Using APDL Snippets in ANSYS Mechanical

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Agenda

• Note: This presentation is being recorded

• Introductions
• Background and Foundation
• Item Snippets
• General Prep Snippets
• General Post Snippets
• Other Stuff to Know
• Conclusion
Introductions
Upcoming Webinars

• Webinars go on Summer Breaks in June and July

• Look for an e-mail in early June with next webinars
  – Will introduce “User Issues” where you suggest a topic and we research and do the presentation

• See upcoming and past webinars at:
  – padtincevents.webex.com
    • Click on ANSYS Webinar Series
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- www.CUBE-HVPC.com
PeDAL – The APDL Editor

- Side-by-side editor and help viewer layout.
- Instant help on any documented APDL command by pressing F1.
- Full syntax highlighting for ANSYS v12 Mechanical APDL.
- Auto-complete drop downs for APDL Commands.
- APDL Command argument hints while typing commands.
- Search ANSYS help phrases and keywords.
- Multiple tabs for the editor and html viewer.
- Full capability web browser built in allows for rich web experience and web searches.
Background and Foundation
APDL?

• **ANSYS Parametric Design Language**
  – The ANSYS program, now Mechanical APDL (MAPDL), originally worked by reading command files:
    • COMMAND, arg1, arg2, arg3, arg4…
    • Punch cards!
  – Using the GUI simply builds a command(s) that are sent to the program
  – A logical improvement was to turn the command stream into a language
    • Variable substitution for any arguments
    • Simple math with variables
    • Added control logic: if-then-else, do, goto
    • Added ability to interrogate the database and return values
    • Added ability to deal with data as arrays, vectors, and matrices

• Everything you can do in MAPDL you can do through a series of text commands: APDL
Why is APDL Worshiped?

• No Limits
  – Everything you can do in MAPDL you can do through a series of text commands: APDL
  – Everything in APDL can be parameterized
  – Almost everything about your model can be interrogated

• Easy to learn and use
  – Very consistent
  – Well documented
  – Can start with contents of log file!

• Simple
  – Concise, man-readable
  – Old limits on character length (8char) keep things short

• Every item in a MAPDL is identified by a number
  – Very Important!
Mechanical and APDL

- When you use ANSYS Mechanical you are building an object oriented description of your model
- When you hit solve, it converts the description into APDL
  - Runs MAPDL in batch

- To add a new function to a complex object oriented system is tough
  - But many features users want exist in MAPDL
  - Especially advanced functions and additional options

- So, users can add APDL commands to their model
  - As an object in the pre- or post-processing branches

- Allows user access to the full breadth and depth
Command Objects

• Users insert “Command Objects” into the tree to insert APDL code
• Originally called “code snippets” many users still call them snippets
• But documentation refers to them as Command Objects
• Icon is a text file with a big Red C
  – (APDL) indicates the type of snippet, you can do other solvers…
  – Decoration (Green check, yellow Lighting bolt, question mark) is the same as for other objects in your model tree.
Not Perfect

- You may not be able to post process your model
  - Some things done to results can not be viewed in Mechanical
- You can’t touch geometry
  - Only works on FE model, not on geometry
  - KP, Line, Area, Volume don’t exist in MAPDL from Mechanical
- Not interactive in Workbench
  - You can’t try out commands and see what happens from inside Mechanical
  - You can only imbed APDL code in batch solves, even when working interactively
  - Plotting and listing is to files only
You Need to Know Some MAPDL

• Biggest issue we see with Command Objects in Tech support:
  – User typed in their script and then ran their model – didn’t work

• You need to be able to fire up MAPDL interactive
  – Read in ds.dat file or save *.db and *.rst and resume/set
  – Then try out your scripts and check that they work

• You are using the extensive features available in MAPDL
  – You can’t treat it as a black box.

• If you are not familiar with MAPDL
  – The documentation is very good
  – Work interactive, commands go in log file
The MAPDL Input File

• When you click Solve Mechanical makes a ds.dat file
  – Use the Files tool in Project to find the file
• Or you can save one anywhere you want
  – Or click anywhere on your solution branch and then use Tools->Write Input file…
Example – No Snippets
Adding Snippets

- Click on Valid Object in Tree then
  - Click on Commands Icon
  - RMB->Insert->Commands
- Insert as many as you want
  - Executed in order
Command Text Window

- When you click on a Command Object you get a text window tab called “Commands”
- Enter and view your APDL code in here
Linking to a Macro file

- You can associate a Command Object with a text file
  - Usually *.mac, but also *.txt
- Export creates a file from your text
- Import links to an existing file
- Refresh replaces the text window with what is in the file
- File name and status are shown in Details view
Three Types of Snippets

• **Item Snippets**
  – Are attached to an item in the tree
  – Contains APDL that modifies only that item
  – Some ID is set for the item number

• **Prep**
  – General commands that get executed right before the solve command

• **Post**
  – Post processing commands that get executed right after the solve
Be in the Right Module

• ANSYS runs usually go through three modules:
  – /PREP7, /SOLU, /POST1
• APDL commands for a given module only work in that module
• Items: /PREP7
• PREP: /SOLU
• POST: /POST
• You can move in and out of modules, but make sure you go back to where you started
  – Very important for PREP snippets!
## Objects you can Add Command Objects To

<table>
<thead>
<tr>
<th>Type</th>
<th>Tree Object</th>
<th>Inserted in APDL File</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITEM</td>
<td>Body</td>
<td>After material for that body is defined</td>
<td>MATID</td>
</tr>
<tr>
<td></td>
<td>Contact Pair</td>
<td>After contact is defined</td>
<td>TID, CID for Type, Real and Mat</td>
</tr>
<tr>
<td></td>
<td>Joint</td>
<td>After the joint definition</td>
<td>_JID</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>After spring definition</td>
<td>_SID.</td>
</tr>
<tr>
<td>PREP</td>
<td>Environment</td>
<td>Right Before the Solve Command</td>
<td></td>
</tr>
<tr>
<td>POST</td>
<td>Solution</td>
<td>Right after the /POST1 command</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre-Stress</td>
<td>Before first solve in Pre-stress modal</td>
<td></td>
</tr>
</tbody>
</table>
Command Object RMB

- File Operations
- Standard object tools
  - Suppress
  - Dup, Copy, Cut
  - Delete, rename
  - Rename Based on Definition
    - Shows File name if you are linked to a file.
Command Object Details View

- The same for Item and PREP Command Objects
- File name and status if you are linked to a file
- Suppression flag
- Target
  - This is where you can point to other solvers besides MAPDL
- Input arguments for your script
  - They can be parameters managed by Workbench!
Command Object Details View: POST

- POST Adds ability to bring back parameters
- User defines prefix for it to use
  - my_ is default
- Result can be a parameter
- More on this in Post section
Other and General Things to Remember

• Anything valid in APDL is valid in a snippet
  – Except geometry and interactive graphics stuff

• Command snippets do get copied to Reports

• Use Duplicate and drag and drop

• If no changes to script on Item snippets, link to the same file!
  – Example: 32 contact pairs that all have the same advanced options

• Remember that Mechanical generates APDL code

• Be aware of location that Mechanical inserts snippets

• Try and use Item Snippets when possible
  – ID makes it easy

• Use files for complex snippets

• Rename your snippets with useful names
Item Snippets
Adding Command Objects to Objects

• An object in the tree gets converted to a block of APDL code
• The Command Object lets you append your own code
• Nice because number of the object is passed to you as a parameter
• Body
  – Really material. This is the most used
• Contact Pair, Joint, Springs
  – Use this to get access to advanced features
• Strongly recommend using files for these
  – Especially if the same scripts are applied to multiple objects
  – Use Arg1-9 to specify anything unique for a given object
• Don’t change item numbers in APDL
Example: APDL Material for a Body

- Usually used for advanced materials not supported in Mechanical

! Commands inserted into this file will be executed just after material definitions in /PREP7.
! The material number for this body is equal to the parameter "matid".

! Active UNIT system in Workbench when this object was created: U.S. Customary (in, lbm, lbf, s, V, A)
!================================================================================= ERMSNIP
mptemp,1,30,50,600,700
mpdata,dens,matid,1,.0007,.00069,.00066,.00065
mpdata,ex,matid,1,29e6 ,28.9e6,28.5e6,27e6
!================================================================================= ERMSNIP

... MP,NUXY,1,0.3,
MP,MURX,1,10000,

/wb,mat,end ! done sending materials
! ***** Begin Command Snippet *****
*set,matid,1
! Commands inserted into this file will be executed just after material definitions in /PREP7.
! The material number for this body is equal to the parameter "matid".

! Active UNIT system in Workbench when this object was created: U.S. Customary (in, lbm, lbf, s, V, A)
!================================================================================= ERMSNIP
mptemp,1,30,50,600,700
mpdata,dens,matid,1,.0007,.00069,.00066,.00065
mpdata,ex,matid,1,29e6 ,28.9e6,28.5e6,27e6
!================================================================================= ERMSNIP

! ***** End Command Snippet *****
!************************* Model Summary ******************
Comments on Item Command Objects

• You can also use the body object to change the element type, section, or real by body
  – MATID also refers to TYPE and REAL
  – Great place to change away from default 185 for solid elements

• Before you go down the road of a fancy Item snippet, make sure that a new feature in Workbench can’t do it
  – Lots of things we used to write snippets for are available now
General Preprocessing Snippets
General Modifications of Your Model

- Executed right before the SOLVE command
- So you are in the /SOLU module
  - Ok for Loads, constraints, and solution options
  - Not OK for materials, moving/creating mesh, etc…
- You can go back to /PREP7 if you need to
  - Just remember to return to /SOLU
- The sky is the limit on what you can do here
  - But remember, if you create items (nodes, elements, numbering, etc..) you can’t post process in Workbench
Selecting Items to Work On

- Everything in MAPDL has a number associated with it
- Item Snippets group by some ID
  - Material ID, Contact Pair, Joint ID, etc…
- But for general stuff you have three choices:
  - APDL selection logic
  - Named Selections -> Nodal Components
  - Combine named selection and APDL selection logic
- Named Selections
  - For Every geometry object you name with Named Selection
  - And, every geometry object you assign a nodal load or constraint
  - A nodal component gets created in MAPDL
    - Note that load names may be tricky to figure out
    - Recommend using named components
Named Selection

- Remember that it makes a nodal component for the nodes that sit on the geometry your select
  - Body named selections don’t get turned into APDL
- They show up in your DS.DAT file as shown
- Use descriptive names
- Some users actually encode stuff they want to pass in the Names Selection
  - F_Hydro_34
  - Write a macro that loops through components
    - Looks for ones starting with F_Hydro
    - Applies a hydrostatic load assuming the highest node is at 34 feet
  - Can get very fancy

/com,************
CMBLOCK,ERMF1,NO...
Parameters

• User ARG1-ARG9 in Details to pass in Parameters
  – If you need more, use multiple Command Objects
• You can also define parameters that you want passed back to Mechanical
  – A trick required – Only user parameters with prefix in a Post Command Object are brought back
  – So, add a `my_param = my_param` to a post object as a workaround

PREP Command Object

! Commands inserted into this file will be executed just prior to the Ansys SOLVE command.
! These commands may supersede command settings set by Workbench.

! Active UNIT system in Workbench when this object was created: U.S. Customary (in, lbm, lbf, s, V, A)
nsel,all
nlist,all
*get,my_nmx,node,,num,max

POST Command Object

! Commands inserted into this file will be executed immediately after the Ansys /POST1 command.

! Active UNIT system in Workbench when this object was created: U.S. Customary (in, lbm, lbf, s, V, A)
nsel,all
set,last
*get,my_stmx,active,,set,sbst
my_nmx = my_nmx
General Postprocessing Snippets
Getting Access to Full MAPDL POST

• Puts you in /POST1
  – Make plots not supported in Mechanical
  – Queries and calculations
  – Return scalar values as parameters
  – Graphs
  – Make output files that you need for other programs

• Also gives you access to POST26
  – Do time dependent post and then bring back graphs or scalar value
Post Parameters

• Do any calculations you want that produce a scalar result and bring back the results

• The way it works:
  – Mechanical scans the Command Object looking for parameter definitions
    • *get,par, *set,par, par=
  – It puts code in to just return those parameters

• No arrays, no string

• You can’t create parameters on the fly
  – *get,my_pf%i%, does not work
Parameter Example

- Get number of modes and participation factors
- Need to know ahead of time how many modes
  - Remember, no do-loops

*set, last
*get, my_nmd, active,, set, sbst
*get, my_pf01, mode, 1, pfact
*get, my_pf02, mode, 2, pfact
*get, my_pf03, mode, 3, pfact
*get, my_pf04, mode, 4, pfact
*get, my_pf05, mode, 5, pfact
*get, my_pf06, mode, 6, pfact
*get, my_pf07, mode, 7, pfact
*get, my_pf08, mode, 8, pfact
*get, my_pf09, mode, 9, pfact
*get, my_pf10, mode, 10, pfact
*get, my_pf11, mode, 11, pfact
*get, my_pf12, mode, 12, pfact
Plots

• If you create a PNG file in your Command Object, Mechanical appends it to the Tree
• Standard MAPDL plotting to png files applies
  – Only requirement is to use /show,PNG
• Note: Files get appended to first post command object
  – Not the object that the plots were created in
• Files show up in MECH directory as PostImageNNN.png
  – Mechanical increments the NNN
  – Use Files viewer on project page to see
Example: Mode Shape Plots
Example: Mode Shape Plots

set, last
/gfile, 600
/show, png
*get, nmd, active,, set, sbst
icc = 1
irr = 1
np = 3
aa = 2.8/np
bb = 1.9/np
xx = -1
yy = 1-bb
/plopts, info, 0
/plopts, minm, 0
/psymb, cs, off
/triad, off
/view, 1, .9875, .125, -.09
/angle, 1, -50.41
/dist, 1, 11
/focus, 1, .386, 1.192, 10
/RGB, INDEX, 100, 100, 100, 0
/RGB, INDEX, 80, 80, 80, 13
/RGB, INDEX, 60, 60, 60, 14
/RGB, INDEX, 0, 0, 0, 15
*do, i, 1, nmd
  set, 1, i
  *get, frq, mode, i, freq
  /window, 1, xx, xx+aa, yy, yy+bb
  /ANUM, 0, 1, -0.85480, 0.37396
  /TSPEC, 15, 0.75, 1, 359, 0
/TLAB, xx+.05, yy+.05, '%i: %frq%'
plnsol, u, sum
/annot, delete
/noerase
xx = xx + aa
icc = icc + 1
*if, icc, gt, np, then
  xx = -1
  yy = yy - bb
  icc = 1
  irr = irr + 1
*endif
*if, irr, gt, np, then
  /erase
  /annot, delete
  icc = 1
  irr = 1
  xx = -1
  yy = 1 - bb
*endif
*enddo
*enddo
/erase
/annot, delete
/win, 1, full
/show, close
Example: Mode Shape Plots

- Things to note
  - Users /erase and annotation without any problems
  - Change background to white or go for blue-blue background to look more like workbench
  - Not a MAPDL plot guru, see The Focus for a quick review of important commands:
    - Making Pretty Plots in ANSYS Mechanical and Mechanical APDL
    - Got to www.PADTINC.com/blog and search for /gfile
Example: A Graph

- Created a macro to make a bar graph of Participation Factors on a modal analysis
- Use this to plot arrays (bar) and table (line)

```
*set,last
*get,nmd,active,,set,sbst
*dim,pfs,,nmd
*do,ii,1,nmd
  *get,pfs(ii),mode,ii,pfact
*enddo
/show,png
/gropt,fill,1
/xrange,0,nmd+1
/gropt,divx,nmd+1
/axlab,x,'Mode'
/axlab,y,'PFact'
*vplot,,pfs(1)
/show,close
```
Other Stuff to Know
Not Just for MAPDL

- Works for other solvers that work with ANSYS Mechanical:
  - ANSYS Rigid Dynamics
  - LS-DYNA
  - SAMCEF
  - ABAQUS

- Put in appropriate keywords or commands and they will be inserted as needed
Debugging

• Biggest issue is that creating snippets is not interactive
  – Testing requires a re-run of your model

• Suggested solution
  – Get your model ready without snippets
  – Write Input File…
  – Bring up in an interactive MAPDL session
  – Write and debug a macro
  – Attach to your ANSYS Mechanical model as a file
    • Or cut and paste it into your Command Object

• Much better way to debug

• Also, don’t forget to check the output file under solution Information
Dealing with Tabular Information

• No way right now to get tabular information from MAPDL back into ANSYS Mechanical
• Use /out or *vwrite to create text files
• View manually
• If you want to see them during/after the run:
  – Use /sys,notepad filename to bring it up

/output,foo.txt
nlist,all
/output
/sys,notepad foo.txt
Conclusions
Suggestions

• Run MAPDL interactively and use log file!!!!!!!!!
• Don’t forget: No Geometry
• Put good comments in your snippets
  – Put in a “search string” like ermsnip so you can find them in your ds.dat easily
• If a restart is possible, when you “Write Input File…” you won’t get your snippets
  – Clear restarts to get full file.
• Tell program to save DB
  – Go to directory and double-click on DB
  – Work on your macros interactively
• Get a very simple/quick model to write/debug with
• As always: Crawl, Walk, Run
Resources

- Help System
- ANSYS.net
- XANSYS.org
- “Weathered” users
- “ANSYS Customization with ANSYS Parametric Design Language”
  - $75/copy
  - www.PADTINC.com/support/techguides
- •
PeDAL – The APDL Editor

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• Full capability web browser built in allows for rich web experience and web searches.
Thoughts

• Don’t just dive into APDL because that is what you know
  – Every release, we need less and less snippets
• The incredible power of APDL is still there and available
  – But you get the incredible power of ANSYS Mechanical at the same time
Thank You…

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