The Focus PADT

A Publication for ANSYS Users

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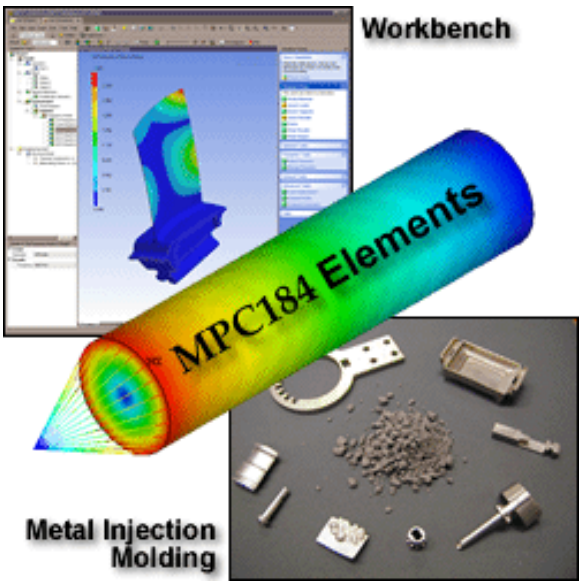

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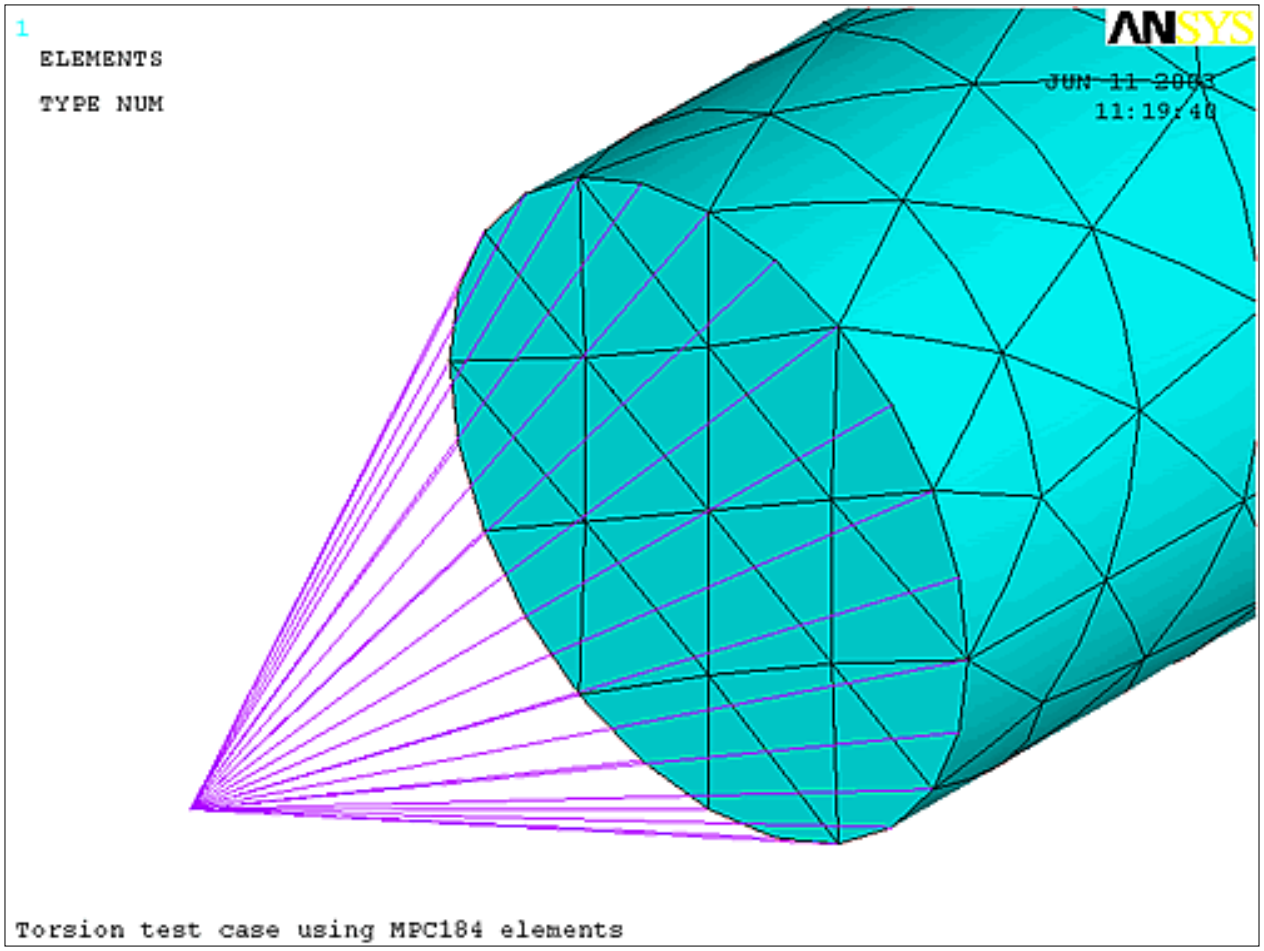
A New Connection: MPC184 Elements

by Ted Harris, PADT



ANSYS introduced the MPC184 element type in Version 7.0, although they existed as an undocumented beta feature called RIGID184 in Version 6.1. These elements have been created to simplify the creation of a spider web of beams, for example.

Many times we use a spider web of line elements or constraint equations to simplify the application of a force or moment load. For example, we can simulate a bolt load on a hole without explicitly modeling the bolt by applying the load at a node at the appropriate point in space, and then connecting that node to the nodes on our hole. The connection could be with constraint equations using CERIG or RBE3, or with stiff beam or link elements.

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The problem with constraint equations is that they are dependent on the nodal coordinate systems to define their direction, and nodal coordinate systems do not get updated for large rotation effects. Therefore constraint equations are only valid for small deflection, small rotation problems. Once our rotations get above a small angle, the constraint equations become less and less accurate.

Beam and link elements work well for large rotations, but we have to apply real constants to input large stiffness values as well as cross sectional and inertia properties. The MPC184 elements use the beam/link approach, but take care of the stiffness and cross sectional properties automatically.

For more information on this topic, see the previously released Rigid Regions article from *The Focus*. Also check out Sheldon Imaoka s article on his ansys.net web site.

The use of MPC184 is simple. We just create a master node in space, typically where our load is to be applied. Then we create the MPC184 elements from that master node to the desired nodes on our part. There are two options for MPC184:

- Keyopt(1)=0 is for rigid link behavior (default, translational DOFs only)
- Keyopt(1)=1 is for rigid beam behavior (translational plus rotational DOFs)

The following input file shows the use of MPC184 elements to apply a torque load to the end of a cylinder:

```
/COM,ANSYS RELEASE 6.1 UP20020321 10:00:51 06/11/2003
fini
/clear
/title,Torsion test case using MPC184 elements
/PREP7
CYL4, , ,.5, , , ,4
/VIEW, 1 ,1,1,1
/REP
!*
ET,1,SOLID92
MP,EX,1,30e6
MP,PRXY,1,.3
MSHAPE,1,3D
MSHKEY,0
VMESH,ALL
n,2000,0,0,5  !create 'master' node for MPC184's
ASEL,S,,,2
lsla,s,1
nsll,s,1
nsel,a,,,2000
nplo
```

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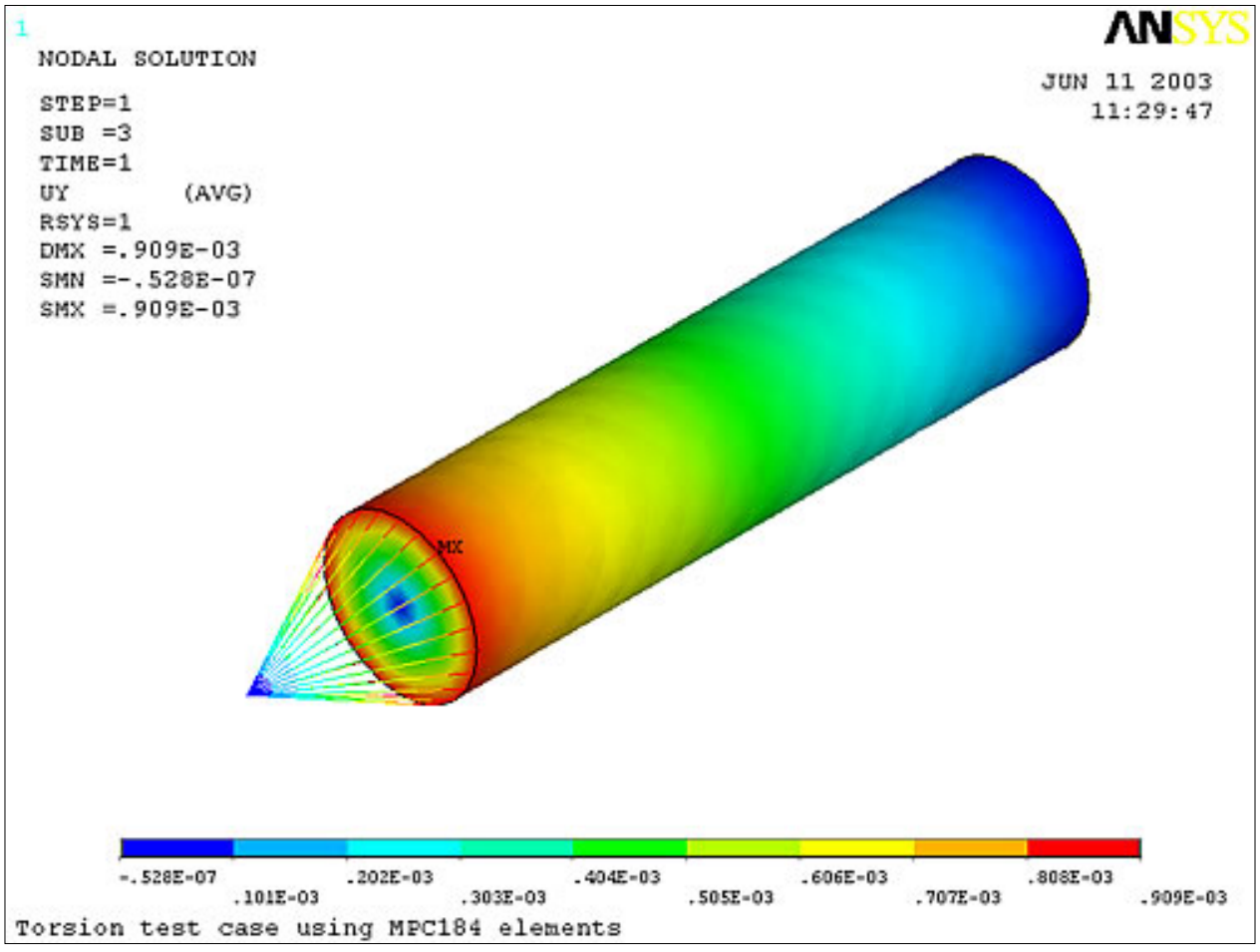
```
et,2,184
keyop,2,1,1   !set option for beam behavior, MPC184
type,2
e,2000,58
*repeat,24,,1
alls
eplo
da,1,all      !constrain one end of cylinder
f,2000,mz,500 !apply a moment to the 'master' node
alls
/solu
nlgeom,on
nsub,3,3,3
solv
/post1
rsys,1
pls,u,y      !plot tangential displacement
```



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PADT has created a macro to aid in the creation of these elements:

```
!mpc_gen.mac
!
!Macro to create a series of MPC184 elements from
!a master node to all the other selected nodes.
!Can be modified to work for other 2-node line
!element types.
!
!Usage: Select the desired nodes. Make sure you
! know the node # for the master node, then
! run the macro.
!
!Ted Harris, PADT, 6/10/03.
!
*ask,nmast_,Master Node,0
*if,nsel(nmast_),eq,1,then

  /prep7
  nsel,u,,,nmast_
  *get,num_,node,,count
  cm,n_tmp,node
  nsel,a,,,all
  *get,nmax_,node,,num,max
  *get,nmin_,node,,num,min
  cmsel,s,n_tmp
  *del,nstat_
  *dim,nstat_,array,nmax_-nmin_+1
  *del,nfill_
  *dim,nfill_,array,nmax_-nmin_+1
  *vfill,nfill_,ramp,nmin_,1
  *vget,nstat_(1),node,nmin_,nsel
  *del,ncomp_
  *dim,ncomp_,array,num_
  *vmask,nstat_(1)
  *vfun,ncomp_(1),comp,nfill_(1)

  *get,etmax_,etyp,0,num,max
  et,etmax_+1,184
  type,etmax_+1
    *do,i,1,num_
    e,nmast_,ncomp_(i)
```

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```
  *enddo

 cmsel,s,n_tmp
 nsel,a,,,nmast_
 esel,s,type,,etmax_+1
 eplo

 cmdel,n_tmp
 i= $nmast_= $num_= $nmax_= $nmin_= $nstat_= $nfill_=
   nstat_= $ncomp_= $etmax_=

*else
 *msg,ui
 No Master Specified or Master Not Selected. Exiting macro.

*endif
```

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Leveraging the Advantages of Workbench

by Eric Miller, PADT

Overview

Over the past several releases, ANSYS Inc. has been rolling out more and more of their Workbench technology. There is already a lot of marketing and technical information available on the various aspects of Workbench, but PADT is still often asked: Why should I use Workbench? or How can Workbench help me? We will attempt to answer these questions with a series of articles on using these new tools to your advantage.

In this first article we will go over what Workbench is and some highlights on the advantages of the technology. In future articles we will delve into specific capabilities such as using CAD associativety, robust meshing, imbedding APDL, post processing with report writing, and using Workbench hand-in-hand with ANSYS Classic.

What s Workbench Got to Do with Me, an ANSYS Classic User?

You likely already own ANSYS Workbench Environment! Because it shipped with the 7.1 release of ANSYS Classic, it is a simple install that runs with your current ANSYS license! Perhaps you ve noticed the extra button on the interactive startup of ANSYS, as in the figure below.

Note that if the option for Workbench Environment is greyed out, it still needs to be installed! The installation CD shipped with the ANSYS 7.1 product. Installation should be a simple process given that ANSYS Classic is already installed.

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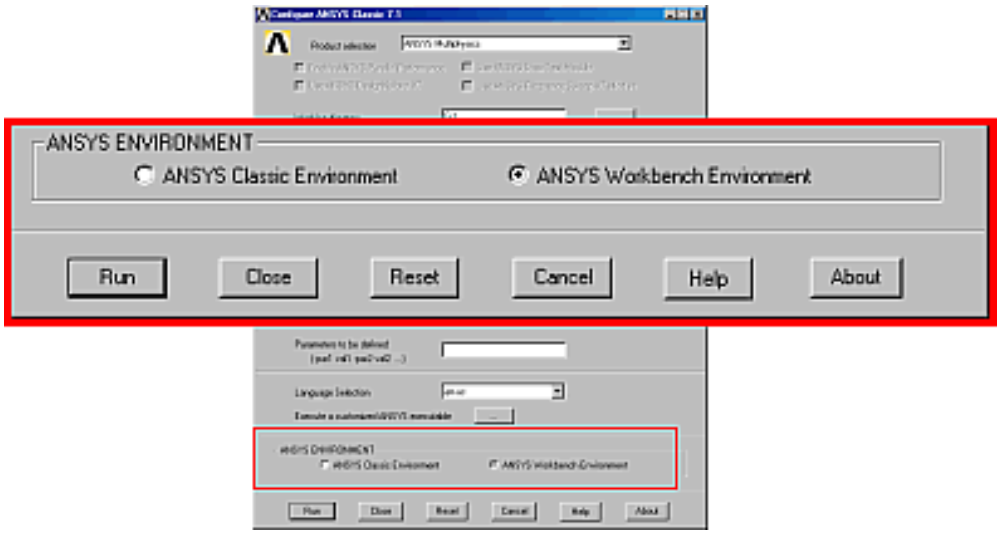

So, What Is Workbench Anyway?

The term Workbench actually refers to a group of technologies that was created by ANSYS Inc. for developing simulation tools. The goal of this technology was to allow developers to quickly develop robust tools that could meet the needs of the entire analysis user spectrum, from designers to Multiphysics analysts. DesignSpace was the first Workbench based product to come out of this effort. The next product was the ANSYS Workbench Environment (AWE), which ships with the ANSYS products. It is a new Pre/Post processor that is well on its way to providing a powerful and robust new front end to high-end FE analysis. Other tools such as DesignModeler, Workbench Project Pages, and DesignExplorer also use the same toolset.

A Faster Way to Build, Run, and Review Models

The most significant advantage to Workbench applications is the way in which users interact with the programs while conducting simulation. The Workbench paradigm is for users to specify objects and attributes on objects instead of the traditional command-driven approach. The difference is subtle but powerful.

The result to the user is that fewer commands are required to carry out the same tasks, and there is less ambiguity as to what action is taken against what object. A positive side effect is that you can also see the state of your model at any time without listing and sifting through large amounts of data. It is hard to describe this without sounding like a sales guy , so users need to try it out to see for themselves. The thing that is most noticeable to experienced users is that they feel they have somehow forgotten something, because the number of steps required to conduct tasks is so much less.

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CAD-Centric Approach Results in Less Work to Prepare Geometry

Simulation tools in the past often repeated the capabilities of CAD tools or required translation and simplification. The Workbench technology is built from the ground up on the premise that CAD is best done in a CAD system, and simulation in a CAE system. A key part of Workbench applications is the ability to quickly attach to existing CAD geometry in an associative manner that understands today s parametric solid modelers.

Once a model is attached the user can change its shape and size by changing parameters that go back and drive the CAD model. The whole series of steps that analysts used to have to go through are now gone. Experienced analysts instantly see how optimization and DOE studies are much easier with this approach.

Meshing Designed for Success Means Better Models Faster

One of the most frustrating parts of analysis is creating a good mesh. With traditional solutions, many companies have spent so much time tweaking parameters to get parts, that they have invested millions of dollars trying to devise meshless analysis tools. To avoid this, ANSYS, Inc. has focused on a meshing module that is built from the ground up to be robust. Although the user is given significant control over the meshing parameters, there are a wealth of internal meshing algorithms to not only obtain a mesh, but to get a high quality mesh. PADT has seen parts mesh 10 to 20 times faster with this technology than in traditional meshers. In addition, you no longer have to deal with slivers and small gaps in geometry.

Open and Flexible Implementation Removes Brick Walls

A significant problem with introducing any new technology in this industry is that when the product is new, it is limited. Users often try to apply a new tool and find that it can t do this and can t do that. Although some Workbench based packages are still evolving, they are all open to customization and provide more traditional solutions so users can get their work done while taking advantage of the new capabilities of the tool. APDL in AWE is a prime example of this. You can conduct complex non-linear analysis and

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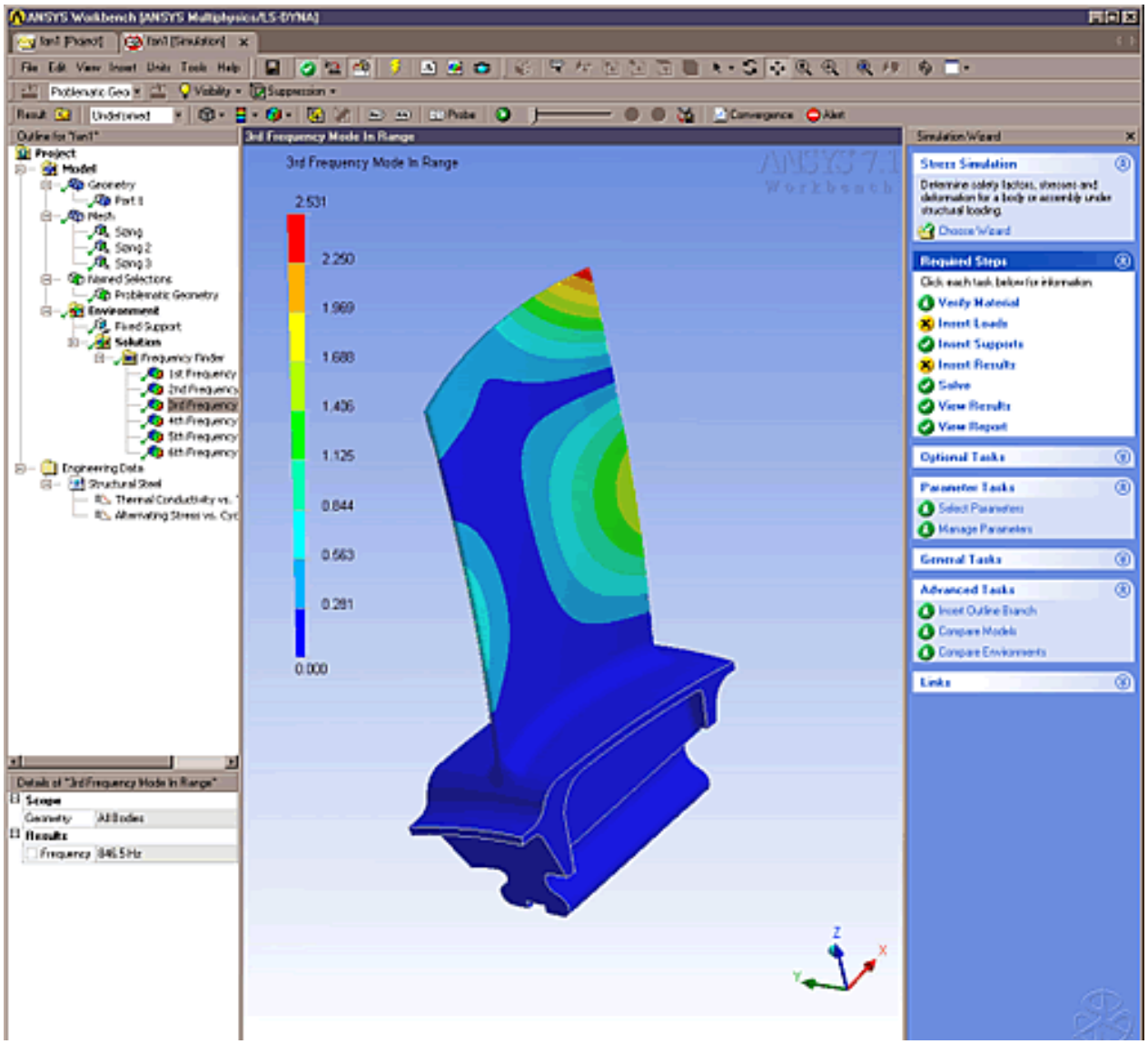
leverage the CAD and meshing advantages of the Workbench technology, because APDL scripts can be imbedded in the model and therefore access the full capability of the ANSYS family.

Just Get in There and Get Started and Follow this Series of Articles!

We do not want to get too long-winded and detailed in this first article. If you have ANSYS 7.1 loaded we recommend that you try out the AWE. If you have complex geometry or meshing difficulties, we strongly recommend that you try it out. In the next issue, we will look at the CAD attachment capability, how to use it, and the significant advantages of a CAD-centric approach.



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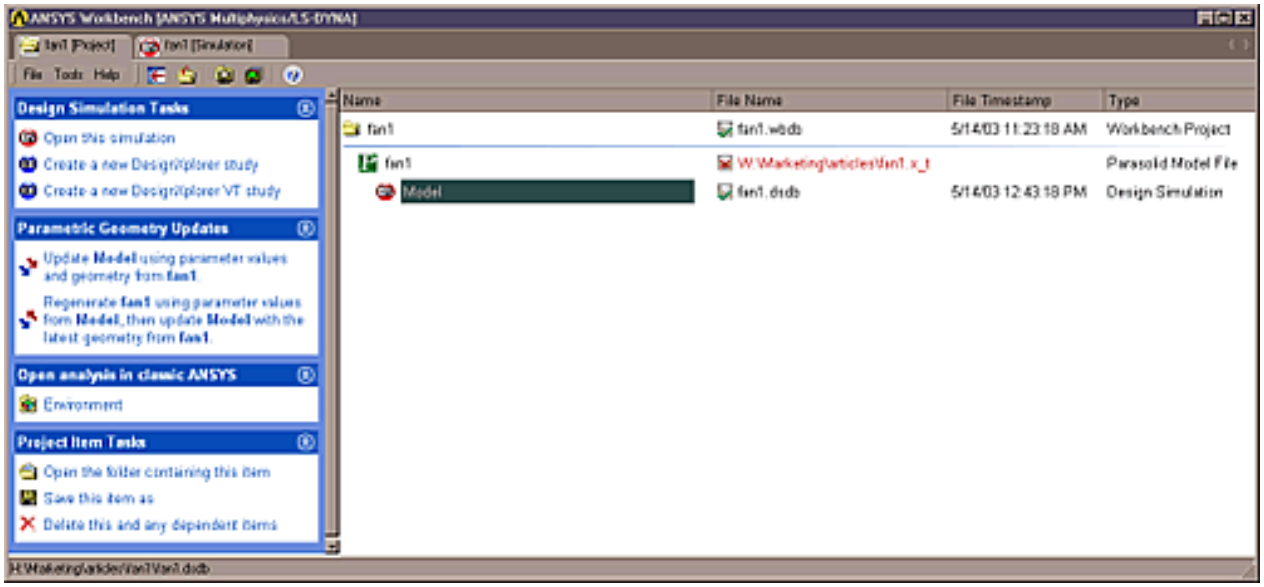

The problem with constraint equations is that they are dependent on the nodal coordinate

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Metal Injection Molding

by Mark Schanze, PADT

For fast production of metal prototypes and low-volume parts, PADT and its customers are increasingly turning to metal injection molding (MIM). The powder-metal parts can be produced at a substantial cost savings compared with machined metal. In service, they exhibit strength and modulus characteristics comparable to wrought metal and surpass the mechanical properties of metal parts produced via investment casting, forging, or machining. Because the metal comprises varied particle sizes and shapes, the resulting parts are significantly stronger than those generated via SLS. In addition, powder-metal has a consistent shrinkage of 12 to 16% depending on formulation. This shrink factor is easily compensated for in model and mold design to produce highly accurate metal parts. The primary limitation of MIM is the cost; it s economical only for small parts up to 200 grams and with wall thickness of less than 0.25 inches.

Feedstock and parts.

Processing the metal, which is comprised of a low-melt binder mixed with 60 to 70% metal powder, is similar to plastic injection molding. According to Mark Schanze, Molding Technologies Manager at PADT, Like plastic injection molding, each MIM project must be carefully evaluated before beginning to analyze shape and design areas that might pose molding or demolding challenges. In addition, variables in feedstock formulations including the type of binder being used, metal particle/grain size and shape distribution, and the mix between water- and gas- atomized particles must be considered as plans are made for injection molding.

Epoxy molds are produced for MIM following the same techniques used for

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plastic injection tools. The major difference is in the gating. MIM gates have to feed directly into the mold and the tools can t be warmed using cold shots, Schanze says. In addition, unlike the plastic injection molding, MIM utilizes low pressure with mold surfaces maintained at about 150°F depending on the binder system. Tools are air-cooled with mold temperature determined in large part by the binder system. According to Schanze, the waxier the binder system, the cooler the mold can be run.

RenCast epoxy injection mold for MIM.
Green and sintered parts in the forground.

Once molded, the green metal parts are sent out for debinding and sintering. Most of the binders used by PADT are debound using water; thermal and catalytic debinding are also sometimes used. Parts are then placed in a furnace and heated at progressively higher temperatures until the metal begins to melt at about 2,550°F (1,400°C). At this point, the temperature is lowered to about 77°F (25°C) over a 30 to 40-minute period to ensure that the part holds its shape as molded.

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About *The Focus*

The Focus is a periodic electronic publication published by PADT, aimed at the general ANSYS user. The goal of the feature articles is to inform users of the capabilities ANSYS offers and to provide useful tips and hints on using these products more effectively. *The Focus* may be freely redistributed in its entirety. For administrative questions, please contact Rod Scholl at PADT.

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