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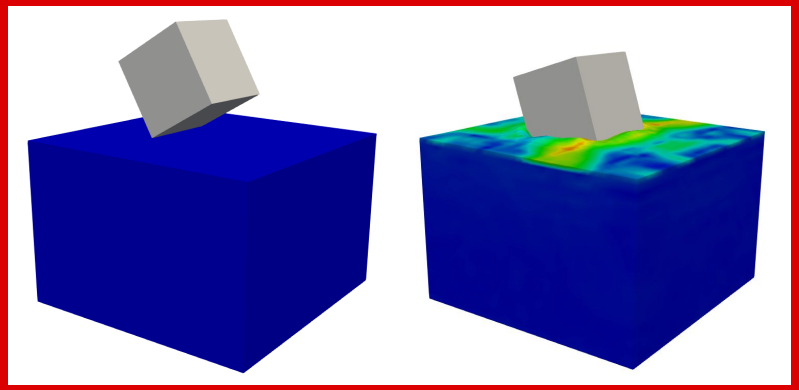


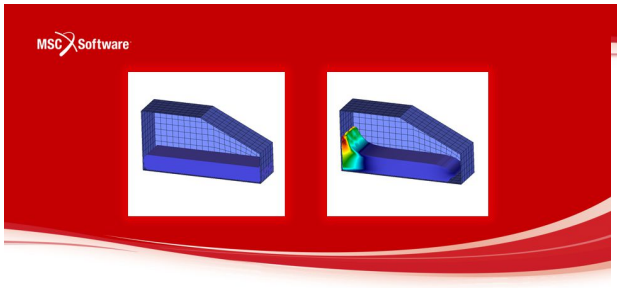
Dytran Guide

BASIC FSI SETUP

In this example a rigid box dropped on a open water environment. This example is extracted and modified from the Dytran DYT101 Training Seminar as a basic introduction to Dytran FSI setup.

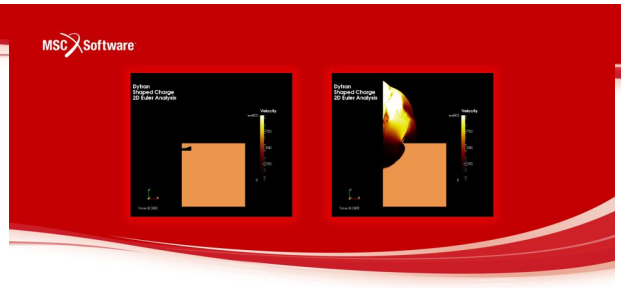
Other standard training course workshops are shown on the next page.

For more information please contact MSC Software.



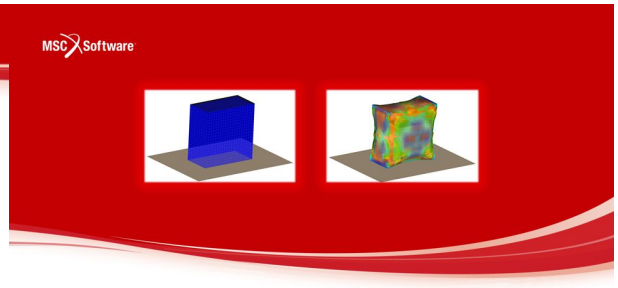
WORKSHOP 2
FLUID INTERACTION

W2-1



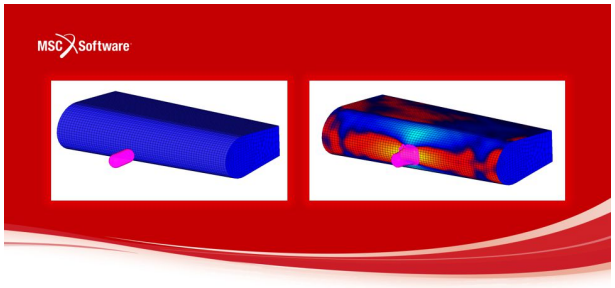
WORKSHOP 4
EFP MINE

W4-1



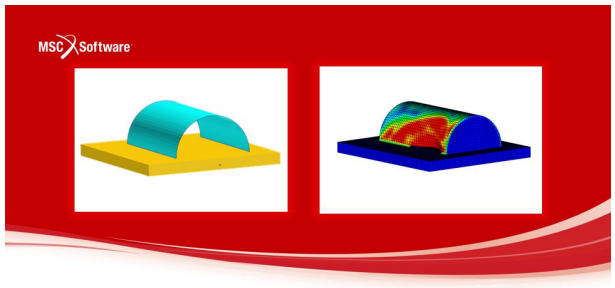
WORKSHOP 7
Blast Inside Container

WS7-1



WORKSHOP 3.1
BIRDSTRIKE

W3-1

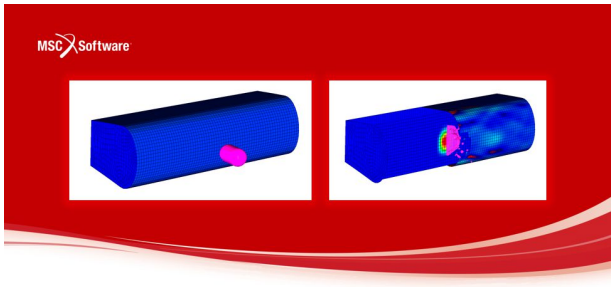


WORKSHOP 5
BUNKER BLAST

W5-1

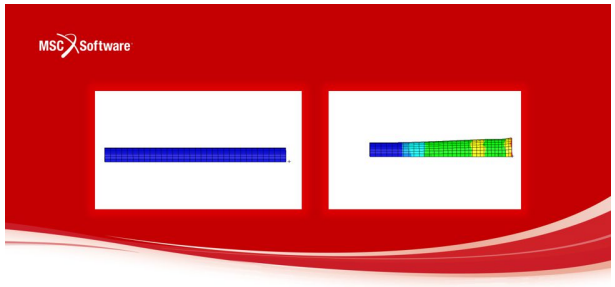
WORKSHOP 8.1
SUBMARINE UNDEX

WS8-1



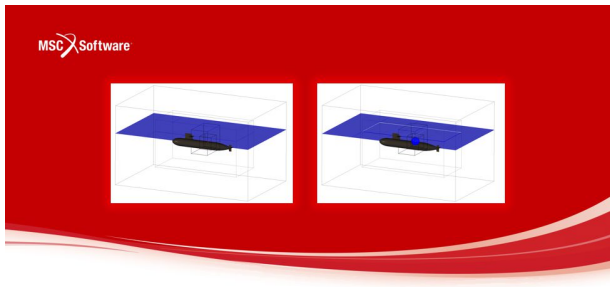
WORKSHOP 3.2
BIRD STRIKE WITH FAILURE

W3-37



WORKSHOP 6.1
LAGRANGE vs EULER

W6-1



WORKSHOP 8.2
SUBMARINE UNDEX SUBMESHES

WS8-49

This workshop is integral to the training notes detailing the pre- and postprocess steps.

COURSE NOTES SECTION 7: Patran Model Processing for Dytran FSI

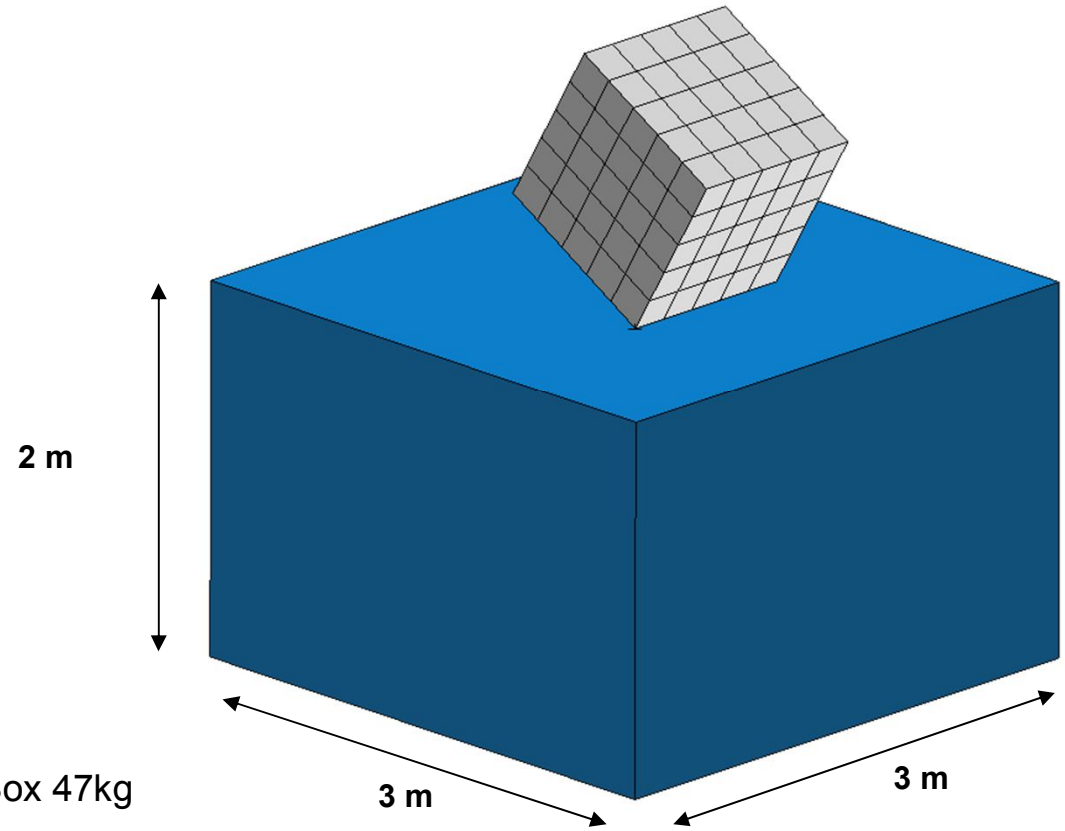
1. **Get familiar with the Patran Dytran preference for FSI setup**
2. **How to define a simple Euler mesh and assign initial states using a basic material model**

COURSE NOTES SECTION 8: Dytran FSI Process

1. **How to run Dytran FSI**
2. **Understanding the Dytran ouput files**

COURSE NOTES SECTION 9: Dytran FSI Results Processing

1. **How to convert and view FSI results with Paraview**



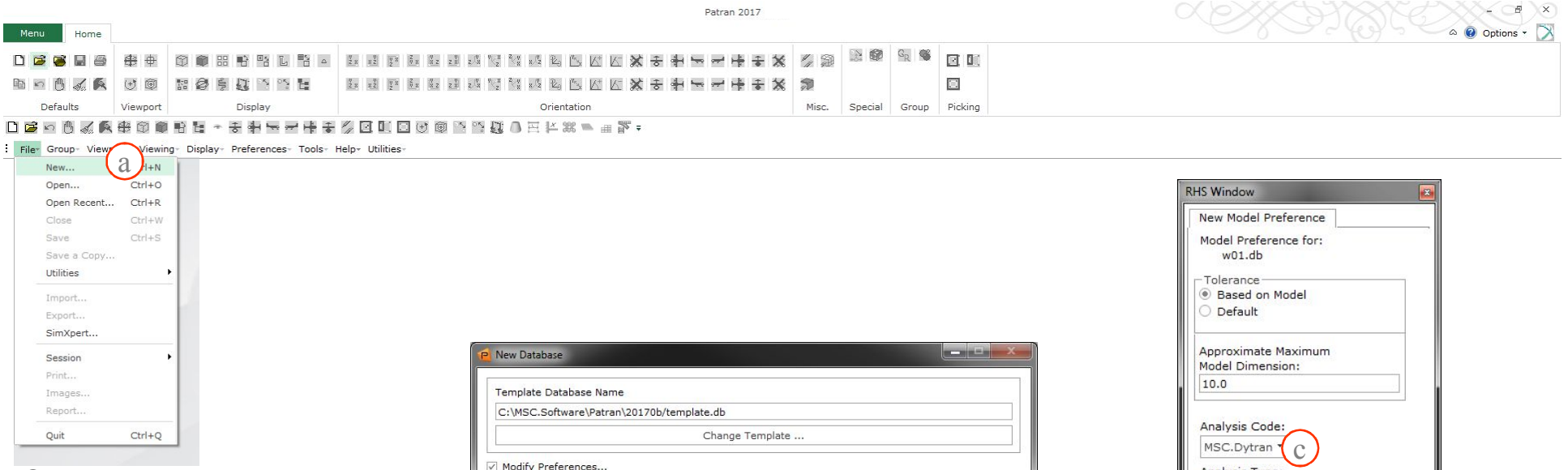
Material = Rigid Box 47kg

Fluids = Air and Water

Impact velocity = -10m/s (5m height)

Simulation Time = 100ms

Step 1. Files: Create a New Database

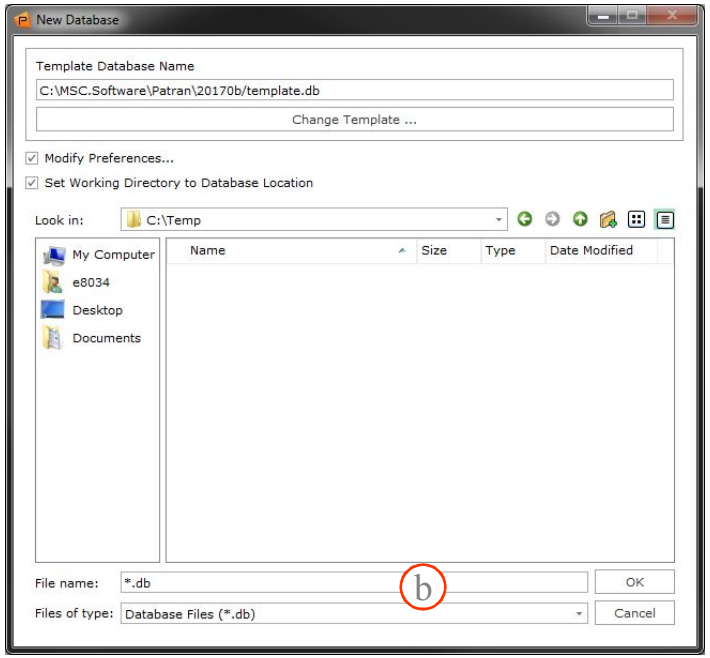


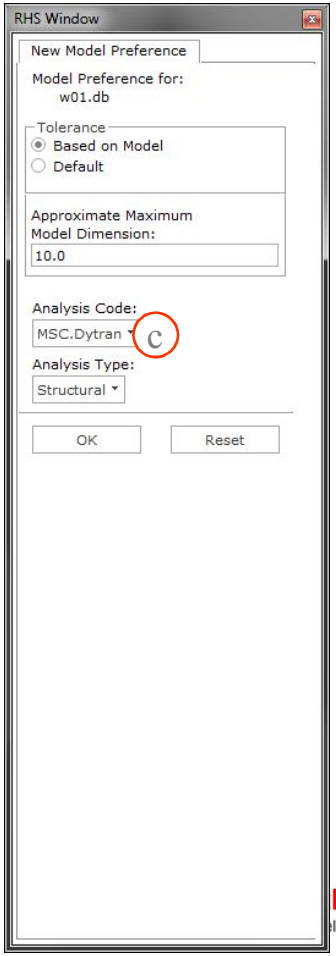
Open new database and name **2_w01**.

a) Open **File** Menu and click **New.**

b) Type **box_drop** under File name and click **OK**.

c) Select **Dytran** for Analysis Code and click **OK**





Step 2.1 Geometry: Create / Coord

Create a rotated Coord.

a) Geometry: Create / Coord / Euler

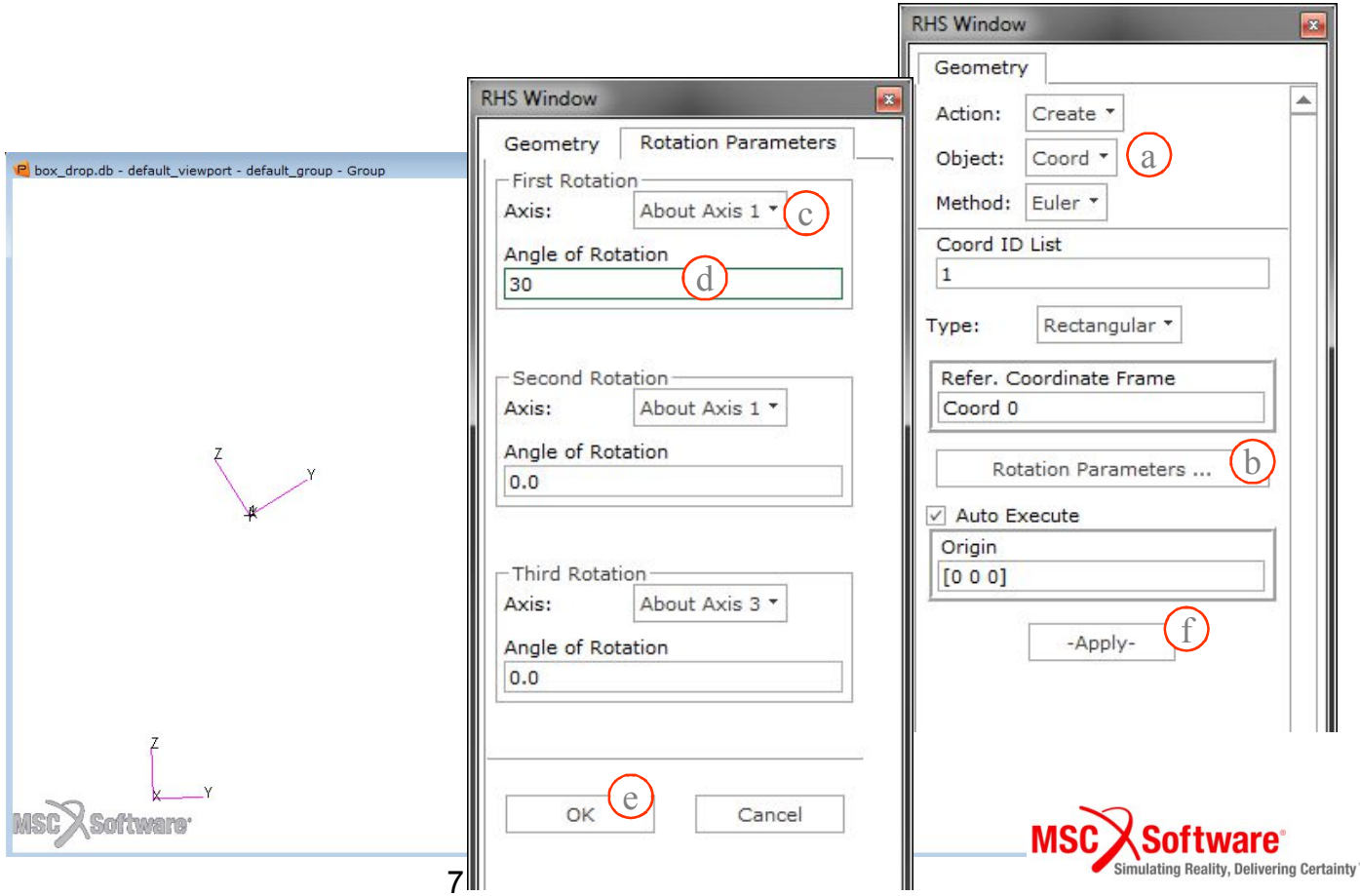
b) Select Rotation Parameters

c) Set About Axis 1

d) Set rotation at 30°

e) Click **OK**

f) Click **Apply**.



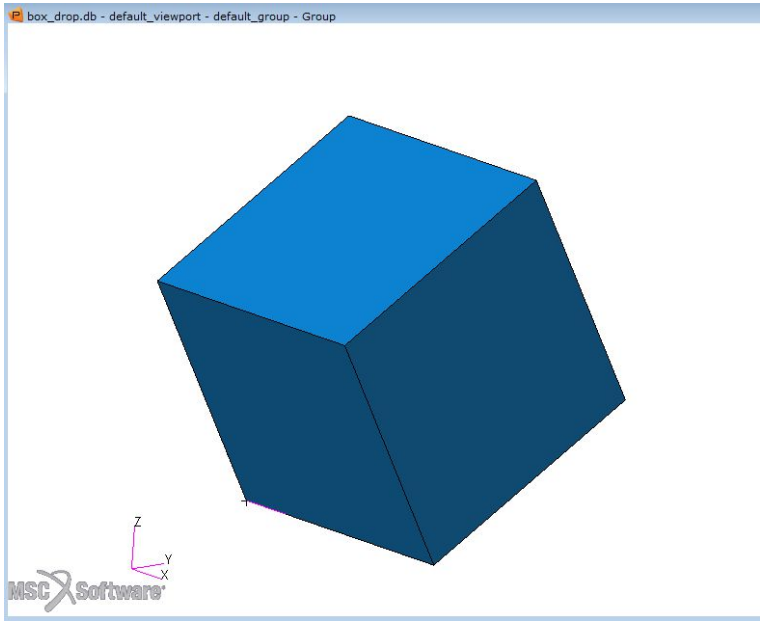
Step 2.2 Geometry: Create / Solid / XYZ

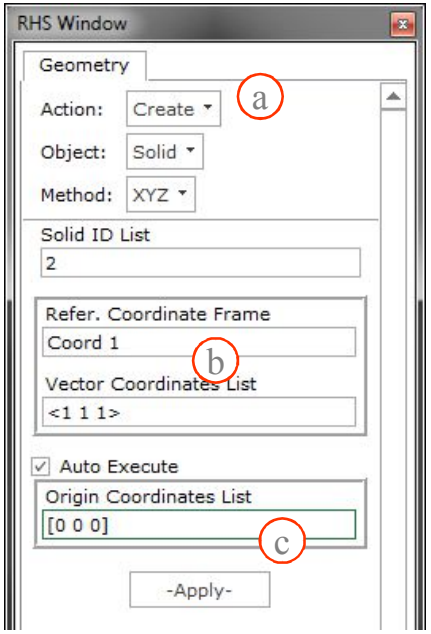
Create a box.

a) Geometry: Create / Solid / XYZ

b) Select Coord 1 as Reference Coord

c) Click **Apply**.





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Step 3.1 Elements: Create / Mesh / Surface

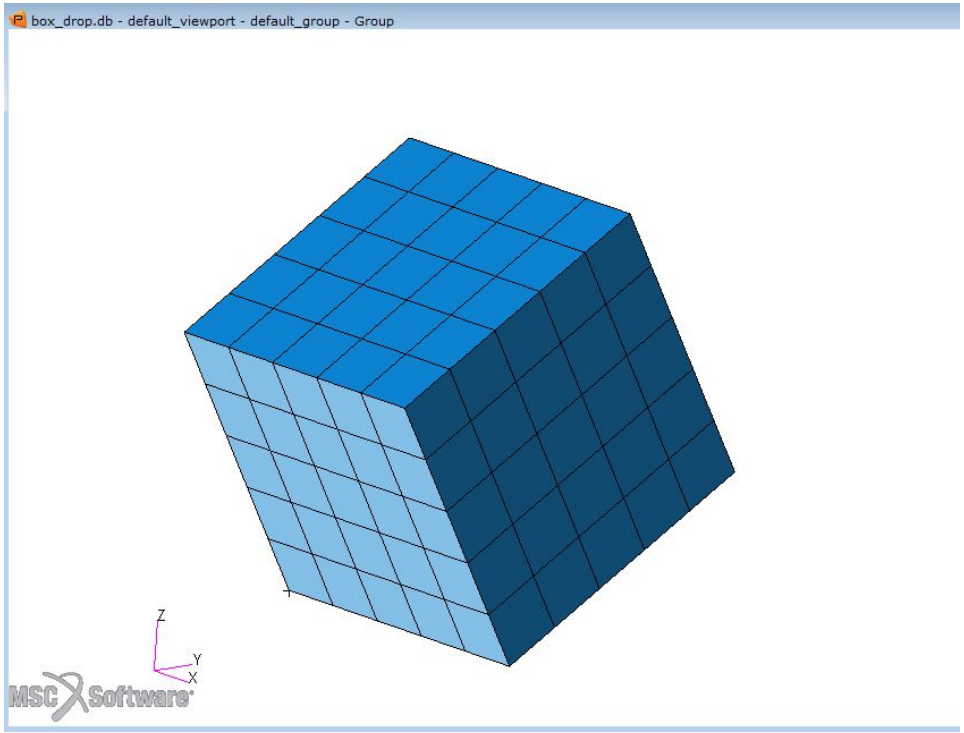
Create a basic mesh for the box.

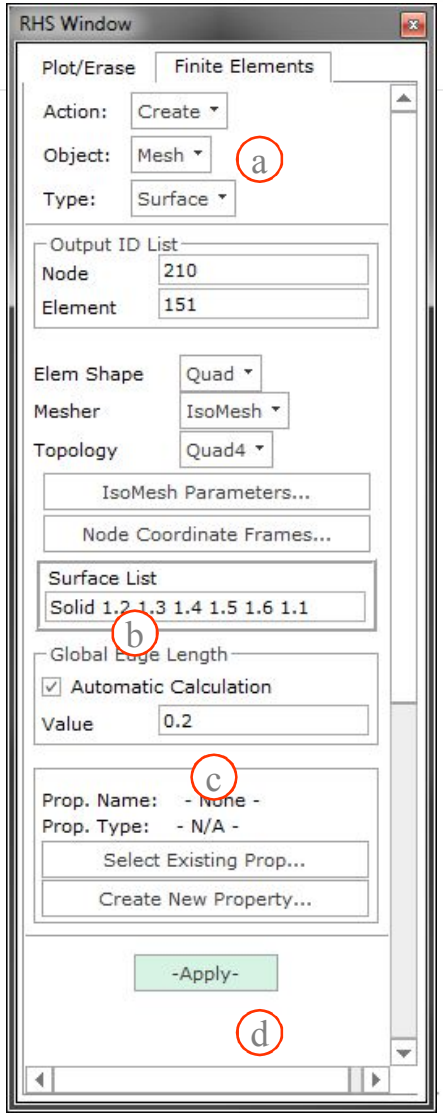
a) Elements: Create / Mesh / Surface

b) Enter **all solid faces** for Surface List.

c) Use default Global Edge Length.

d) Click **Apply**.



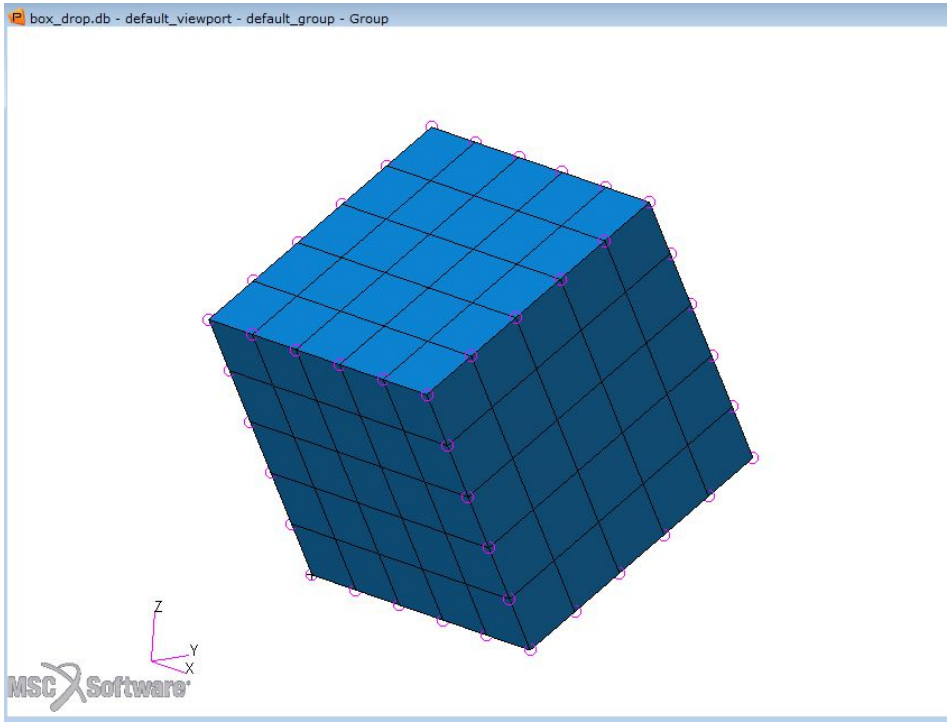


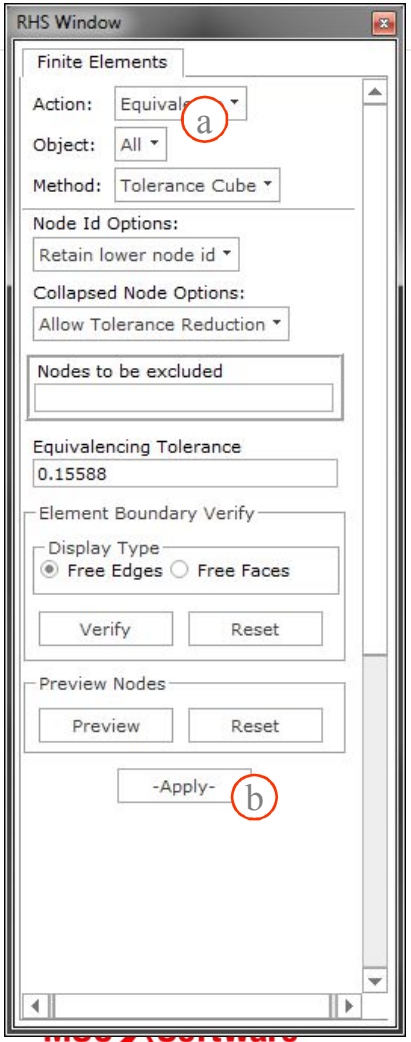
Step 3.2 Elements: Equivalence / All

Bind edge nodes.

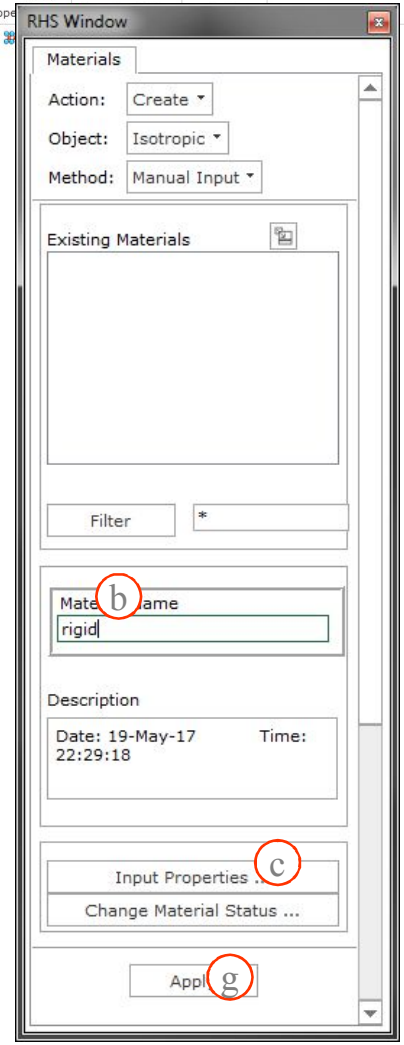
a) Elements: Equivalence / All

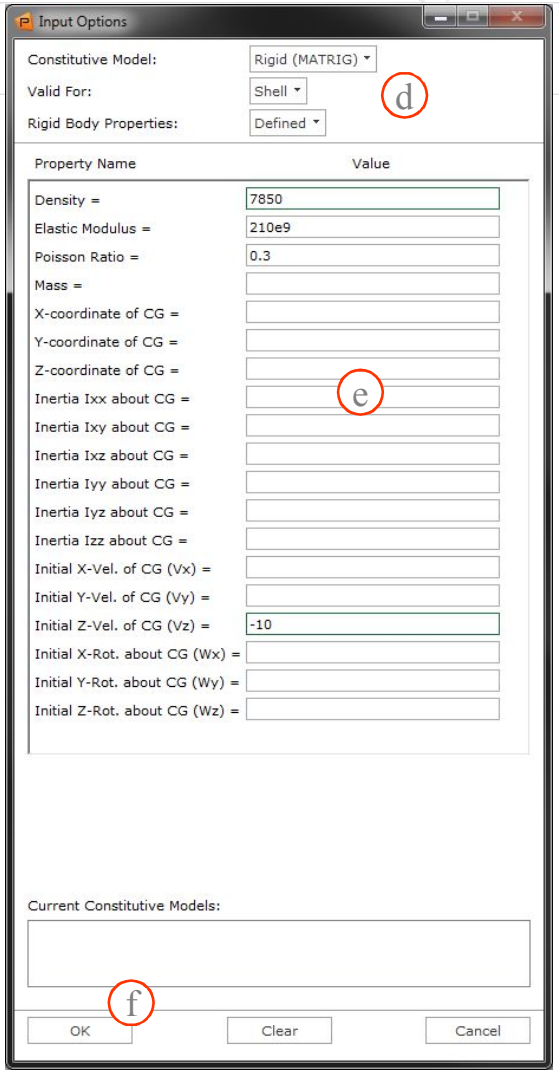
b) Click **Apply**.





Step 4. Materials: Create / Isotropic

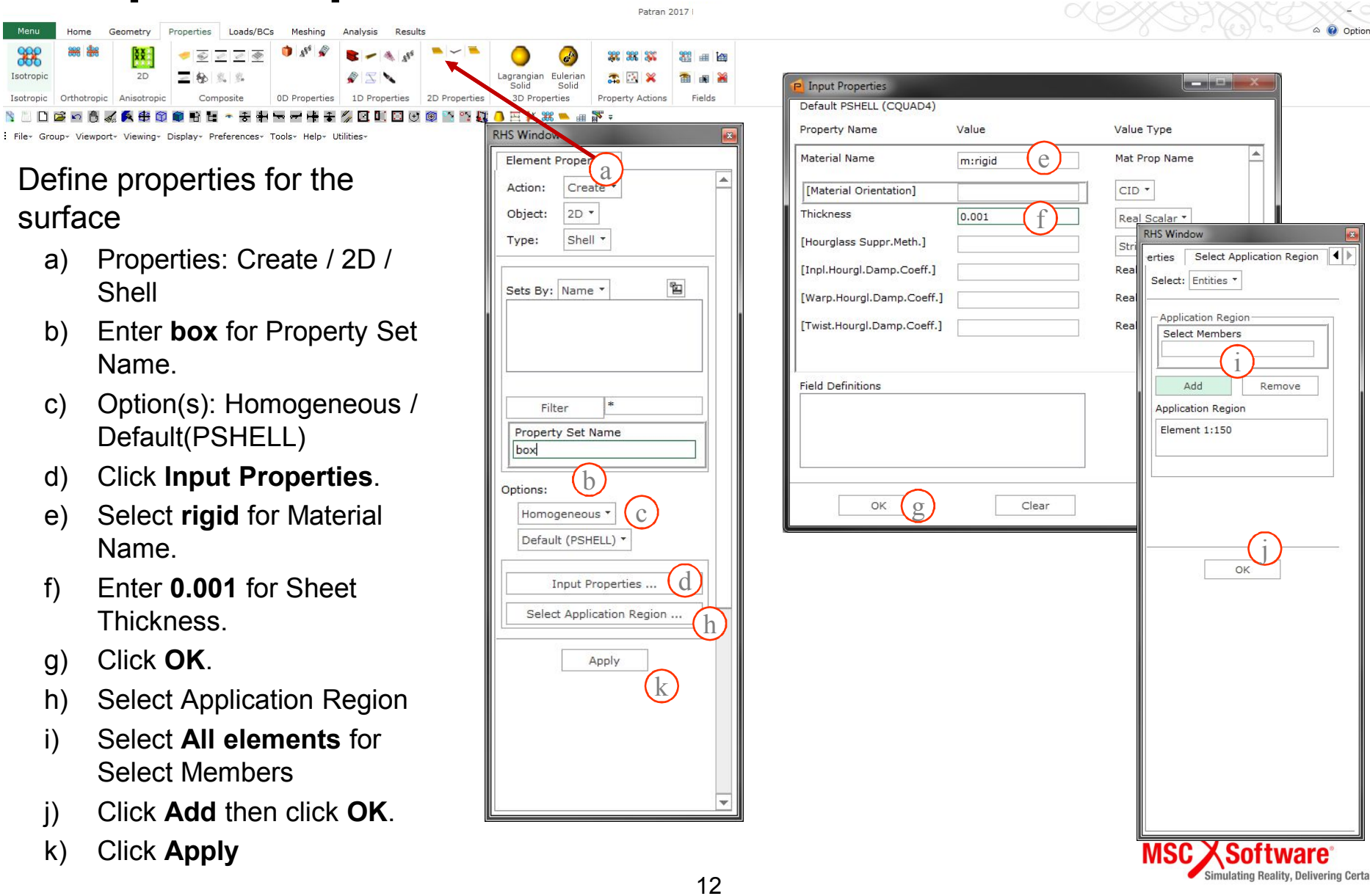




Define material properties.

a) Materials: Create / Isotropic / Manual Input.
b) Enter **rigid** for Material Name.
c) Click on **Input Properties**.
d) Constitutive Model: **Rigid (MATRIG)**
   Valid For: **Shell**
   Rigid Body Properties: **Defined**
e) Enter:
   7850 for Density,
   210e9 for Elastic Modulus
   0.3 for Poisson Ratio
   -10 for Initial Z-Vel of CG
f) Click **OK**.
g) Click **Apply**.

Step 5. Properties: Create / 2D / Shell



Define properties for the surface

a) Properties: Create / 2D / Shell

b) Enter **box** for Property Set Name.

c) Option(s): Homogeneous / Default(PSHELL)

d) Click **Input Properties**.

e) Select **rigid** for Material Name.

f) Enter **0.001** for Sheet Thickness.

g) Click **OK**.

h) Select Application Region

i) Select **All elements** for Select Members

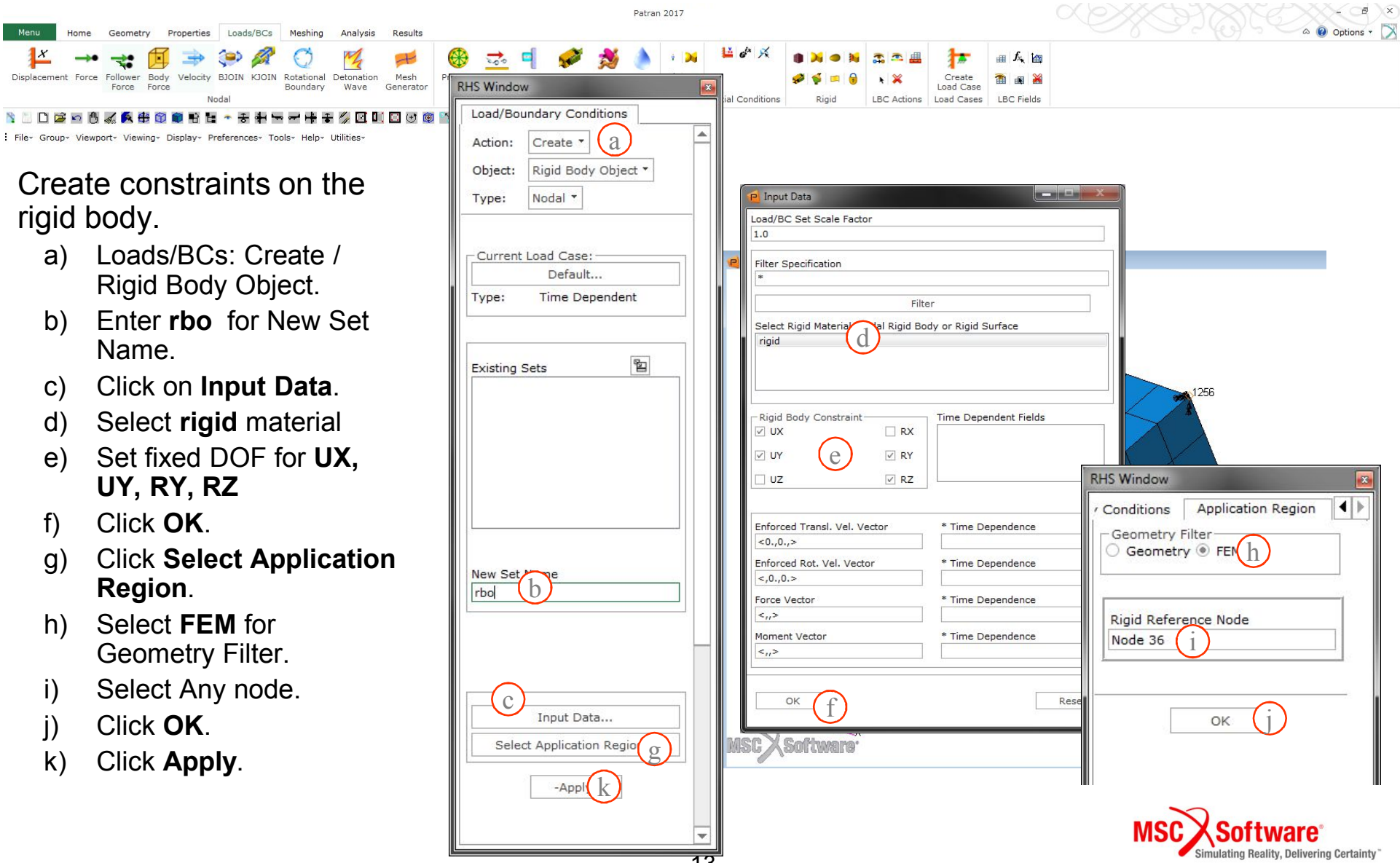
j) Click **Add** then click **OK**.

k) Click **Apply**

Step 6. Loads/BCs: Create / Rigid Body Object

Create constraints on the rigid body.

a) Loads/BCs: Create / Rigid Body Object.
b) Enter **rbo** for New Set Name.
c) Click on **Input Data**.
d) Select **rigid** material
e) Set fixed DOF for **UX, UY, RY, RZ**
f) Click **OK**.
g) Click **Select Application Region**.
h) Select **FEM** for Geometry Filter.
i) Select Any node.
j) Click **OK**.
k) Click **Apply**.



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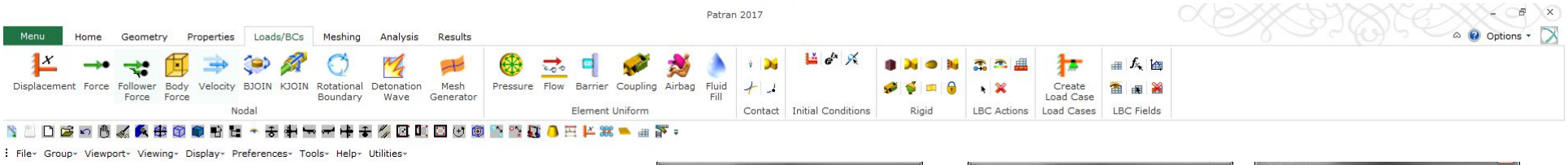
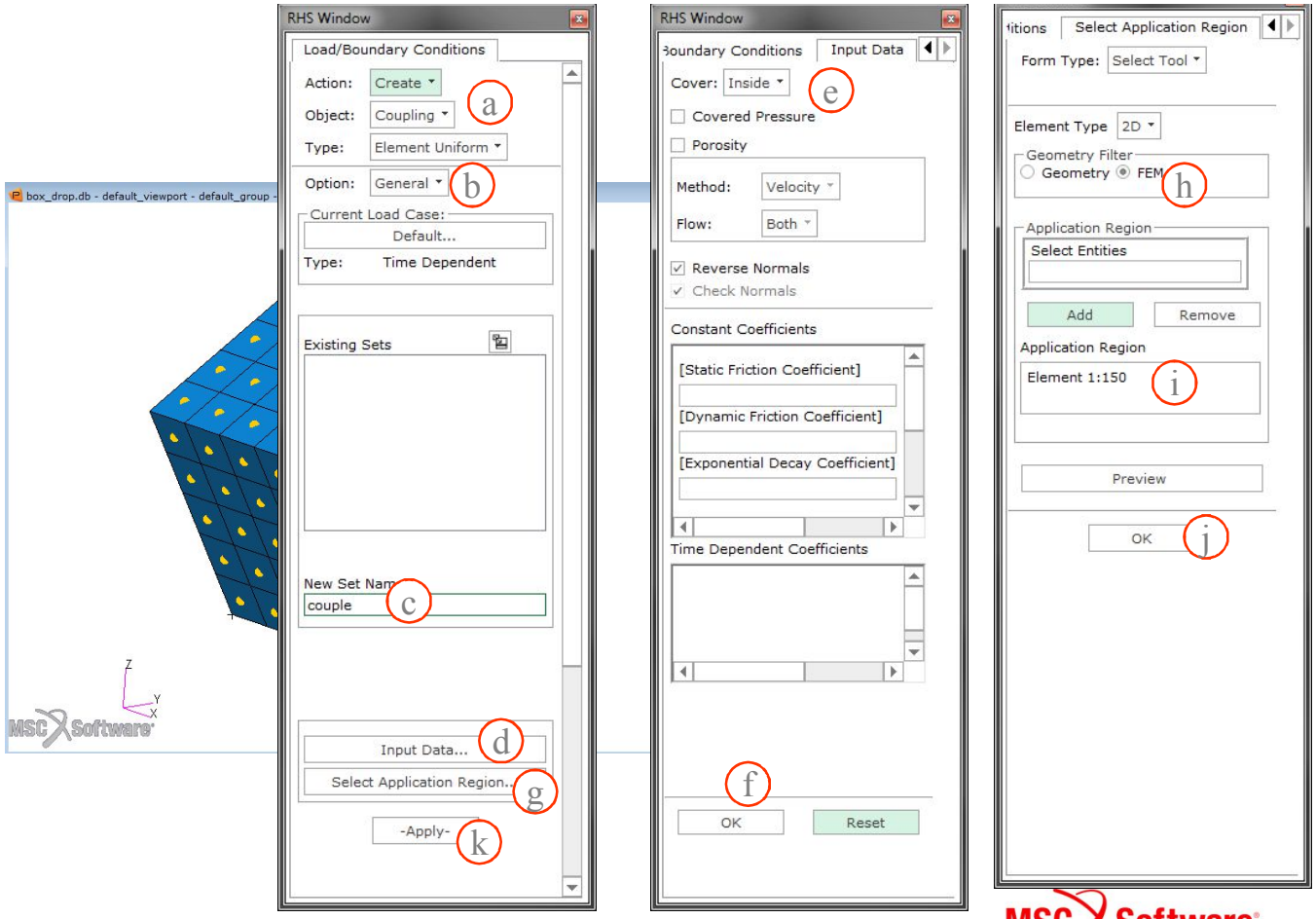
Step 7. Loads/BCs: Create / Coupling

Define coupling interface surface.

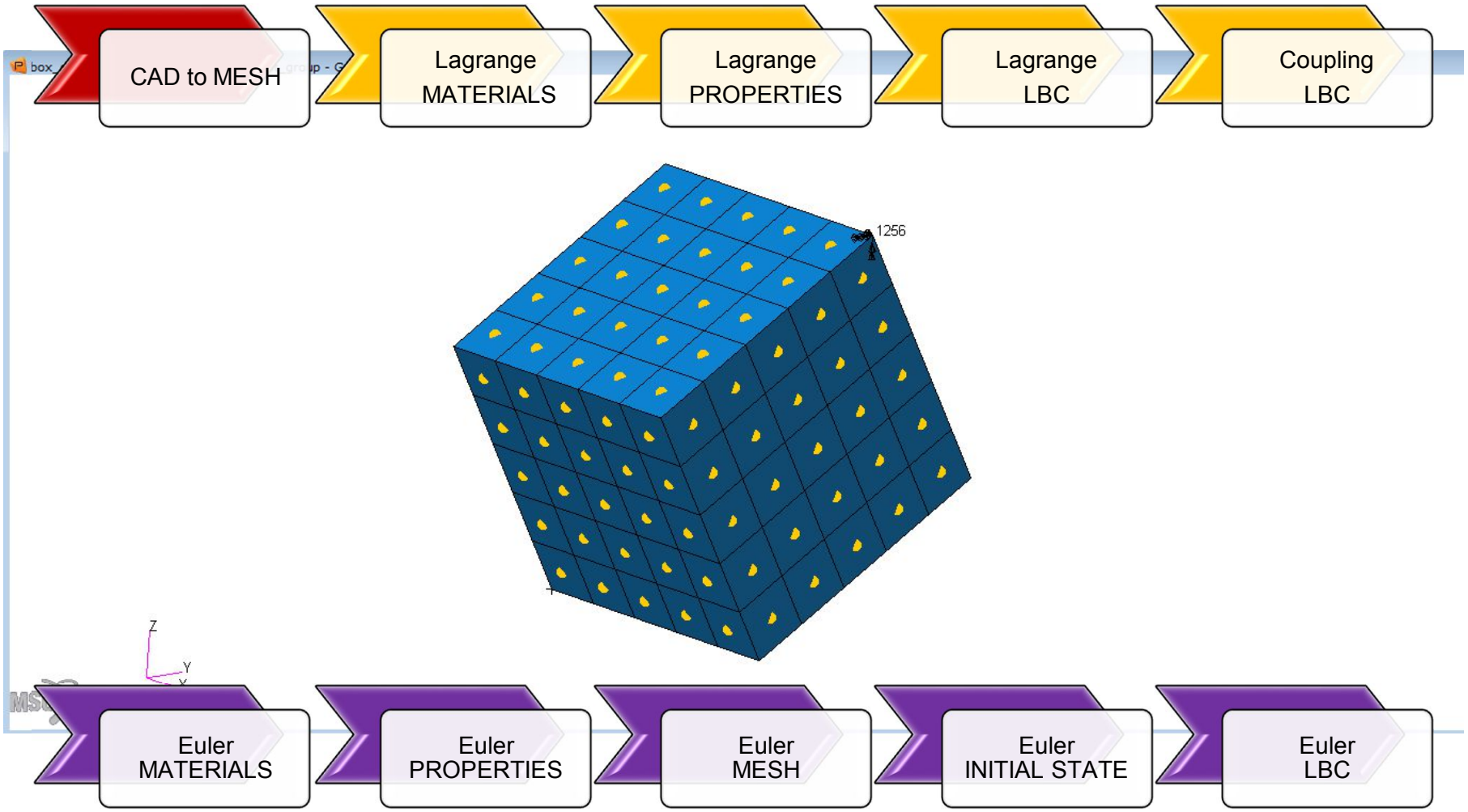
a) Loads/BCs: Create / Coupling
b) Set Option to **General.**
c) Enter **couple** for New Set Name.
d) Click on **Input Data**.
e) Verify Cover is set to **Inside.**
f) Click **OK**.
g) Click **Select Application Region**.
h) Select **FEM** for Geometry Filter
i) Select **All elements**.
j) Click **Add** and click **OK**.
k) Click **Apply**.





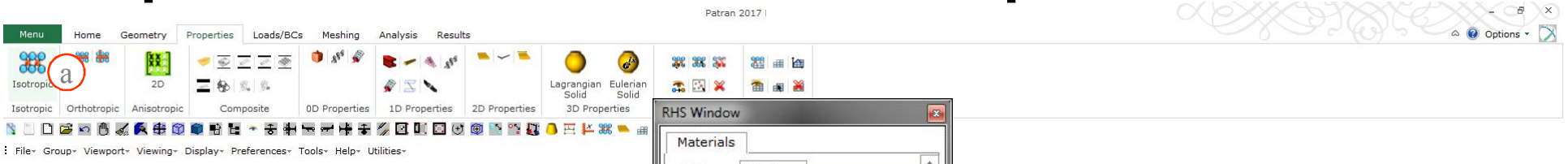
Structure Model Creation

Structure Model Setup



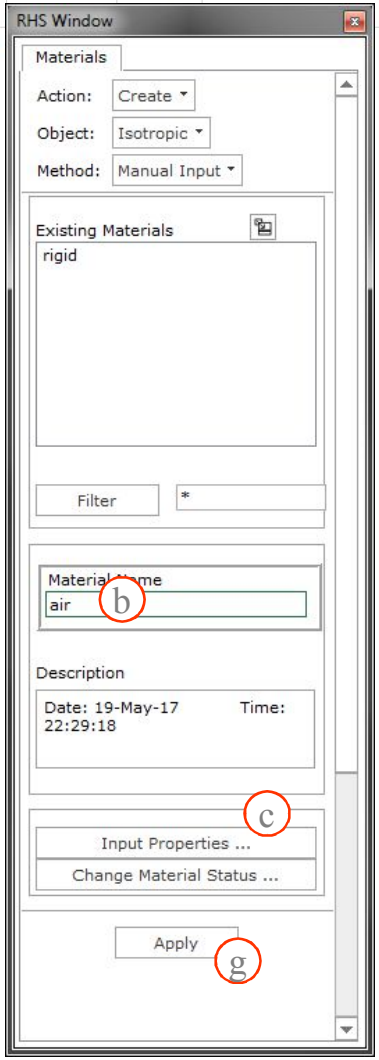
Fluid Model Setup

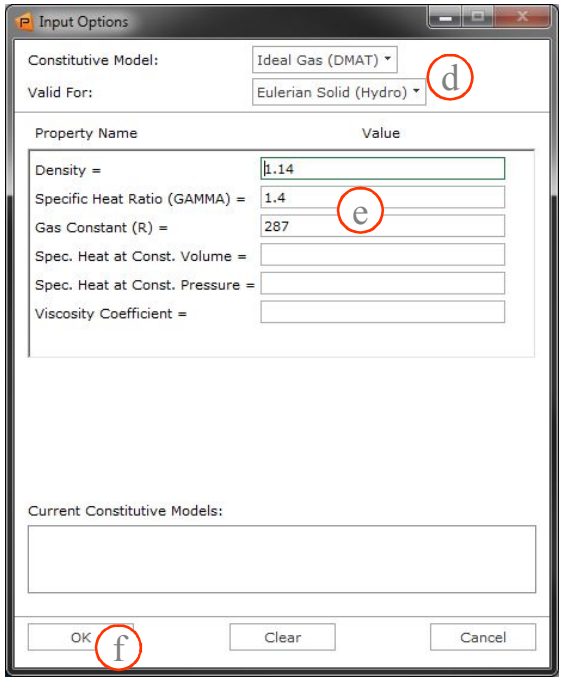
Step 8.1 Materials: Create / Isotropic



Define Euler material properties.

a) Materials: Create / Isotropic / Manual Input.
b) Enter **air** for Material Name.
c) Click on **Input Properties**.
d) Constitutive Model: **Ideal Gas (DMAT)**
   Valid For: **Eulerian Solid**
e) Enter:
   1.14 for Density,
   1.4 for GAMMA
   287 for R
f) Click **OK**.
g) Click **Apply**.





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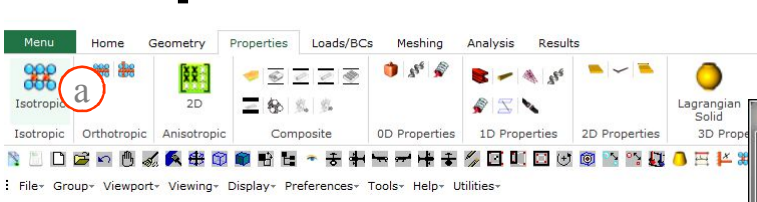
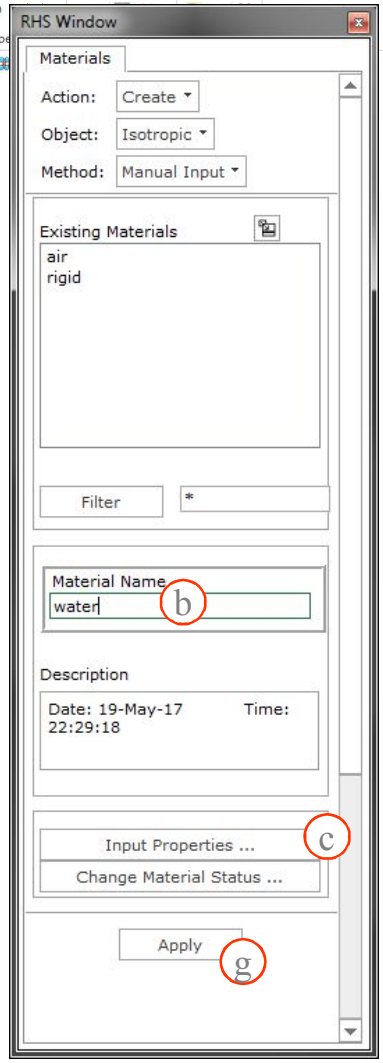
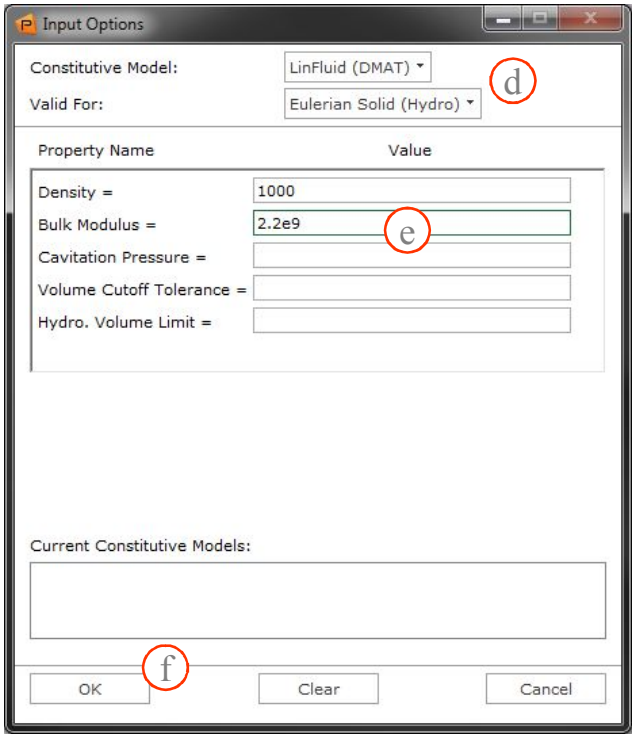
Step 8.2 Materials: Create / Isotropic



Define Euler material properties.

a) Materials: Create / Isotropic / Manual Input.
b) Enter **water** for Material Name.
c) Click on **Input Properties**.
d) Constitutive Model: **LinFluid (DMAT)**
   Valid For: **Eulerian Solid**
e) Enter:
   1000 for Density,
   2.2e9 for Bulk Modulus
f) Click **OK**.
g) Click **Apply**.





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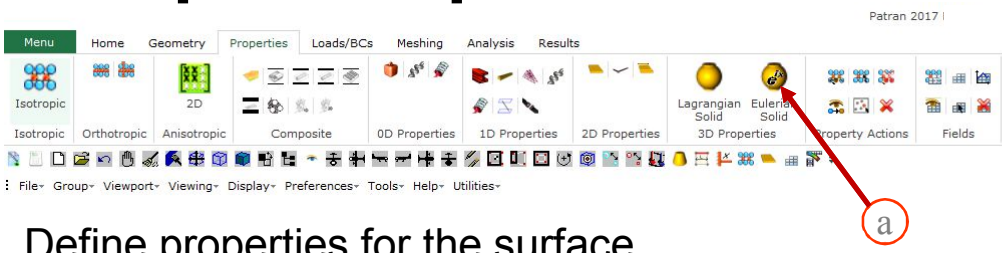
Step 9. Properties: Create / 3D / Eulerian



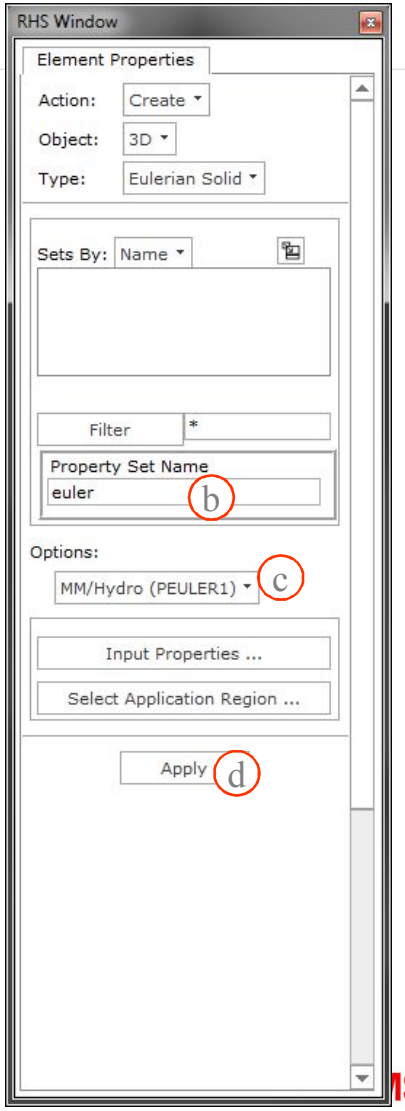
Define properties for the surface

a) Properties: Create / 3D / Eulerian Solid

b) Enter **euler** for Property Set Name.

c) Options: **MMHYDRO (PEULER1)**

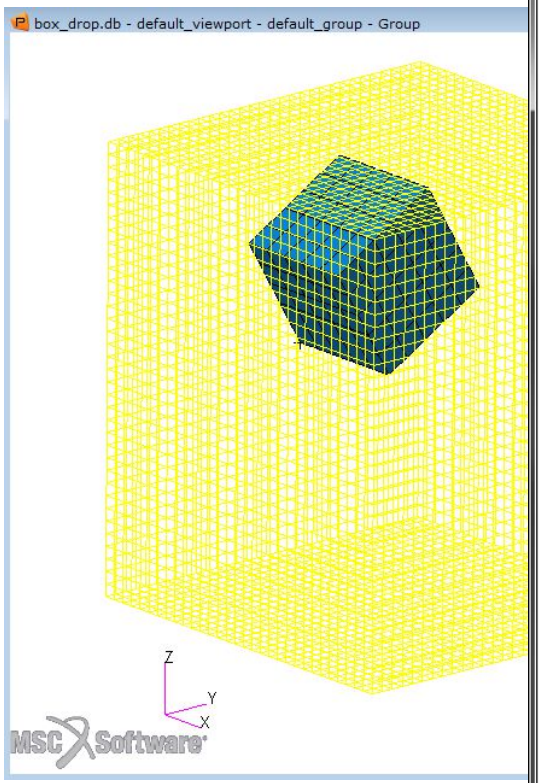
d) Click **Apply**

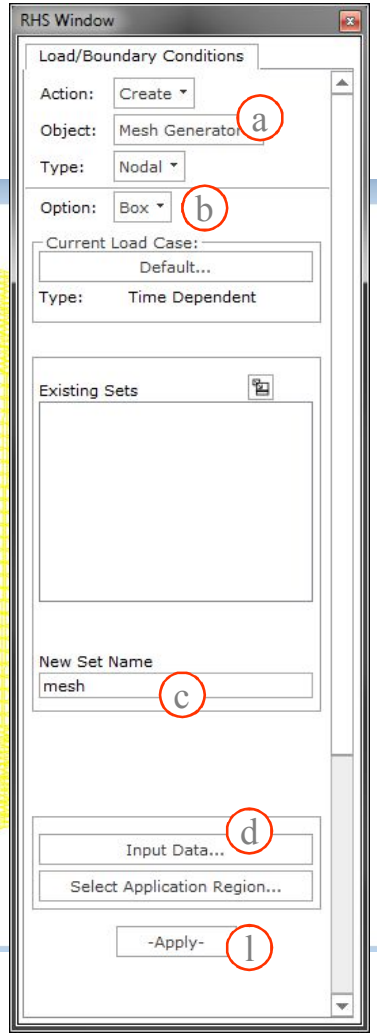


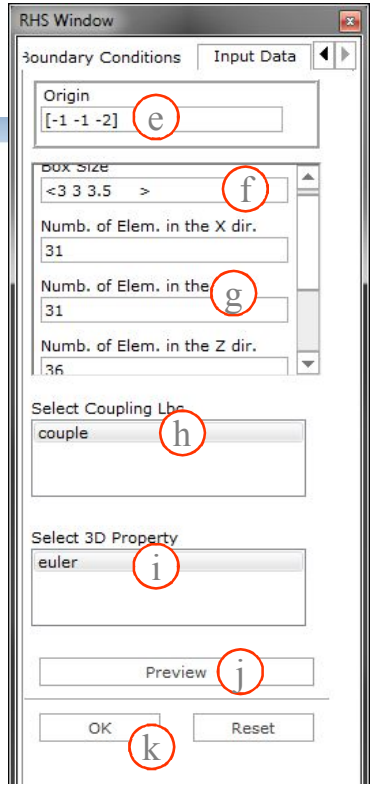
Step 10. Loads/BCs: Create / Mesh Generator

Define Euler mesh.

a) Loads/BCs: Create / Mesh Generator
b) Set Option to **Box.**
c) Enter **mesh** for New Set Name.
d) Click on **Input Data**.
e) Set Origin to **[-1 -1 -2].**
f) Set Box Size to **<3 3 3.5>.**
g) Set number of elements in each direction to **31, 31, 36** for X,Y,Z respectively.
h) Select **couple** for Coupling Lbc.
i) Select **euler** for 3D property.
j) Click Preview to see mesh.
k) Click **OK**.
l) Click **Apply**.







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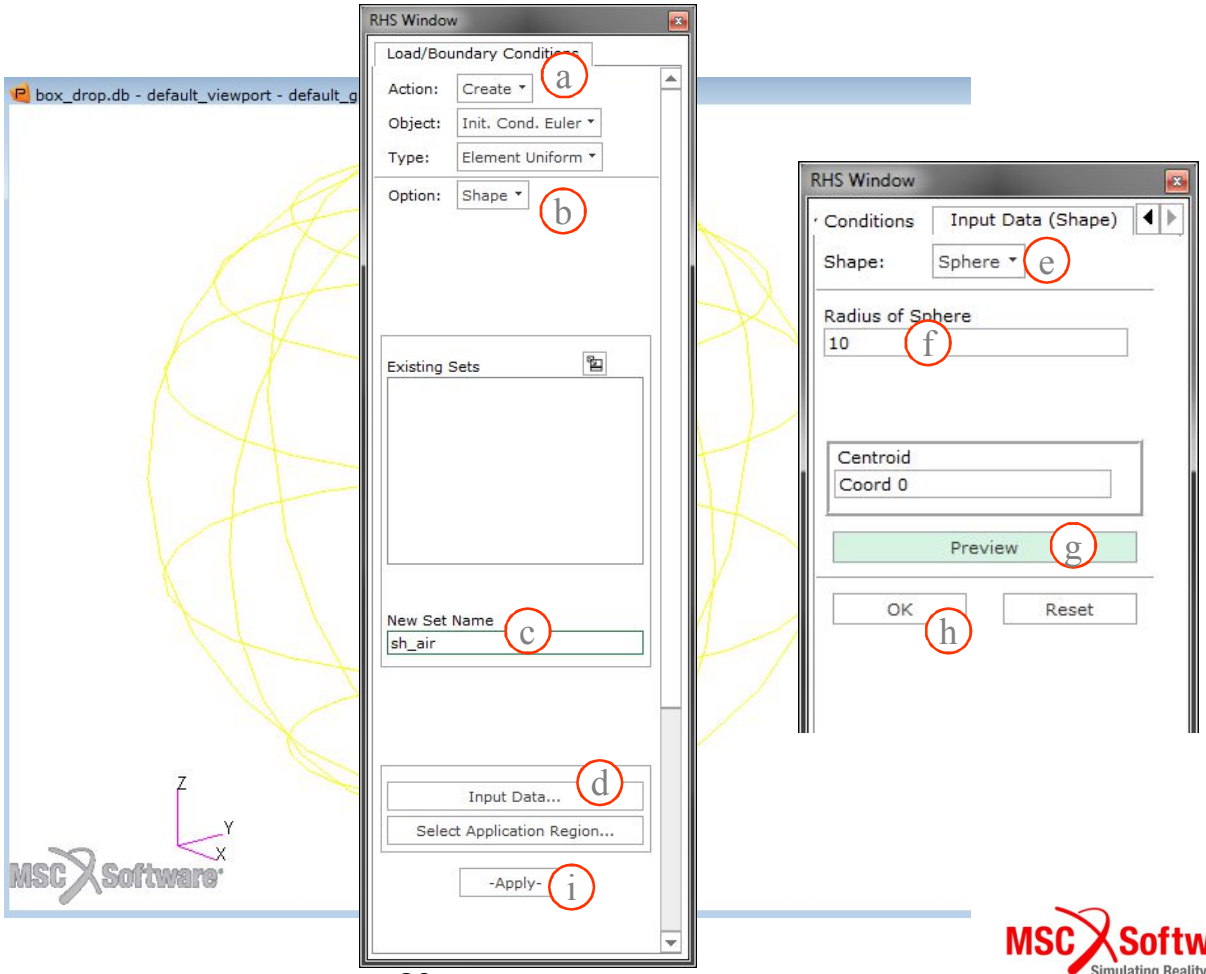
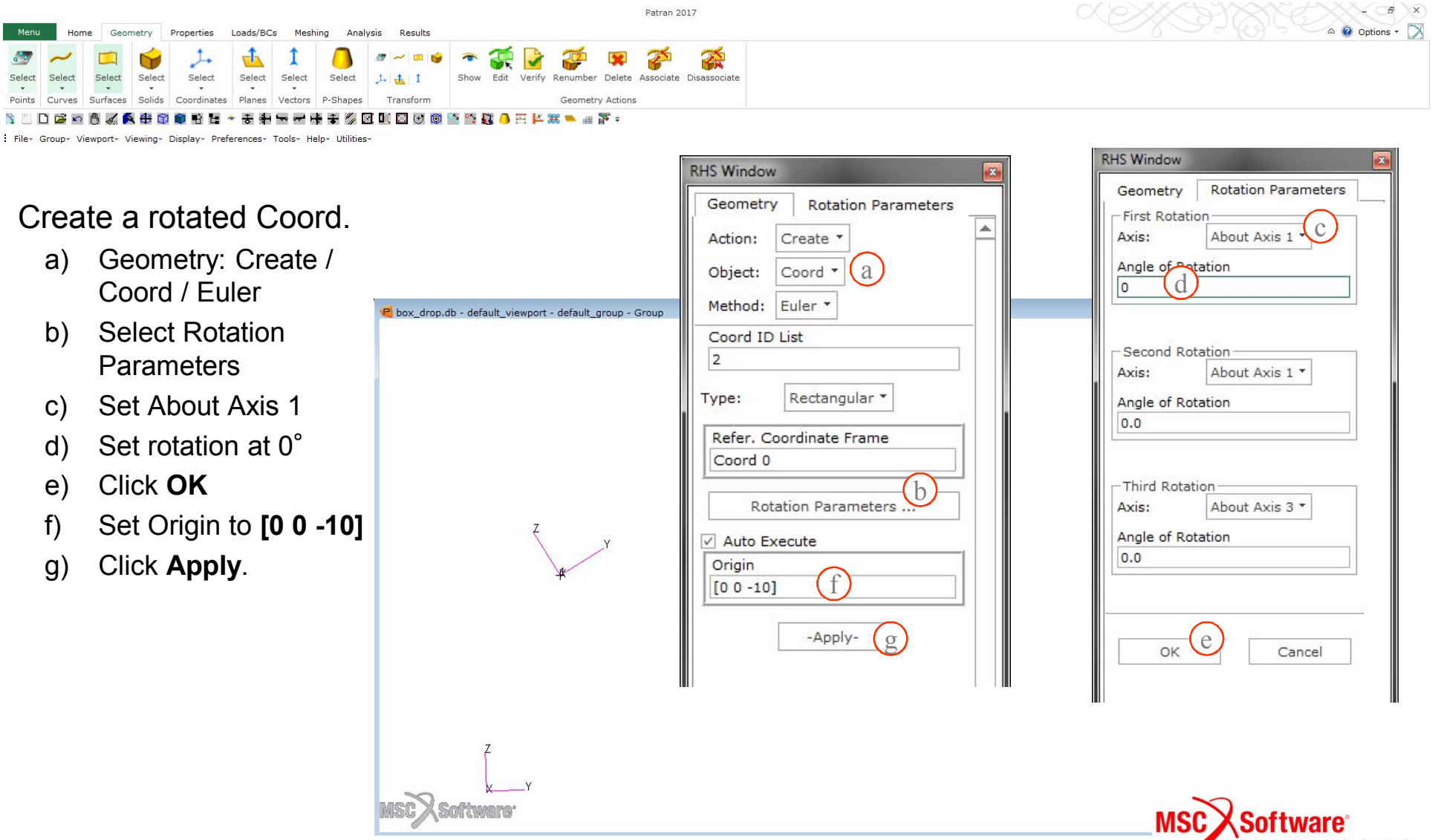
Step 11.1 Loads/BCs: Create / Init Cond Euler

Define initial Euler regions.

a) Loads/BCs: Create / Init. Cond. Euler
b) Set Option to **Shape.**
c) Enter **sh_air** for New Set Name.
d) Click on **Input Data**.
e) Set shape to **Sphere.**
f) Set radius to **10.**
g) Click **Preview.**
h) Click **OK.**
i) Click **Apply**.



Step 11.2 Geometry: Create / Coord



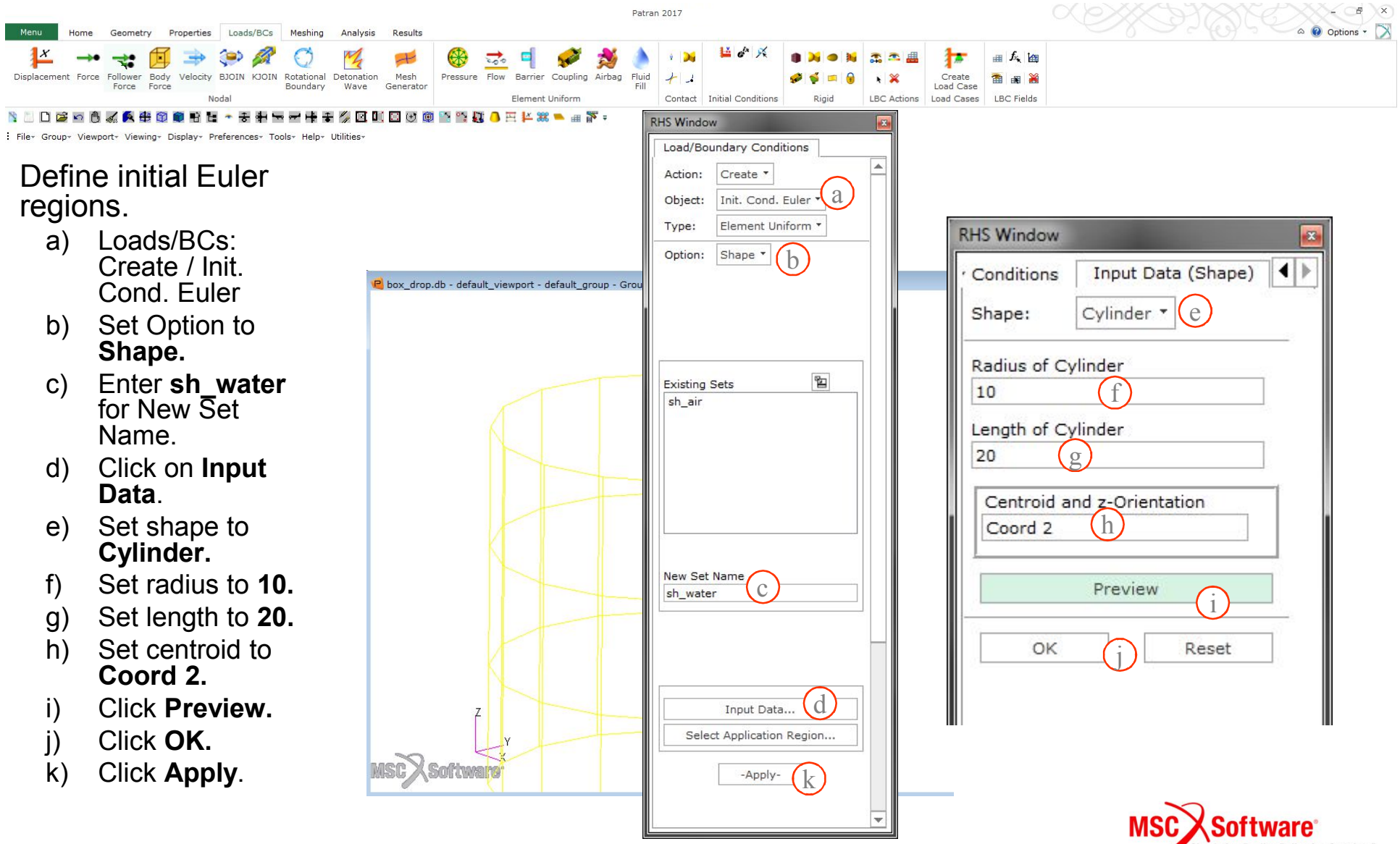
Create a rotated Coord.

a) Geometry: Create / Coord / Euler
b) Select Rotation Parameters
c) Set About Axis 1
d) Set rotation at 0°
e) Click **OK**
f) Set Origin to **[0 0 -10]**
g) Click **Apply**.

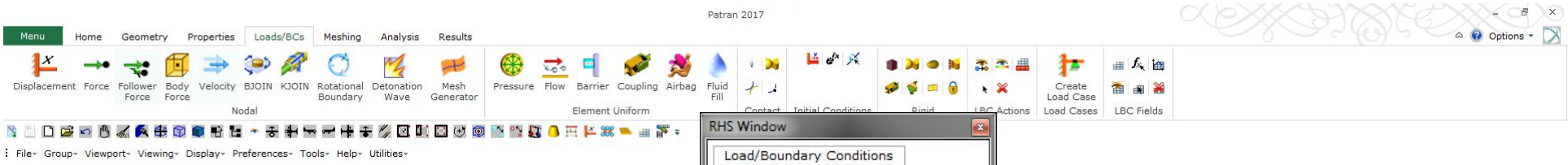
Step 11.3 Loads/BCs: Create / Init Cond Euler

Define initial Euler regions.

a) Loads/BCs: Create / Init. Cond. Euler
b) Set Option to **Shape.**
c) Enter **sh_water** for New Set Name.
d) Click on **Input Data**.
e) Set shape to **Cylinder.**
f) Set radius to **10.**
g) Set length to **20.**
h) Set centroid to **Coord 2.**
i) Click **Preview.**
j) Click **OK.**
k) Click **Apply**.

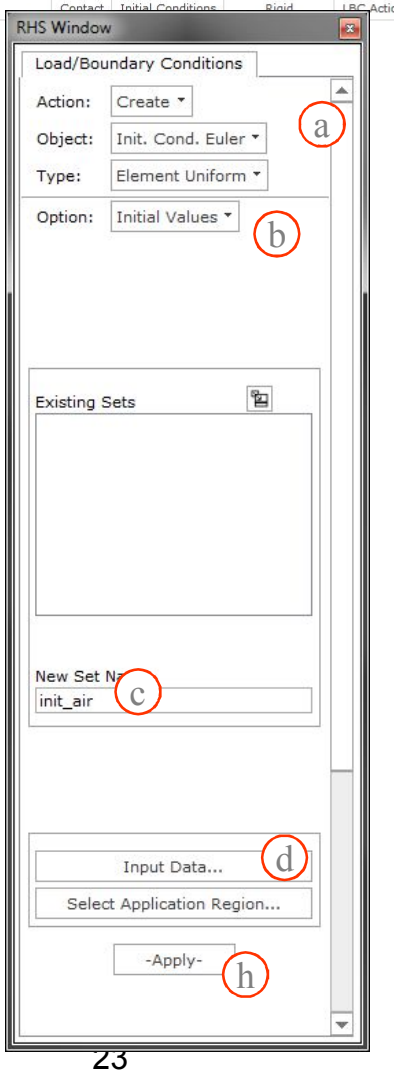


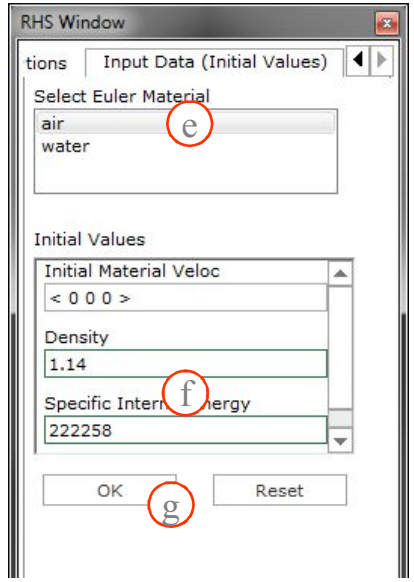
Step 11.4 Loads/BCs: Create / Init Cond Euler



Define initial Euler material values.

a) Loads/BCs: Create / Init. Cond. Euler
b) Set Option to **Initial Values.**
c) Enter **init_air** for New Set Name.
d) Click on **Input Data**.
e) Select **air** as material.
f) Set initial values to
   Density = **1.14**
   Specific Internal Energy = **222256**
g) Click **OK**.
h) Click **Apply**.





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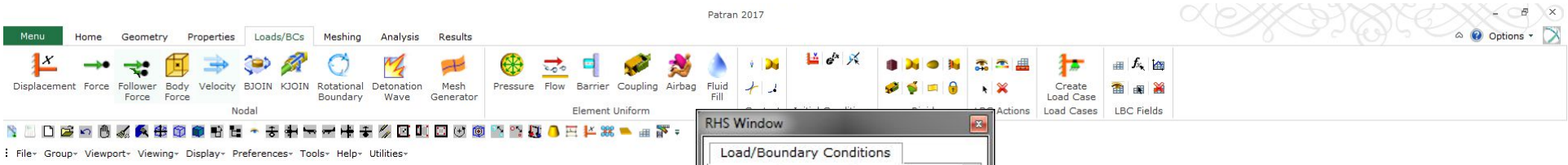
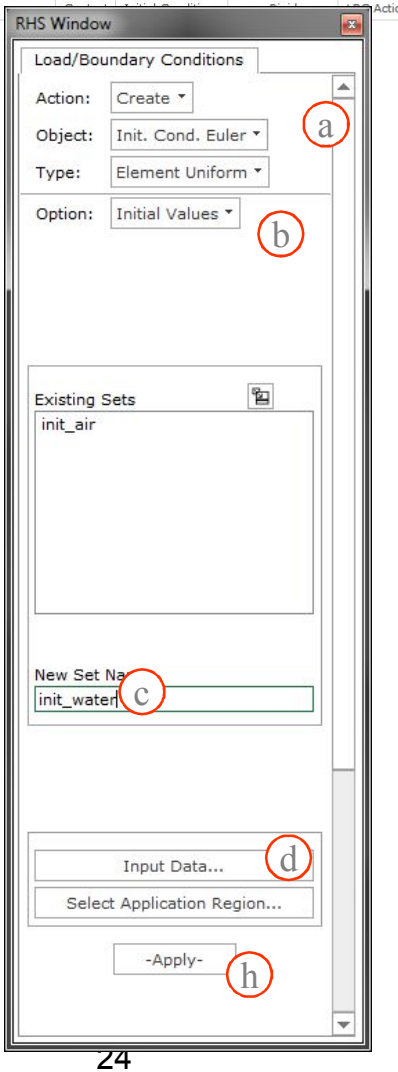
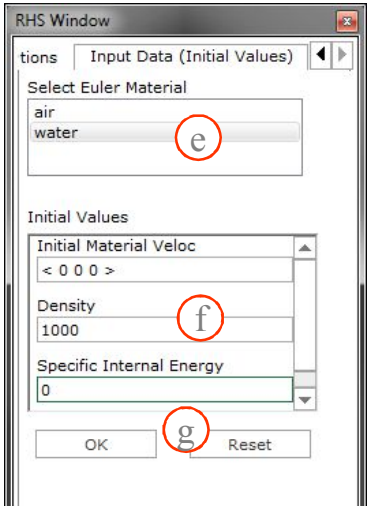
Step 11.5 Loads/BCs: Create / Init Cond Euler



Define initial Euler material values.

a) Loads/BCs: Create / Init. Cond. Euler
b) Set Option to **Initial Values.**
c) Enter **init_water** for New Set Name.
d) Click on **Input Data**.
e) Select **water** as material.
f) Set initial values to
   Density = **1000**
   Specific Internal Energy = **0**
g) Click **OK**.
h) Click **Apply**.





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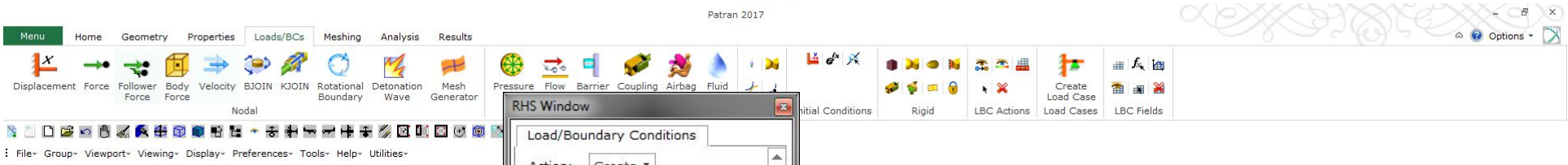
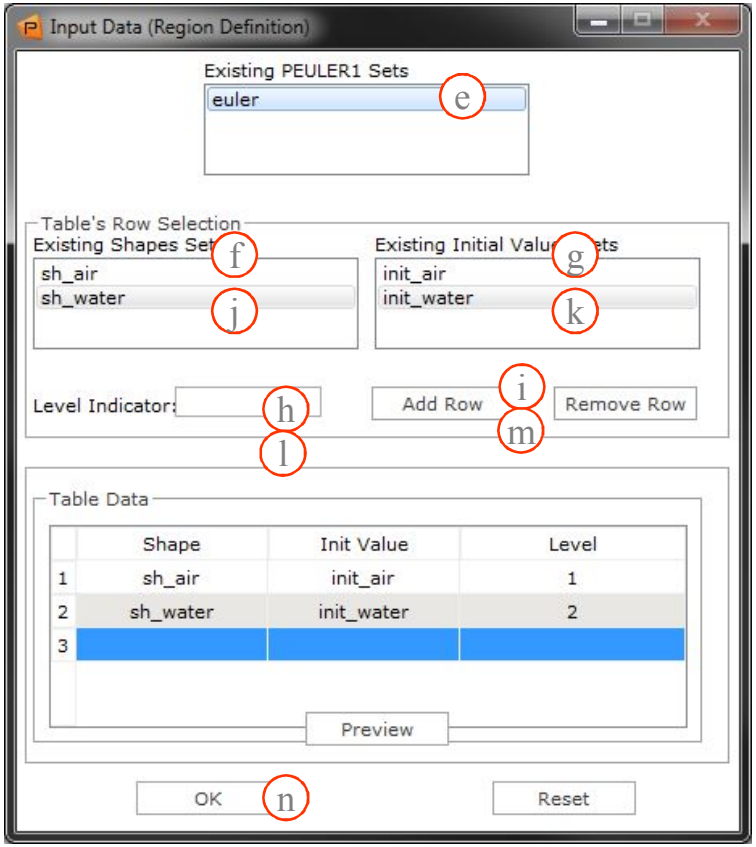
Step 11.6 Loads/BCs: Create / Init Cond Euler



Define Euler regions.

a) Loads/BCs: Create / Init. Cond. Euler
b) Set Option to **Region Definition.**
c) Enter **regdef** for New Set Name.
d) Click on **Input Data**.
e) Select **euler** as PEULER1 set**.**
f) Select shape sh_air
g) Select initial value init_air
h) Enter level 1
i) Add row
j) Select shape sh_water
k) Select initial value init_water
l) Enter level 2
m) Add row
n) Click **OK**.
o) Click **Apply**.



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Step 12.1 Analysis: Analyze / Input Deck

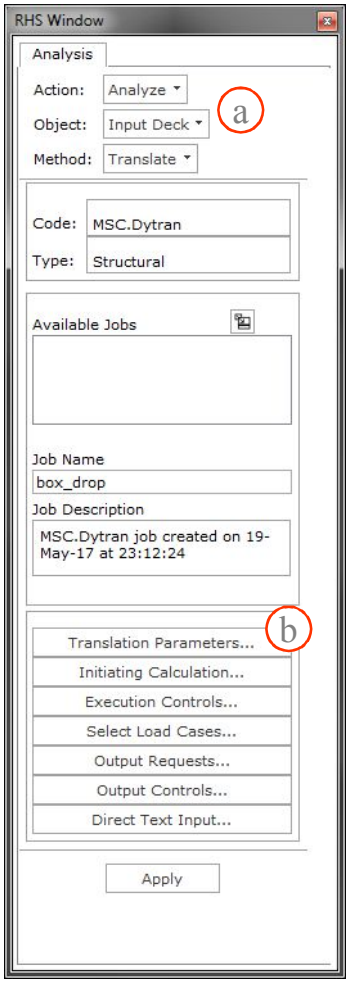
Set up analysis

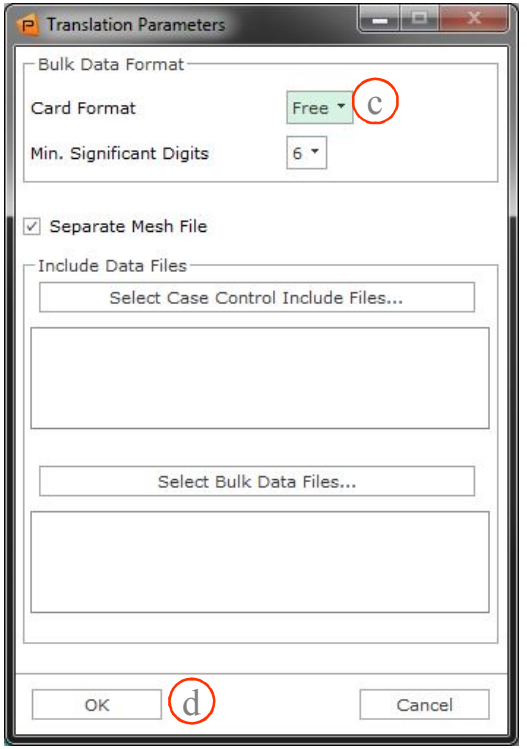
a) Analysis: Analyze / Input Deck / Translate

b) Click on **Translation Parameters**.

c) Select **Free** for Card Format.

d) Click **OK**.





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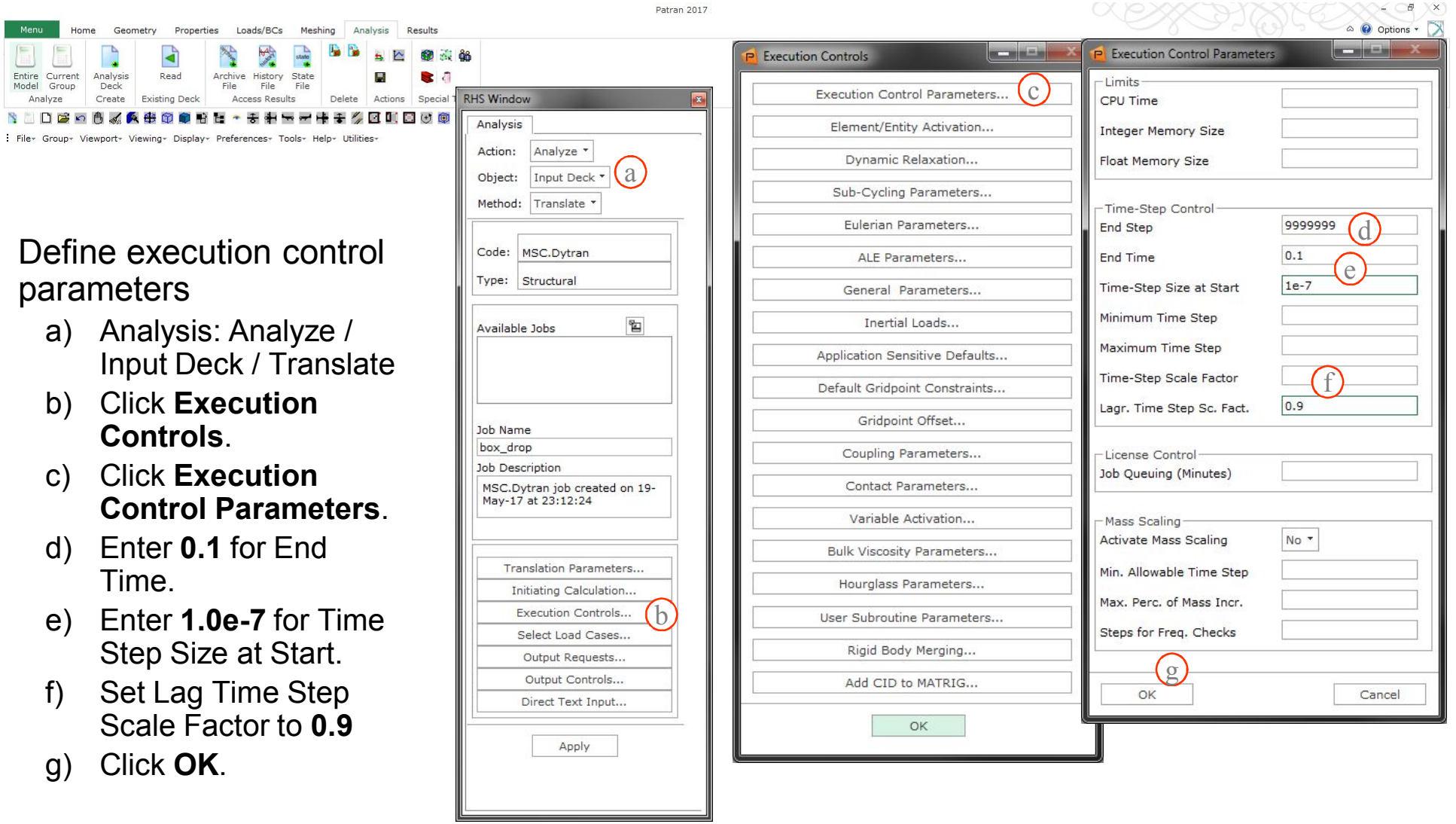
Step 12.2 Analysis: Analyze / Input Deck



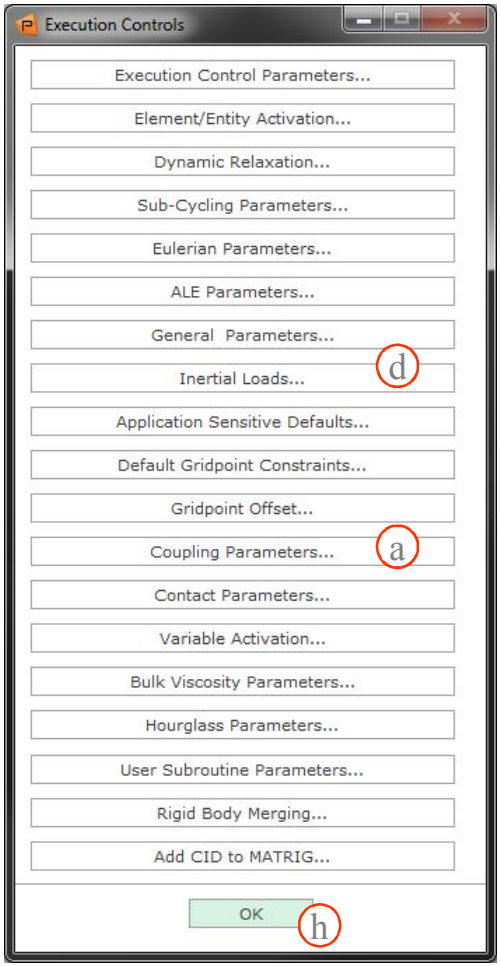
Define execution control parameters

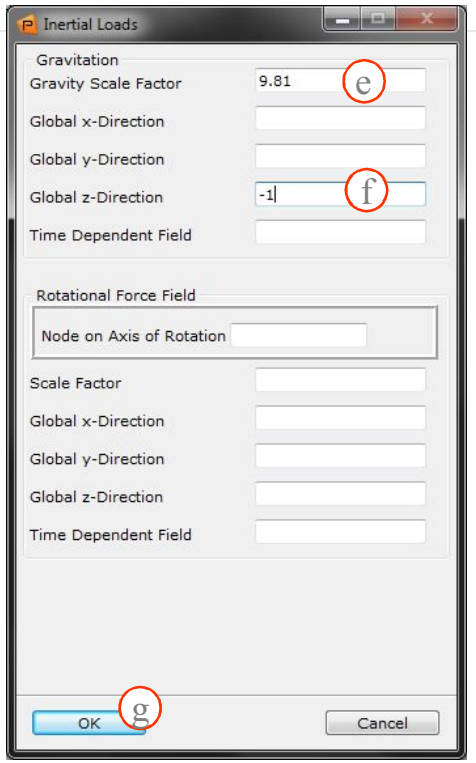
a) Analysis: Analyze / Input Deck / Translate
b) Click **Execution Controls**.
c) Click **Execution Control Parameters**.
d) Enter **0.1** for End Time.
e) Enter **1.0e-7** for Time Step Size at Start.
f) Set Lag Time Step Scale Factor to **0.9**
g) Click **OK**.

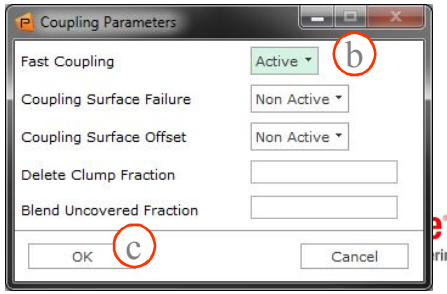
Step 12.3 Analysis: Analyze / Input Deck

Define execution control parameters

a) Select **Coupling Parameters**
b) Set Fast Coupling to **Active**
c) Click **OK**
d) Select **Inertia Loads**
e) Set Gravity Scale Factor to **9.81**
f) Set Gravity vector in Z = **-1**
g) Click **OK**
h) Click **OK**



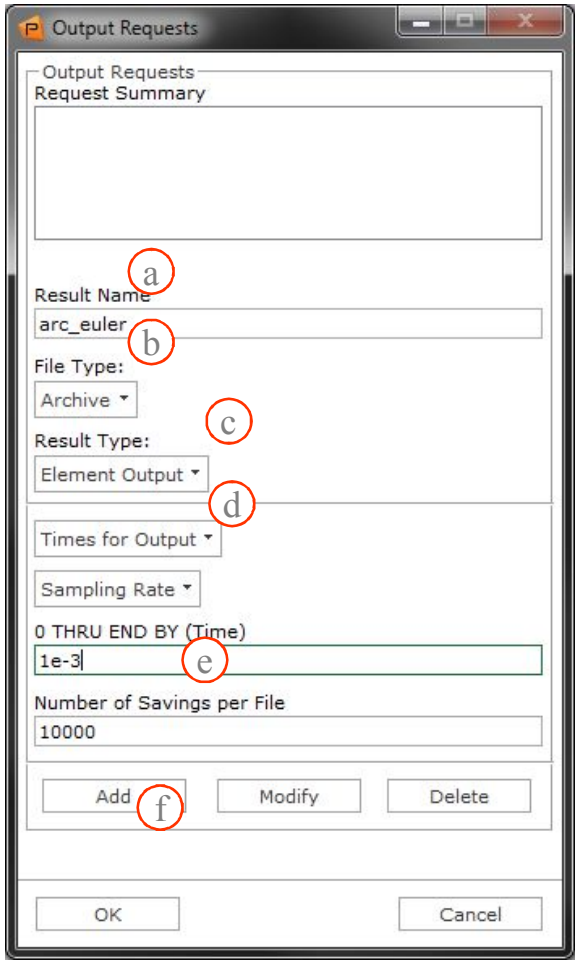


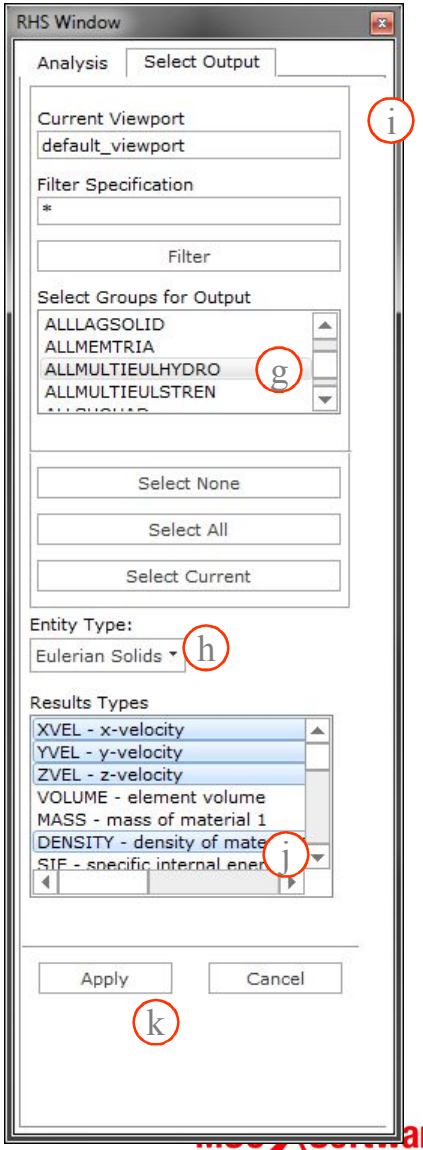


Step 12.4 Analysis: Analyze / Input Deck

Creating output requests.

a) Enter **arc_euler** for Result Name.
b) Select **Archive** for File Type.
c) Select **Element Output** for Result Type.
d) Select **Times for Output**
e) Enter **1e-3** for 0 THRU END BY (Time)
f) Click **Add**.
g) Select **ALLMULTIEULHYDRO** for Select Groups for Output.
h) Select **Eulerian Solids** for Entity Type
i) Select **XVEL, YVEL, ZVEL, DENSITY, PRESSURE, FMAT, FMATPLT, VOID** for Result Types.
j) Click **Apply**.

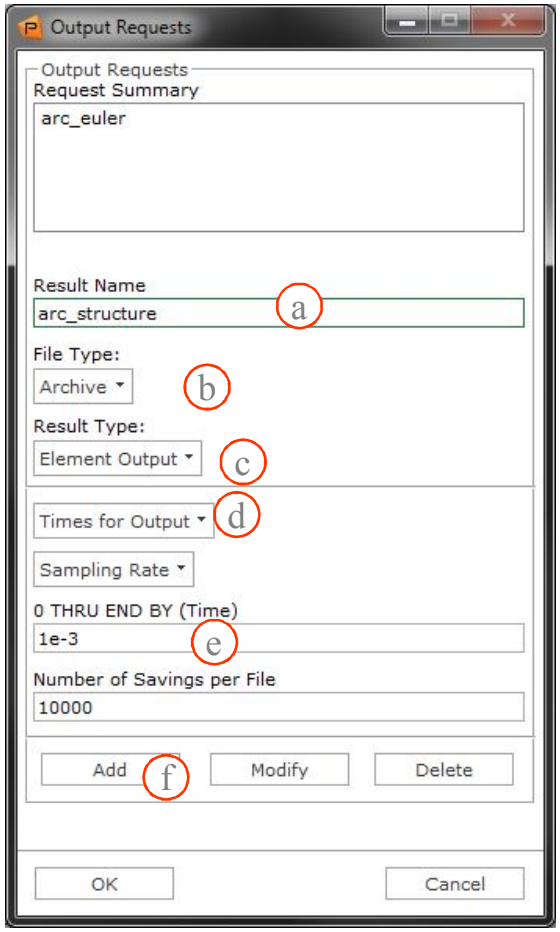


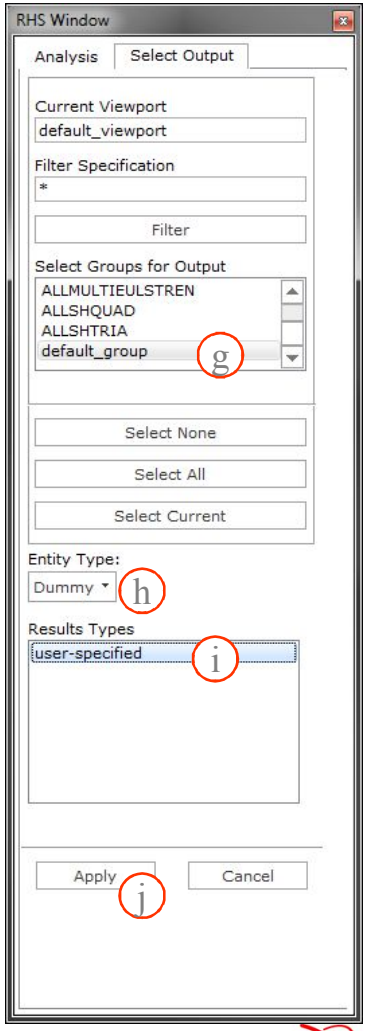


Step 12.5 Analysis: Analyze / Input Deck

Creating output requests.

a) Enter **arc_structure** for Result Name.
b) Select **Archive** for File Type.
c) Select **Element Output** for Result Type.
d) Select **Times for Output**
e) Enter **1e-3** for 0 THRU END BY (Time)
f) Click **Add**.
g) Select **default_group** for Select Groups for Output.
h) Select **Dummy** for Entity Type
i) Select **user-specified** for Result Types.
j) Click **Apply**.

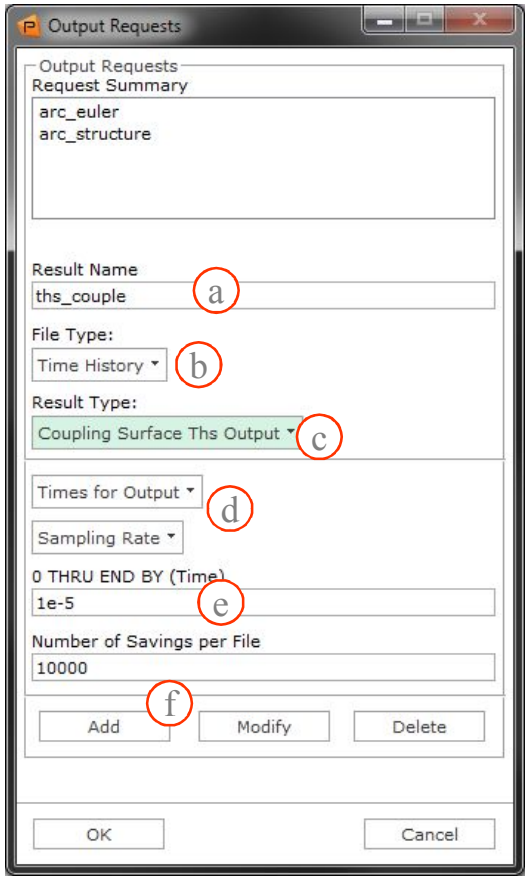


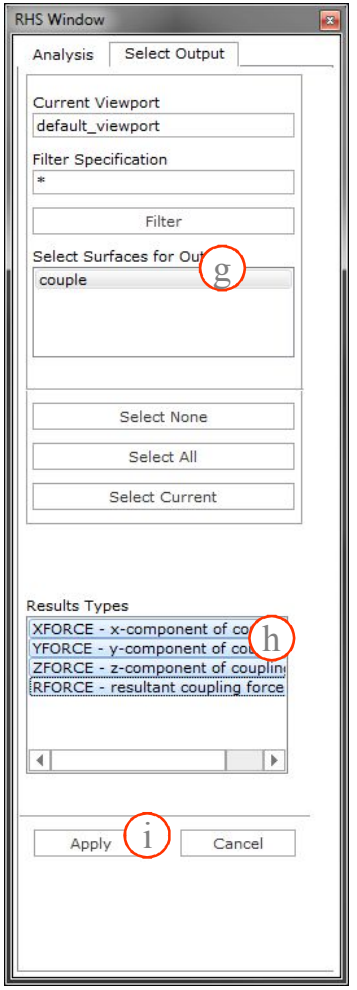


Step 12.6 Analysis: Analyze / Input Deck

Creating output requests.

a) Enter **ths_couple** for Result Name.
b) Select **Time History** for File Type.
c) Select **Coupling Surface Ths Output** for Result Type.
d) Select **Times for Output**
e) Enter **1e-5** for 0 THRU END BY (Time)
f) Click **Add**.
g) Select **couple** for Select Surfaces for Output.
h) Select **all outputs** for Result Types.
i) Click **Apply**.

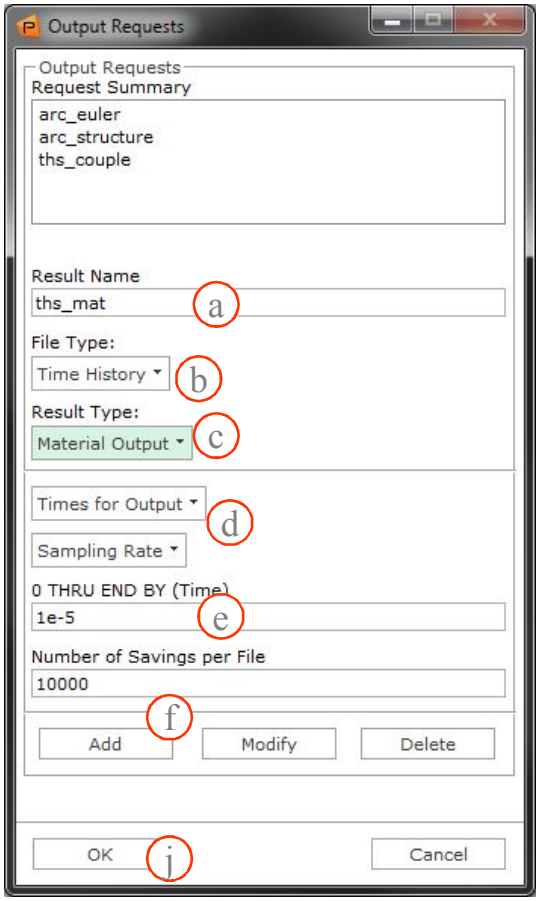


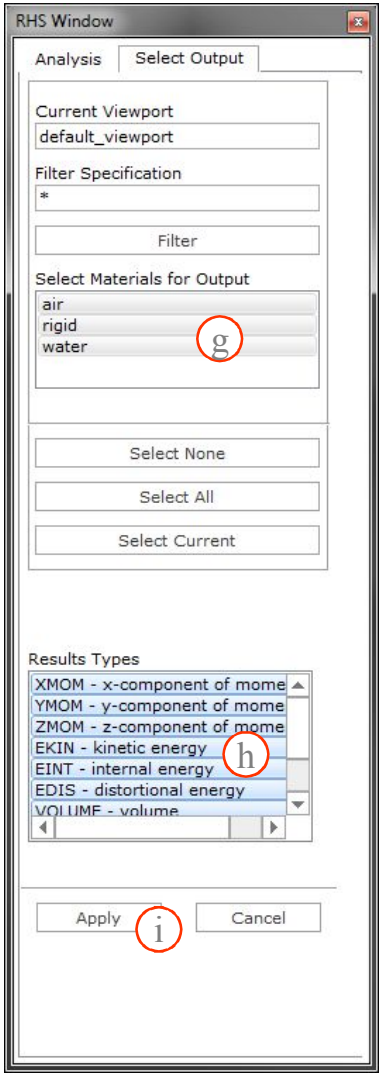


Step 12.7 Analysis: Analyze / Input Deck

Creating output requests.

a) Enter **ths_mat** for Result Name.
b) Select **Time History** for File Type.
c) Select **Material Output** for Result Type.
d) Select **Times for Output**
e) Enter **1e-5** for 0 THRU END BY (Time)
f) Click **Add**.
g) Select **all materials** for Select Materials for Output.
h) Select **all outputs** for Result Types.
i) Click **Apply**.
j) Click **OK.**





Step 12.8 Analysis: Analyze / Input Deck

Add additional entries to modify and write out input deck.

a) Select Direct Text Input.

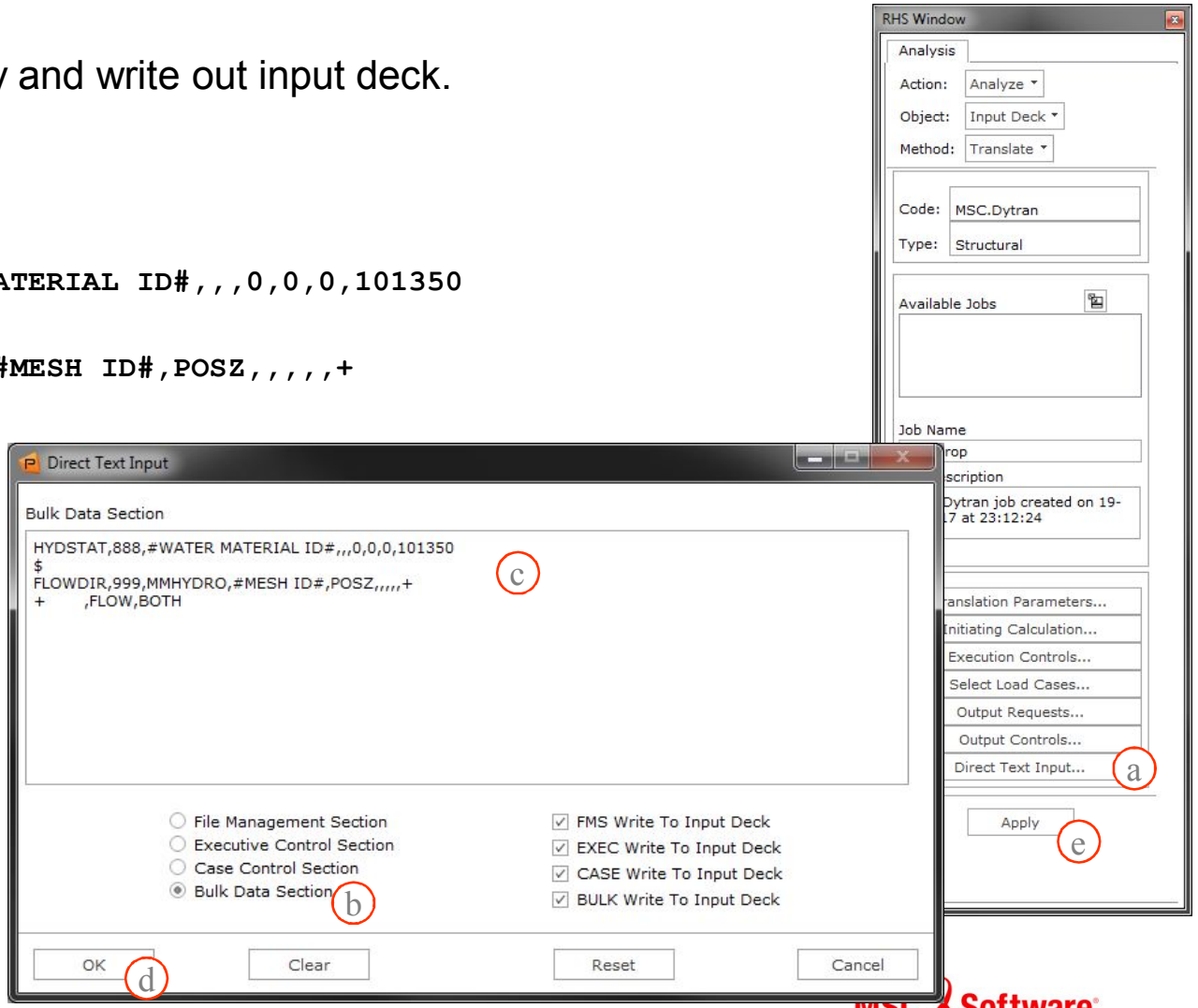
b) Select Bulk Data Section.

c) Enter

```
HYDSTAT,888,#WATER MATERIAL ID#,,,0,0,0,101350
$
FLOWDIR,999,MMHYDRO,#MESH ID#,POSZ,,,,,+
+       ,FLOW,BOTH
```

a) Click **OK.**

b) Click **Apply.**



Step 13 Analysis: Input Deck Edit

Edit Input deck with special features.

a) Add additional output breakdown per material.

b) Fix HYDSTAT to water material ID.

c) Fix FLOWDIR to MESH ID.

d) Save.

```
$ Output result for request: arc_euler
TYPE (arc_euler) = ARCHIVE
ELEMENTS (arc_euler) = 1
SET 1 = ALLMULTIEULHYDRO                                                    (a)
ELOUT (arc_euler) = XVEL YVEL ZVEL DENSITY PRESSURE VOID FMAT FMATPLT FMATPLT2,
 FMATPLT3 DENSITY2
TIMES (arc_euler) = 0 THRU END BY 1e-3
SAVE (arc_euler) = 10000
....
HYDSTAT,888,3,,,0,0,0,101350   (b)
$
FLOWDIR,999,MMHYDRO,6,POSZ,,,,,+ (c)
+       ,FLOW,BOTH
....
$ -------- Material air id =2
DMAT,2,1.14,2
EOSGAM,2,1.4,287,,
$
$ -------- Material water id =3
DMAT,3,1000,3
EOSPOL,3,2.2e+009
....
$ ------- Mesh Box: mesh
MESH,6,BOX,,,,,,,+
+       ,-1,-1,-2,3,3,3.5,,,+
+       ,31,31,36,,,,EULER,2
```

SECTION 5 INTERRUPT

Dytran FSI Process

Step 14. Dytran Analysis on Linux

Create alias to Dytran run script:

```
$ alias dytran=/msc/Dytran/2017/bin/Dytran
```

To run:

```
$ dytran jid=jobname [options]
```

Execute this workshop:

```
$ dytran jid=2_w01 nproc=4 ncpus=1 dmp=both intelmpi=yes
```

Step 14. Dytran Analysis on Windows

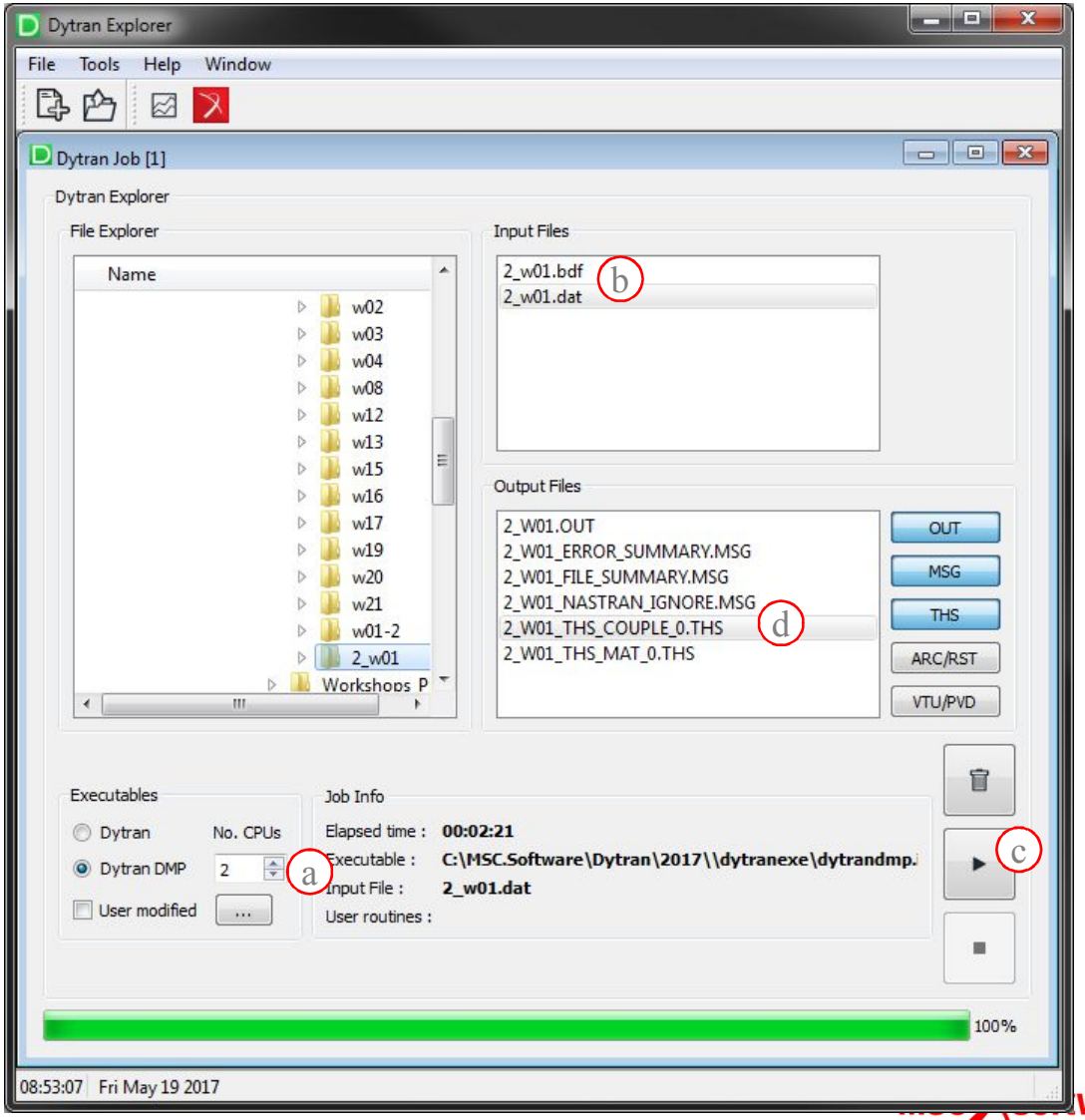
Execute Dytran

a) Select **DytranDMP** execulable and set to **2** cores

b) Select **2_w01.dat** file.

c) Click **"Play"** icon.

d) After analysis, make sure **.ARC** and **.THS** files were created in output window.



SECTION 6 INTERRUPT

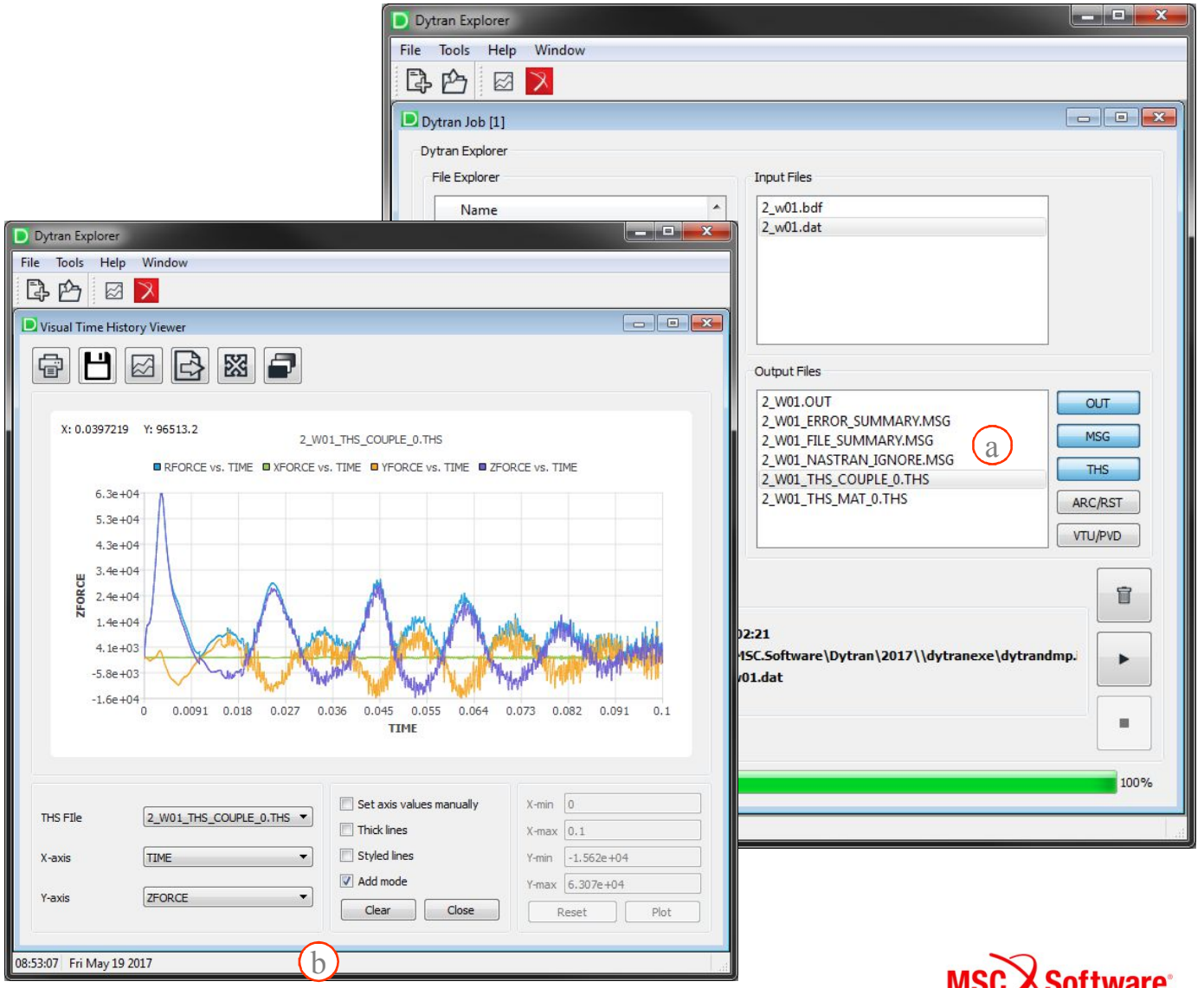
Dytran FSI Results Processing

Step 15. Dytran Time History

Viewing time histories are possible directly by Dytran Explorer

a) Double Click the **COUPLE.THS** file shown in the Output files window.

b) Select **all results** for the Y-axis



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Step 16. Convert Dytran Result Files

- **ARC to VTK Converter**
  - Bundled with Dytran
    - Dytran_installation_dir\bin\exe\arc2vtk.exe
    - Usage:

```
C:\MSC.Software\Dytran\2017\bin\exe\arc2vtk.exe  [-ascii] [-vtk] [-nonauto] <archive-file.ARC>
C:\MSC.Software\Dytran\2017\bin\exe\arc2vtk.exe  [-ascii] <intfor-file.intfor>
C:\MSC.Software\Dytran\2017\bin\exe\arc2vtk.exe  <vtu-file.VTU>
C:\MSC.Software\Dytran\2017\bin\exe\arc2vtk.exe  <timehistory-file.THS>
```

  - **Includes THS to CSV Converter**

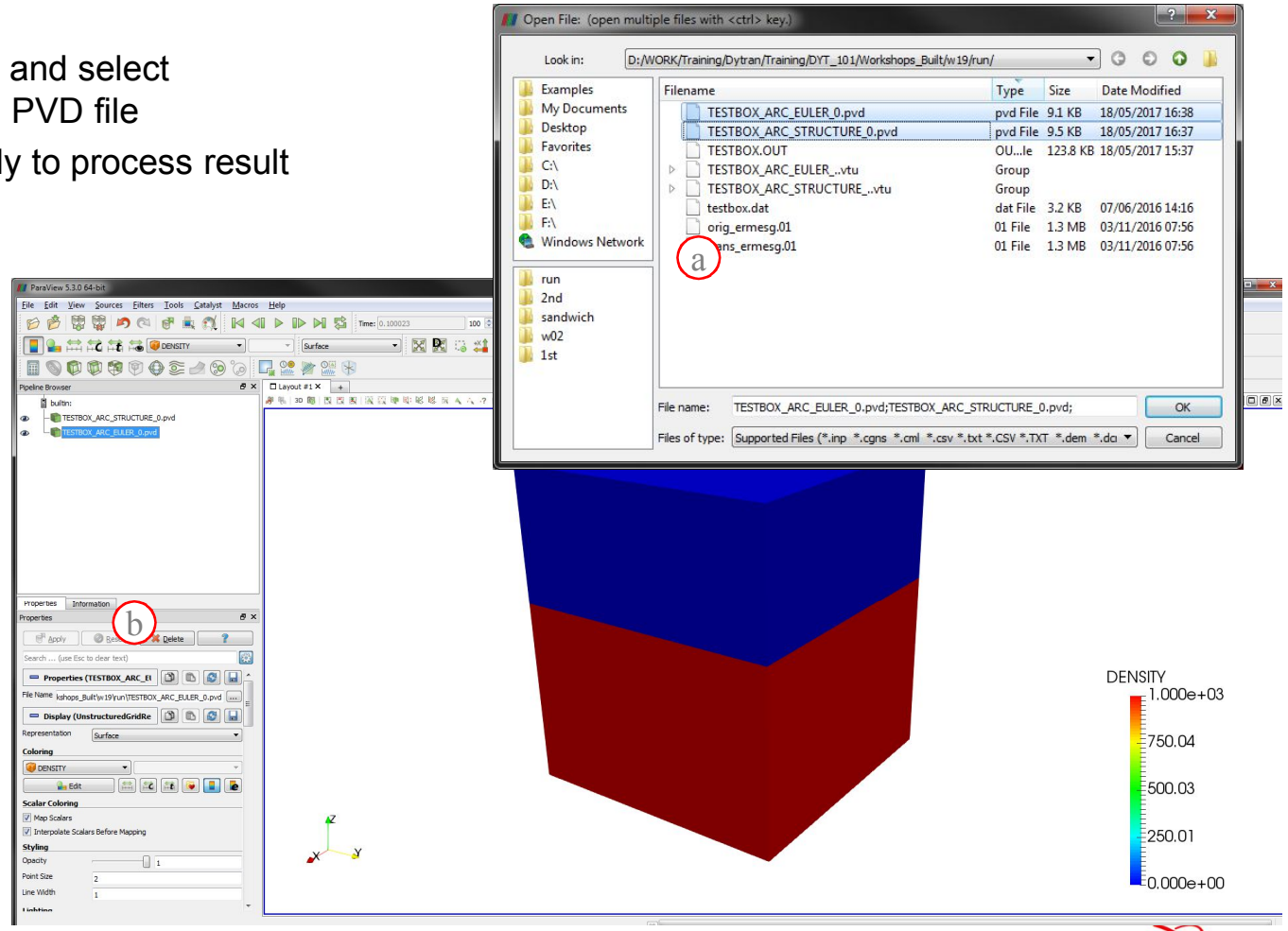
  - Easiest method to convert THS data to CSV Format for spreadsheet use
  - Converts ARC files to open source VTU format to use with Paraview

Step 17.1 Process Results in Paraview

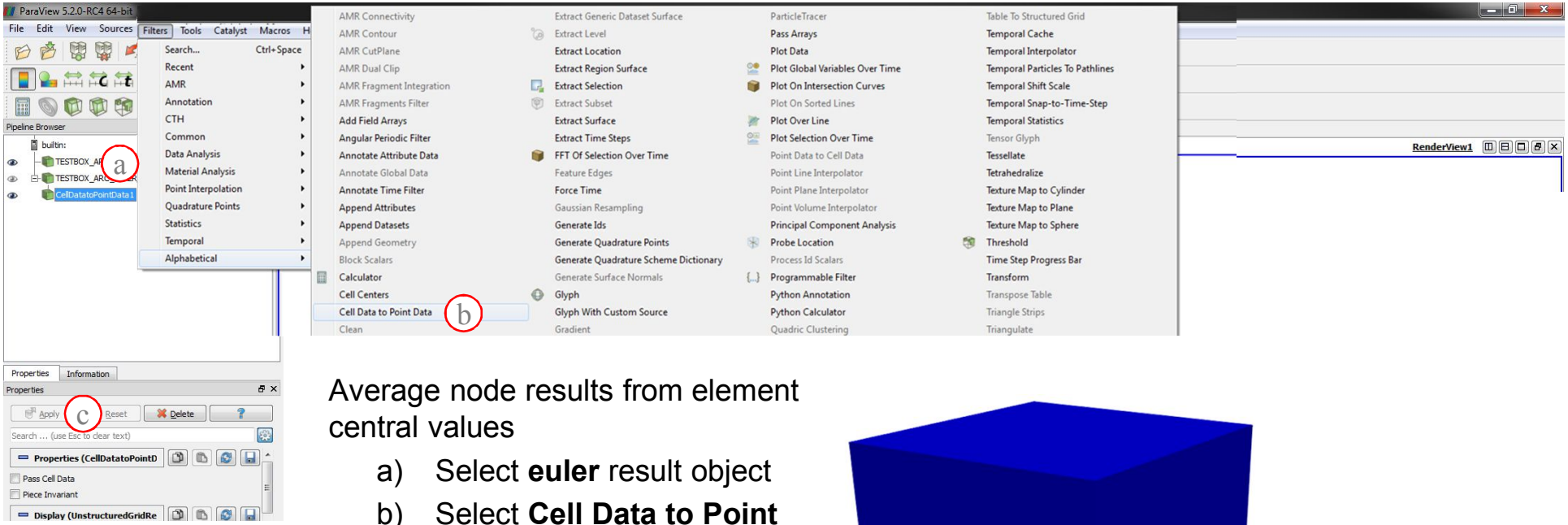
Open Paraview

a) File Open and select converted PVD file

b) Click Apply to process result



Step 17.2 Process Results in Paraview

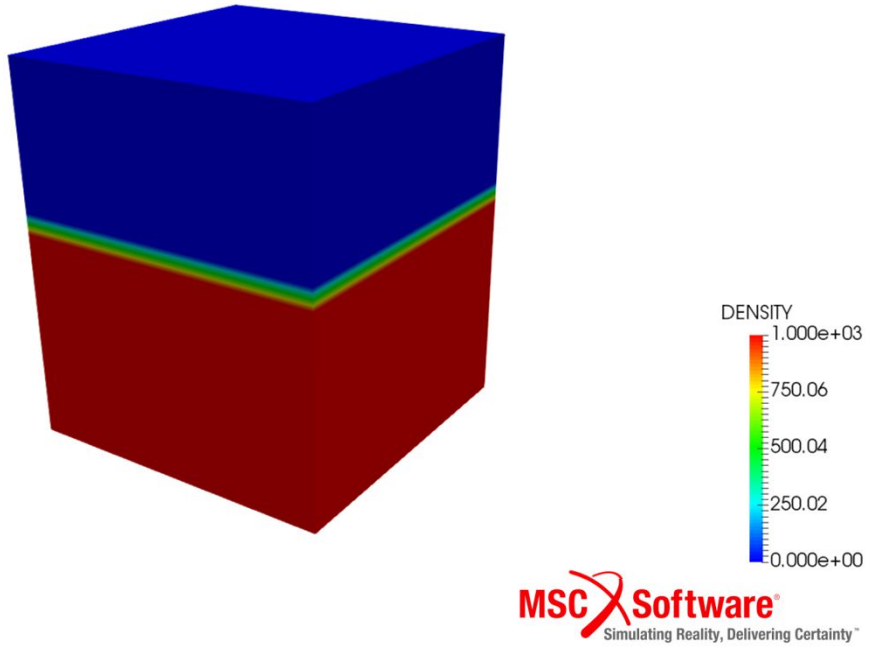


Average node results from element central values

a) Select **euler** result object

b) Select **Cell Data to Point Data** filter

c) Click **Apply**



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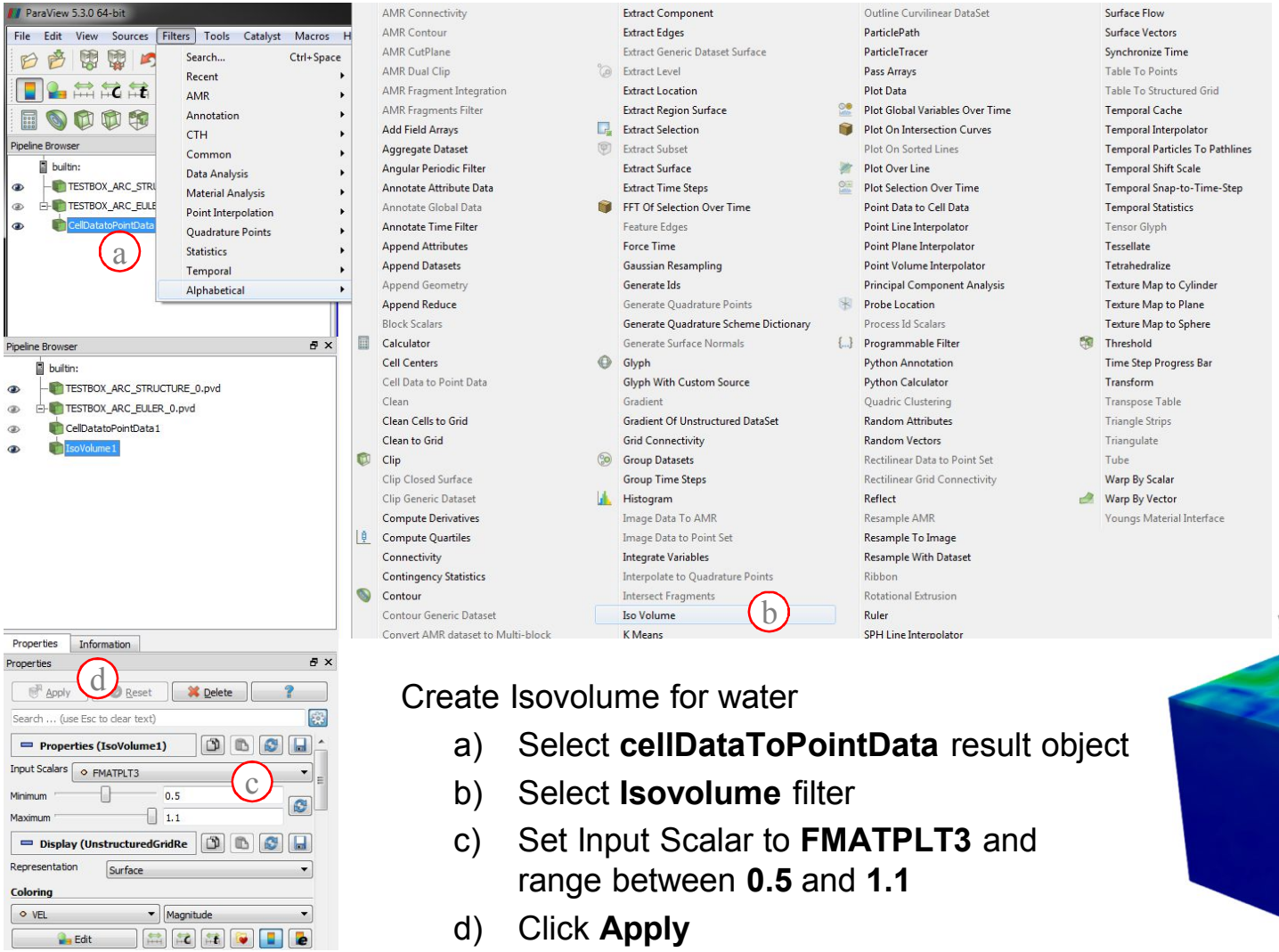
Step 17.3 Process Results in Paraview



Create Isovolume for water

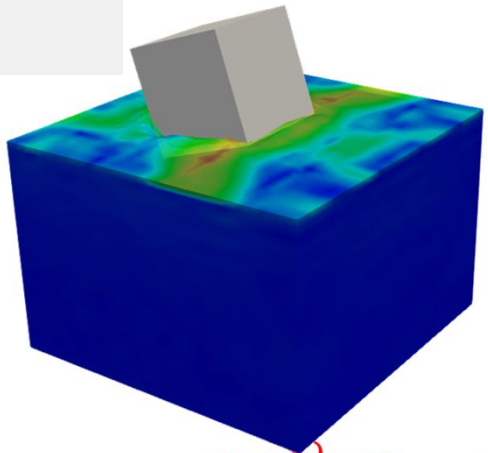
a) Select **cellDataToPointData** result object

b) Select **Isovolume** filter

c) Set Input Scalar to **FMATPLT3** and range between **0.5** and **1.1**

d) Click **Apply**

e) Change Fringe



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