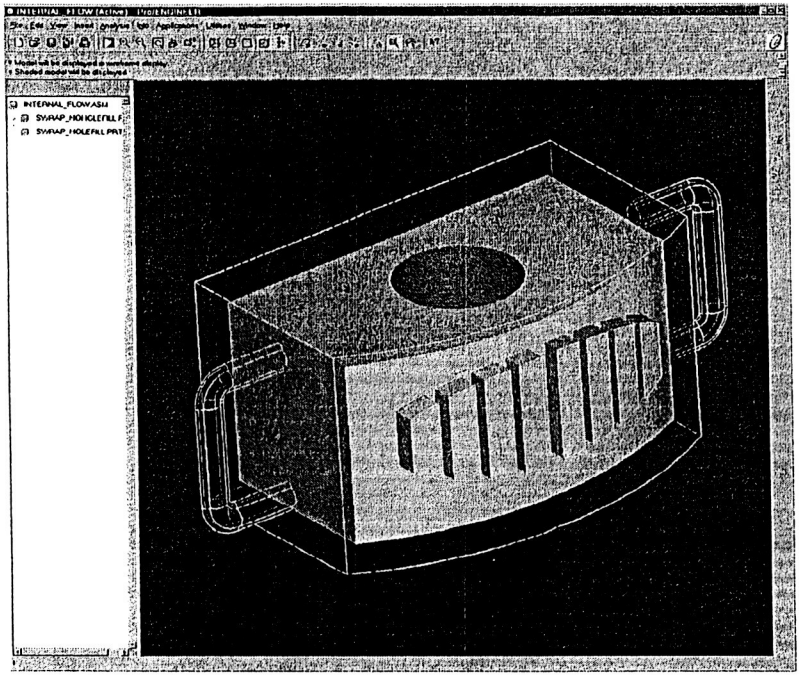
1) Create two shrinkwrap parts – one auto hole-filled that will be used as the fluid part, and one no auto-hole-fill part that will be used as the cutout part. Create solid protrusions from each of the shrinkwraps, by using technique above.
2) Create a new assembly, and assemble both shrinkwrap parts such that they overlay on each other. **(both_swraps_coassembled.tif)**
3) Select *Component -> Adv Utils -> Cut Out.*
4) Select the part to perform the cutout to (the auto hole-fill shrinkwrap part) and choose *Done Sel.*
5) Select the parts to use as the cutouts to (the no auto-hole-fill shrinkwrap part) and choose *Done Sel -> Done.* When prompted about supporting associative placement for the feature, click yes. At this point, what remains in the auto-hole-fill shrinkwrap part represents the wetted volume of the part. The assembly can be used to model both the device under simulation and the wetted volume. **(fluid_nomesh_int.tif, internal_flow_meshed.tif)**

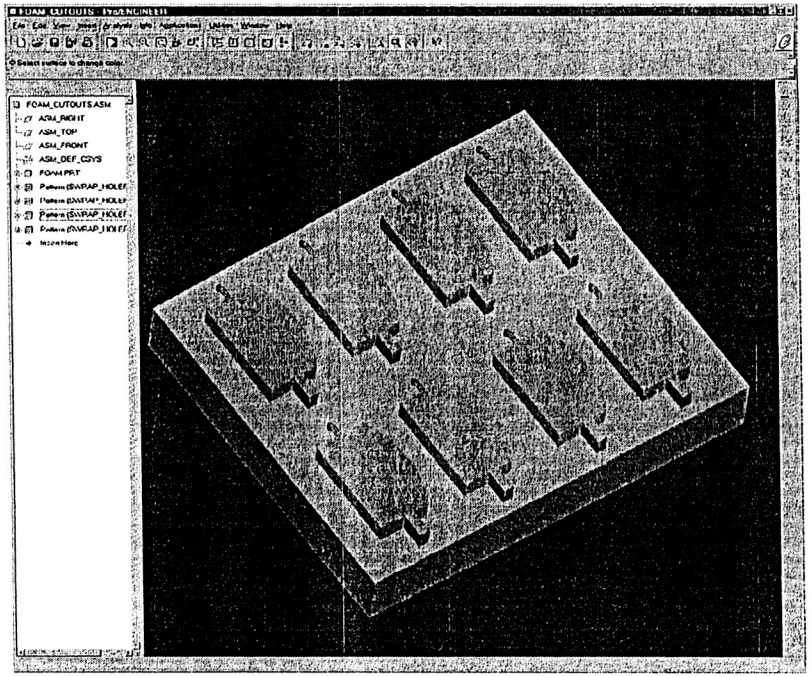


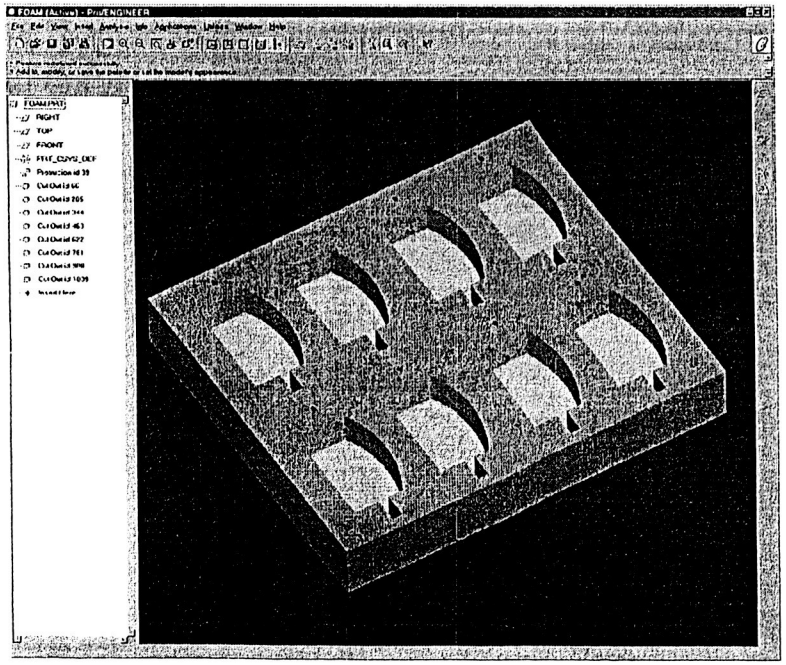


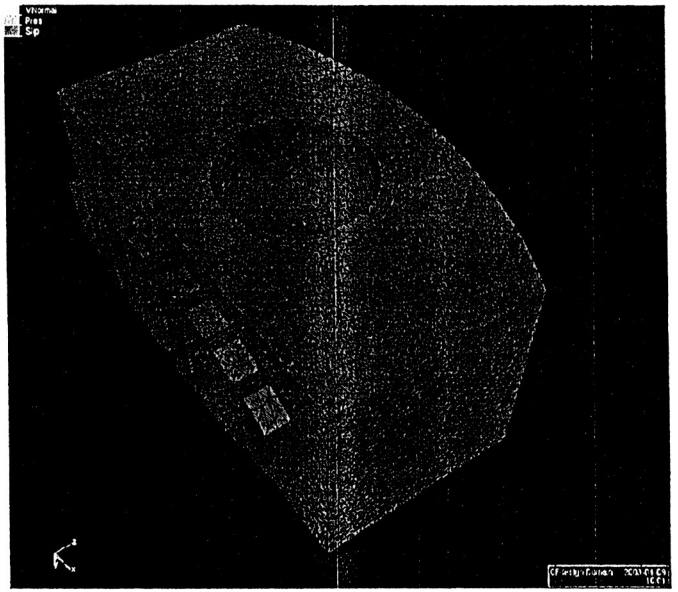


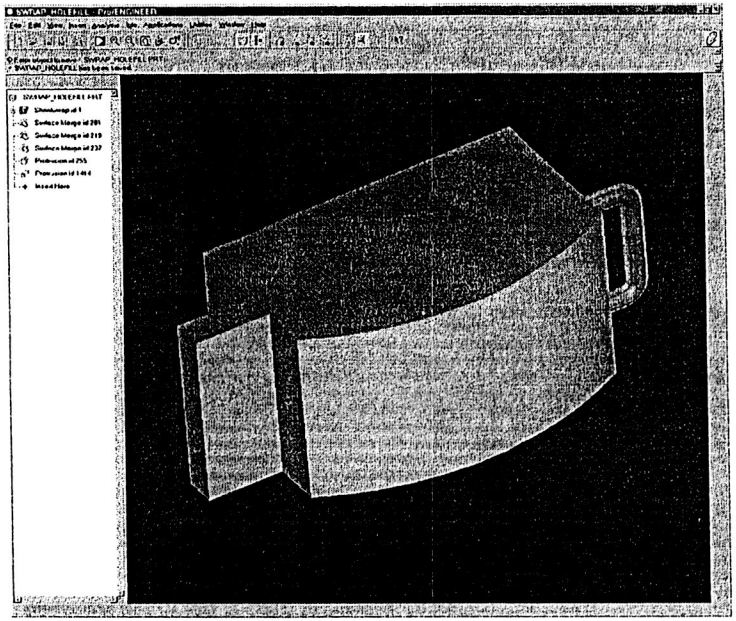


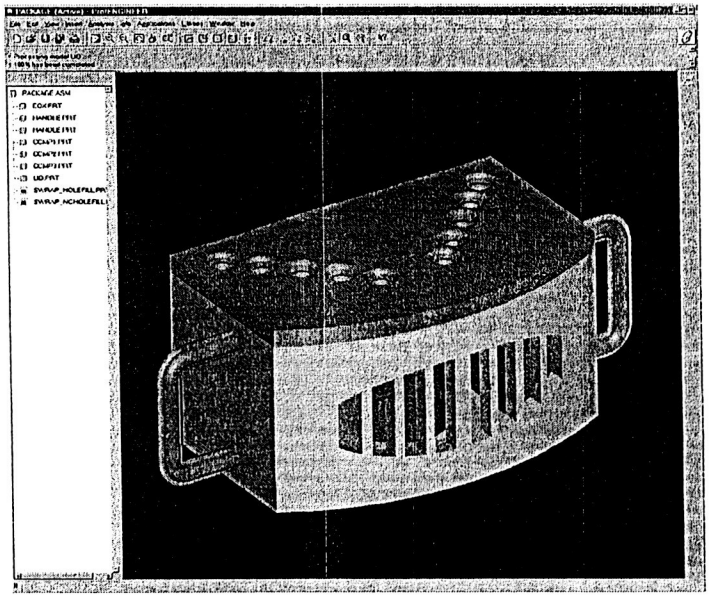


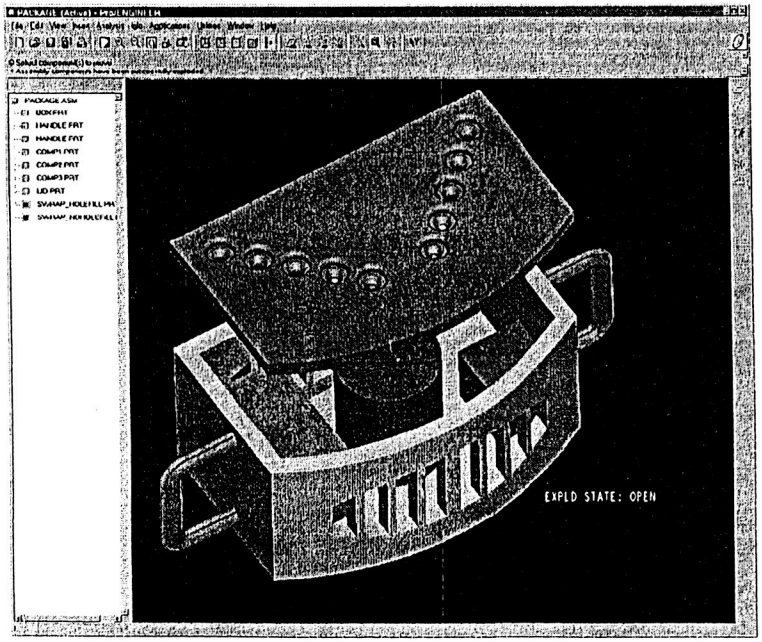


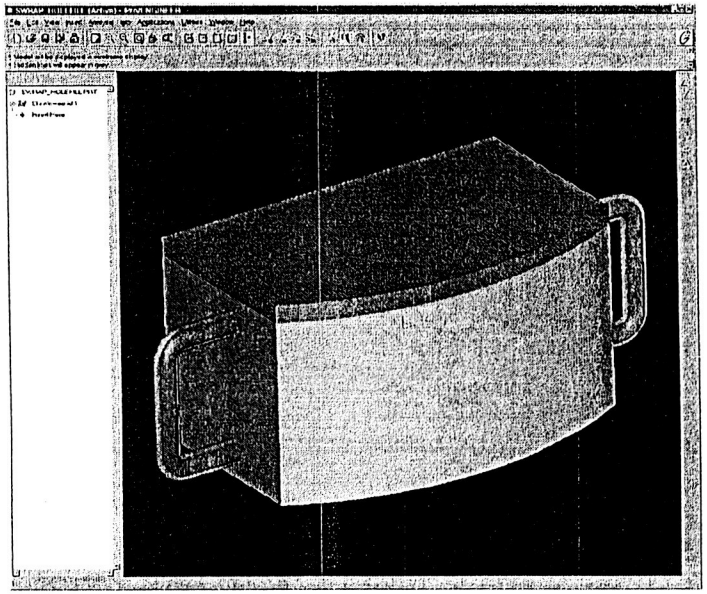


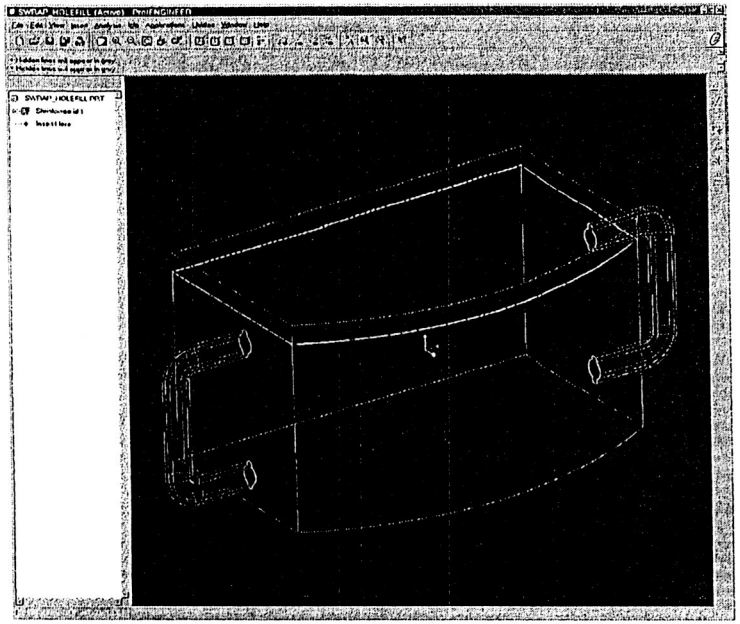


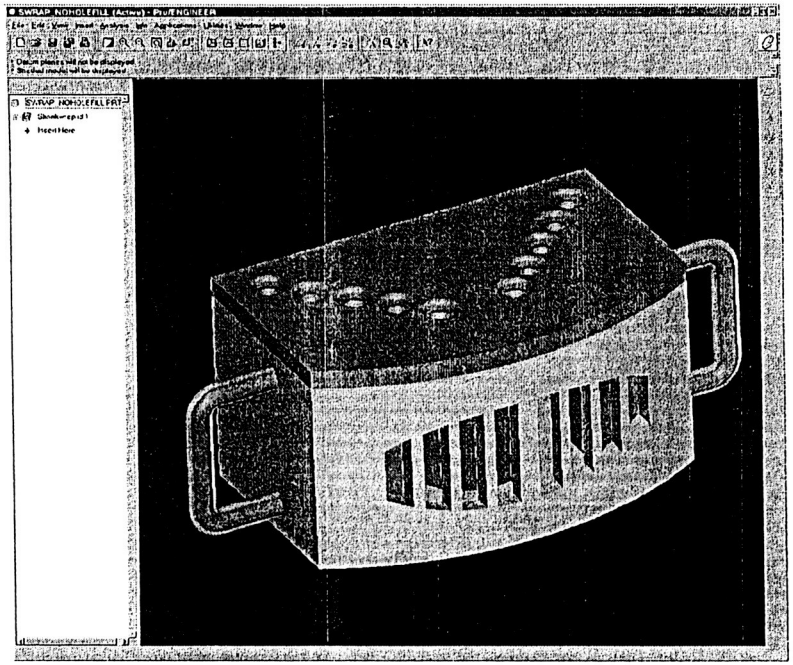


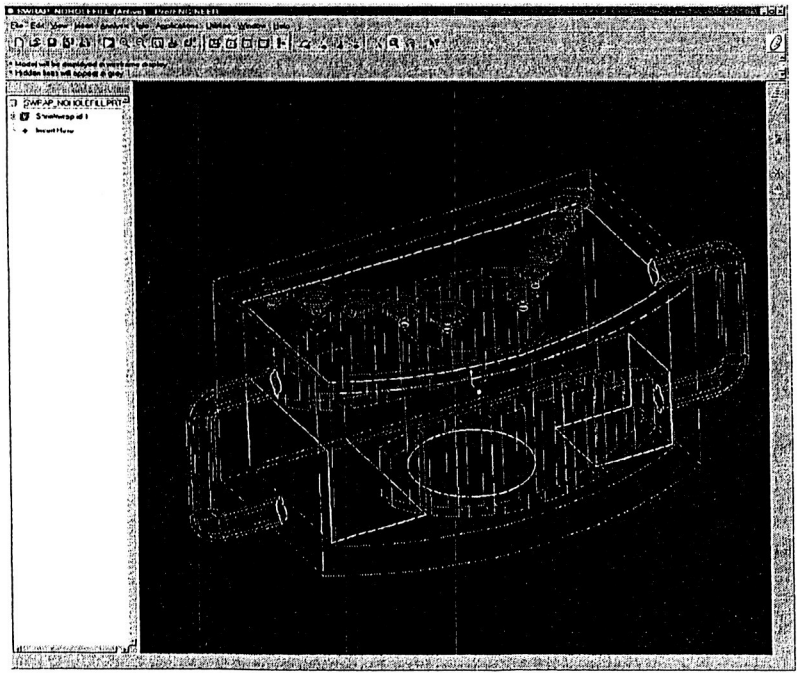


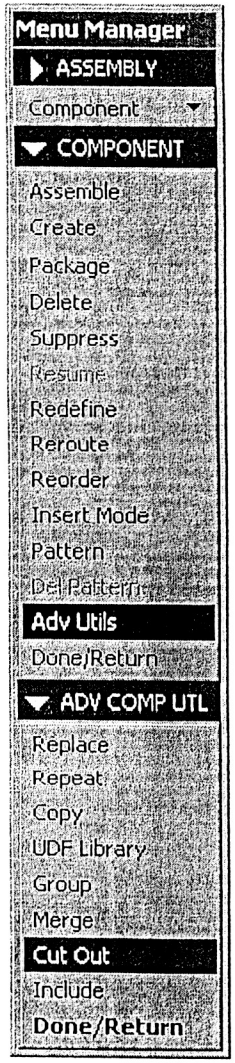

EXPLD STATE: OPEN

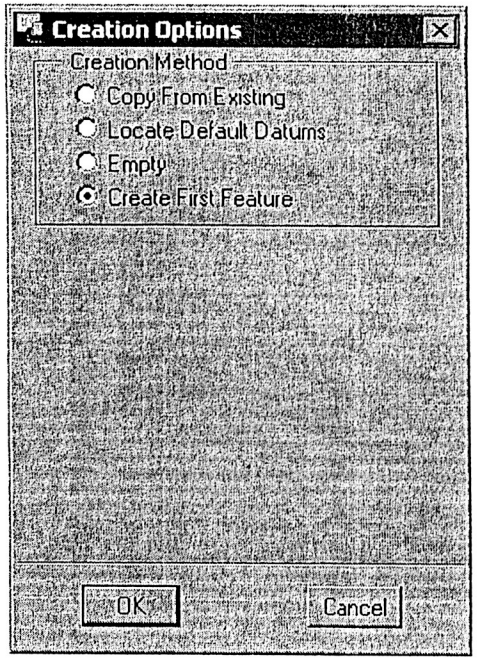


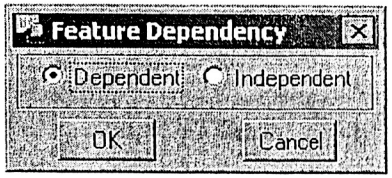






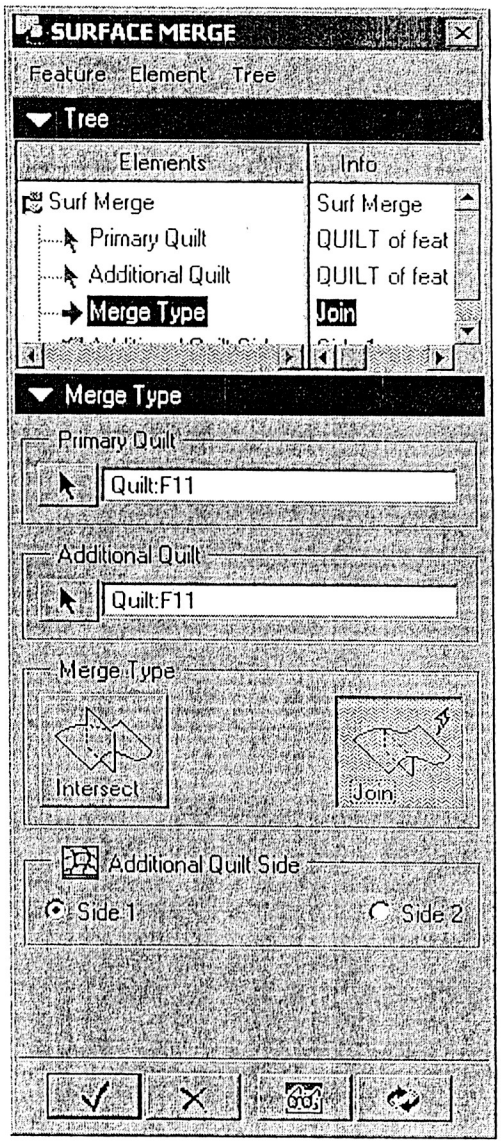

Menu Manager
ASSEMBLY
Component
COMPONENT
Assemble
Create
Package
Delete
Suppress
Resume
Redefine
Reroute
Reorder
Insert Mode
Pattern
Del Pattern
Adv Utils
Done/Return
ADV COMP UTL
Replace
Repeat
Copy
UDF Library
Group
Merge
Cut Out
Include
Done/Return

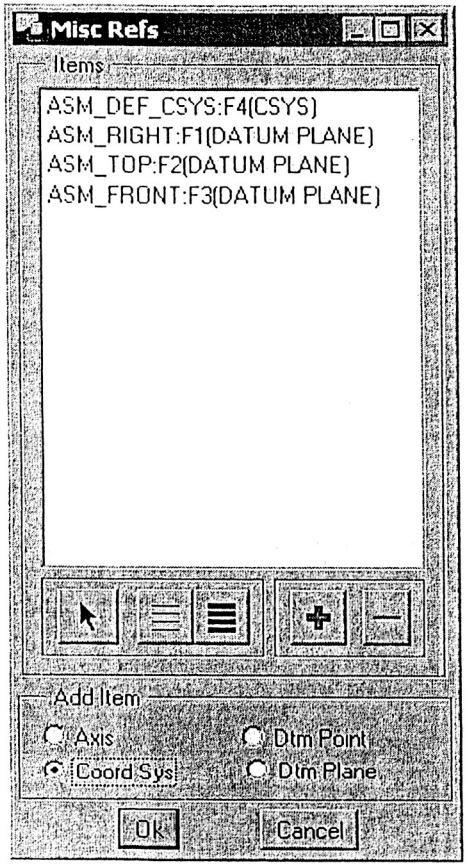

Creation Options
Creation Method
Copy From Existing
Locate Default Datums
Empty
Create First Feature
OK
Cancel

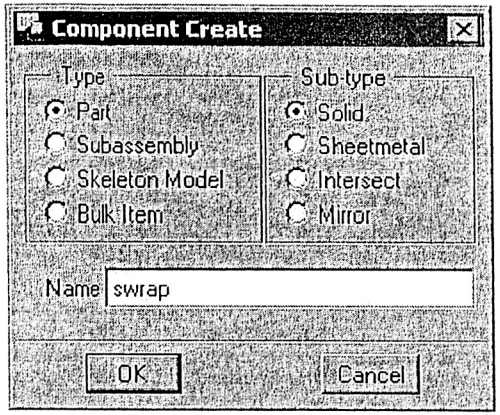

Feature Dependency
Dependent
Independent
OK
Cancel

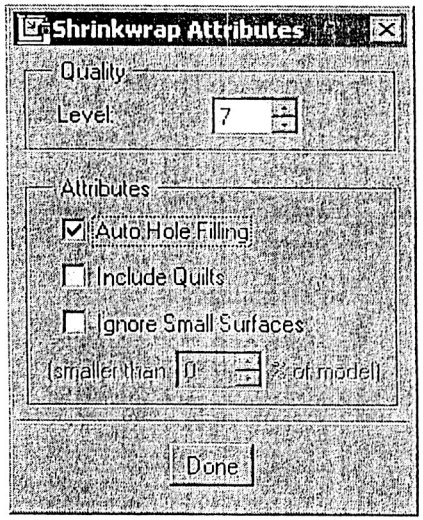

Menu Manager
PART
Feature
FEAT
Create
FEAT CLASS
Solid
Surface
Sheet Metal
Composite
Cosmetic
User Defined
Data Sharing
Style
Done/Return
SOLID
Hole
Round
Chamfer
Cut
Protrusion
Rib
Shell
Pipe
Tweak
Intersect


Menu Manager
PART
Feature
FEAT
Create
FEAT CLASS
Solid
Surface
Sheet Metal
Composite
Cosmetic
User Defined
Data Sharing
Style
Done/Return
QUILT SURF
New
Merge
Trim
Extend
Transform
Draft
Area Offset
Draft Offset

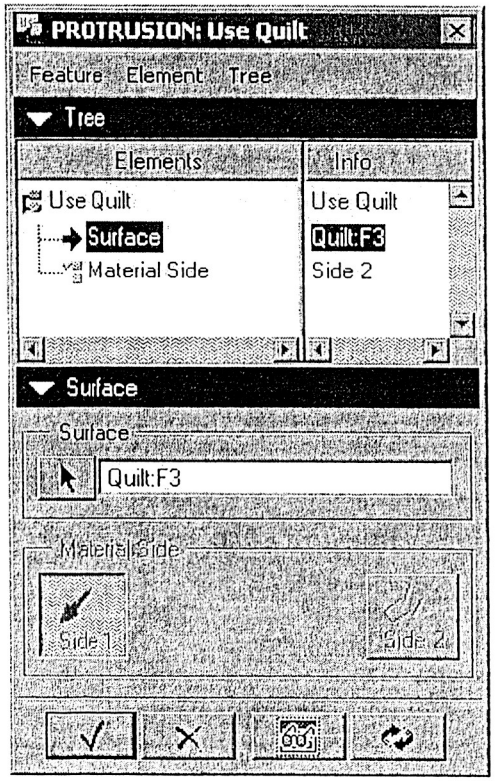

SURFACE MERGE
Feature
Element
Tree
Tree
Elements
Info
Surf Merge
Surf Merge
Primary Quilt
QUILT of feat
Additional Quilt
QUILT of feat
Merge Type
Join
Merge Type
Primary Quilt
Quilt:F11
Additional Quilt
Quilt:F11
Merge Type
Intersect
Join
Additional Quilt Side
Side 1
Side 2

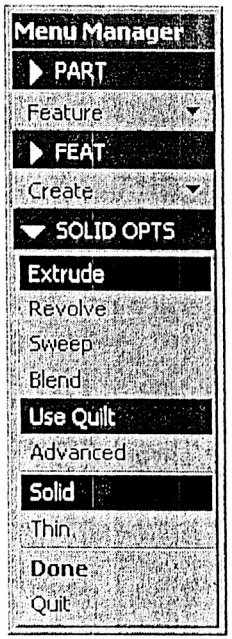

Misc Refs
Items
ASM_DEF_CSYS:F4(CSYS)
ASM_RIGHT:F1(DATUM PLANE)
ASM_TOP:F2(DATUM PLANE)
ASM_FRONT:F3(DATUM PLANE)
Add Item
Axis
Dtm Point
Coord Sys
Dtm Plane
OK
Cancel

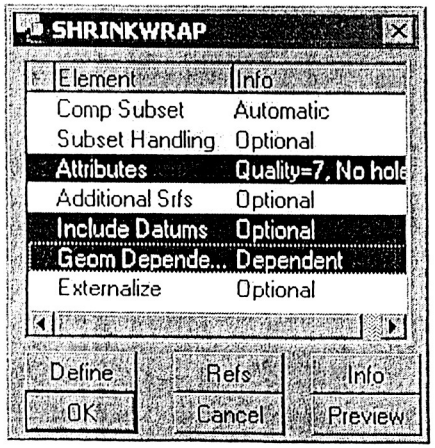

Component Create
Type
Part
Subassembly
Skeleton Model
Bulk Item
Sub-type
Solid
Sheetmetal
Intersect
Mirror
Name
swrap
OK
Cancel


Shrinkwrap Attributes
Quality
Level
7
Attributes
Auto Hole Filling
Include Quilts
Ignore Small Surfaces
smaller than
0
% of model
Done


Menu Manager
Component
COMPONENT
Assemble
Create
Package
Delete
Suppress
Resume
Redefine
Reroute
Reorder
Insert Mode
Pattern
Del Pattern
Adv Utils
Done/Return
FEAT CLASS
Solid
Surface
Sheet Metal
Composite
Cosmetic
User Defined
Data Sharing
Style
Done/Return
DATA SHARIN
CopyGeom
ExtCopyGeom
PublishGeom
Shrinkwrap
ExtShrinkwrap
Inheritance
Merge
ExtMerge
CutOut
ExtCutOut
Quit


PROTRUSION: Use Quilt
Feature
Element
Tree
Tree
Elements
Info
Use Quilt
Surface
Material Side
Use Quilt
Quilt:F3
Side 2
Surface
Surface
Quilt:F3
Material Side
Side 1
Side 2


Menu Manager
PART
Feature
FEAT
Create
SOLID OPTS
Extrude
Revolve
Sweep
Blend
Use Quilt
Advanced
Solid
Thin
Done
Quit


SHRINKWRAP
Element
Info
Comp Subset
Automatic
Subset Handling
Optional
Attributes
Quality=7, No hole
Additional Srfs
Optional
Include Datums
Optional
Geom Depende...
Dependent
Externalize
Optional
Define
Refs
Info
OK
Cancel
Preview