

AFDEX_V19R01

Intelligent Metal Forming Simulation

New features and improvements



1. AFDEX 2D/3D Solver

2. AFDEX 3D Solver

3. GUI





1. Function to visualize three strain components of total strain

1

Step	IT	Descriptions...
37	0	Scheme for simplifying node separation
38	1	Floating-point treatment scheme to do a stable arithmetic
39	0	Option of forming load limit of press
40	0	Stabilization option to alleviate numerical convergence probl...
41	0	Maximum number of repetitive FE calculations for nodal det...
42	0	Option for automatic material tilting at initial step of each st...
43	0	Scheme for skin-layer elements to be added
44	0	
45	0	
46	0	Nodal recontact control parameter
47	0	Number of die fracture model
48	1	Identifying long punch forging in terms of reflection of rigid...
49	1	Function for calculating indices for evaluating metal flow lines
50	0	Option for treating two contacting dies
51	0	Scheme for volume compensation only in ring rolling
52	0	Enable accuracy improvement for internal temperature of ob...
53	0	Minimum distance between nodes on the opposite side
54	0	Number of steps for restoration of remeshing oriented volu...
55	0	
56	-1	Index for controlling material penetration into die gap
57	1	Index to skip saving the solution step at which remeshing is ...
58	0	Maximum number of iterations allowed for solution converg...
59	0	Disable flow analysis

2

ex01 - AFDEX_V19R01 3D - [Post Processing]

Process Control

- Stage1
 - Workpiece
 - MODL01_workpiece.stl
 - AISI_1010(T=20C)
 - Upper Die
 - MODL01_upper.stl
 - ToolSteel2
 - v=(0, -1, 0)
 - Soap_Cold(Steel)
 - Lower Die
 - MODL01_lower.stl
 - ToolSteel3
 - v=(0, 0, 0)
 - Soap_Cold(Steel)
 - Symm_Plane (2)
 - Forming1

MFRCAJAFDEX V19R01
TIME: 1.901217E+01
TOTAL STRAIN: XX

Legend:
+2.46281E+000
+2.12958E+000
+1.79636E+000
+1.46314E+000
+1.12991E+000
+7.96688E-001
+4.63464E-001
+1.30240E-001
-2.02984E-001
-5.36208E-001
-8.69432E-001

Strain / Strain rate

- Elastoplastic strain
- Principal strain rate
- Strain rate
- Total strain
 - $\epsilon_{11}^{+} XX$
 - $\epsilon_{22}^{+} YY$
 - $\epsilon_{33}^{+} ZZ$
- Effective strain rate
- Effective strain

Stress / Pressure

- Principal stress
- Stress
- Effective stress
- Hydrostatic pressure

Porous

- Temperature

Microstructure

- Grain flow
- Nodal velocity
- Folding
- Elastic/plastic zone

Die / Boundary

- Mechanical
- Metallurgical

1. By default, AFDEX does not calculate total strain and its components.
2. If this function is needed, enter I Default(49) = 1. As shown in the picture on the right, the components can be visualized on the post-processor.



2. Improved the functionality of die elastic deformation

- The newly introduced function avoids the die deformation and adds this to the deformation of the workpiece.

The screenshot displays a software interface for process simulation. On the left, a tree view shows a project named 'ex12' with a 'Process Control' folder containing 'Stage1' and 'Workpiece'. The 'Workpiece' folder is expanded, showing various die models and material properties. The main window is titled 'Process Information' and contains several sections: 'Title & File Information', 'Bulk Forming', '+Forming', '+Simulation', '+System of Units', and '+Analysis'. The 'Forming' section is selected, showing options for 'Cold' and 'Hot' forging. The 'Simulation' section is set to '2D Axi-symmetric'. The 'System of Units' section is set to 'Newton'. The 'Analysis' section is set to 'Flow Analysis'. A 'Die Structural Analysis' dialog box is open, showing four options: 'Single Die: Die Usage Just After Shrink-fit Causing Die Deformation', 'Single Die: Die Insert Machining After Shrink-fit', 'Assembled Die: Die Usage Just After Shrink-fit Causing Die Deformation', and 'Assembled Die: Die Insert Machining After Shrink-fit'. A fifth option, 'Workpiece Penetration of Die Deformation Into The Fixed Die Allowed (to be being developed)', is selected and highlighted with a red box. A 'New function' label is placed below this option. The 'Advanced' button in the 'Process Information' dialog is also highlighted with a red box. A red circle with the number '1' is placed over the 'ex12' folder in the tree view, and a red circle with the number '2' is placed over the 'Advanced' button.

1

Process Information

Title & File Information

Title ex12

File D:\AFDEX manual\4. V19R01\2D\Part2\ex12.a2dprj

Bulk Forming

Forging

+Forming

Cold Hot

+Simulation

2D Axi-symmetric 2D Plane-strain 3D

+System of Units

kgf Newton

+Analysis

Flow Analysis Die Structural Analysis Workpiece Die Interaction Heat Treatment

Advanced

2

Die Structural Analysis...

Single Die: Die Usage Just After Shrink-fit Causing Die Deformation

Single Die: Die Insert Machining After Shrink-fit

Assembled Die: Die Usage Just After Shrink-fit Causing Die Deformation

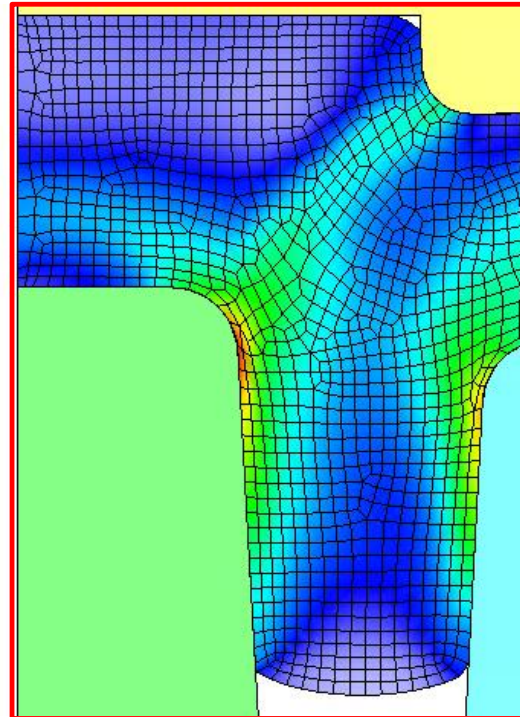
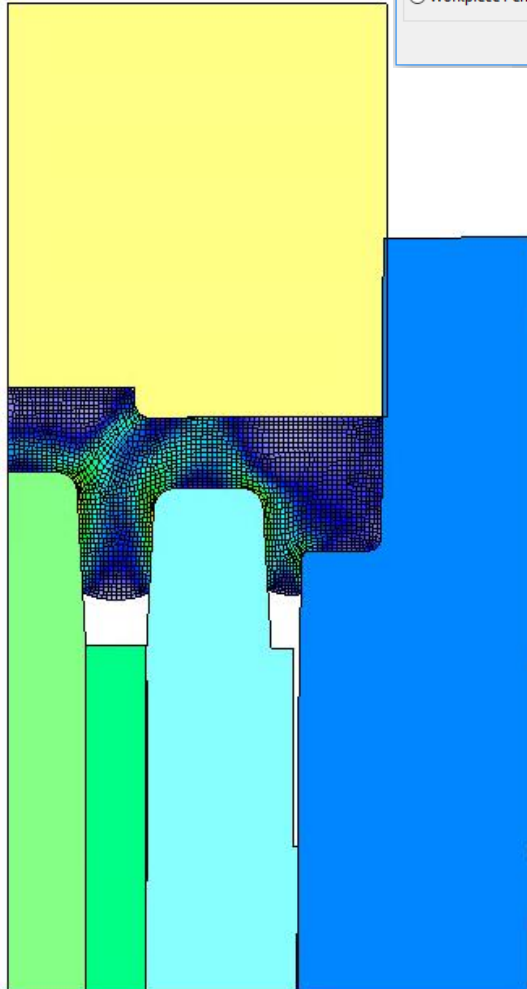
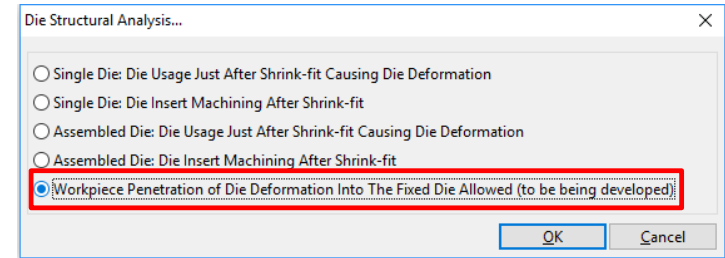
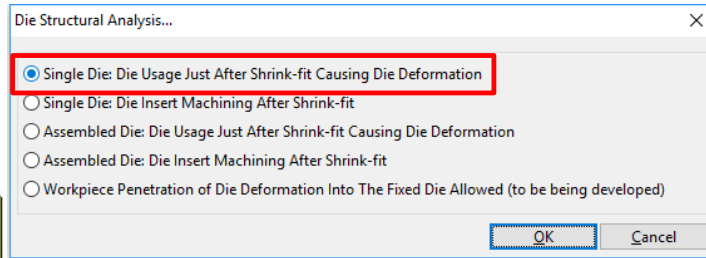
Assembled Die: Die Insert Machining After Shrink-fit

Workpiece Penetration of Die Deformation Into The Fixed Die Allowed (to be being developed)

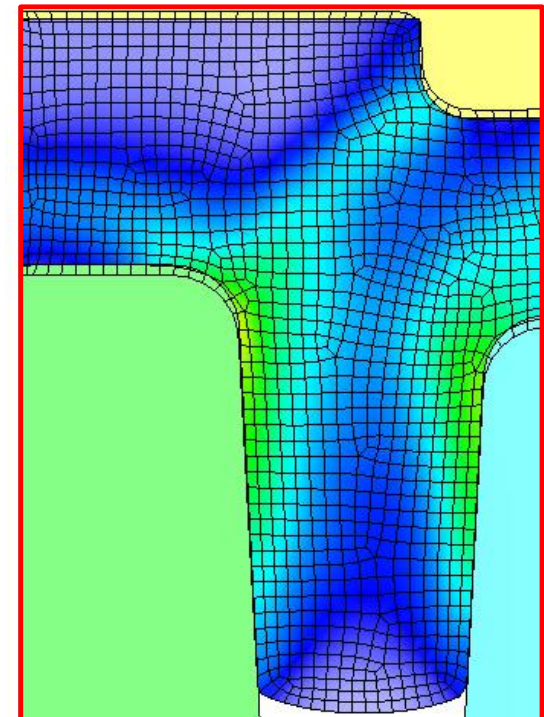
New function

OK Cancel

2. Improved the functionality of die elastic deformation



The die deforms in this case.



The workpiece deforms instead of the die.

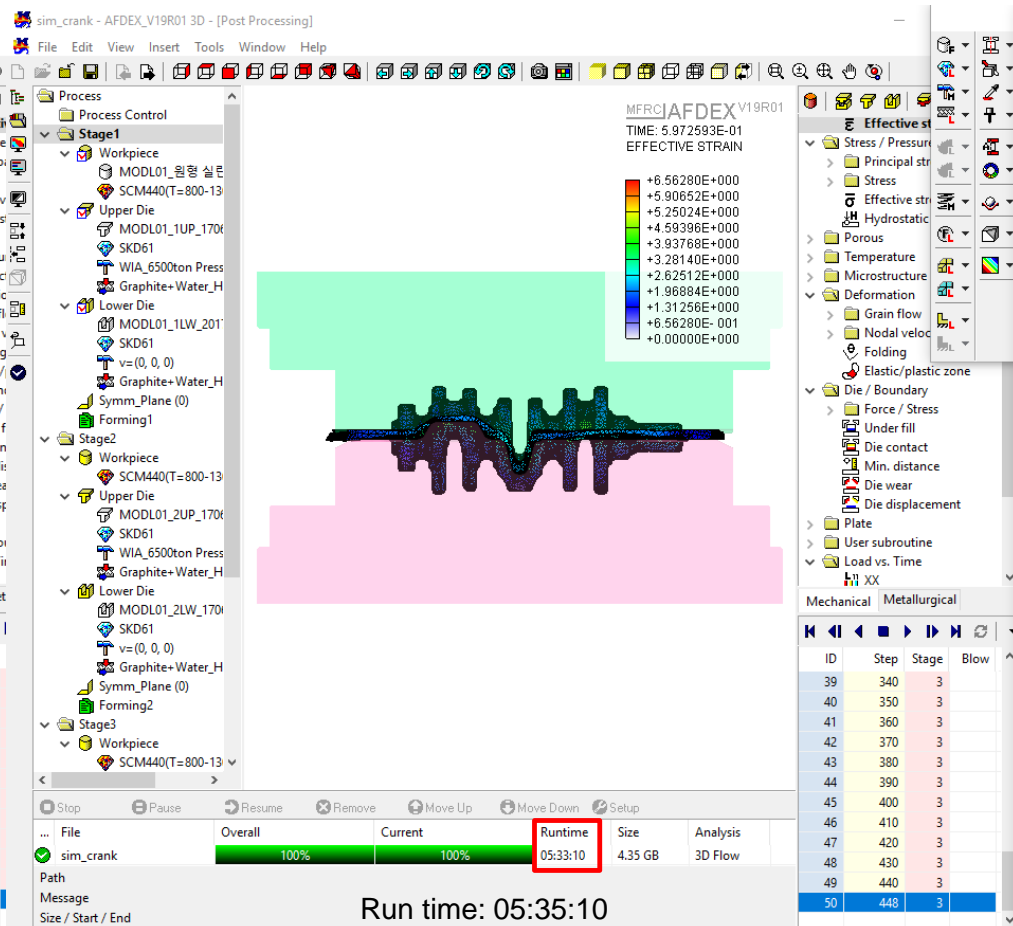
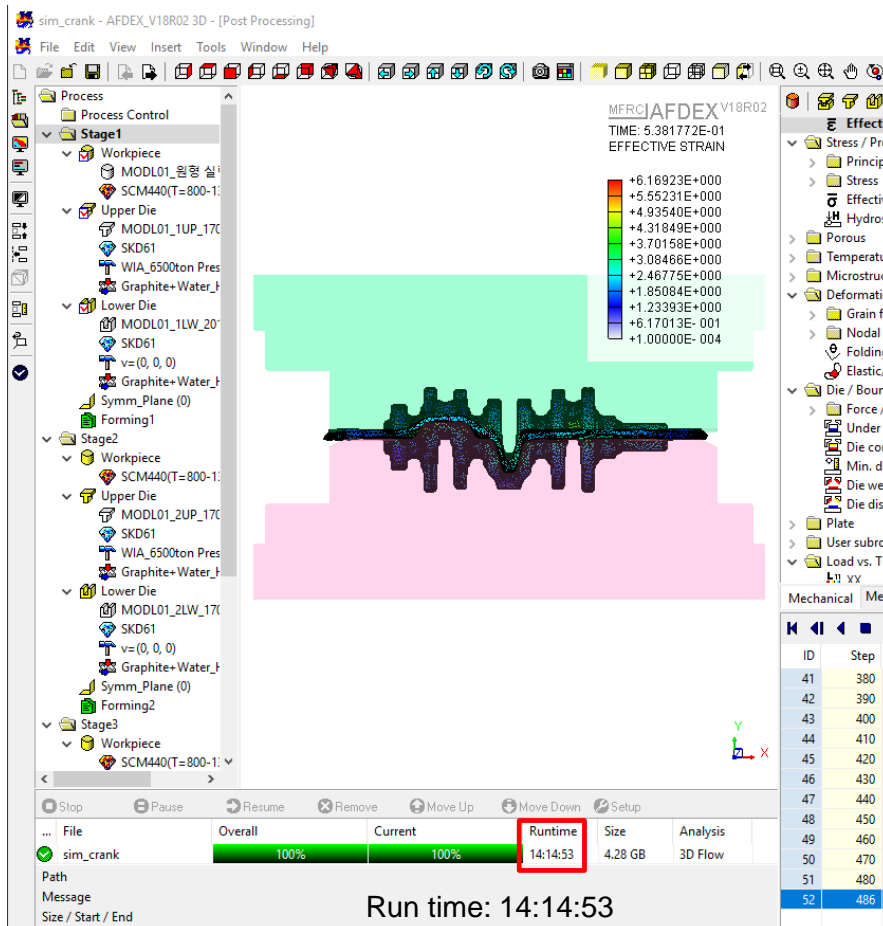


3. Reduced computational time

➤ Reduced computational time for large scale problems with complex geometry and mesh

AFDEX_V18R02

AFDEX_V19R01





4. Function for visualization of thinning in post-processor

The screenshot shows the AFDEX V19R01 2D post-processor interface. The main window displays a U-shaped part with a color-coded effective strain distribution. A legend on the right indicates strain values from $+1.00000E-004$ (blue) to $+2.95121E+000$ (red). The 'Customize Thinning...' dialog box is open, showing the following settings:

Direction / Thickness	
Direction	[Dropdown]
Initial Thickness	0 mm
Cutoff Thickness	
<input type="checkbox"/> Cutoff Above	10 %
<input type="checkbox"/> Cutoff Below	-20 %

Three numbered callouts (1, 2, 3) point to the 'Direction' dropdown, the 'Initial Thickness' input field, and the 'Cutoff Thickness' section of the dialog box, respectively.

1. Select the X,Y or Z Direction from the drop down list.
2. Enter the Initial Thickness
3. Cutoff Thickness
Cutoff Above: Maximum limit in percentage
Cutoff Below: Minimum limit in percentage
The range is automatically decided if the two check boxes are not selected.

1. AFDEX 2D/3D Solver

2. AFDEX 3D Solver

3. GUI





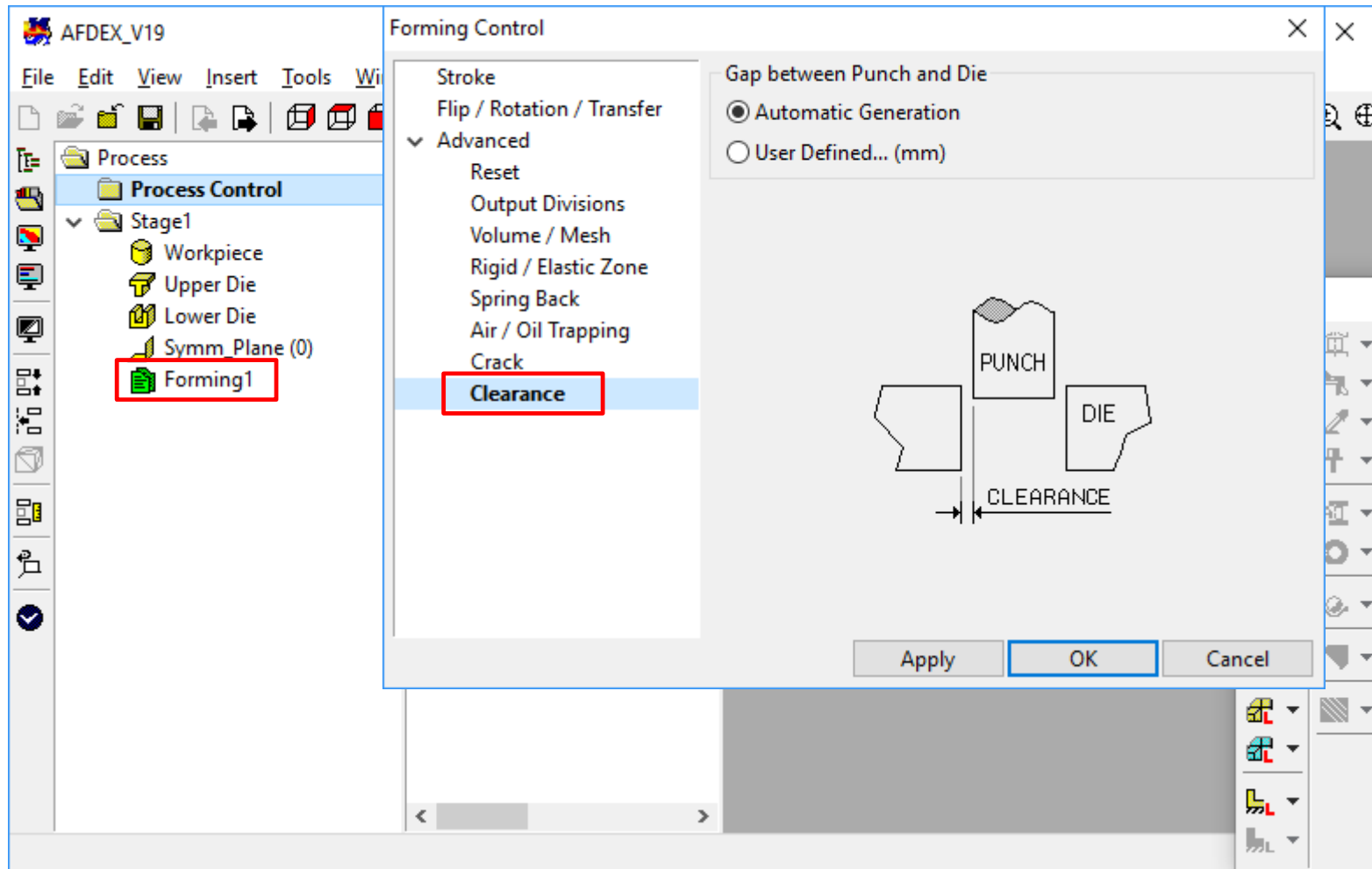
1. New function to prevent workpiece flow into undesired gaps between upper and lower dies

Step	IT	Descriptions...
46	0	Nodal recontact control parameter
47	0	Number of die fracture model
48	1	Identifying long punch forging in terms of reflection of rigid...
49	0	Function for calculating indices for evaluating metal flow lines
50	0	Option for treating two contacting dies
51	0	Scheme for volume compensation only in ring rolling
52	0	Enable accuracy improvement for internal temperature of ob...
53	0	Minimum distance between nodes on the opposite side
54	0	Number of steps for restoration of remeshing oriented volu...
55	0	
56	-1	Index for controlling material penetration into die gap
57	1	Index to skip saving the solution step at which remeshing is ...
58	0	Maximum number of iterations allowed for solution converg...
59	0	Disable flow analysis
60	0	Enable efficient algorithm for flow forming
61	0	Index for contact and friction treatment type
62	0	
63	0	
64	0	
65	0	Index for controlling FLD calculation
66	0	Index for determining different friction conditions of cut-face
67	0	
68	0	

1. Process Control -> I Default (56) is used for controlling workpiece penetration into the die gaps
 - 1: This function is disabled
 - 1: This function is enabledI Default(56) = 1 usually results in higher computational time. So modelling a bigger punch (to avoid the unwanted clearance) is recommended.



1. New function to prevent workpiece flow into undesired gaps between upper and lower dies

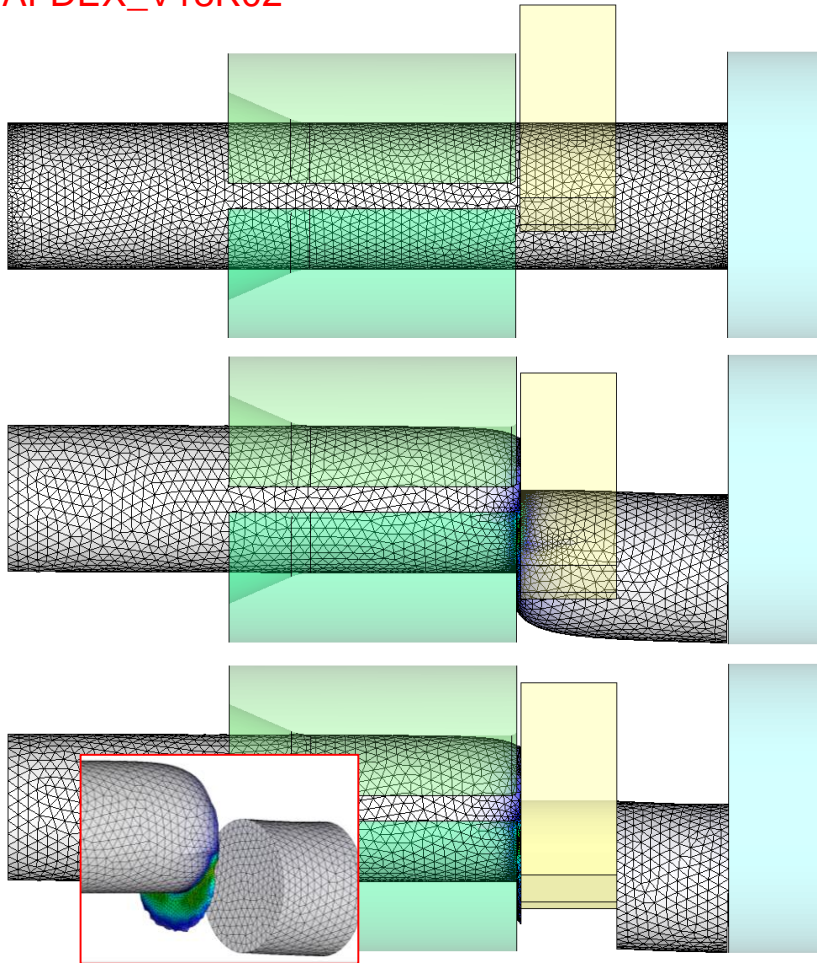


1. Forming1 -> Clearance allows the user to enter the gap between the punch and the die.

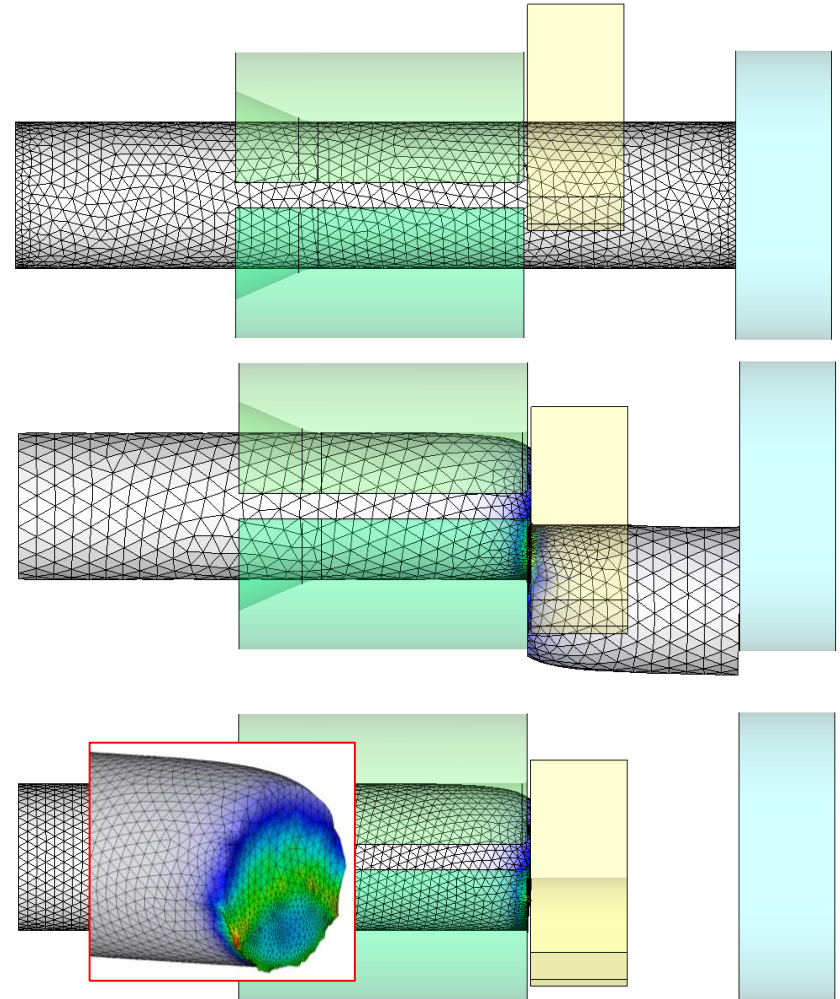


2. Function for shearing process simulation

AFDEX_V18R02



AFDEX_V19R01



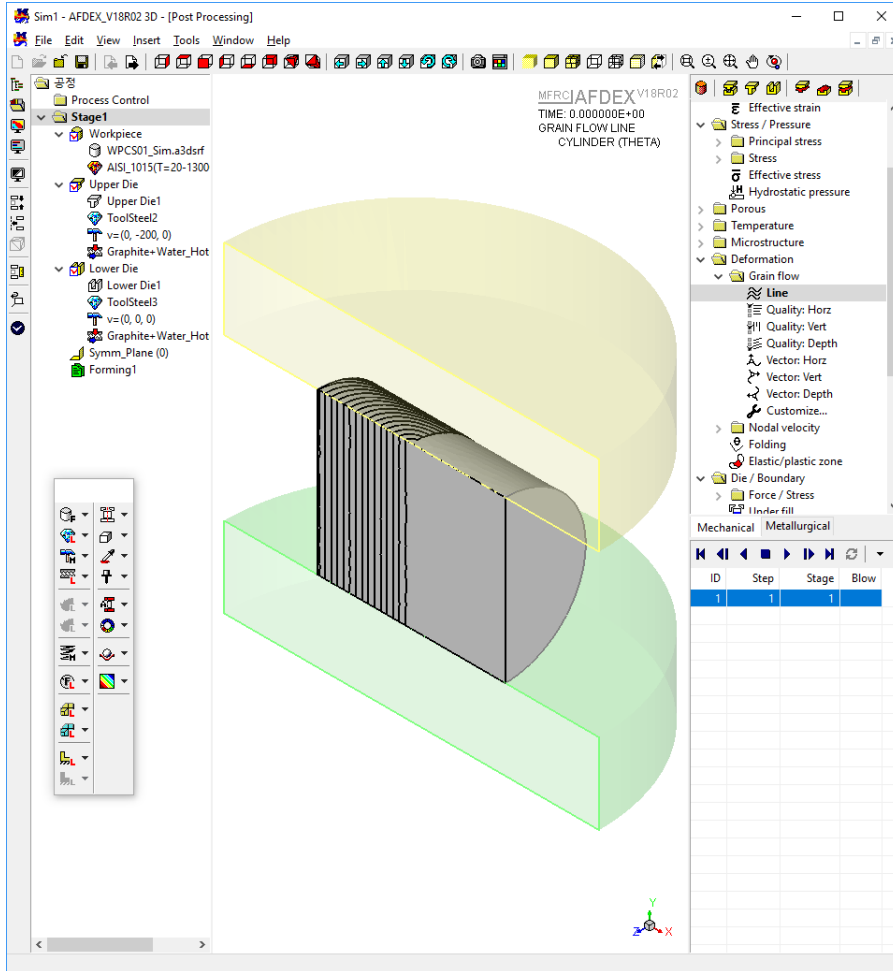
AFDEX_V18R02: The sheared surface had some irregularities. And the other part of the workpiece was not deleted.

AFDEX_V19R01: Improved function for representing the sheared surface in a more realistic way. The other part can be deleted.

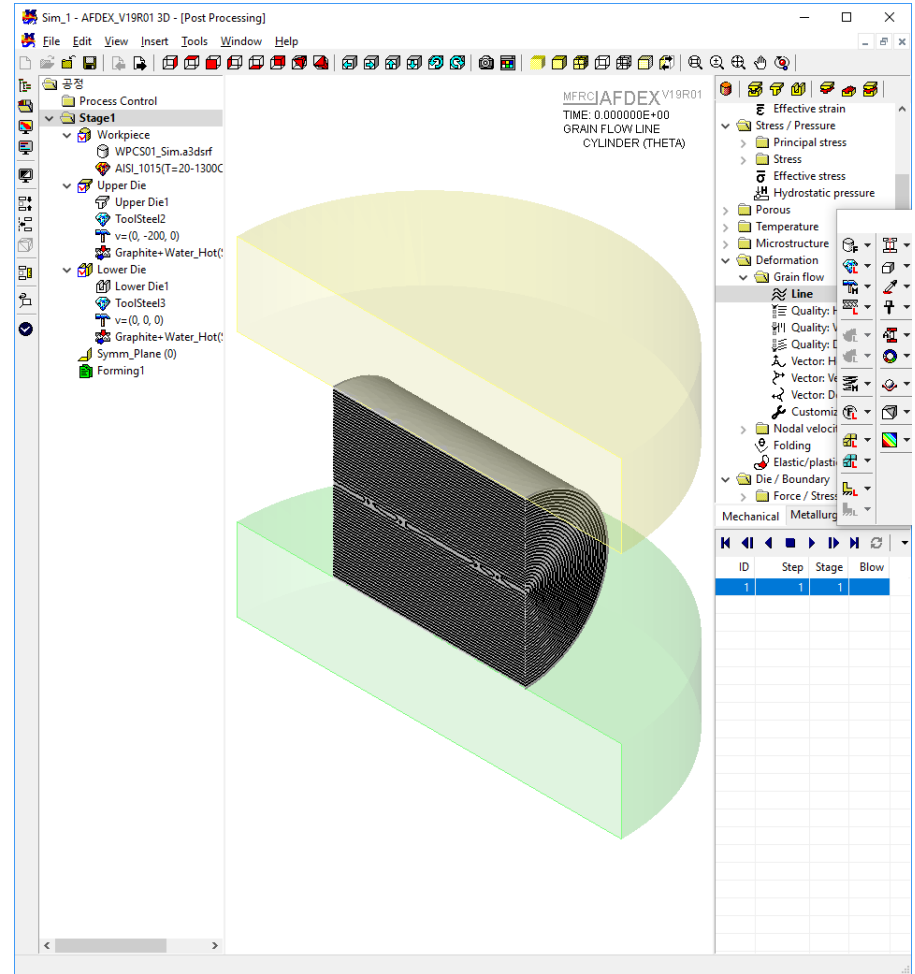


3. Improvement of metal flow line prediction in the case of stage by stage simulation

AFDEX_V18R02



AFDEX_V19R01



AFDEX_V18R02: Some abnormalities in metal flow lines in the case of stage by stage analysis and workpiece rotation.

AFDEX_V19R01: Improved function for metal flow line prediction.



5. Increased the maximum number of elements

AFDEX_V18R02

```

C:\windows\system32\cmd.exe
nXYZ      279912
nFace     3268435
nPoly     1622598
Bosser_t4      708.129988989999995
Solid_List_Cavity      199.201988898999998
Solid_List_Wheel      76.856898989999995

NOLDPRO, NNEWPRO 1403096859 106295387

fortrl: severe (157): Program Exception - access violation
Image      PC      Routine      Line      Source
A3DFS_V18R02.exe 00007FF7DDA69E92 Unknown Unknown Unknown
A3DFS_V18R02.exe 00007FF7DD24899F Unknown Unknown Unknown
A3DFS_V18R02.exe 00007FF7DDA6792D Unknown Unknown Unknown
A3DFS_V18R02.exe 00007FF7DDEE8331 Unknown Unknown Unknown
A3DFS_V18R02.exe 00007FF7DE5D81BE Unknown Unknown Unknown
A3DFS_V18R02.exe 00007FF7DE1D0F2F Unknown Unknown Unknown
KERNEL32.DLL   00007FF729D47974 Unknown Unknown Unknown
ntdll.dll     00007FFF2BFCA271 Unknown Unknown Unknown

=====
= EEEEEEEEEE NNN   NNN DDDDDDDD =
= EEEEEEEEEE NNNN  NNN DDDDDDDDDD =
= EEE         NNNNN  NNN DDD   DDDD =
= EEEEEEEEEE NNN  NN  NNN DDD   DDD =
= EEEEEEEEEE NNN  NN  NNN DDD   DDD =
= EEE         NNN   NNNNN DDD   DDDD =
= EEEEEEEEEE NNN   NNNN DDDDDDDDDD =
= EEEEEEEEEE NNN   NNN DDDDDDDDDD =
=====
계속하려면 아무 키나 누르십시오 . . .
  
```

AFDEX_V18R02: Maximum number of elements: 500,000

AFDEX_V19R01: Maximum number of elements: 1,500,000

In V19R01, the limit in the pre-processor stands at 1,000,000 elements. If the number of elements have to be increased, the user can do so by editing the SCF file.

AFDEX_V19R01

```

C:\windows\system32\cmd.exe
CURRENT STAGE = 0.12 % DONE
ALL PROCESS = 0.12 % DONE

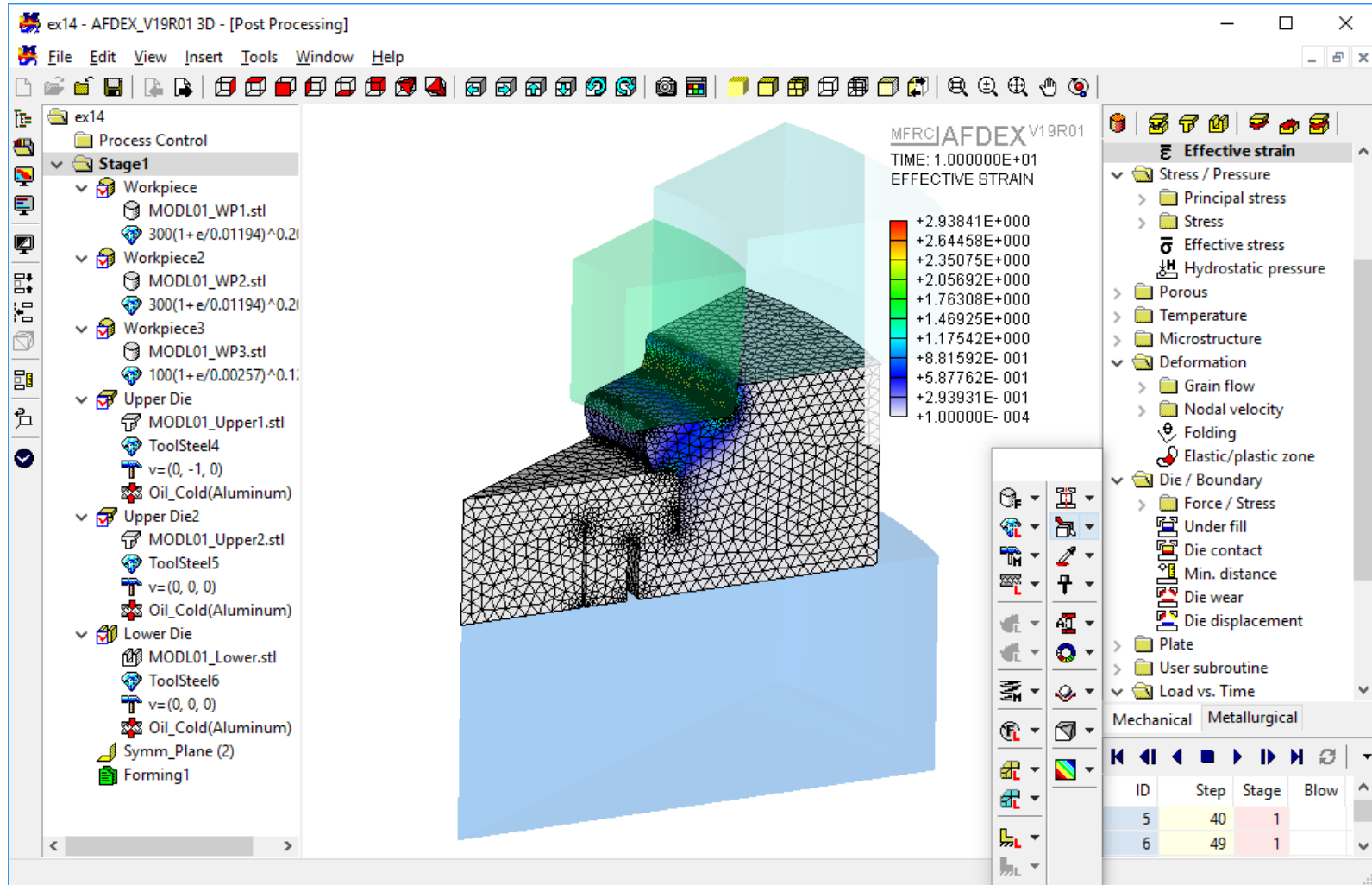
##### NSTEP = 6 #####
PROBLEM TYPE = 3
NCSGT, NOSTG, WEI 1 1 2.0000000000000000
DV, WDIGVAL -1.797693134862316E+308 1.0000000000000000
BC, WBNDCHG 9.449197027600194E-001 6.000000000000000001E-001
AO, WTTTTO 16.196006184008183 1.745329251994330E-004
A1, WTTT1 145.687289216269278 179.998989989999997
A2, WTTT2 9.326058259428599E-001 6.2500000000000000E-001
A3, WTTT2 9.456976654494570E-001 6.2500000000000000E-001
Q2, WTTT3 2.301781538006648E-001 1.0000000000000000E-004
NM, NSTEPRM5H 5 25
NLSTEP, N_END, T_TIME_S 6 1 1.671415188483365E-003
NCSGT, NOSTG, WEI 1 1 2.0000000000000000
DV, DIGVAL -1.797693134862316E+308 2.0000000000000000
BC, 1.000/BNCHG 9.449197027600194E-001 2.0000000000000000E-001
AO, TTTTTO 16.196006184008183 1.0000000000000000
A1, TTTT1 145.687289216269278 179.998989989999997
A2, TTTT2 9.326058259428599E-001 2.5000000000000000E-001
A3, TTTT2 9.456976654494570E-001 2.5000000000000000E-001
Q2, TTTT3 2.301781538006648E-001 1.0000000000000000E-004
NM, NSTEPRM5H 5 50
NLSTEP, N_END, T_TIME_S 6 1 1.671415188483365E-003

STAGE:: NOW= 1 OLD= 1, TIME:: GONE= 0.1021E-01 LEFT= 0.1092E-01

! NOW SOLVING METAL FLOW PROBLEM (ISOTHERMAL ANALYSIS) !
  
```



6. New function for 3D multi-body simulation

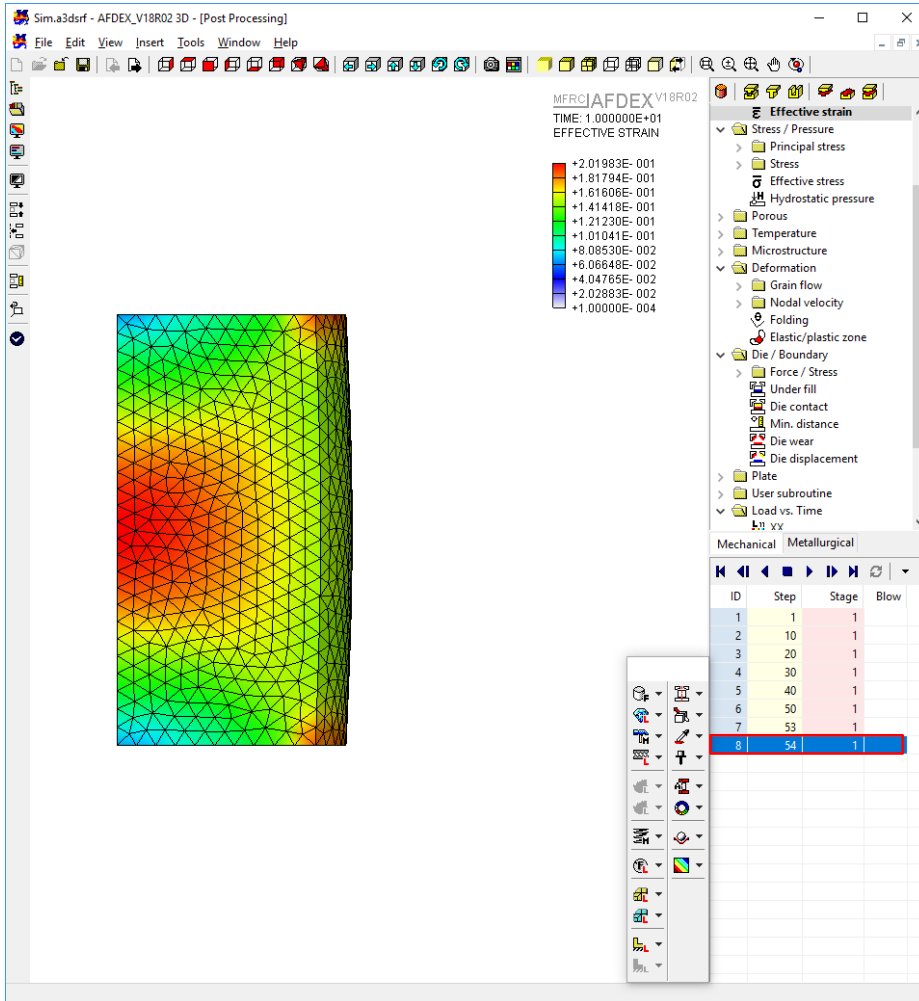


Refer AFDEX_3D_Tutorial_Part2 ex14.

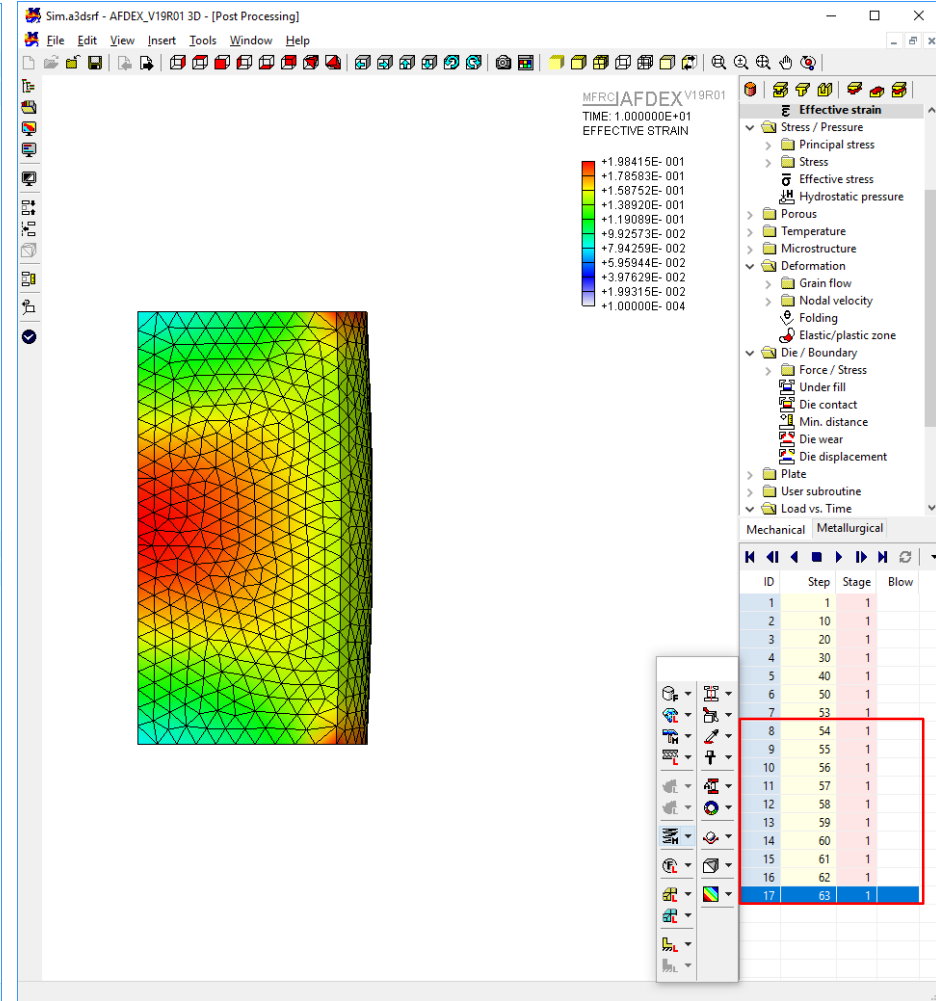


7. Improved function for solution step saving interval in 3D springback simulation

AFDEX_V18R02



AFDEX_V19R01

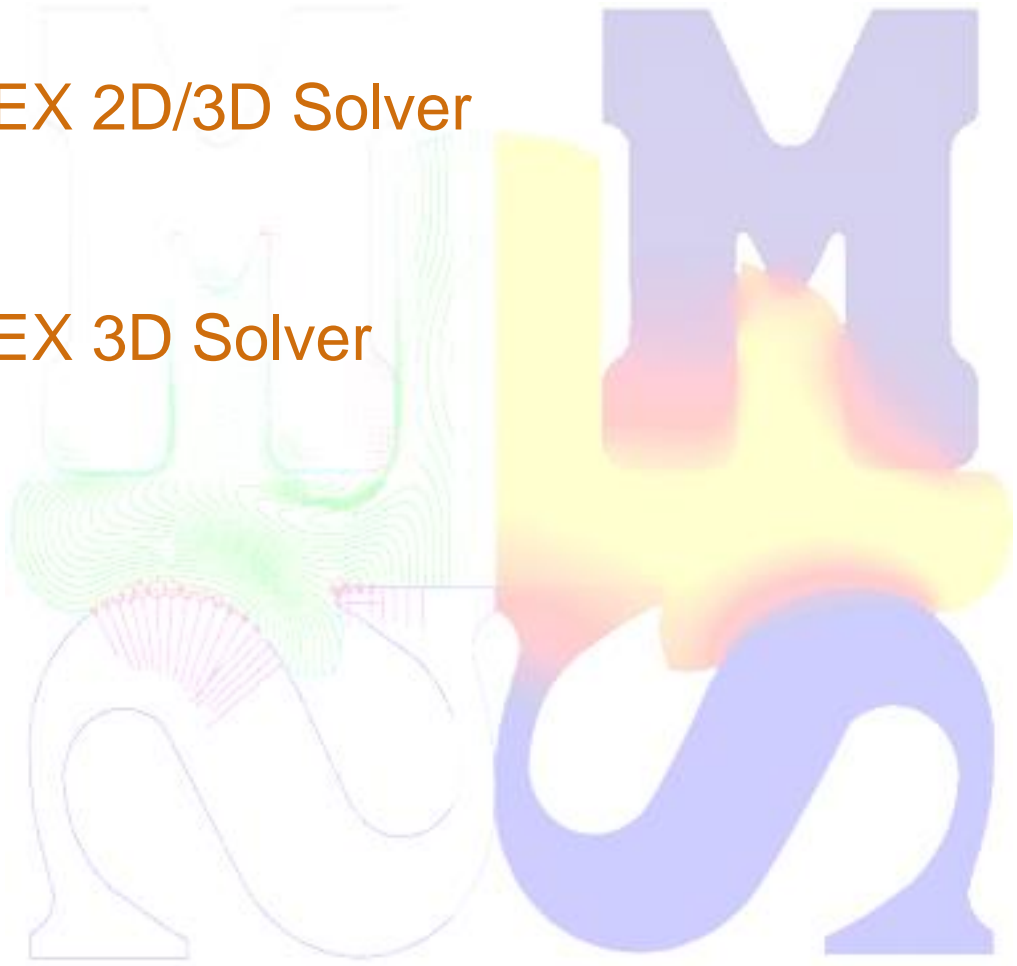


Improved function for saving the solution steps based on the input entered by user in the case of springback simulation. V18R02 had a bug in this feature which has been rectified now.

1. AFDEX 2D/3D Solver

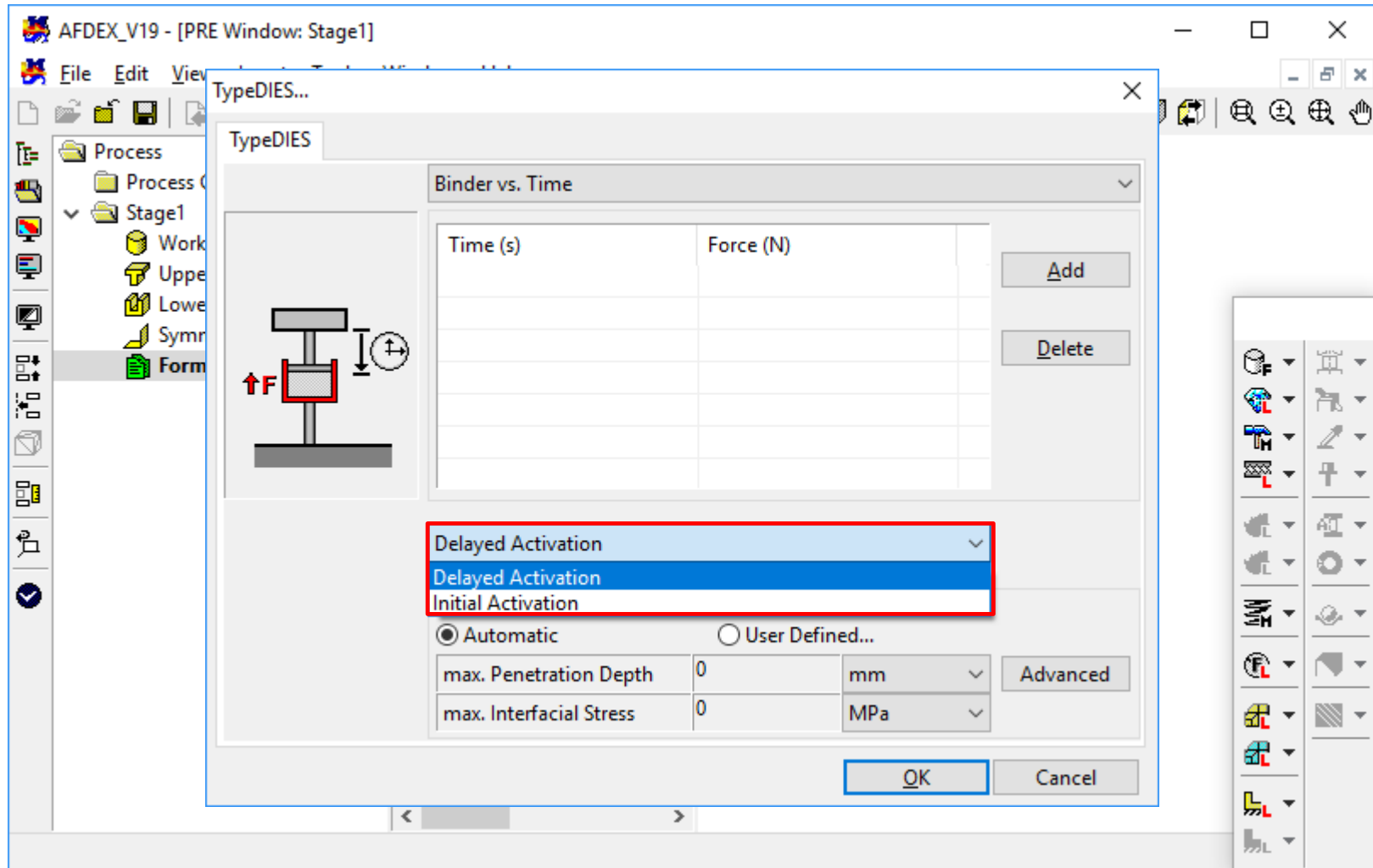
2. AFDEX 3D Solver

3. GUI





1. A new binder function to select the activation type (Delayed / Initial)

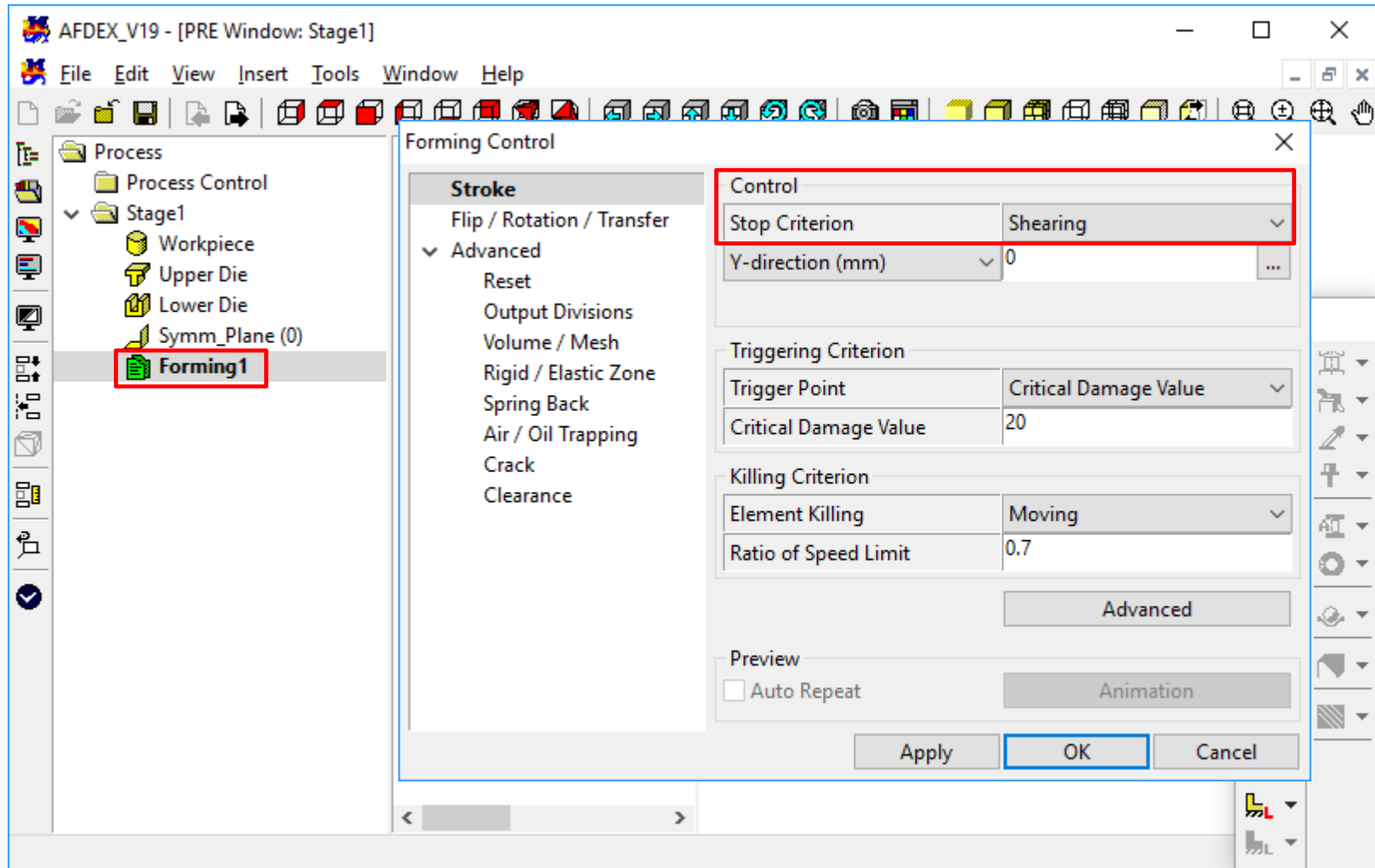


Delayed Activation: The binder force is activated after some delay.

Initial Activation: The binder force is applied from the first solution step.



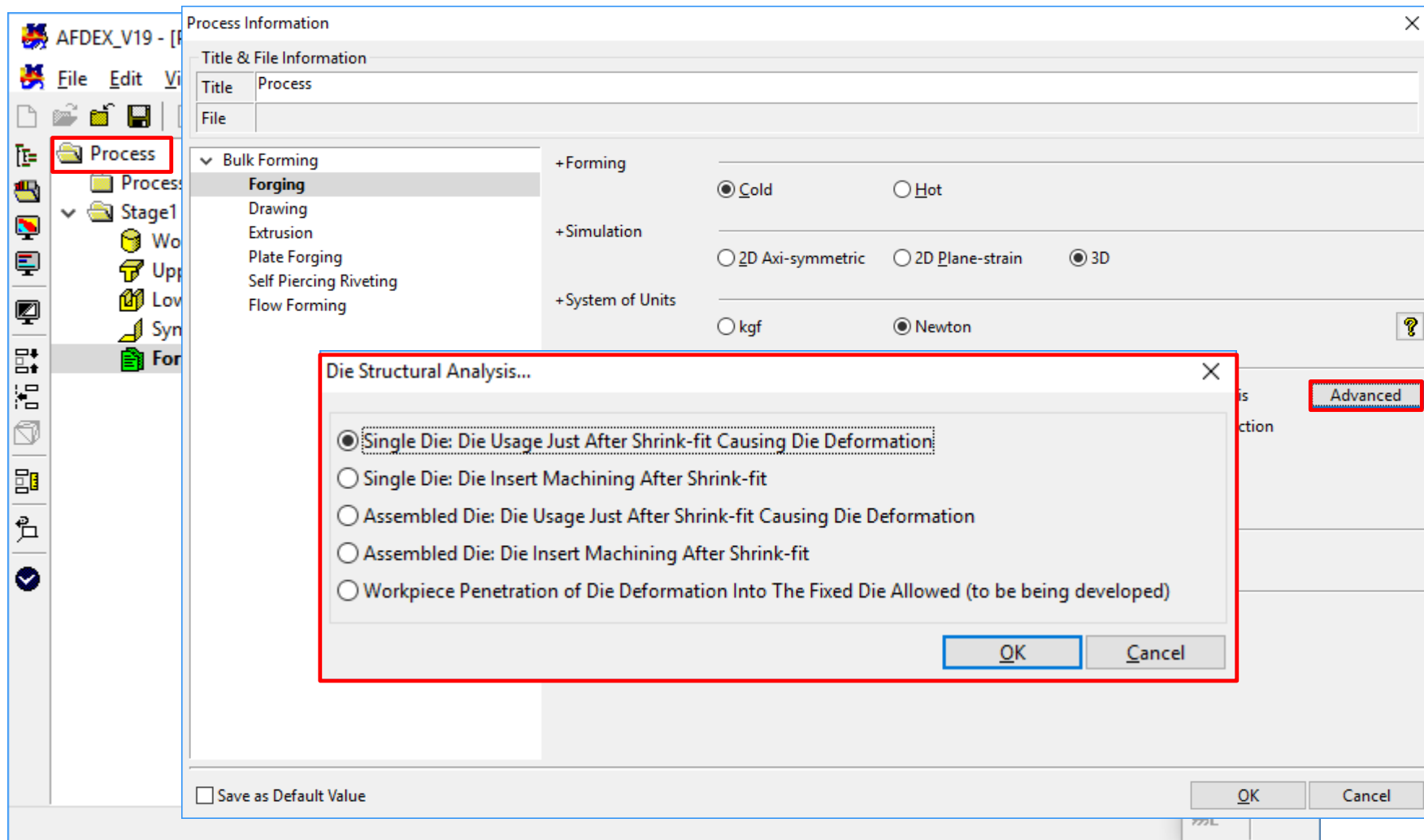
2. Function for shearing process simulation



In the Forming Control window, “Shearing” has to be selected from the dropdown list of “Stop Criterion”.



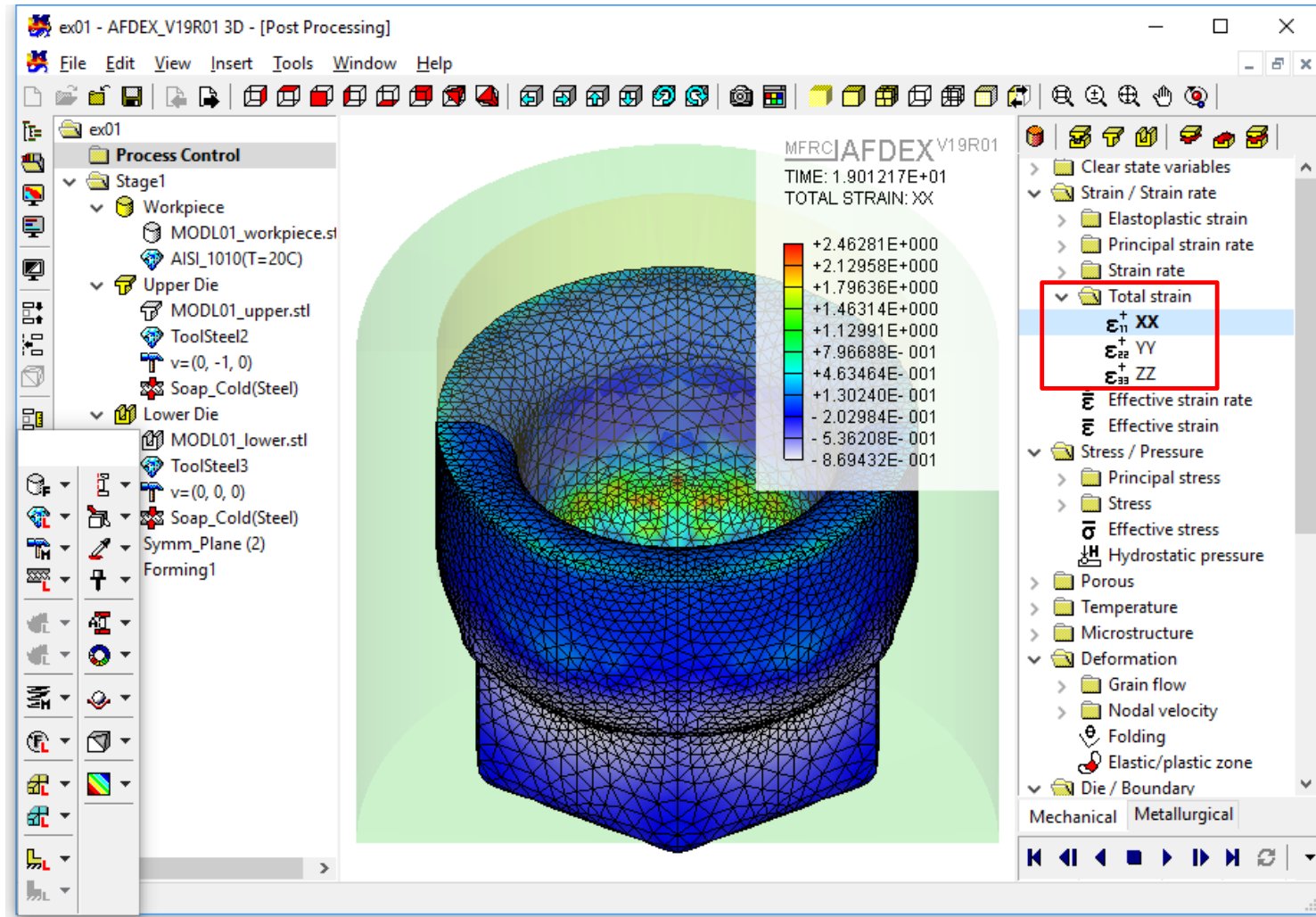
3. Advanced functionalities in die structural analysis



The user can click on the “Advanced” button next to Die Structural Analysis to know the different types.



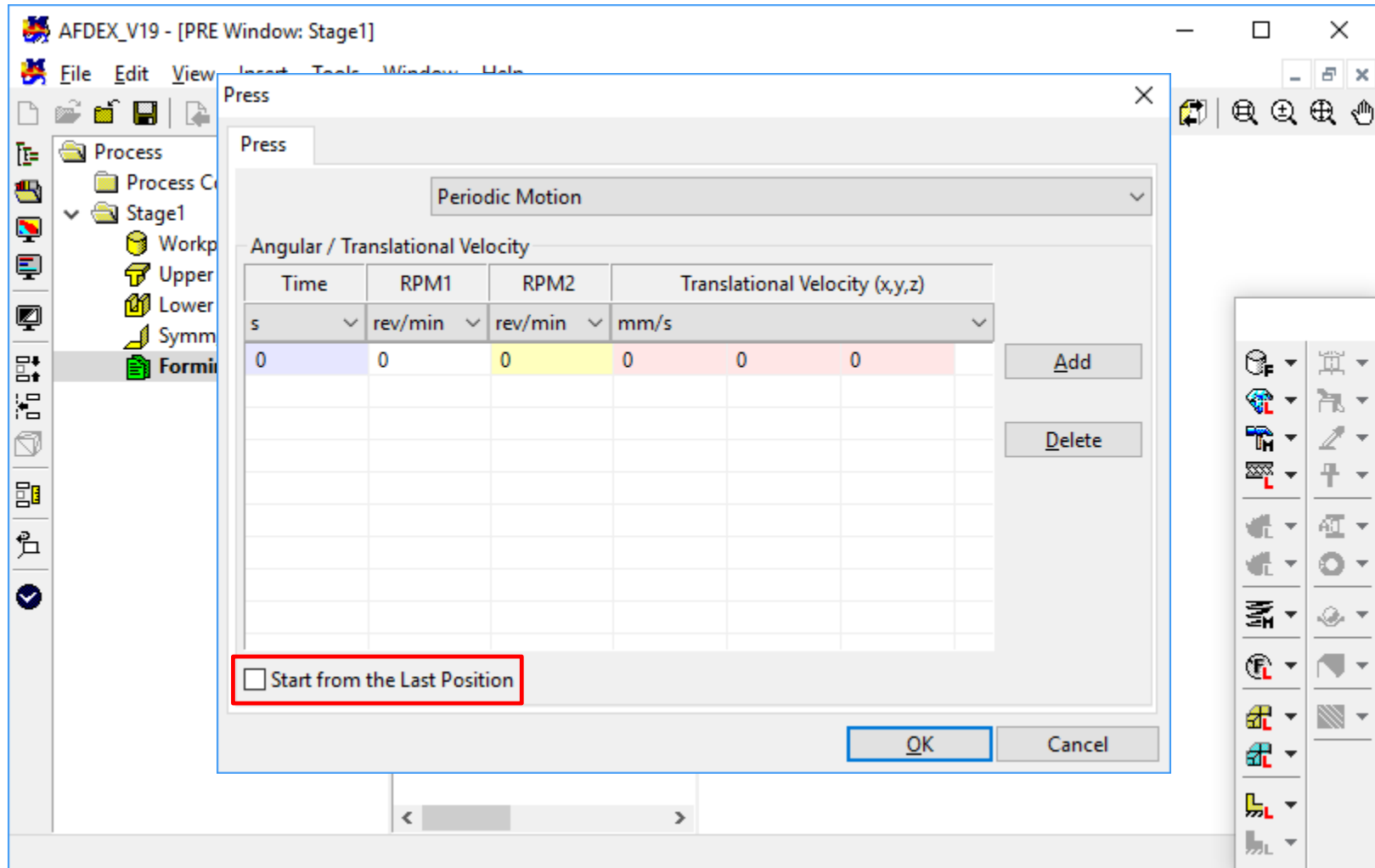
4. Visualization of total strain in post-processor



When I Default(49) = 1, the three components of total strain can be visualized in the post-processor.



5. New function for returning a die to a last position rather than its original position



AFDEX_V18R01: The die returns to the initial position at the end of every cycle.

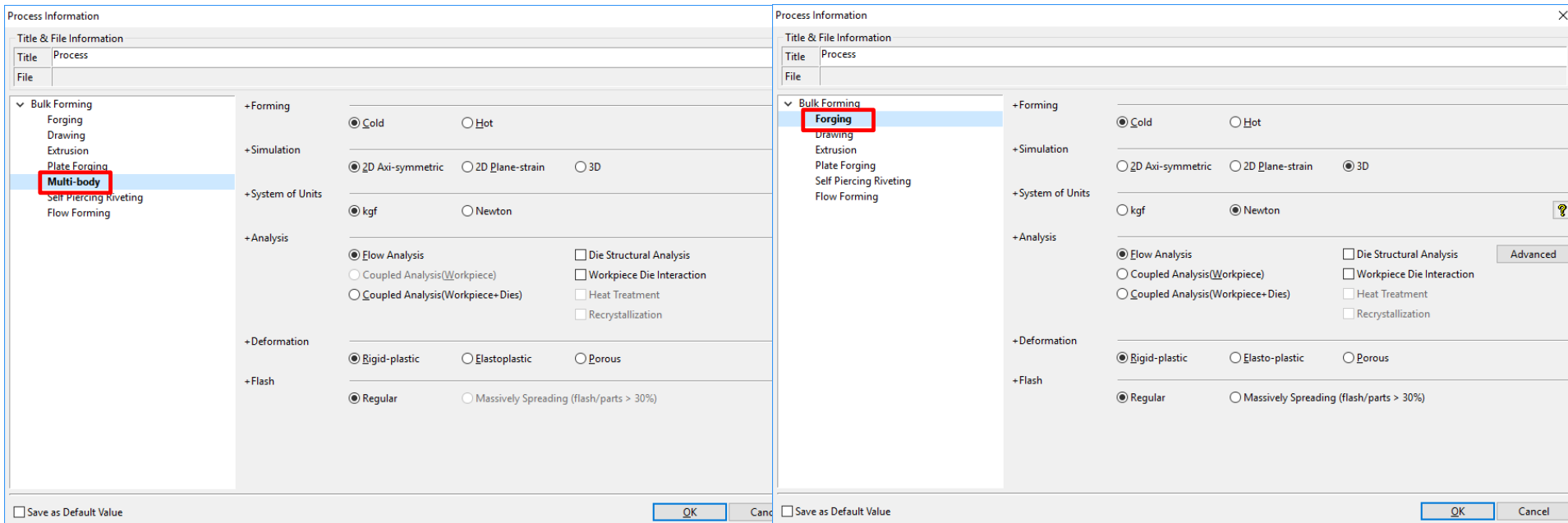
AFDEX_V19R01: When the “Start from the Last Position” checkbox is enabled, the die resumes from the position of the previously completed cycle.



6. New function for 3-dimensional multi-body simulation

AFDEX_V18R02

AFDEX_V19R01



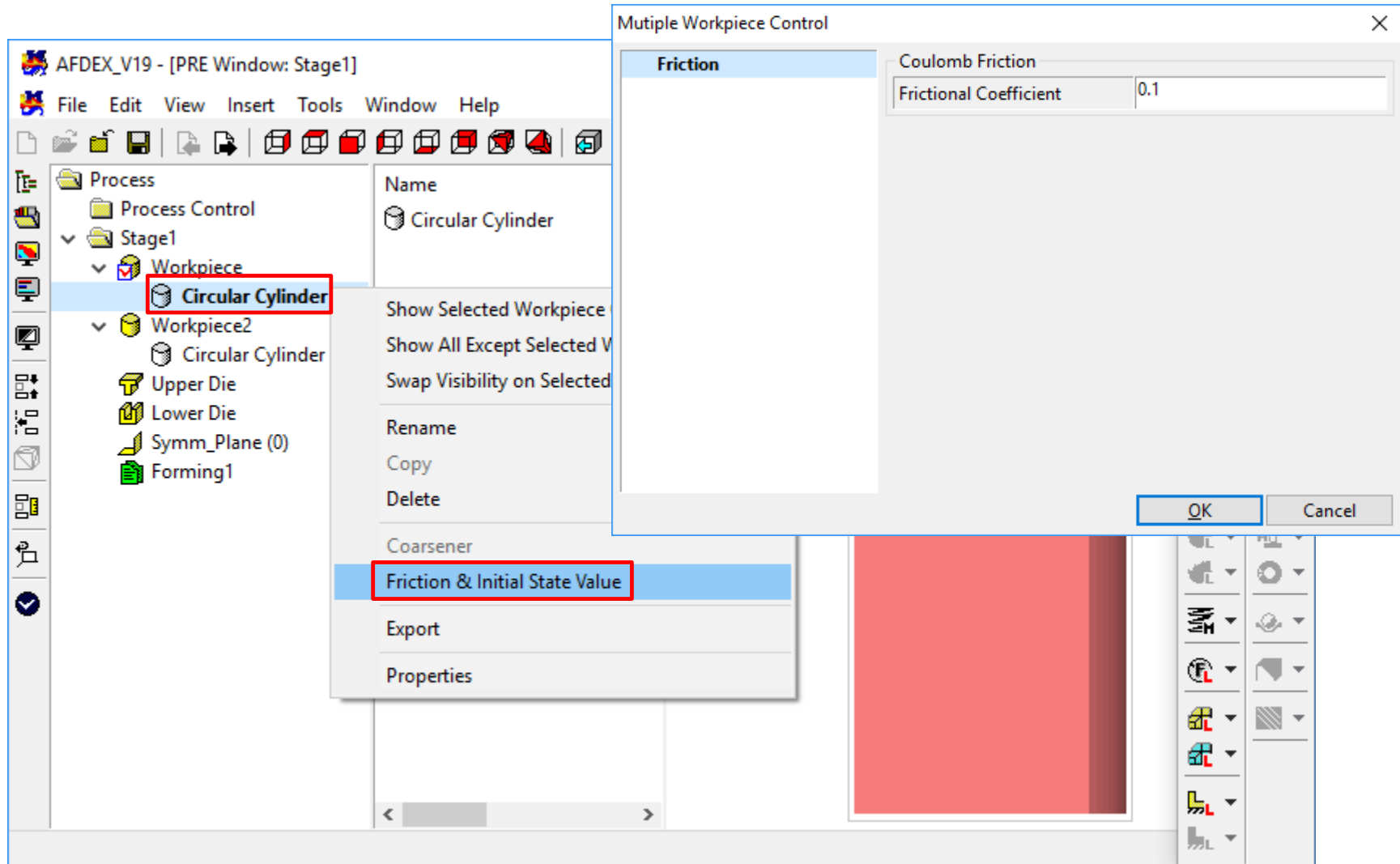
AFDEX_V18R01: No function for 3D multi-body simulation. Only 2D was possible.

AFDEX_V19R01: Now the “Multi-body” option has been deleted from the initial “Process Information” window. The user has to select “Forging” and then can carry out multi-body simulation in 2D as well as in 3D.

Refer AFDEX_3D_Tutorial_Part2 ex14.



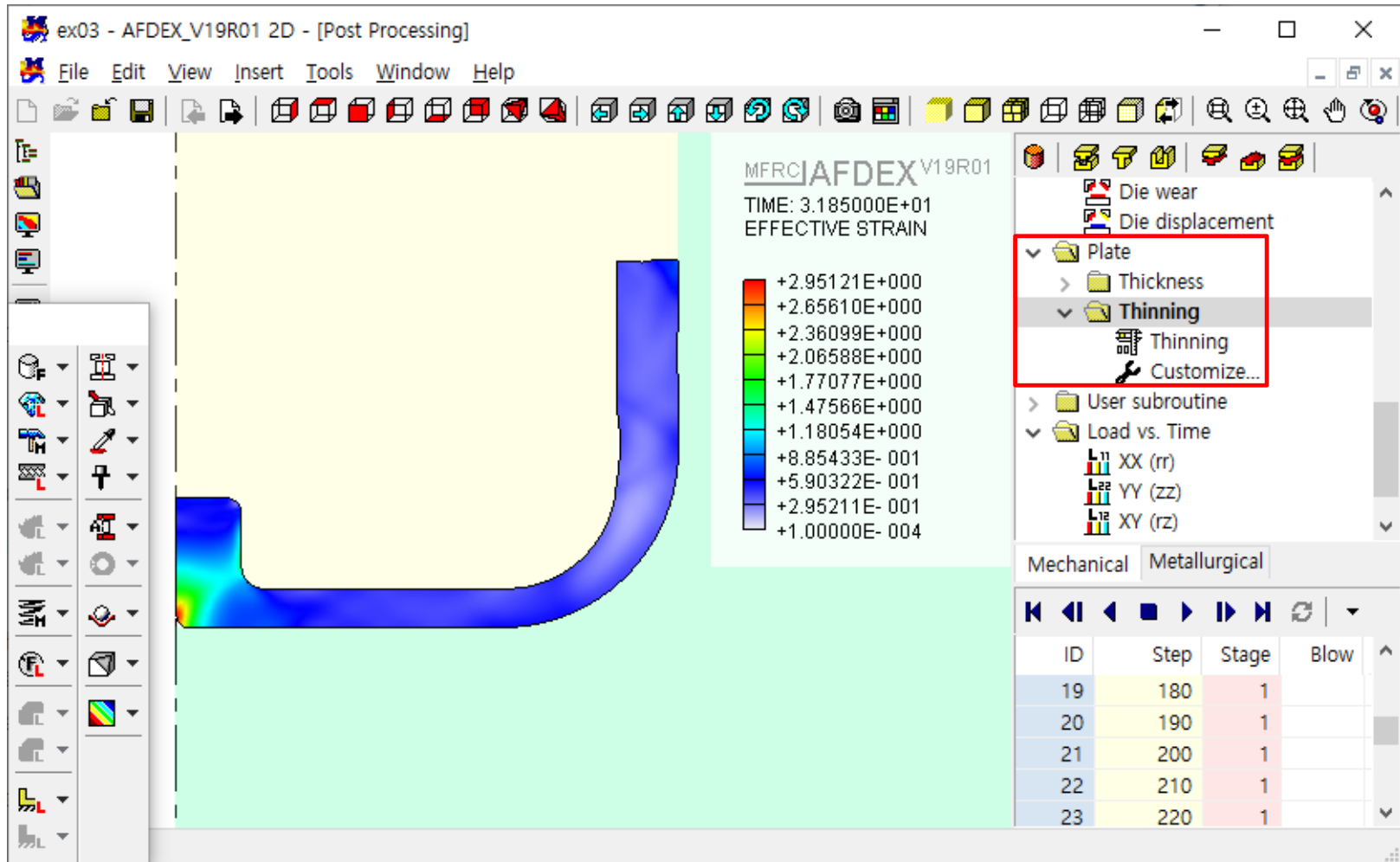
7. New function for friction definition between workpieces in multi-body simulation



Right click on the workpiece geometry file and then select “Friction & Initial State Value” to enter the friction coefficient between two workpieces in the case of multi-body simulation.



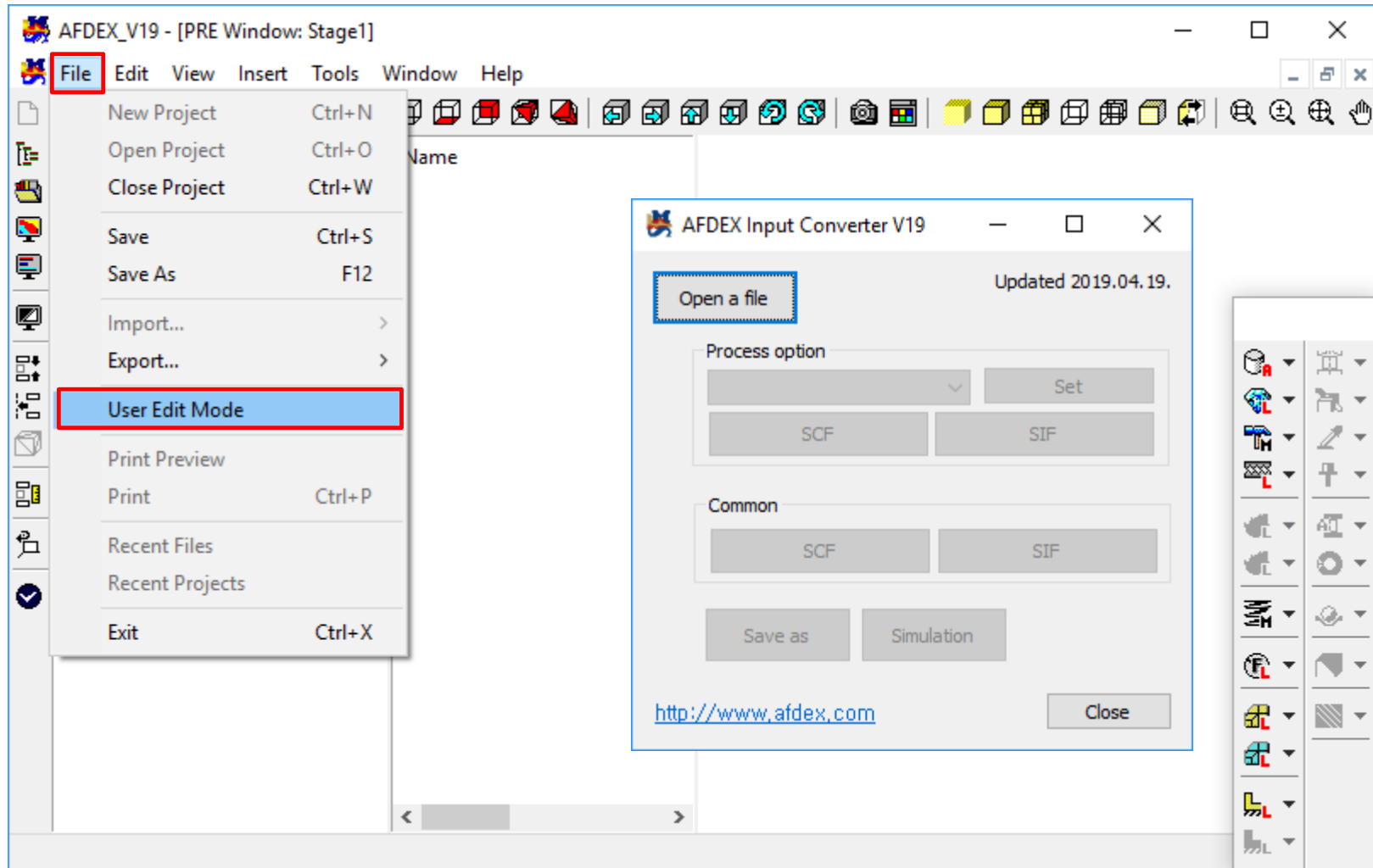
8. New function for visualization of thinning



Select Plate -> Thinning in order to visualize the thinning in GUI.



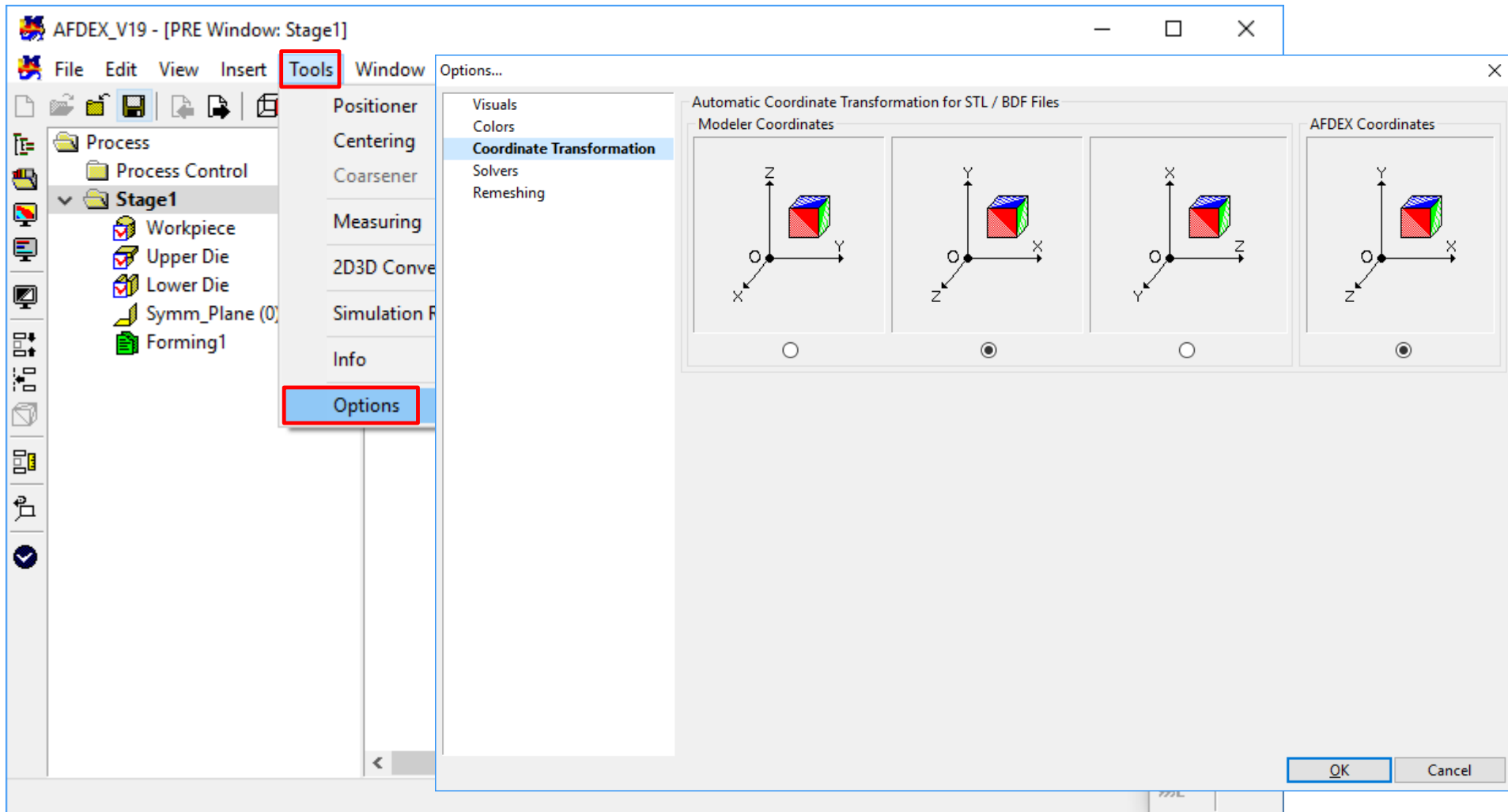
9. New function for opening simulation files edited using AFDIC (AFDEX Input Converter)



The user can open the project files created using AFDIC(AFDEX Input Converter) through this function.



10. New function for adjusting the coordinate transformation of the geometry





11. Function to control 2D analysis die geometry

The screenshot shows the AFDEX software interface. The main window displays a project tree on the left with the following structure:

- AFDEX_V19 - [Project->Upper Die: Circular Cylinder]
- File Edit View Insert Tools Window Help
- Process
 - Process Control
 - Stage1
 - Workpiece
 - Upper Die
 - Circular Cylinder**
 - Lower Die
 - Symm_Axis (1)
 - Forming1

The 'Circular Cylinder' object is highlighted with a red box. The 'AutoEdit' dialog box is open, showing the 'Line / Arc Segments' section with the 'Automatic Remove Die Gaps' checkbox checked. The table below shows the coordinates for the die segments:

		X	Y	R	
<input type="checkbox"/>	1	0.00000	0.00000	0.00000	Insert
<input type="checkbox"/>	2	30.00000	0.00000	0.00000	Add
<input type="checkbox"/>	3	30.00000	70.00000	0.00000	Delete
<input type="checkbox"/>	4	0.00000	70.00000	0.00000	

At the bottom of the dialog, there is a 'Number of Elements for Die' field and a 'Reset' button. The 'OK' button is highlighted with a blue box. In the main window, the 'Range' section shows:

Range					
X	0	-30	mm	Corners	4
Y	0	-70	mm		
Z	0	-0	mm	Area	2100 mm^2

The 'AutoEdit' button is highlighted with a red box. The 'Close' button is also visible.

Automatic Remove Die Gaps: AFDEX automatically detects the die corners and closes the die gaps at the corresponding locations. Check box: If the user wants to close the gaps based on specific die points, these points have to be selected using the checkbox on the left of that point.