The Focus

PADT

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Be a Superhero with Workbench Scripting

By Doug Oatis

As a continuation to last month's riveting article about beam modeling, I decided to dive into something a little more mysterious about Workbench – Customization and Scripting. As many of you know, you can still use APDL in command snippets in Workbench, but if you want to run macros interactively in Workbench, you need to write them in JScript.

I'll take this moment right now to admit that I am not a computer science person. I took a couple of years of C++ in high school, played around with Python, and I know a little HTML. I'm probably most adept at using APDL, in fact, I would have been happy had the April Fool's article about ANSYS buying Windows and rewriting the source code in APDL been true. All things considered, I've found JScript to be different, but not terribly difficult to learn. So this will hopefully be the beginning to a couple of articles about scripting in Workbench. A good JScript reference is the MS's JScript Tour.

Some quick notes that I've picked up through my JScripting journey:

- Commenting is performed by using //
- Simple looping is done with for(variable start;conditional statement;increment)
- Use {} to define commands that are performed for a loop or conditional
- Always put agb.Regen(); at the end of every DM script – this regenerates the model
- SYNTAX! – I couldn't tell you how many times I'm debugging for 30+ minutes only to find I put a comma instead of a semicolon (I wonder which charge number I put that under…)

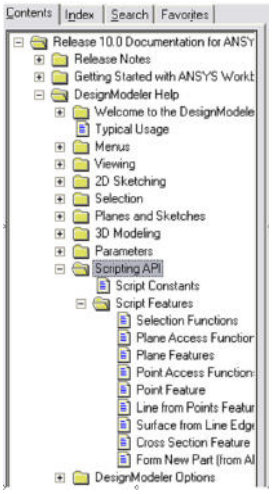

Figure 1: Help Tree

To get familiar with WB Scripting, we'll start with some scripting in Design Modeler, since it is documented in the DM Help. The help for this is located underneath the Scripting API in the ANSYS Workbench Help (See Figure 1).

(Cont. on Pg. 2.)

Radiation is Your Friend

By Rod Scholl

It turns out it's pretty easy to add radiation to a thermal model. The help manual can be very helpful in this area (as usual) but it leaves out the pep talk that indicates how easy it is to implement. Also, I just think radiation is neato and I look for any excuse I can to include it.

When to add it?

The implementation effort is just about the same as adding convection, except there is an impact on solve time given its highly non-linear nature. If you have a transient analysis, this impact will be negligible. If you are doing a steady state analysis, it might take 20 solves to reach a solution, thereby making a 20X impact on solution times. Yet, given that thermal models don't require much mesh density and only have 1 DOF per node, this often isn't a problem either.

Try a quick hand-calc of the heat load compared to your input loads to see how significant the impact of radiation is in your case.

$$Q_{i-j} = A_i F_{ij} \varepsilon \sigma (T_i^4 - T_j^4)$$

- A is the area
- ε is the emissivity (somewhere between 0 and 1)
- T is the temperature (must be in absolute so add 273 to your Celcius temps to get to kelvin, or 460 to your farenheits to get Rankine)
- σ is the Stefan Boltzman constant:
  `0.119E-10 Btu/hr/in2/°R4`
  `5.670 400(40)×10-8 W·m-2·K-4`

Radiosity vs. /AUX12

Before "radiosity" was added to ANSYS, radiation had to be implemented using the /AUX12 module. This involves a subroutine to calculate the view factors and this subroutine has size limits somewhat restrictive as models have grown larger over the years. There's also a couple more steps in the procedure, including defining a superelement which can seem daunting. There aren't many reasons why one would use the older /AUX12 method

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Contents

(Scripting, Cont.)

What I read in the help dealt with 'Line from Points Feature'. There is a sample script listed, and you can learn a bit by reading it after reviewing some JScript basics. What I did with this script is take it and supercharge it (well, not really) using looping and conditional statements to automatically build up major portions of a beam derrick.

The only prerequisite for making this script is consistency in creating your point file. For my example, I created a 5-tier derrick with a point at each corner. This allows easing looping to build up the legs (vertical beams) and each horizontal tier. The only user input required is to specify how many tiers and legs there are.

Without further delay, here's my script:

1 Define a "Points from File" object, give it a name, and specify the file location (the file used is also available on the ftp site). Make sure to update the file location on the 3rd line

2 Specify how many groups (horizontal sections) and how many legs

3 Create a "Lines from Point" object and loop through the groups joining the same point number together

4 Create another "Lines from Point" object, specify operation as add frozen, and the loop through and join sequential points together in each group.

You'll notice that I regenerate after every operation. Also, notice that I have j=2 for larger loop for the level creation. This is because I decided I didn't want to create a beam level on the "ground". Also notice the if statement so I can join Point 4 to Point 1.

To run, simply go File > Run Script in Design Modeler. You should see the model shown at the start of the article (Minus the Superhero) Now you can go and impress your friends!

You can download a copy of the script and input files from: ftp.padtinc.com/public/downloads/DM_pnt_bm_script.zip .

```
doug_point=agb.FPoint(agc.FPointConstruction,
agc.FPointCoordinateFile);
doug_point.Name="DougsFile"; //Watch syntax on naming
doug_point.CoordinateFile="D:\\ANSYS\\Tower3.txt";
   // Change for your File
agb.Regen();

group_num=5;
num_legs=4;
var dp1;
var dp2;

//Time to make the legs in one operation

d_line=agb.LinePt();
d_line.Name="Legs";

for(j=1;j<=num_legs;j++)
{
  for(i=1;i<=group_num;i++)
  {
    dp1=i;
    dp2=i+1;
    d_line.AddSegment(doug_point.GetPoint(dp1,j),
       doug_point.GetPoint(dp2,j));
  }
}
agb.Regen();

//Time to make each level
d_flat=agb.LinePt();
d_flat.Name="Levels";
d_flat.Material=agc.Frozen;
for(j=2;j<=group_num;j++)
{
  for(i=1;i<=num_legs;i++)
  {
    dp1=i;
    dp2=i+1;
    if(i==4)
    {
      dp2=1;
    }
    d_flat.AddSegment(doug_point.GetPoint(j,dp1),
      doug_point.GetPoint(j,dp2));
  }
}
agb.Regen();
```

How do I learn more about Workbench Scripting?

Workbench is an incredibly rich scripting environment. The only problem is that the libraries that make up Workbench are changing so fast that the documentation has not caught up. However, being a community of smart people, many users in the ANSYS world have written some very sophisticated scripts in Workbench Simulation. If you feel the need to be a Superhero, your first step is to subscribe to the Workbench Forum area on the ANSYS Customer Portal. This is where those who do scripting hang out and share their efforts, occasionally including the developers that created the scripting language.

(Radiation, Cont.)

rather than the new "Radiosity" method… but both are supported. Some people find that /AUX12 is easier to achieve convergence in radiation-dominated problems. However, for larger models, if you use /AUX12 expect 20gb view factor files and loooong pauses during calculation of the viewfactor matrix where you will all but swear the code is crashed… just keep waiting.

Also, I suspect there is residual stigma against implementing radiation because of the slightly more complicated /AUX12 procedure, whereas Radiosity is easier.

These example scripts should come in handy if you are new to radiation.

`tradiation.mac`:
Radiation with Radiosity Solver (No Space Node)

`tspacenode3d.mac`:
Radiation with Radiosity Solver and Space Node

`tradaux12.mac`:
Radiation with /AUX12 method

`tradiation2d.mac`:
Radiation with Radiosity Solver (No Space Node) 2D

`tspacenode.mac`:
Radiation with Radiosity Solver and Space Node 2D

To implement Radiosity, you simply apply a surface effect boundary condition (SF, SFA, SFL, etc.) directly on the element or geometry (or on a surface effect element like SURF152) – and specify an enclosure number. This enclosure number groups surfaces into sets where radiation is only evaluated for surfaces with the same enclosure number – this is similar to using REAL ID's to define which contacts elements should be paired. You can always group all surfaces into a single enclosure, but on big models you might gain some time by breaking them up into sets and thereby making the view factor calculation less expensive.

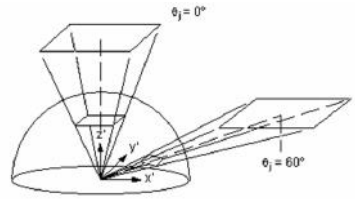
To implement the AUX12 method, you are basically building the view factors as a MATRIX50, and a different method to calculate form factors. This form factor matrix is read in as a superelement. (Note that there is no expansion pass, because there are no DOF's in this element.)

View Factor Calculation

The AUX12 method on an element-by-element basis checks for the portion of the surface visible to one-another and thereby arrives at an AREA*Emmisivity value for each element combination as a percentage (0 to 1) of the total hemisphere visible to the element.

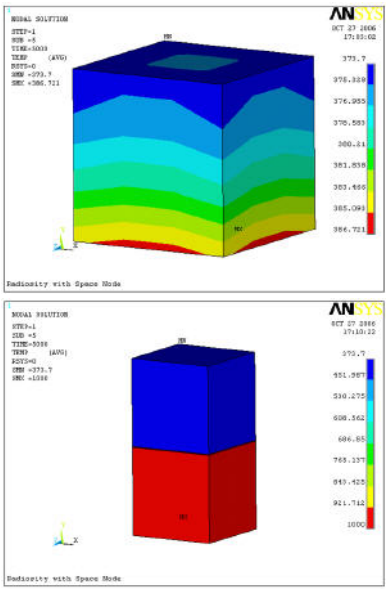
$$[F]_{n\,x\,n} = \begin{bmatrix} F_{11} & F_{12} & \cdots & F_{1n} \\ F_{21} & F_{22} & \cdots & F_{2n} \\ \vdots & \vdots & & \vdots \\ F_{n1} & F_{n2} & & F_{nn} \end{bmatrix}$$

As you may guess this is numerically intensive as element count grows. Using the older /AUX12 method you will have to specify a number of rays via the VTYPE command. The larger the number, the more computational time required. A couple times when I've varied the number I found that the default of 20 for 3-D still loses a little more accuracy than I'd prefer, and generally I use the maximum of 100. This is more computationally expensive, but not dramatically so… seems that once you are up to 20 rays, its easier to add more without too much expense. You might want to try two different values, like 20 and 30, and convince yourself that your number of rays is sufficient. Many folks just stick with the default, which in most cases is fine.



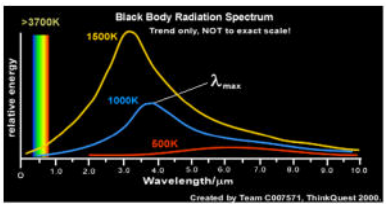
With the radiostiy method, a cube rather than a sphere is used for the projecting surface, for which the manual, and several web resources dig into the theory on the minor loss in accuracy. Luckily you don't need to understand any of this to implement it. In this case I also use an option of 100 rather than the default of 10… but maybe I'm just paranoid to get the last 1% of error out of an analysis.

You can always view the created matrix, via VFOPT or WRITE – which can be a fun exercise to take a couple elements and compare a quick hand-calc to the computed view factor.



Emissivities

Knowing the emissivity of a surface is often tricky. For all the accuracy I add with high ray tracing numbers, its probably made moot by the inaccuracy of most emmisivity numbers. Expect poor sources for emisivities – and note that oxidation and other factors often change the emissivity of a surface over product life. Further, surfaces actually have different emissivites (or absorbtions) for different ranges of the spectrum. Thus a single emissivity number is an approximation suited for many applications – but if you are dealing with radiation dominated problems with non-black body sources (meaning the whole spectrum isn't being emitted or absorbed for material reasons) you will need a different tool than ANSYS such as CFX.



Space Node

As you expect the energy should balance. A space node is often used for this. For all the rays that don't see another element, this exchange can be assigned to a space node. The advantage of this is one can specify the temperature nonzero of space. This can be 0 Kelvin, if it's truly radiating to "space" but more often you might choose a "background" temperature to represent the unmodeled portion of the system – such as

(Cont. on Pg. 3.)

(Radiation, Cont.)

the outer shell of an engine, or room temperature.

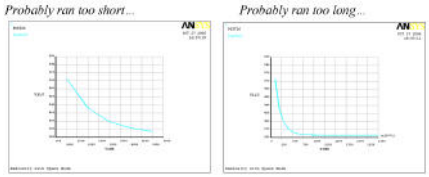
A nice advantage of the space node, given that you assign a DOF temperature to it, is you can check reaction loads at that node, and energy balance to see what amount of energy is leaking into space. Without a spacenode, you have to assume the missing energy went to space, but you will not ahve a verifiable way to account for this. In my experience a space node never hurts, and is defined with just three commands,

```
N,800000
!or some other unused node number
SPCNOD,1,80000
!for enclosure 1
D,80000,temp,50
!for 50 degree space temperature.
```

Note, that a space node is one of those rare cases where no element must be associated with the node.

Getting Convergence

Because of the T*4 nonlinearity, convergence isn't necessarily a breeze, although in most cases it's trivial. ANSYS provided a few different methods for doing this, but I prefer the transient method. The other methods (such as QSOPT) are actually automated versions of this technique, so they are no faster, or more stable, just saves you typing a few commands.



Basically, you will specify a starting temperature (such as IC,ALL,TEMP,700), and then run a transient analysis for it to reach steady-state. You will have to plot your results (in /POST26) to verify that you have reached near-equilibrium. The pic below shows a run perhaps terminated a little soon, but its up to the analyst the accuracy needed.

For particularly hairy radiation problems you might not be able to chose a uniform starting temperature that yields convergence. This has been the rare case for me, but when encountered, I make intelligent guesses for a few different regions. In an extreme case, this too does not converge, and I first run a steady state conduction solution on my initial condition guesses (without radiation present) then add radiation and resolve. Something about the smooth temperature gradients eases convergence. Likely none of this will matter to you and a single IC command at ANY temperature will do the trick. You also might find that the /AUX12 converges more readily than radiosity, so you can always go back to that.

Strange Brew:

I can't let an article on radiation go by without a nod to the film "Strange Brew' (http://www.imdb.com/title/tt0086373/). Or more accurately the film within the film Strange Brew:

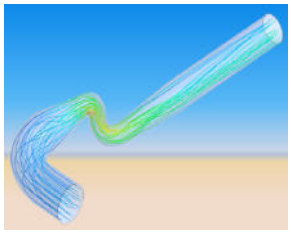
Bob McKenzie: Fleshy-headed mutant. Are you friendly?
Doug McKenzie: No way, eh? Ra-... radiation has made... me an enemy of civilization.

I looked all over the web for a picture of the other mutant to go with this… and came up empty handed. But if you recall, the mutant was a guy with panty-hose on his head, with two oranges for eyes. Ahhh, they just don't make fine cinema like they used to…

The files for this article can be found at: ftp.padtinc.com/public/downloads/radiation.zip

CFX: Transforming Mesh Assemblies

By J. Luis Rosales, PhD



The purpose of this article is to demonstrate the process of rotating, translating, scaling and reflecting a mesh model in CFX. Once a model is brought into CFX, it can be further manipulated to easily setup the desired problem. Four example problems will be shown with each demonstrating one of the aforementioned transformations. These examples are intended to help users of CFX simplify the meshing process.

Example 1: Model Rotation

An image of a sector model for a simplified motor is shown in Fig. 1 in the CFX-Pre viewer window. The model is an annular cavity with a protrusion from the inner radial wall. The conditions are that the outer wall is kept stationary while the inner wall and protrusion rotate at a constant velocity. The sidewalls in the circumferential direction can be modeled as periodic in this case, however, the full geometry can easily be constructed using the built-in transformation functions in CFX-Pre.

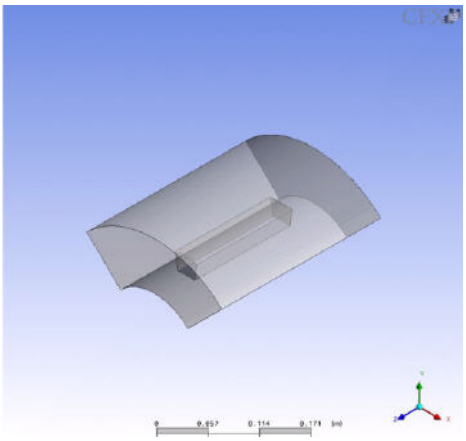


Figure 1: Sector Model for Simplified Rotating Motor

(CFX, cont.)

By highlighting the name Assembly under the MESH tab, the Transform Mesh Assembly icon can be selected. The CFX-Pre screen will appear as shown in Fig. 2.

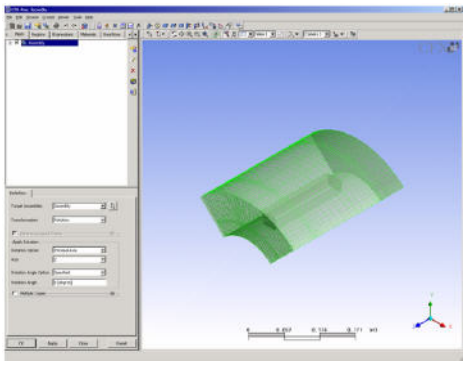


Figure 2: CFX-Pre Window

Below the Mesh tab window inside the Definition tab you will see the Target Assemblies and Transformation selection pull-down windows. There is only one assembly but many transformation types. In this example, the model will be rotated to create a full 3D model. Select the Rotation option if it is not already selected. Under Apply Rotation, the Rotation Option and Axis should be set to Principal Axis and Z. In this example, the model is positioned so that it rotates about the z-axis, but any arbitrary position is fine as long as the axis coordinates are known. Also under the Apply Rotation selection window, the Rotation Angle Option and the Rotation Angle should be set to Specified and 90 [degree]. Below those options click on the selection box for Multiple Copies and enter 3 for the # of Copies. It is a good idea to also toggle on the box for Glue Matching Assembles. This will help you avoid having to set up GGI interfaces between the wedges. After rotation, the model will appear as shown in Fig. 3.

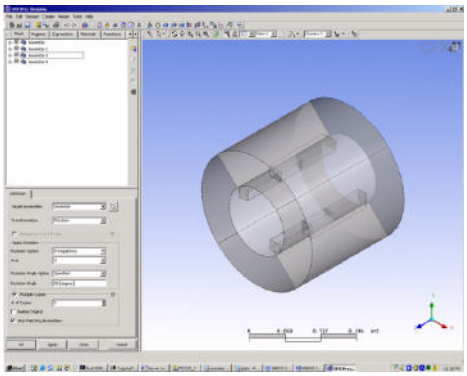


Figure 3: Full 3D Simplified Model

The new full 3D model can now easily be setup in CFX-Pre and solved. The steps required to setup this model and others will be given in a future article. The rotation capability in CFX-Pre can be used as shown in this example or to rotate models into different positions as needed.

The image of a single unit in an array of heated blocks is shown in Fig. 4. The protruding block has a constant heat flux over its surface and is one block of a 4x4 array of blocks. The entire array can be meshed in an external meshing package, but building the full array can easily be done by importing a single block unit into CFX-Pre. The translation capability in CFX-Pre will now be used to construct the full 3d Model of the 4x4 array.

After importing the single unit into CFX-Pre, highlight the assembly name and click on the Transform Mesh Assembly icon. A new Definition tab will appear below the Mesh tab window.

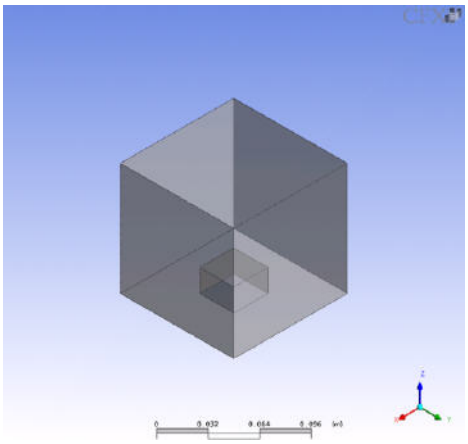


Figure 4: Single Unit of a Simplified Array of Heated Blocks

Again, under the Definition tab the name of the assembly should be selected for the Target Assemblies pull-down window and Translation should be selected for the Transformation pull-down window. The single block unit will first be copied to create the front row units. Under Apply Translation, Deltas should be selected for the Method. Enter a value of 0.1 for the Dx component and leave the Dy and Dz components with 0.0. Check the box for Multiple Copies and enter a value of 3 for the # of Copies. Ensure the Glue Matching Assemblies is selected and click the Apply button. Figure 5 shows the result of using the translation function in CFX-Pre to create the front row of the 4x4 block array.

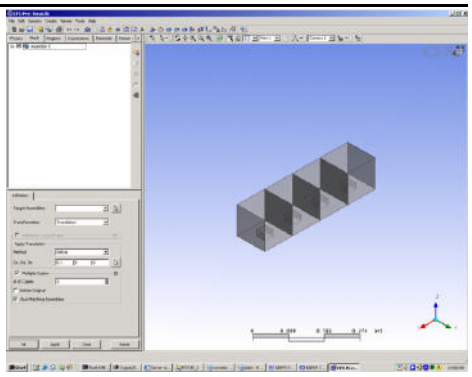


Figure 5: CFX-Pre View After Creating the Front Row

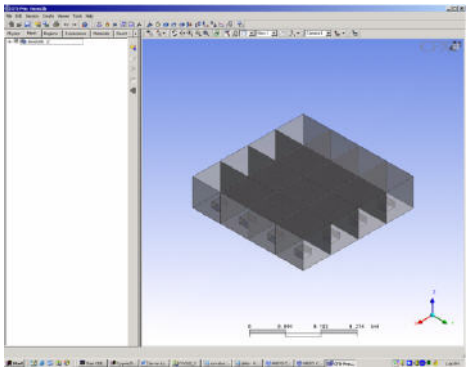


Figure 6: CFX-Pre View After Creating the Complete 4x4 Array

The next step is to create the full 4x4 array. This can be done easily in CFX-Pre. Returning to the Definition tab, select the new assembly in the Target Assemblies pull-down window, which will now consist of the group of 4 single units. Change the value of Dx to 0.0 and the value of Dy to 0.1. Keep the value for the # of Copies to 3 and keep the Glue Matching Assemblies box selected. The new 4x4 array will appear as shown below in Fig. 6.

The complete 4x4 array is now a single assembly but the individual blocks can still be selected to apply not uniform heating throughout the array. The current example shows one use of translation function. The current 4x4 array would not be too hard to create in a mesh program but a much larger repeatable model of say 10x10 or larger can more easily be handled in CFX-Pre using the translation capabilities.

Example Problem 3: Model Scaling

One obvious use of the scaling capability in CFX-Pre is to resize models that were imported using the wrong units. A quick and simple example is to use the model in the previous translation problem. The single unit will be copied once without being glued and the copied model will be scaled down as a comparison. The (Cont. on Pg. 6.)

(CFX, cont.)

single unit once imported appears as shown in Fig. 4. Using the same steps described above, a single copy is made and the view is as shown in Fig. 7.

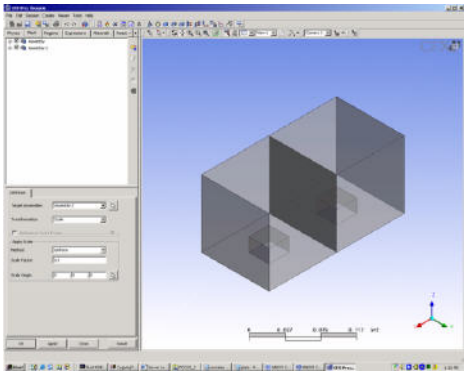


Figure 7: CFX-Pre View After a Single Copy with Translation

Note, when not gluing the copy to the original, two separate assemblies will result. Under the Definition tab, select the newly created assembly under the Target Assemblies pull-down window. Select Scale for the Transformation type. Although the scaling can be uniform or non-uniform, a uniform scaling will be used. Under Apply Scale, select Uniform for Method and 0.5 for the Scale Factor. Set the Scale Origin to 0.10, 0.0, 0.0 and click on OK. The resulting view in the CFX-Pre viewer is shown in Fig. 8.

The current example scaled the copy down and moved the origin to provide the view given in Fig. 8. The origin location will be dependent on the model.

Example Problem 4: Model Reflection

An image of a half symmetry model is shown in Fig. 9 below. The reflection capability in CFX-Pre is perfect for reflecting the model to provide a full 3D model. A

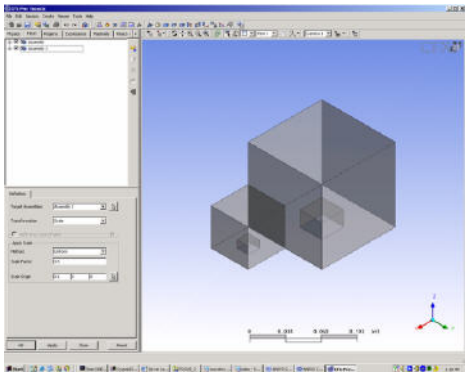


Figure 8: Original and Scaled Down Unit

symmetry model is useful for steady symmetric flow past the cylinder. However, once the flow becomes unstable, a full 3D model is required. Instead of building and meshing a new model, the current model can be reflected. Under the Definition tab, select the name of the assembly representing the symmetry model, in the Target Assemblies pull-down window. After Transformation, select the Reflection option.

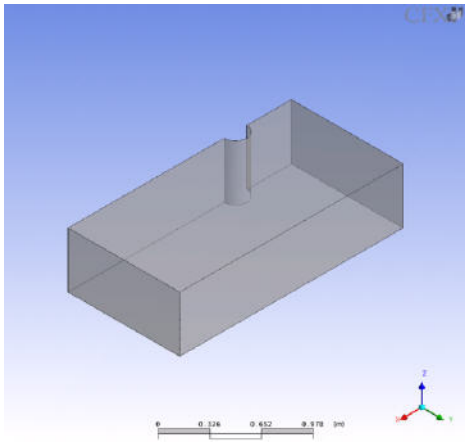


Figure 9: Half Symmetry Model of Flow Past a Vertical Cylinder

The model can be arbitrarily positioned and reflected as long as the reflection plane is known. In this case, the reflection plane is the XZ plane. Under Apply Reflection, select the XZ Plane after Method and use a value of 0.0 after Y. Again, toggle on the box for Glue Matching Assemblies and click Ok. The view in the CFX-Pre viewer will appear similar to Fig. 10.

The interface will be glued so it does not have to be GGI manually. The current model could also have been built using the Translate and Rotate capabilities in combination but reflection is much easier.

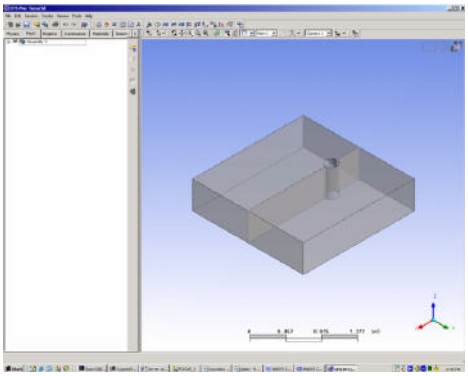


Figure 10: CFX-Pre View After Reflecting The Half-Symmetry Cylinder Model

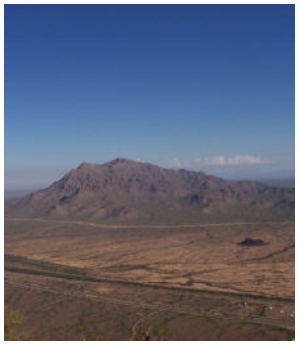
Summary

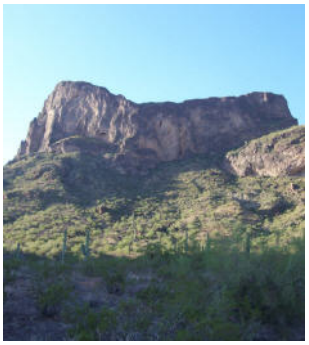
The Rotate, Translate, Scale and Reflect capabilities in CFX-Pre give the user the option of manipulating imported models. Sometimes it is easier to use these capabilities than to build the full mesh in a meshing package. The combination of these functions will allow the user to position the model in almost any orientation. Since the positioning of a model should be done in a CAD package, the user may rarely use them but the current article was written to raise attention to their presence.

PADT Scrap Book:

Filling White Space With Random Snapshots Grabbed off People's Hard Drives

On the way to an ANSYS, Inc. Meeting in Lyon, Eric Miller Spent a Few Days in Paris





Doug Oatis and David Mastel Spent a Day Climbing Picacho Peak (the mountain half way between Phoenix and Tucson. They found a Friend on the way

Awesome APDL: GTHT, Hot Spot Locations

Just the other day I needed to select some areas by location rather then number. To do this you can use the undocumented *get command for finding the "hot spot" or selection location of a line, area or volume.

This macro, GTHT is a general macro that returns the X,Y,Z selection location for whatever entity type you want, in the coordinate system you need. Since *get returns the location in the global coordinate system, it uses *vfun to convert the location into a local CSYS.

You then use

```
xSEL,S,LOC,X
xSEL,R,LOC,Y
xSEL,R,LOC,Z
```

(where x is l, a, or v) to select what you need.

The macro is presented here with TST1.MAC which shows how to use it.

```
!  GTHT.MAC: GET ENTITY HOT SPOTS
!
_typ = arg1   ! ARG1: Type
              !       1 = Line
              !       2 = Area
              !       3 = Volume
_nm = arg2    ! ARG2: Ent Number
_lbl = arg3   ! ARG3: String Label
              !       Put in ''
_cs = arg4    ! ARG3: Coordinate
              !   System to show
              !   Results In
! Create temp arrays
*dim,_acnt,,3
*dim,_temp,,1,3
! Get Hot Spot Info in put it
!    in _acnt
*if,_typ,eq,1,then  !LINE
  *vget,_acnt(1),40,_nm,8,3,,,4
*endif
*if,_typ,eq,2,then ! AREA
  *vget,_acnt(1),60,_nm,6,2,,,4
*endif
*if,_typ,eq,3,then ! VOLUME
  *vget,_acnt(1),80,_nm,6,2,,,4
*endif
! Transfer _ACNT to _TEMP
!  so we can use *vfun
_temp(1,1) = _acnt(1)
_temp(1,2) = _acnt(2)
_temp(1,3) = _acnt(3)
! Change from global to _CS
*vfun,_temp(1),local,_temp(1),_cs
hs_%_lbl%_x = _temp(1,1)
hs_%_lbl%_y = _temp(1,2)
hs_%_lbl%_z = _temp(1,3)

!Clean up Parameters
_typ= $_nm= $_tag= $_acnt= $_temp=

!---- TST1.MAC
block,-1,1,-1,1,-1,1
local,11,1,0,0,0,0,90
gtht,1,3,'l11',11
gtht,2,2,'ar'
gtht,3,1,'vl'

lsel,s,loc,x,hs_l11_x
lsel,r,loc,y,hs_l11_y
lsel,r,loc,z,hs_l11_z

asel,s,loc,x,hs_ar_x
asel,r,loc,y,hs_ar_y
asel,r,loc,z,hs_ar_z

vsel,s,loc,x,hs_vl_x
vsel,r,loc,y,hs_vl_y
vsel,r,loc,z,hs_vl_z
```

Resources

Linearized Stress in Workbench Simulation: Every once in a while someone asks how to get linearize stress in Workbench. You can certainly do it with APDL, but you can also do it in WB using JSCRIPT. Pierre THIEFFRY from the ANSYS, Inc. Has created a great tool for this that is also a more advanced example for Workbench Customization. Visit the Workbench Portal on the Customer portal and Search for "Stress linearization in Workbench" to find his posting. http://www1.ansys.com/customer/wb/wb-home.asp

Upcoming Training Classes

Month	Start	End	#	Title	Location
Nov '06	1-Nov	3-Nov	101	Introduction to ANSYS, Part 1	Tempe, AZ
	8-Nov	9-Nov	107	ANSYS WB DesignModeler	Tempe, AZ
	13-Nov	14-Nov	301	Heat Transfer	Irvine, CA
	16-Nov	17-Nov	102	Introduction to ANSYS, Part 2	Tempe, AZ
	27-Nov	28-Nov	604	Introduction to CFX	Tempe, AZ
Dec '06	6-Dec	8-Dec	101	Introduction to ANSYS, Part 1	Irvine, CA
	11-Dec	13-Dec	104	ANSYS Workbench, Intro	Tempe, AZ
	14-Dec	14-Dec	105	ANSYS Workbench, Struc NL	Tempe AZ
	18-Dec	18-Dec	106	ANSYS WB DesignXplorer	Tempe, AZ
Jan '07	10-Jan	12-Jan	101	Introduction to ANSYS, Part 1	Tempe, AZ
	18-Jan	19-Jan	100	Engineering with FE Analysis	Tempe, AZ
	25-Jan	26-Jan	801	ANSYS Cust. With APDL	Tempe, AZ
	29-Jan	31-Jan	104	ANSYS WB Simulation, Intro	Tempe, AZ

Links

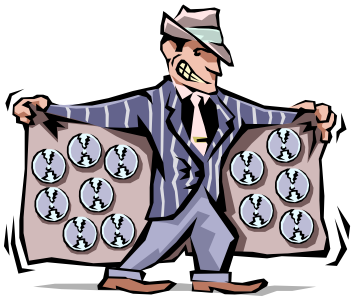
There has been a great discussion on XANSYS about reports for analysis. Visit the archive at www.xansys.org and search on "Improving FE Education" to see the entire thread.

The University of Alberta has nice collection of ANSYS tutorials at: http://www.mece.ualberta.ca/tutorials/ansys/

News

- ANSYS, Inc. Turns in Another Great Quarter for Wall Street link
- ANSYS Releases Icewave(TM) 1.1 Software for Electromagnetic Compatibility and Interference Analyses link

The Focus is a periodic publication of Phoenix Analysis & Design Technologies (PADT). Its goal is to educate and entertain the worldwide ANSYS user community. More information on this publication can be found at: http://www.padtinc.com/epubs/focus/about



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