

Better Squishing with Manual Rezoning

By: Eric Miller

Most of us doing structural analysis are stuck with studying stuff that deflects and may have a little bit of plasticity in it. But some people get lucky and they get to squish stuff as part of their job. There is something very satisfying about seeing a part get totally crushed. The downside has been that a crushed part means a crushed mesh, and the solution often failed before completion because of excessive mesh distortion. Over the past couple of releases ANSYS, Inc. has been making things easier by introducing the ability to stop an analysis, remesh, and then move forward. This process is called "Manual Rezoning" and is covered very well in Chapter 6 of the Advanced Analysis Guide. Since the documentation is so good, this article will just touch on some key issues and give some pointers to get you through any rough spots. The example in the manual is perfect.

If you think about what rezoning requires, it is a very complex process going on behind the scenes in ANSYS. A mesh is created using the shape of the deformed geometry and then all loads and BC's must be mapped to the new mesh. Then the program must map the strain state to the elements, including plastic and hyperelastic effects. This new mesh must reach equilibrium before the analysis can continue. Because of the amount of programming required to support this, the capability is only available for a sub-set of 2D solid and contact elements: PLANE182/183, TARGE169, CONTA171/172. You can only use it with TB HYPER, BISO, MISO, NLISO and PLASTIC,MISO material models. See the table in Section 6.2 for a full list of restrictions.

Here are some basic lessons we have learned:

1. Make sure you save restarts (RESCONTROL). Saving ALL for each substep is the safest. IF you have a lot of substeps and big files, set frequency to 25 or so to save the last 25 restarts (rescontrol,,all,1,25).
2. Don't get distracted by convergence

problems. If the non-linear solution stops because the solution did not converge, check the distorted mesh. Your problem could be with contact or material models and not with the mesh quality. Looking at Newton Raphson Residuals (NLDIAG,NRRES,ON and

problem, you will spend some time figuring out which previous substep to remesh and restart from, how big of a zone to remesh, and what the mesh should look like. Familiarity with your problem, the geometry and ANSYS

(Continued on Page 2)

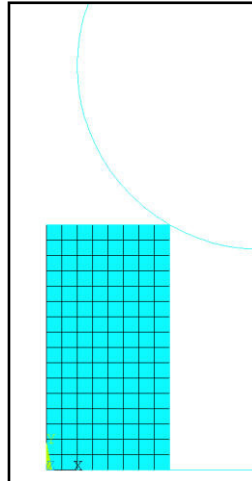


Figure 1: Original Mesh

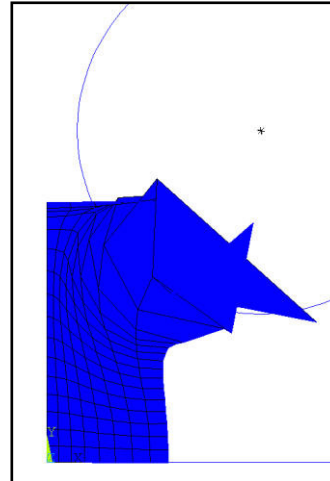


Figure 2: Failed Mesh

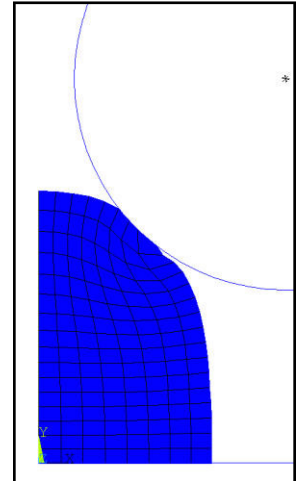


Figure 3: Mesh Before Failure

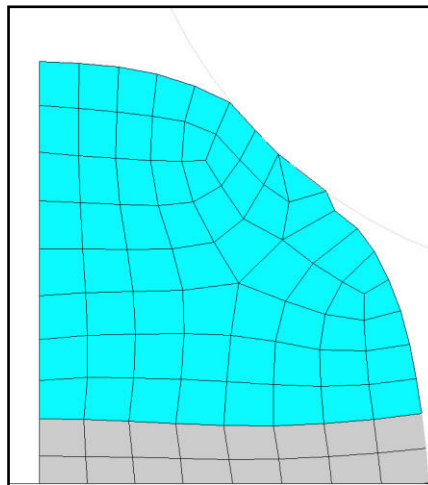


Figure 4: New Mesh

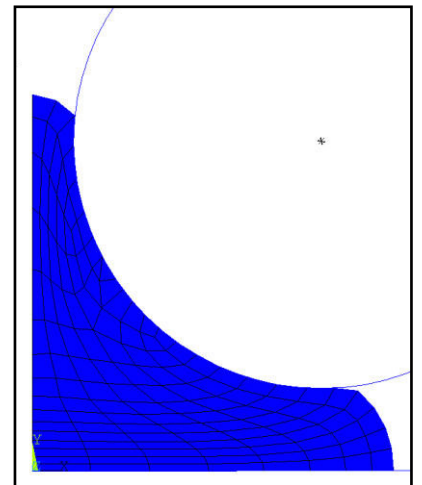


Figure 5: Solved Mesh

PLNSOL,NRRES) can help determine where the non-convergence may lie. Fix those problems before you look at rezoning.

3. If you have a failure due to element quality, then follow the steps outlined in the manual to improve the mesh for the distorted shape.
4. Unless you have a well-behaved

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meshing options really pay off here.

5. If you try out a given mesh at a given substep (using MAPSOLVE) and the mapping does not converge, keep backing up to earlier substeps. Try this on the example problem in the manual. If you start with iteration 10, you will find that it doesn't converge on the MAPSOLVE. Iteration 8 does. The example in the manual uses iteration 7.
6. Once you have done a rezone on a given substep and tried it out, the RST file gets truncated. So if you fail on iteration 1,125 don't try and rezone on 1,100 first. If that was too early you can't recover and go back (unless you saved a copy of your result and restart files).
7. Use APDL scripts to simplify the task. Once established you just change one or two values in it (like the iteration and mesh parameters) and rerun it. One thing to note though, don't put a SOLVE after the MAPSOLVE in the same macro. If the MAPSOLVE fails ANSYS will just keep on running and will do a restart on your original mesh.
8. Don't be afraid of changing MOPT options. The alternative meshers available through this command may give better meshes for nasty geometry,

and MOPT,AORDER,ON greatly helps mesh areas of disparate size

9. To get better control, look at meshing multiple zones rather than one zone.
 10. We have found that creating a plot that shows the new mesh surrounded by the old is useful. Here are the APDL commands we stick on our scripts where you would normally just put the amesh command.
- ```

esel,u,,,all !Unselect all the elements
amesh,2 !Mesh the area made from the
 !old elements (aremesh,-1)

epplot !Plot the new mesh
/noerase !Turn off erase
/user !Set zoom and focus based
 !upon new elements

esel,invert !Select everything but the
 ! new elements
/num,-1 !Turn off colors and numbers
Eplot !Plot old elements
/erase !Turn erase back on
/num, !Set numbering back

```
11. When viewing the distorted geometry, make sure the distortion scale is set to one (/DSCALE,,1), which is the default. Also, look at the geometry with PLDISP which shows the mesh shape, or if you are plotting contours, issue a /EDGE,1,1 to see the mesh. We also find that setting the colors to reverse video (PltCtl->Style->Colors->Reverse Video) is a better way to view the mesh.

Beyond these recommendations, you need the same level of ANSYS user experience and common sense that is required for any complex non-linear analysis. With this capability and some perseverance you can solve problems that you would never have even contemplated before.

#### Typical Rezone Macro

```

finish
/clear,nostart
/file,RznExample
/show,png
/show,file
/solution
rezone>manual,1,8
remesh,start ! start process
 esel,,,65,128 ! select region to remesh
 aremesh,-1 ! create area for new mesh
 shpp,modify,11,45 ! control quad shape
 shpp,modify,12,45 ! tighter
 !-----
 ! Area mesh replaced to mesh and plot
 esel,u,,,all !Unselect all the elements
 amesh,2 !Mesh the area made from
 !the old elements (aremesh,-1)
 /show,file !A /show,png was done earlier
 epplot !Plot the new mesh
 /noerase !Turn off erase
 /user !Set view to user
 esel,invert !Invert active elements
 /num,-1 !Turn off colors/numbers
 eplot !Plot old elements
 /erase !Turn erase back on
 /num, !Turn num/color back on
 /show,close !Close plot file
 /show,term
 !-----
 esel,all
 nsel,all
 remesh,fini ! finish remeshing process
 mapsolve,50 ! map solutions
 /eof ! we prefer to stop here,
 !check that the mapsolve
 ! worked then do the restart
 finish
 /solution ! restart
 antype,,restart

```

## Guest Article:

# Friction Between Rubber,

By: Kurt Miller  
Axel Products

*We are pleased to have another fantastic article about material property characterization from Kurt Miller of Axel Products*

Friction is the resistance to sliding between two surfaces in contact when pressed together. Friction is often described with a single coefficient (COF) which is the sliding resistance force divided by the normal force pushing the two surfaces together. This value is thought to be applicable across a range of normal forces. It isn't hard to find a table on the Internet or in an old textbook which provides static and dynamic friction values for various material pairs. It couldn't be easier. As long as the analysis at hand is entirely insensitive to friction values, we'll be OK.

Even Despite Leonardo da Vinci's observations that his wooden blocks demonstrated friction values that were insensitive to the area of contact and the normal force, this is not often the case with plastic, rubber and various hard surfaces. Changing the normal pressure from values typical of lightweight ASTM sled tests to normal pressures typical in sealing applications can double the COF and strangely enough in some cases actually reduce the COF!

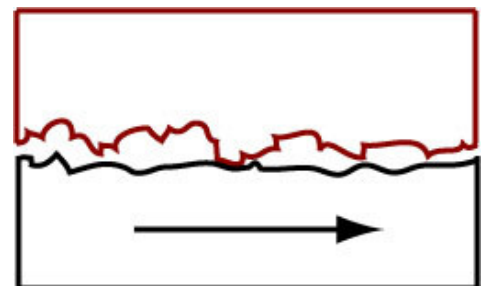
Consider a simple microscopic bumps model (**Guillaume Amontons** (1663-1705)). The microscopic bumps and holes on the two material surfaces touch each other and the interference between the two sets of bumps in the direction of movement causes a frictional force. Changes in the normal force between the surfaces changes the nature of the contact and therefore the



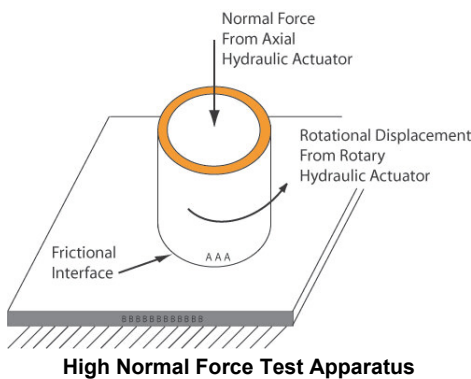
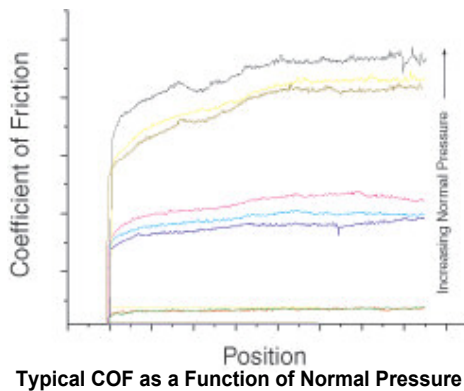
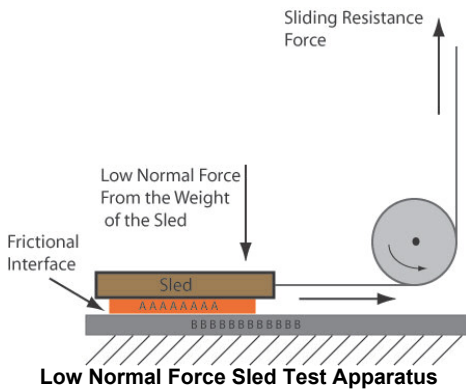
Sketch of da Vinci's Test Apparatus

magnitude of the frictional force. There can also be complex yet very real molecular forces between two surfaces but for this discussion will stay within the microscopic

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Typical Microscopic Bump Profile



bumps model. It is safe to say that anything that would alter the material properties of the microscopic bumps and the nature of the contact between the two materials will also alter the frictional forces. So based on this logic and experience in the lab, here are some things to get right when measuring friction values for use in engineering analysis:

### Test the Right Material

This may seem obvious but this needs to be said. A soft silicone (say, 50 durometer) is very different than a stiff silicone (say, 75 durometer) and the resulting friction values will be very different. Stainless steel is different than bronze. Ideally, the 2 materials used in the experiment will be the same materials as in the parts, processed in the same way.

### Get the Surface Finish Right

This can be tricky but the surface finish is very important. Hard surfaces like steel need to be machined to a similar roughness and if possible, in the same direction as the application. Plastics and rubbers need to have a similar mold surface as the actual parts. Glass needs to be cleaned to match the application.

### Achieve a Reasonable Surface Pressure

Changing the normal pressure between the 2 surfaces by 10% or 50% may not have much effect. However, changing the normal force by 2 orders of magnitude could have a dramatic effect. Common ASTM friction experiments use a lightweight sled that generates a relatively small normal pressure between subject materials. For many applications, this will generate meaningful values but for compressed elastomer seals, the normal pressure of interest will be orders of magnitude higher. In some cases, coatings intended to reduce friction will physically break down under high surface pressure and can generate friction forces higher than would have been present without the coating.

Plastic parts that remain in contact for a long time prior to relative movement may creep such that the microscopic bumps flow into each other. This can result in very high static friction values. This can be approximated in the laboratory by holding the subject materials in contact for a day or more at an elevated temperature prior to testing.

### Test Near to the Application Temperature

Plastics and rubbers will soften at elevated temperatures and stiffen at cold tempera-

tures. Special attention need to be applied in cases where the material moves through a glass transition temperature. Naturally, the friction measurements will change as well.

### Achieve a Similar Rate of Relative Movement

Because the stiffness of some materials can increase with rate due to the rate sensitive properties of one or both, the relative rate of movement can be important. For most materials, changing the rate by 50% will have little effect. However, if the relative velocity in the application is orders of magnitude higher or lower than the experiment, there will likely be a significant error. This isn't uncommon in application where high frequency vibrations cause high relative velocities.

When the static friction is much greater than the dynamic friction, there is a greater likelihood of slick-slip behavior resulting in squeak and itch noises. This behavior is complex and beyond the scope of this note.

### Understand the sensitivity of the analysis to friction

If getting the exactly right value for friction is critical to the analysis, then all of the above factors need to be carefully examined. If small changes in friction parameters cause a design to fail then the design may not be very robust. In real world applications, surfaces wear, materials deteriorate and unintended material can contaminate the surfaces. Small changes in the basics can cause big frictional force changes. Understand how friction data that is used was measured or define experiments to be done under your defined conditions. If you have a chance to define your experiment, specify the materials, the surface finish, the normal pressure, the temperature and the rate.

### For more information:

At Axel Products we have several instruments and methods to measure friction.

For more information, download [www.axelproducts.com/downloads/Friction.pdf](http://www.axelproducts.com/downloads/Friction.pdf).



## Resources

Simpleware converts 3D Images to structural or fluidmeshes. Easy and robust, it may be the program you have been looking for.

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# Ready Spot? ... "Prefetch!"



*We spent some time trying to come up with a clever opening to link dogs, pizza, and fetching into a witty passage that showed not only how smart we are, but that we also are hip engineers who like dogs and pizza. Unfortunately everything sounded a bit contrived at worst, and silly at best. But who can back away from a bad joke once half-made? Not us... So in the end we offer this apology for our weak potential as night-club comics, but still present this useful, if dull, bit of information that might improve your productivity. – the Editors of "The Focus"*

You arrive home late. Your family has left you one piece of pizza in a box precariously close to the edge of the table. You are tired from trying to get one more non-linear run in and you accidentally hit the box as you reach for that last piece. The box catapults the slice away from the table and it falls in slow motion to the floor where Freckles, who is usually your best friend, waits with an open mouth to literally wolf it down. You fall to the floor in a heap of disappointment, tears running down your face as your stomach growls in mockery of your lost, but truly deserved, meal. Filled with self-pity, you wish that you could have fetched, no wait, "prefetched", that slice before that useless piece of fur with a mixed breed heritage named Freckles decided to betray you. Hmm... "Prefetch." Well, at least you have coined a new phrase from this most disheartening of experiences. But wait, once again Bill Gates and his minions have stolen your glory.

Our IT guy, Dave Mastel, recently enlightened us to a more formal definition relating to the WinXP Prefetch directory. This directory is the repository of data about launched applications and boot files. Windows OS preloads portions of these files and programs into memory so that they launch more quickly. Sounds like a good idea, unless you make your living running a

As a refresher, in many cases one benefits from specifying the scratch space size, via the `-m` argument on ANSYS startup. The maximum amount of `-m` one can specify depends on the amount of contiguous RAM available. This varies from computer to computer. On windows, it typically ranges from about 1000mb to 1400mb, for computers with up to 3GB ram. Those with 4GB and the /3GB switch typically get between 1700mb and 2400 mb. However, I and others have noticed a degradation in the typical size... it seems to be solely due to the Prefetch "feature".

monolithic analysis code that requires large chunks of contiguous memory.

So, go to `C:\Windows\Prefetch` and delete everything you find. (Don't worry, those files come back soon enough, so no fears of "deleting something you need.") For me, I boosted from 1200 to 1325 Mb available for contiguous scratch space. Others have gotten an even larger improvement.

Better still, edit your registry to only prefetch boot data as shown.

And as for mongrel pre-fetching...next time jump down and wrest it from its mouth with your own maw. It's the only way they'll REALLY respect you.

[Start] [Run] [Regedit]  
Registry Key: HKEY\_LOCAL\_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Memory Management\PrefetchParameters  
Modify/Create the Value Data Type(s) and Value Name(s) as detailed below.  
Data Type: DWORD Value // Value Name: EnablePrefetcher  
Setting for Value Data: [0 = Disabled / 1 = Application Launch Prefetch / 2 = Boot Prefetch / 3 = Prefetch All]

## Upcoming Training Classes

| Month   | Start  | End    | #   | Title                              | Location   |
|---------|--------|--------|-----|------------------------------------|------------|
| Feb '06 | 6-Feb  | 8-Feb  | 104 | ANSYS Workbench Simulation - Intro | Temp, AZ   |
|         | 9-Feb  | 9-Feb  | 105 | ANSYS Workbench, Struct Nonlin     | Tempe, AZ  |
|         | 13-Feb | 15-Feb | 101 | Intro to ANSYS, Part 1             | Irvine, CA |
|         | 22-Feb | 23-Feb | 301 | Heat Transfer                      | Tempe, AZ  |
|         | 28-Feb | 1-Mar  | 801 | ANSYS Customization with APDL      | Tempe, AZ  |
| Mar '06 | 6-Mar  | 8-Mar  | 101 | Introduction to ANSYS, Part I      | Albq, NM   |
|         | 9-Mar  | 10-Mar | 102 | Introduction to ANSYS, Part II     | Albq., NM  |
|         | 16-Mar | 17-Mar | 203 | Dynamics                           | Tempe, AZ  |
|         | 23-Mar | 24-Mar | 501 | ANSYS/LS-DYNA                      | Irvine, CA |
|         | 27-Mar | 29-Mar | 902 | Multiphysics Sim. for MEMS         | Tempe, AZ  |



## Links

Ever need to know an undocumented command. DRD, another ANSYS CP, has a great write up:

[www.drd.com/searchable/techsupport/undocument.html](http://www.drd.com/searchable/techsupport/undocument.html)



## News

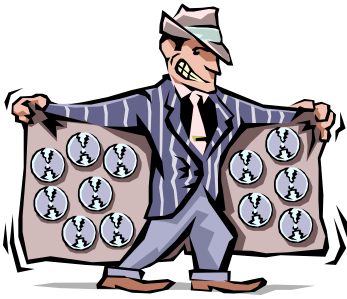
- [ANSYS, Inc. and Matereality Announce Interoperability](#)

- [Harvard Thermal Acquired by ANSYS, Inc.](#)


- [PADT Offers Classes in Las Vegas](#)

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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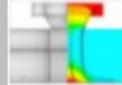
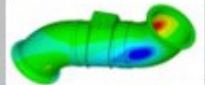

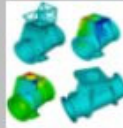
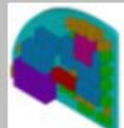
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As an example, some of the seminar topics are:

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- Introduction to AUTODYN
- Homeland Security Modeling
- ANSYS Delivers Unified Meshing
- Modeling with Scan Data
- Drive Innovation and Quality with ANSYS: Design for Six Sigma
- ANSYS Advanced Implicit FSI Technology
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