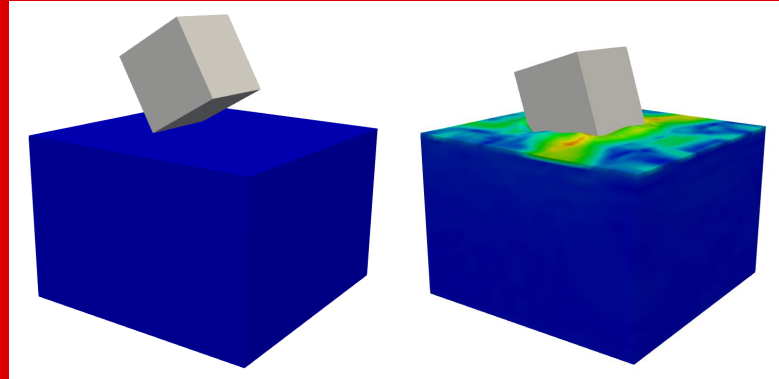
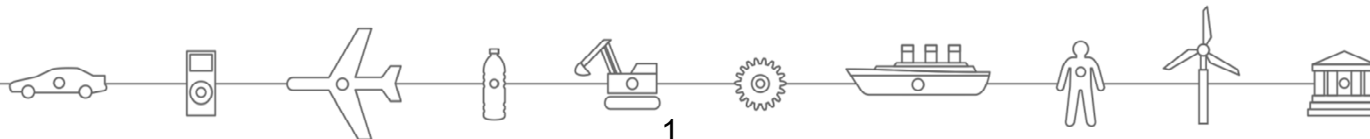




Dytran Guide

BASIC FSI SETUP

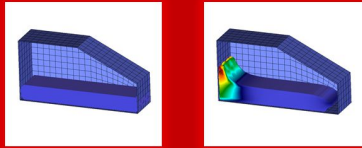




In this example a rigid box dropped on a open water environment. This example is extracted and modified from the Dytran DYT101 Training Seminar as a basic introduction to Dytran FSI setup.

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

For more information please contact MSC Software.

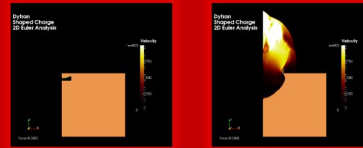


WORKSHOP 2

FLUID INTERACTION



W2-1

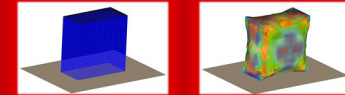


WORKSHOP 4

EFP MINE



W4-1

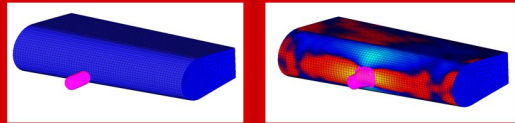


WORKSHOP 7

Blast Inside Container



WS7-1

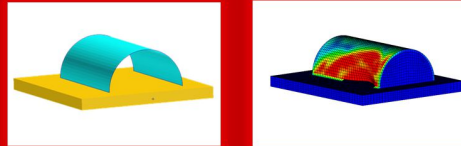


WORKSHOP 3.1

BIRDSTRIKE



W3-1



WORKSHOP 5

BUNKER BLAST



W5-1

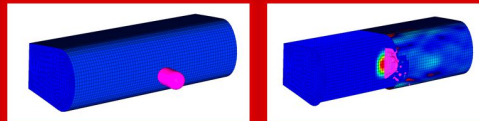


WORKSHOP 8.1

SUBMARINE UNDEX



WS8-1

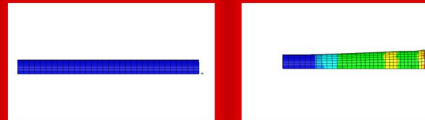


WORKSHOP 3.2

BIRD STRIKE WITH FAILURE



W3-37

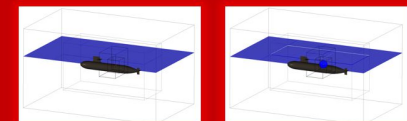


WORKSHOP 6.1

LAGRANGE vs EULER



W6-1



WORKSHOP 8.2

SUBMARINE UNDEX SUBMESHERS



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

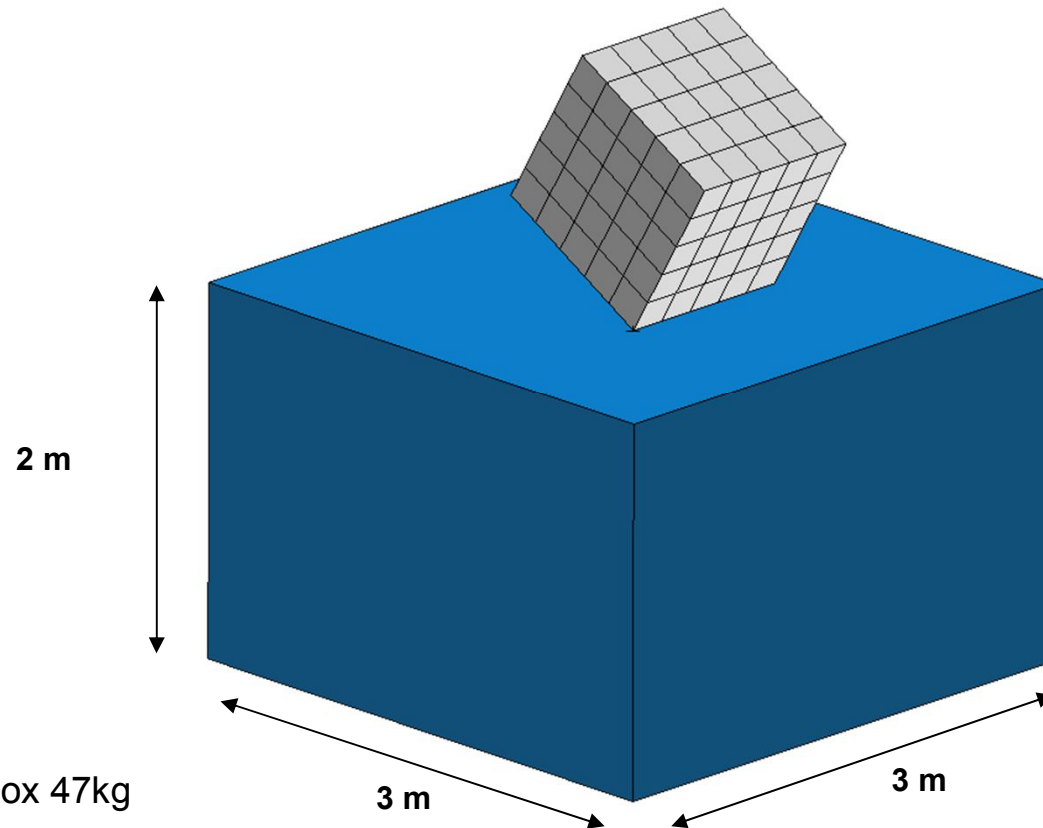
- 1. Get familiar with the Patran Dytran preference for FSI setup**
- 2. How to define a simple Euler mesh and assign initial states using a basic material model**

COURSE NOTES SECTION 8: Dytran FSI Process

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

COURSE NOTES SECTION 9: Dytran FSI Results Processing

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



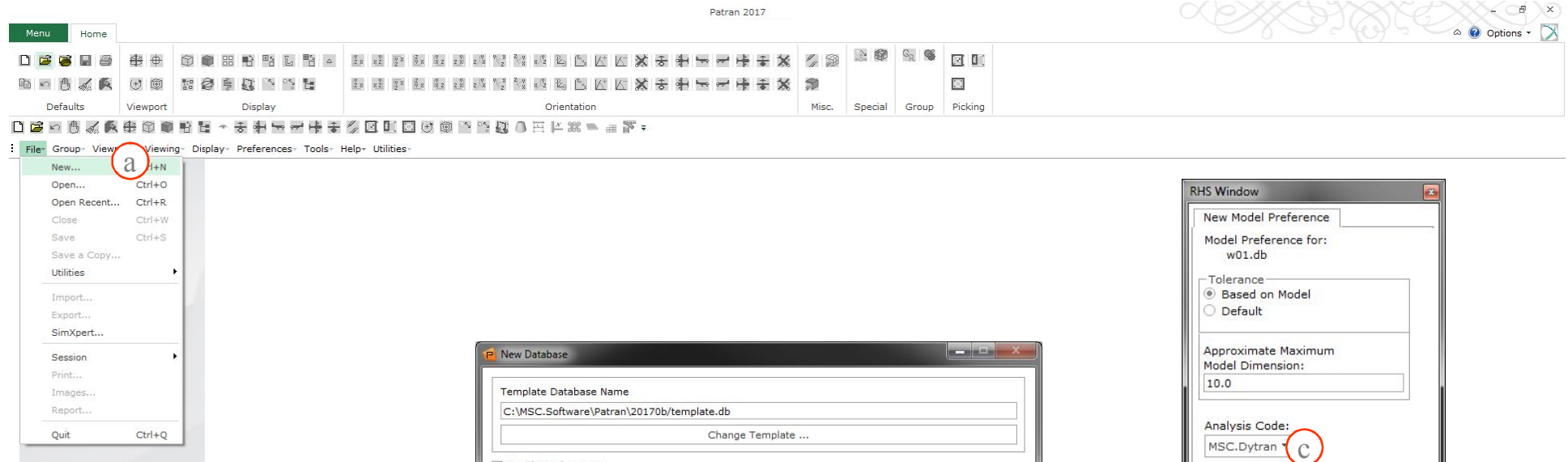
Material = Rigid Box 47kg

Fluids = Air and Water

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

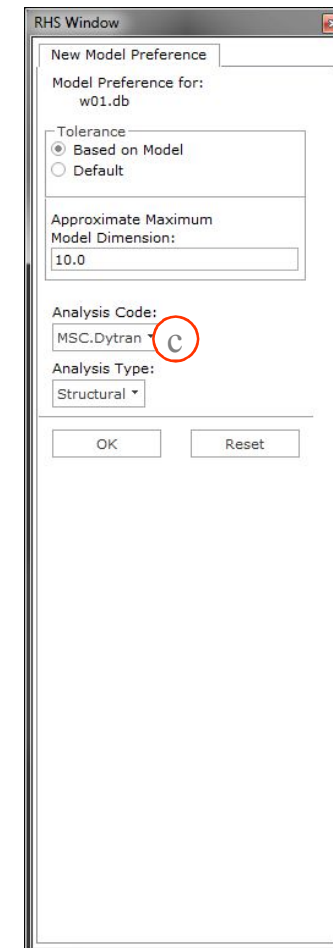
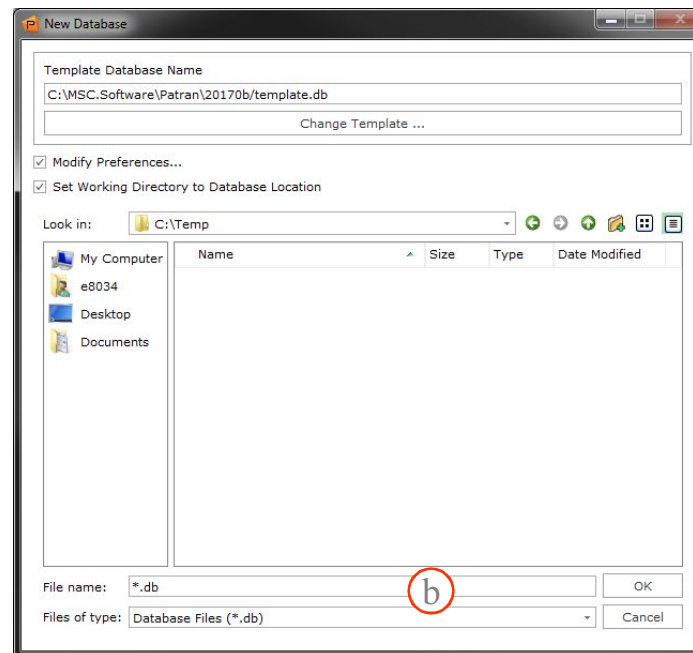
Simulation Time = 100ms

Step 1. Files: Create a New Database



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

- Open **File** Menu and click **New**.
- Type **box_drop** under File name and click **OK**.
- Select **Dytran** for Analysis Code and click **OK**

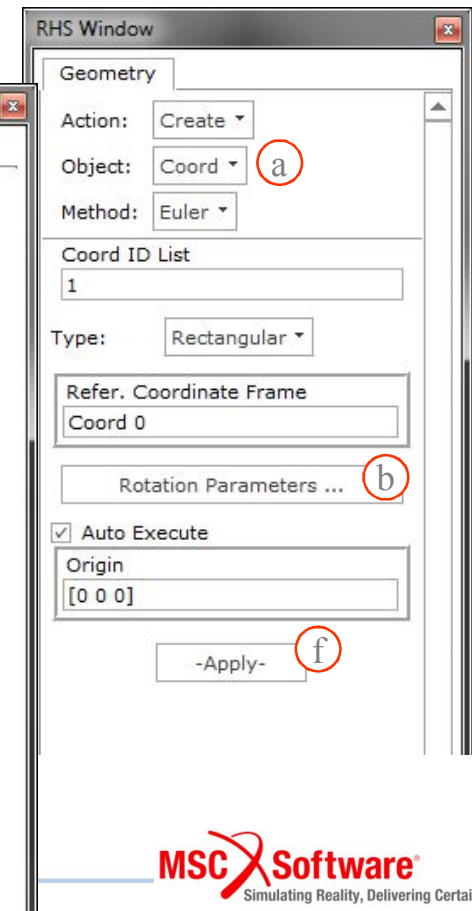
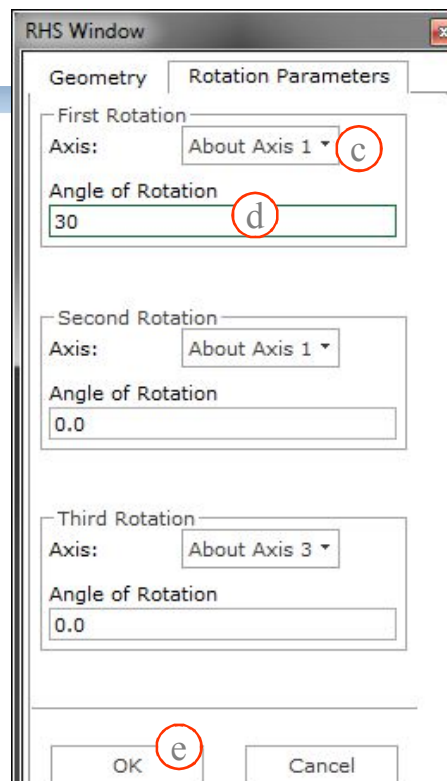
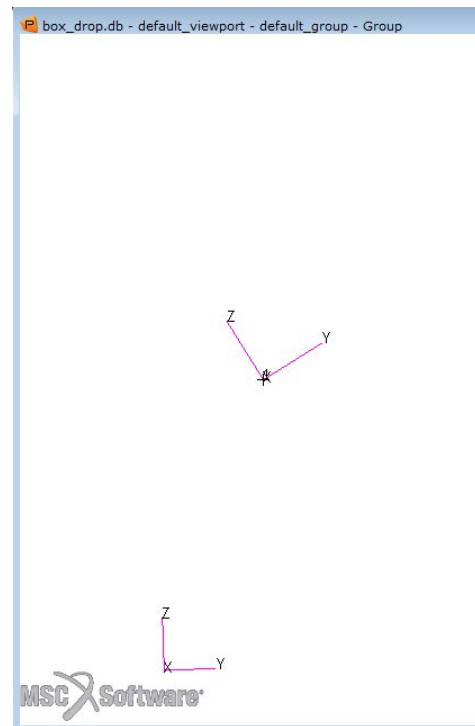


Step 2.1 Geometry: Create / Coord



Create a rotated Coord.

- Geometry: Create / Coord / Euler
- Select Rotation Parameters
- Set About Axis 1
- Set rotation at 30°
- Click **OK**
- Click **Apply**.

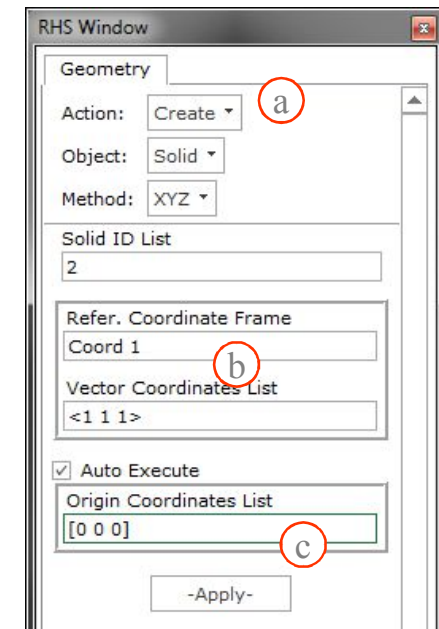
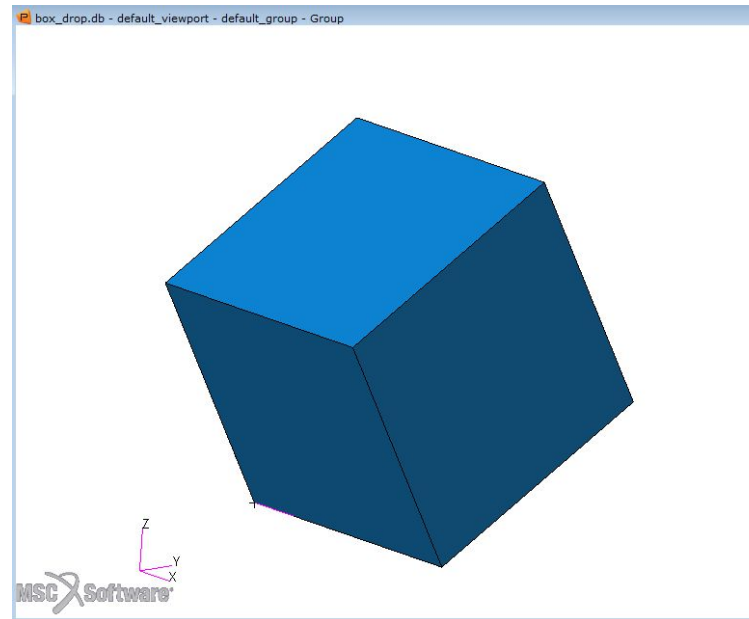


Step 2.2 Geometry: Create / Solid / XYZ



Create a box.

- Geometry: Create / Solid / XYZ
- Select Coord 1 as Reference Coord
- Click **Apply**.



Step 3.1 Elements: Create / Mesh / Surface

Patran 17

Menu Home Geometry Properties Loads/BCs Meshing Analysis Results

Mesh Seeds Mesh Control Meshers FEM Actions Node Element MPC

File Group Viewport Viewing Display Preferences Tools Help Utilities

box_drop.db - default_viewport - default_group - Group

MSC Software

RHS Window

Plot/Erase Finite Elements

Action: Create

Object: Mesh **a**

Type: Surface

Output ID List

Node 210

Element 151

Elem Shape Quad

Mesher IsoMesh

Topology Quad4

IsoMesh Parameters...

Node Coordinate Frames...

Surface List

Solid 1.2 1.3 1.4 1.5 1.6 1.1

Global Edge Length

☒ Automatic Calculation

Value 0.2

Prop. Name: - None -

Prop. Type: - N/A -

Select Existing Prop...

Create New Property...

-Apply- **d**

Create a basic mesh for the box.

- Elements: Create / Mesh / Surface
- Enter **all solid faces** for Surface List.
- Use default Global Edge Length.
- Click **Apply**.

Step 3.2 Elements: Equivalence / All

Patran 2017

Menu Home Geometry Properties Loads/BCs Meshing Analysis Results

Mesh Seeds Mesh Control Meshers FEM Actions Node Element MPC

File Group Viewport Viewing Display Preferences Tools Help Utilities

box_drop.db - default_viewport - default_group - Group

MSC Software

RHS Window

Finite Elements

Action: Equival **a**

Object: All

Method: Tolerance Cube

Node Id Options:

Retain lower node id

Collapsed Node Options:

Allow Tolerance Reduction

Nodes to be excluded

Equivalencing Tolerance

0.15588

Element Boundary Verify

Display Type

☒ Free Edges ☐ Free Faces

Verify Reset

Preview Nodes

Preview Reset

-Apply- **b**

Simulating Reality, Delivering Certainty™

Bind edge nodes.

- Elements: Equivalence / All
- Click **Apply**.

Step 4. Materials: Create / Isotropic

Define material properties.

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

Step 5. Properties: Create / 2D / Shell

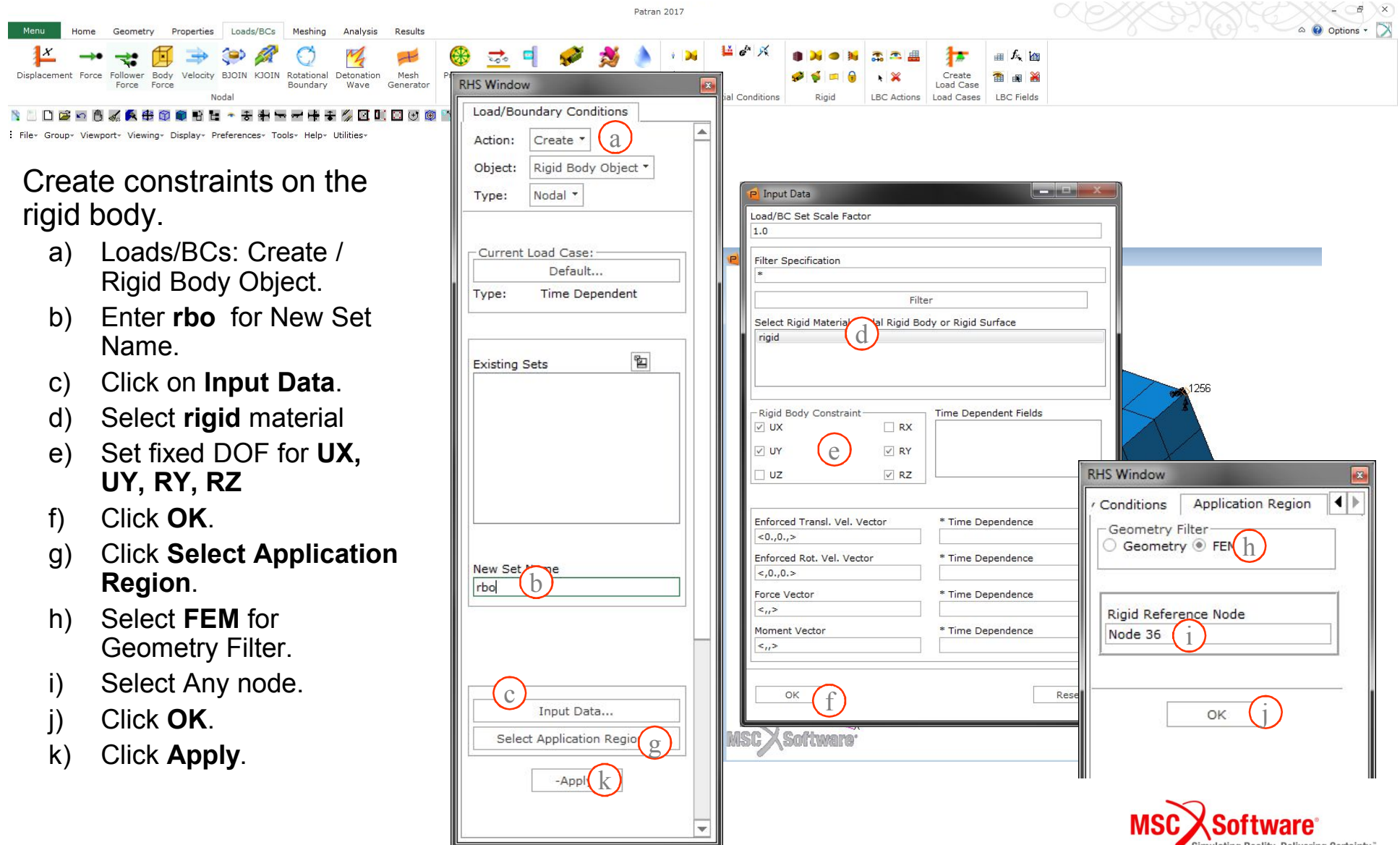
Define properties for the surface

- Properties: Create / 2D / Shell
- Enter **box** for Property Set Name.
- Option(s): Homogeneous / Default(PSHELL)
- Click **Input Properties**.
- Select **rigid** for Material Name.
- Enter **0.001** for Sheet Thickness.
- Click **OK**.
- Select Application Region
- Select **All elements** for Select Members
- Click **Add** then click **OK**.
- 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**.

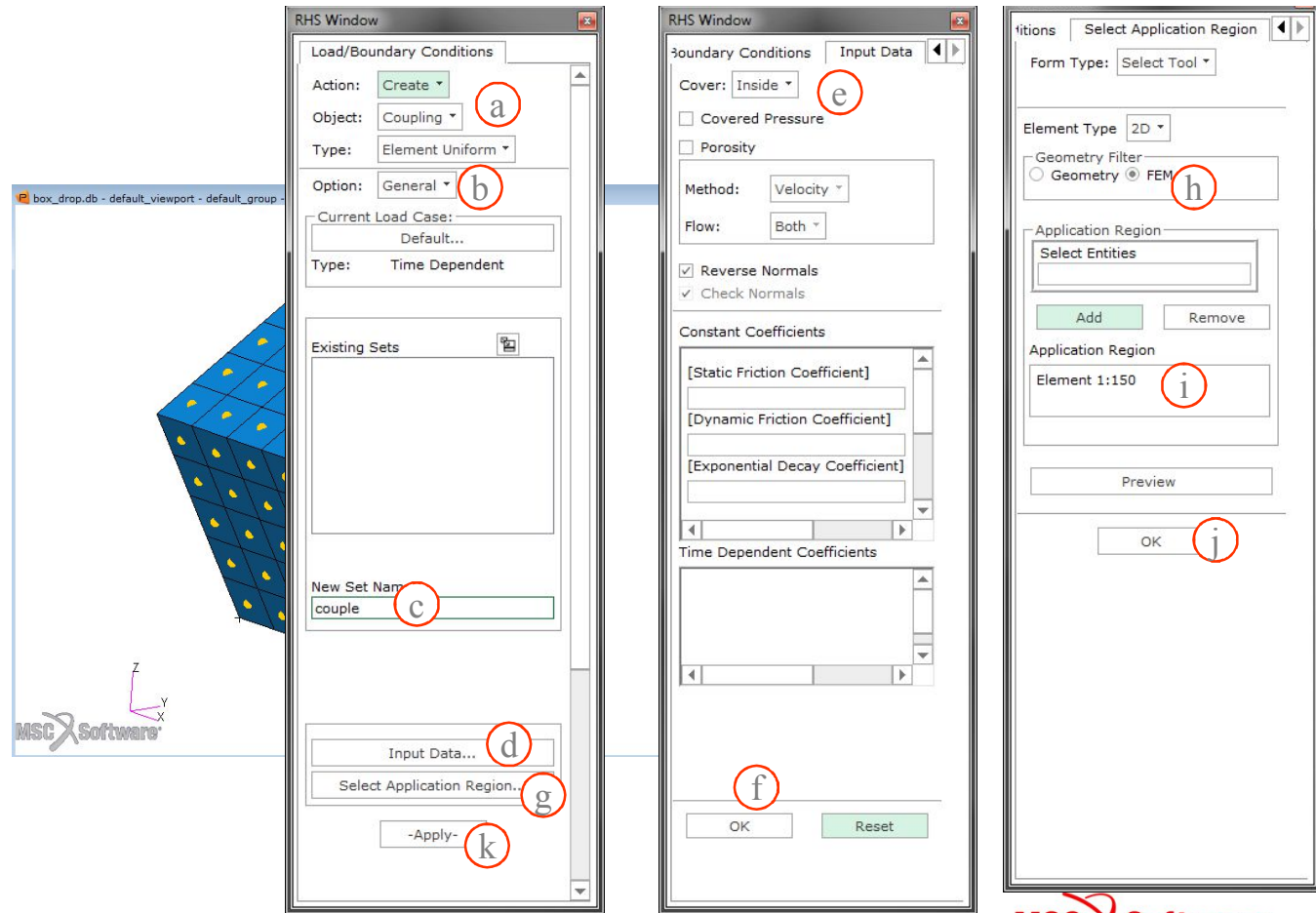


Step 7. Loads/BCs: Create / Coupling



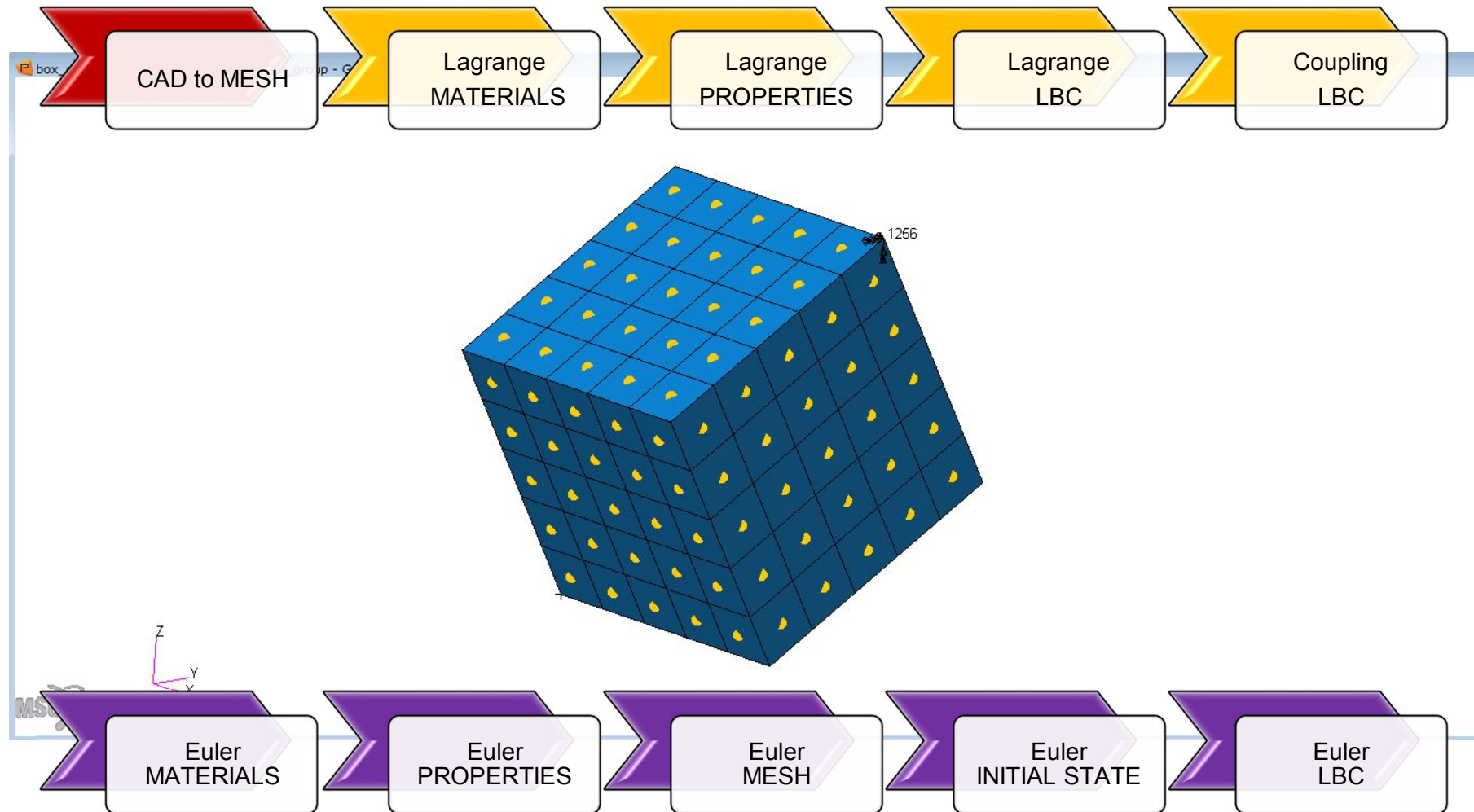
Define coupling interface surface.

- Loads/BCs: Create / Coupling
- Set Option to **General**.
- Enter **couple** for New Set Name.
- Click on **Input Data**.
- Verify Cover is set to **Inside**.
- Click **OK**.
- Click **Select Application Region**.
- Select **FEM** for Geometry Filter
- Select **All elements**.
- Click **Add** and click **OK**.
- Click **Apply**.



Structure Model Creation

Structure Model Setup



Fluid Model Setup

Step 8.1 Materials: Create / Isotropic

Define Euler material properties.

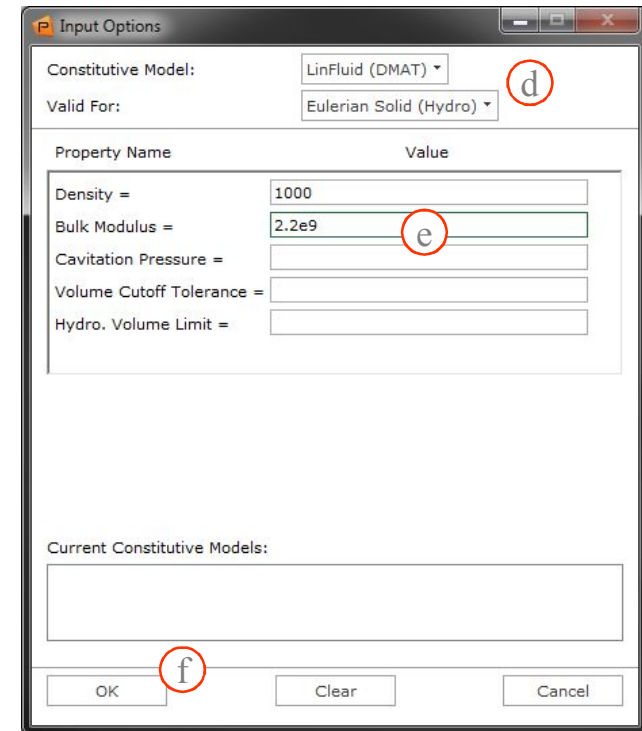
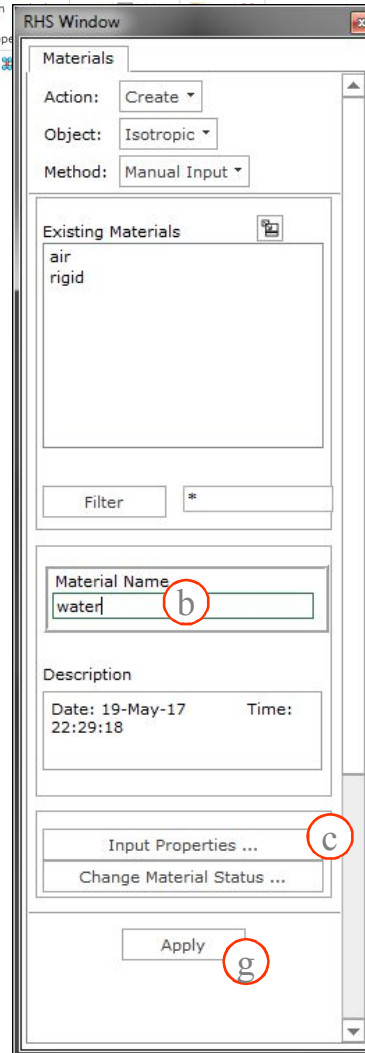
- Materials: Create / Isotropic / Manual Input.
- Enter **air** for Material Name.
- Click on **Input Properties**.
- Constitutive Model: **Ideal Gas (DMAT)**
Valid For: **Eulerian Solid**
- Enter:
1.14 for Density,
1.4 for GAMMA
287 for R
- Click **OK**.
- Click **Apply**.

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**.

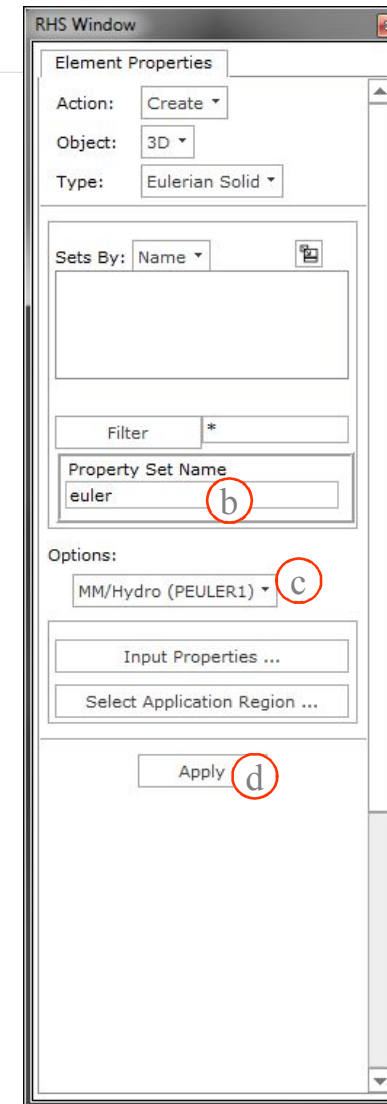


Step 9. Properties: Create / 3D / Eulerian



Define properties for the surface

- Properties: Create / 3D / Eulerian Solid
- Enter **euler** for Property Set Name.
- Options: **MMHYDRO (PEULER1)**
- Click **Apply**

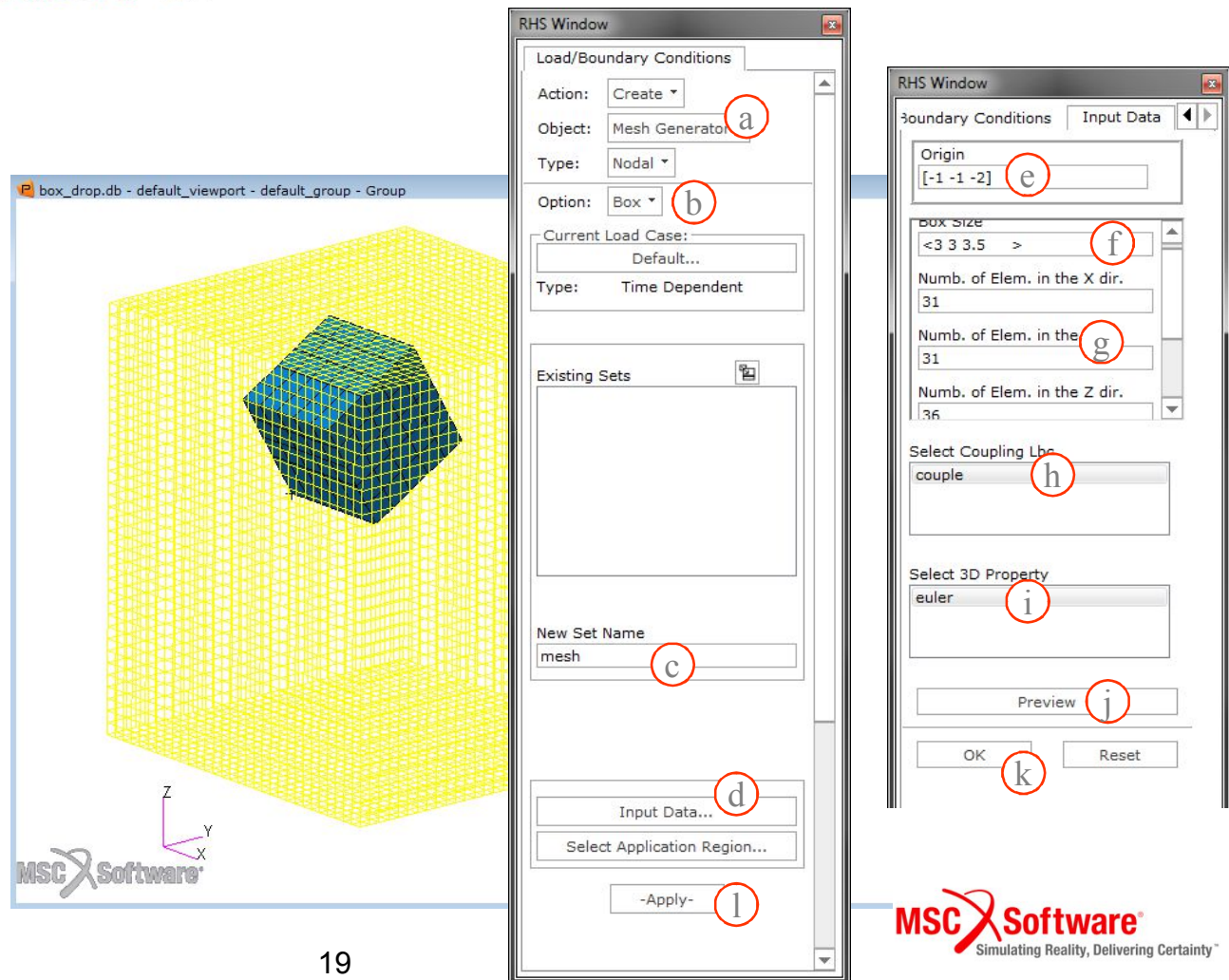


Step 10. Loads/BCs: Create / Mesh Generator



Define Euler mesh.

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

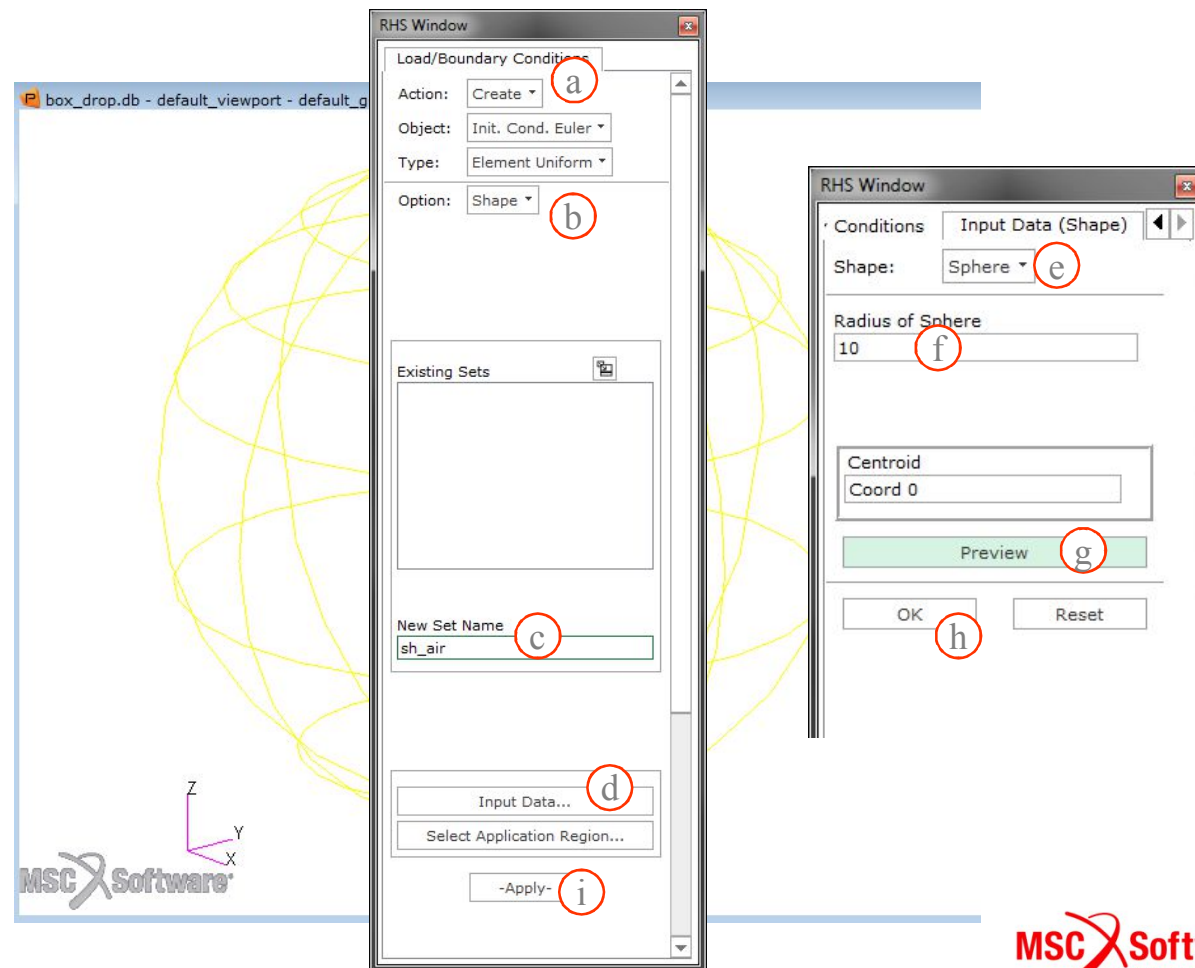


Step 11.1 Loads/BCs: Create / Init Cond Euler



Define initial Euler regions.

- Loads/BCs:
Create / Init.
Cond. Euler
- Set Option to
Shape.
- Enter **sh_air** for
New Set Name.
- Click on **Input
Data**.
- Set shape to
Sphere.
- Set radius to **10**.
- Click **Preview**.
- Click **OK**.
- Click **Apply**.

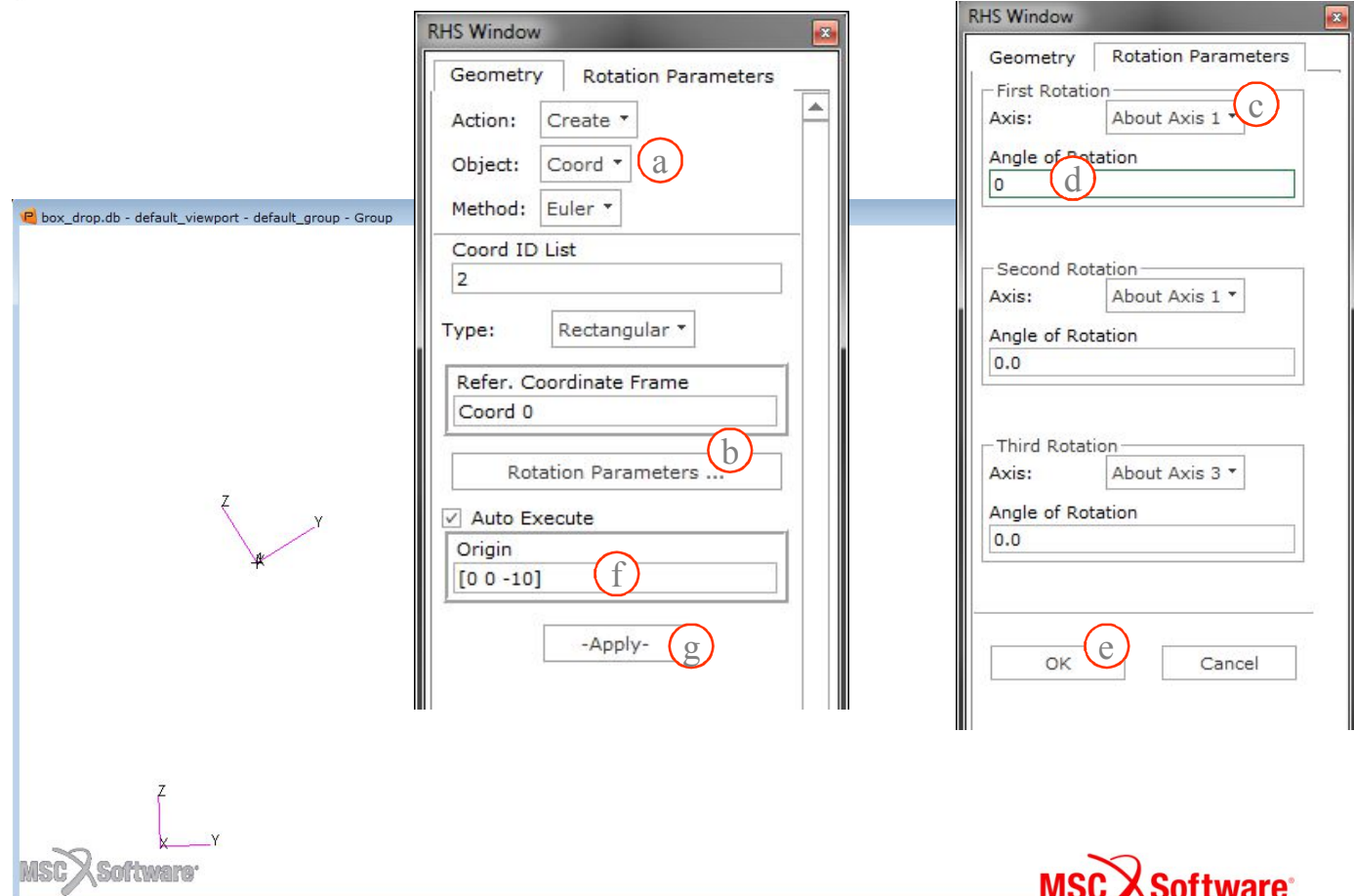


Step 11.2 Geometry: Create / Coord

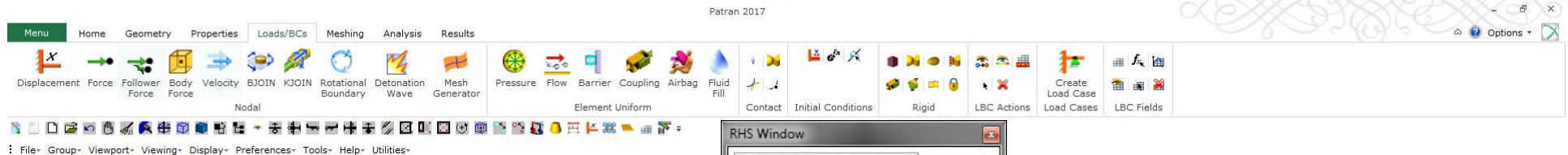


Create a rotated Coord.

- Geometry: Create / Coord / Euler
- Select Rotation Parameters
- Set About Axis 1
- Set rotation at 0°
- Click **OK**
- Set Origin to **[0 0 -10]**
- Click **Apply**.

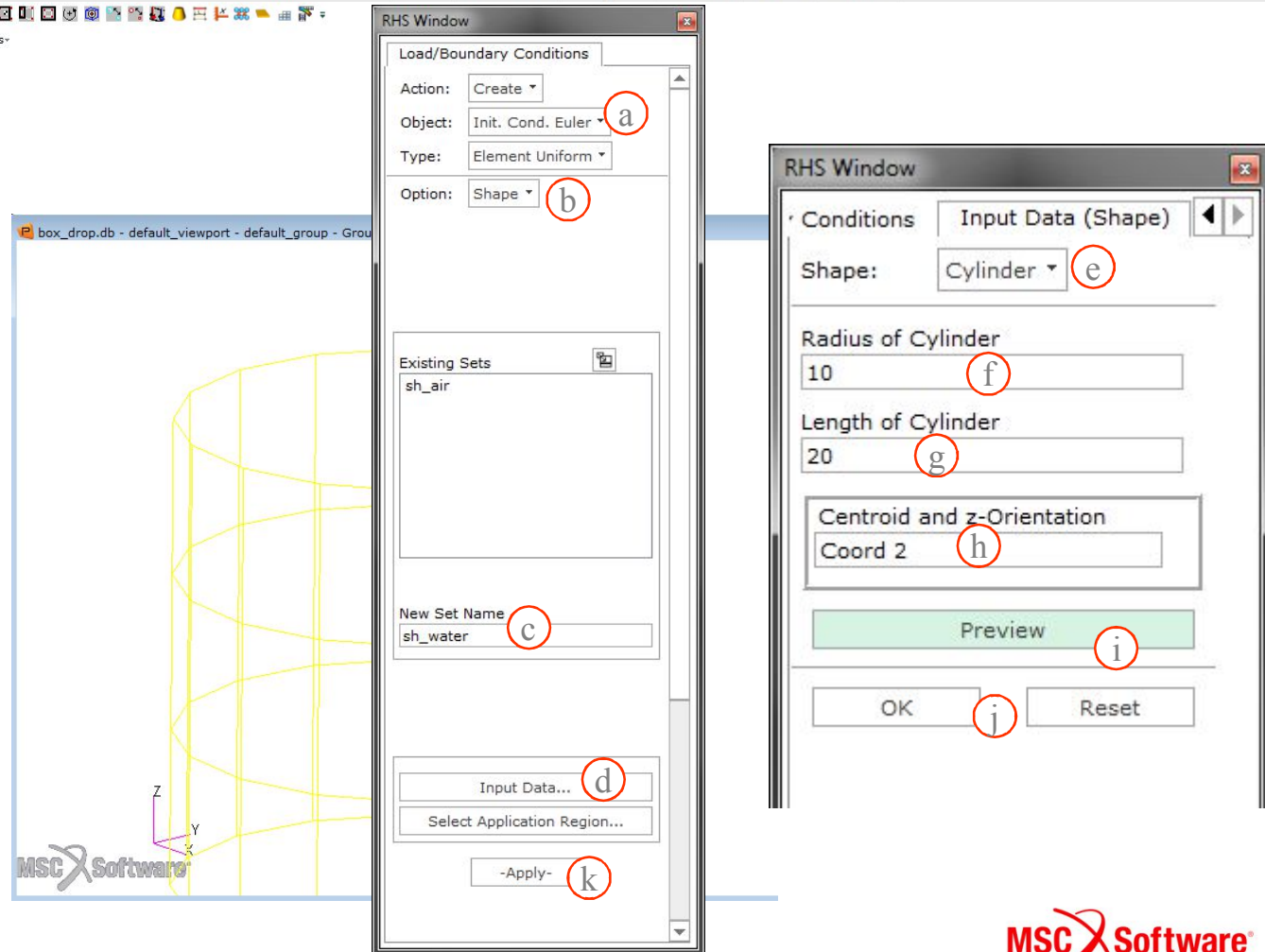


Step 11.3 Loads/BCs: Create / Init Cond Euler

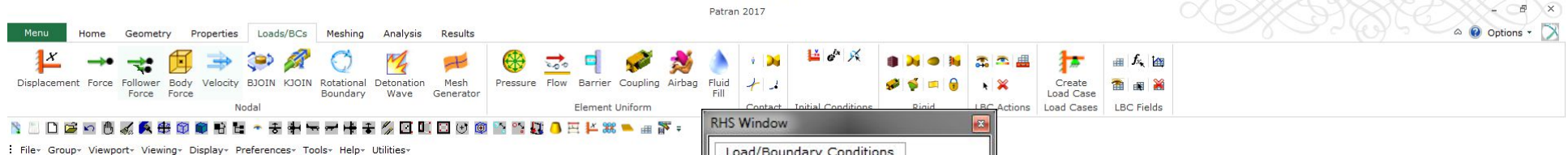


Define initial Euler regions.

- Loads/BCs: Create / Init. Cond. Euler
- Set Option to **Shape**.
- Enter **sh_water** for New Set Name.
- Click on **Input Data**.
- Set shape to **Cylinder**.
- Set radius to **10**.
- Set length to **20**.
- Set centroid to **Coord 2**.
- Click **Preview**.
- Click **OK**.
- Click **Apply**.

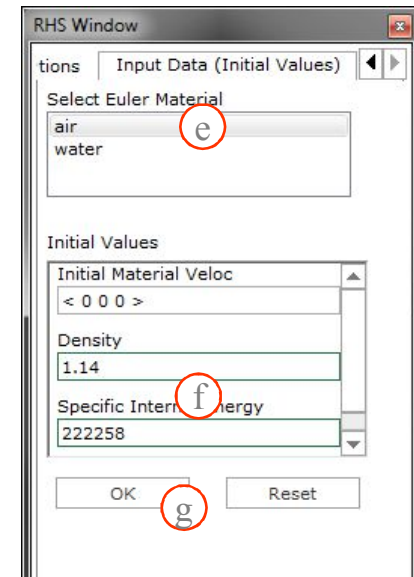
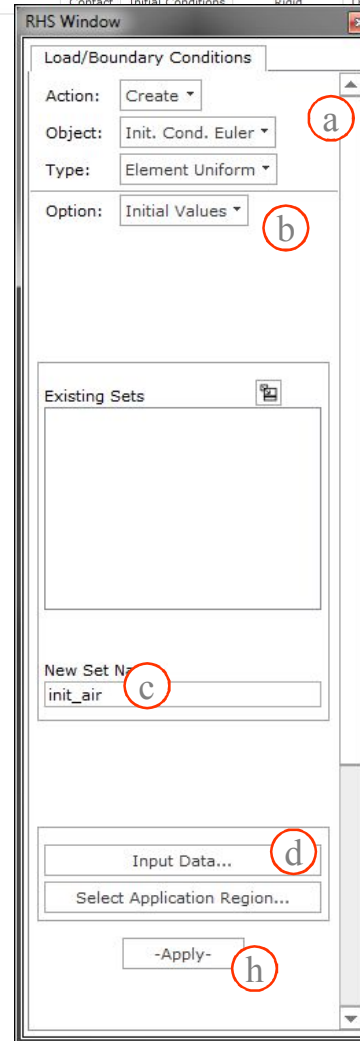


Step 11.4 Loads/BCs: Create / Init Cond Euler



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**.



Step 11.5 Loads/BCs: Create / Init Cond Euler

Define initial Euler material values.

- Loads/BCs: Create / Init. Cond. Euler
- Set Option to **Initial Values**.
- Enter **init_water** for New Set Name.
- Click on **Input Data**.
- Select **water** as material.
- Set initial values to
Density = **1000**
Specific Internal Energy = **0**
- Click **OK**.
- Click **Apply**.

24

Step 11.6 Loads/BCs: Create / Init Cond Euler

Patran 2017

Menu Home Geometry Properties Loads/BCs Meshing Analysis Results

Displacement Force Follower Force Body Velocity BJOIN KJOIN Rotational Boundary Detonation Wave Mesh Generator

Nodal

File Group Viewport Viewing Display Preferences Tools Help Utilities

Pressure Flow Barrier Coupling Airbag Fluid

Initial Conditions Rigid LBC Actions Create Load Case Load Cases LBC Fields

RHS Window

Load/Boundary Conditions

Action: Create

Object: Init. Cond. Euler

Type: Element Uniform

Option: Region Definition

Existing Sets

New Set Name: regdef

Input Data...

Select Application Region...

-Apply-

Input Data (Region Definition)

Existing PEULER1 Sets

euler

Table's Row Selection

Existing Shapes Set

sh_air

sh_water

Existing Initial Value Sets

init_air

init_water

Level Indicator:

Add Row

Remove Row

Table Data

	Shape	Init Value	Level
1	sh_air	init_air	1
2	sh_water	init_water	2
3			

Preview

OK

Reset

Define Euler regions.

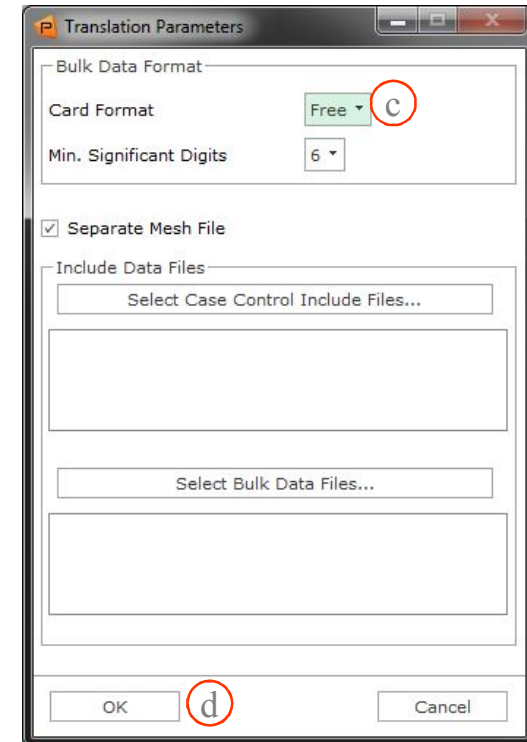
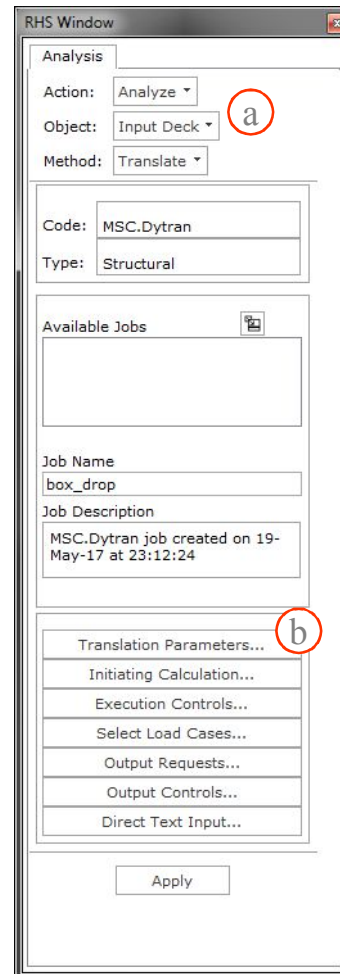
- Loads/BCs: Create / Init. Cond. Euler
- Set Option to **Region Definition**.
- Enter **regdef** for New Set Name.
- Click on **Input Data**.
- Select **euler** as PEULER1 set.
- Select shape **sh_air**
- Select initial value **init_air**
- Enter level 1
- Add row
- Select shape **sh_water**
- Select initial value **init_water**
- Enter level 2
- Add row
- Click **OK**.
- Click **Apply**.

Step 12.1 Analysis: Analyze / Input Deck



Set up analysis

- Analysis: Analyze / Input Deck / Translate
- Click on **Translation Parameters**.
- Select **Free** for Card Format.
- Click **OK**.



Step 12.2 Analysis: Analyze / Input Deck

Define execution control parameters

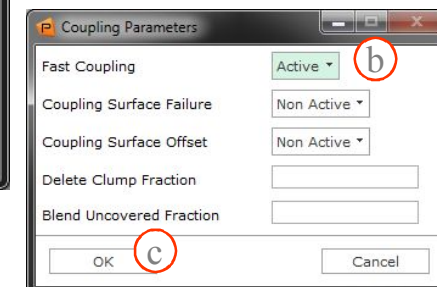
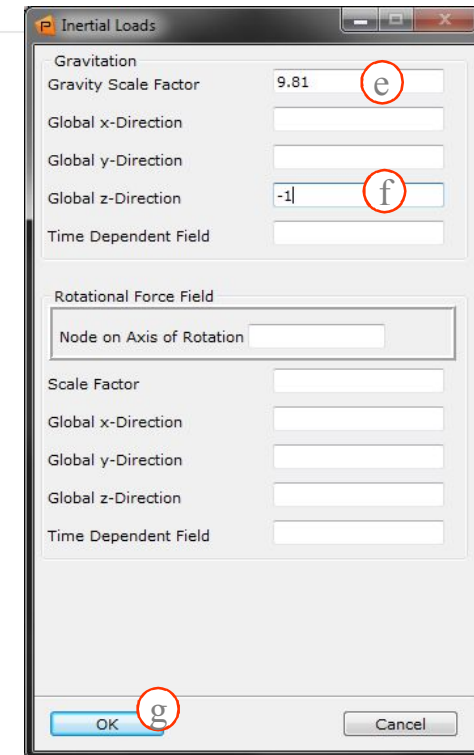
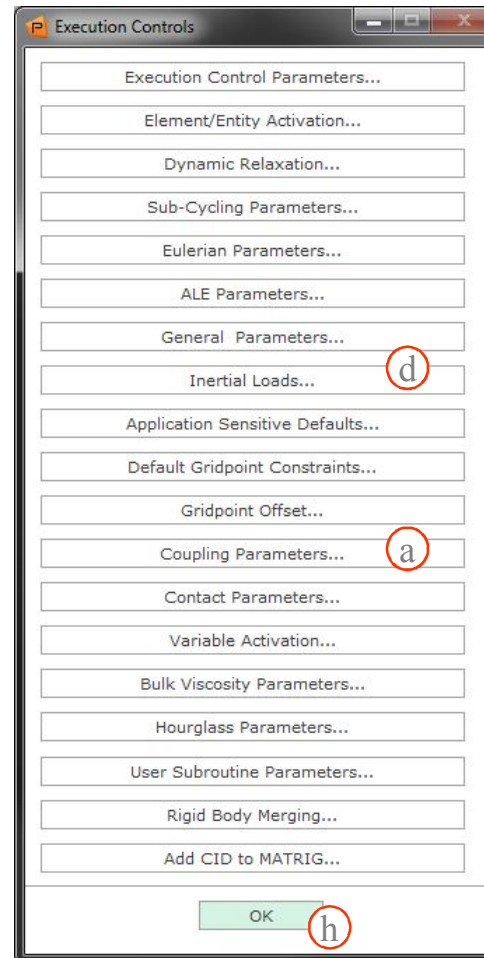
- Analysis: Analyze / Input Deck / Translate
- Click **Execution Controls**.
- Click **Execution Control Parameters**.
- Enter **0.1** for End Time.
- Enter **1.0e-7** for Time Step Size at Start.
- Set Lag Time Step Scale Factor to **0.9**
- Click **OK**.

Step 12.3 Analysis: Analyze / Input Deck



Define execution control parameters

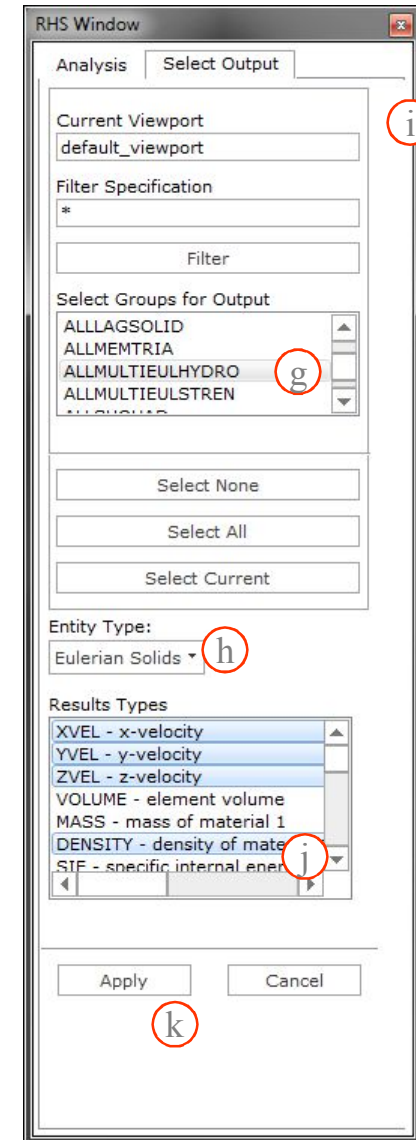
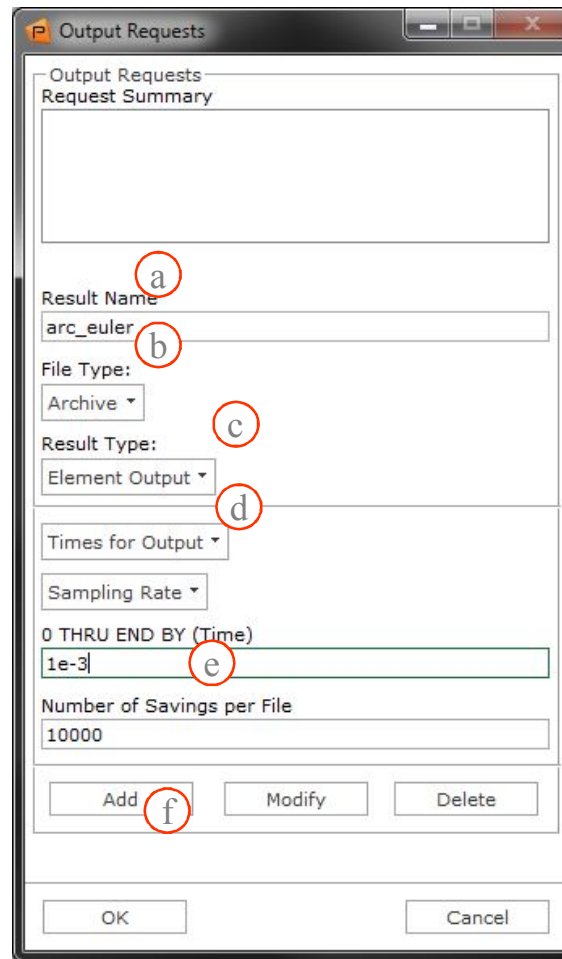
- Select **Coupling Parameters**
- Set Fast Coupling to **Active**
- Click **OK**
- Select **Inertia Loads**
- Set Gravity Scale Factor to **9.81**
- Set Gravity vector in $Z = -1$
- Click **OK**
- Click **OK**



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**.

The 'Output Requests' dialog box is shown with the following fields and annotations:

- Request Summary:** arc_euler
- Result Name:** arc_structure (annotated with 'a')
- File Type:** Archive (annotated with 'b')
- Result Type:** Element Output (annotated with 'c')
- Times for Output:** (annotated with 'd')
- 0 THRU END BY (Time):** 1e-3 (annotated with 'e')
- Number of Savings per File:** 10000
- Buttons:** Add (annotated with 'f'), Modify, Delete, OK, Cancel

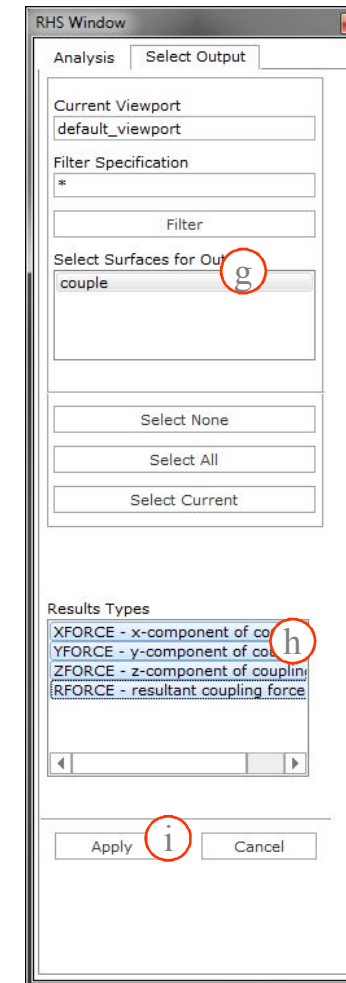
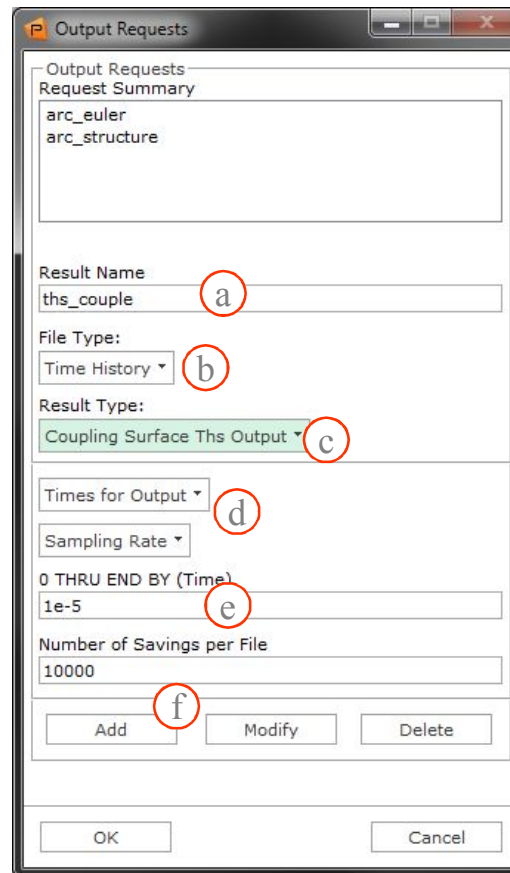
The 'RHS Window' dialog box is shown with the following fields and annotations:

- Analysis:** Select Output
- Current Viewport:** default_viewport
- Filter Specification:** *
- Filter:** (button)
- Select Groups for Output:** ALLMULTIEULSTREN, ALLSHQUAD, ALLSHTRIA, default_group (annotated with 'g')
- Select None:** (button)
- Select All:** (button)
- Select Current:** (button)
- Entity Type:** Dummy (annotated with 'h')
- Results Types:** user-specified (annotated with 'i')
- Buttons:** Apply (annotated with 'j'), Cancel

Step 12.6 Analysis: Analyze / Input Deck

Creating output requests.

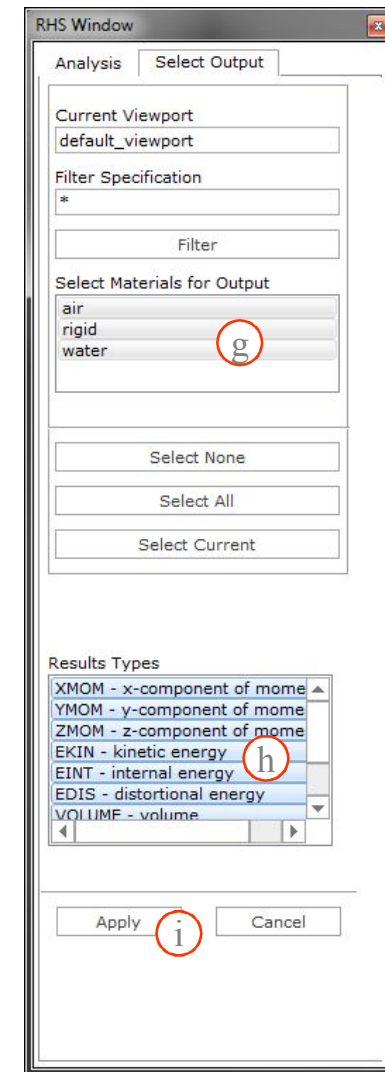
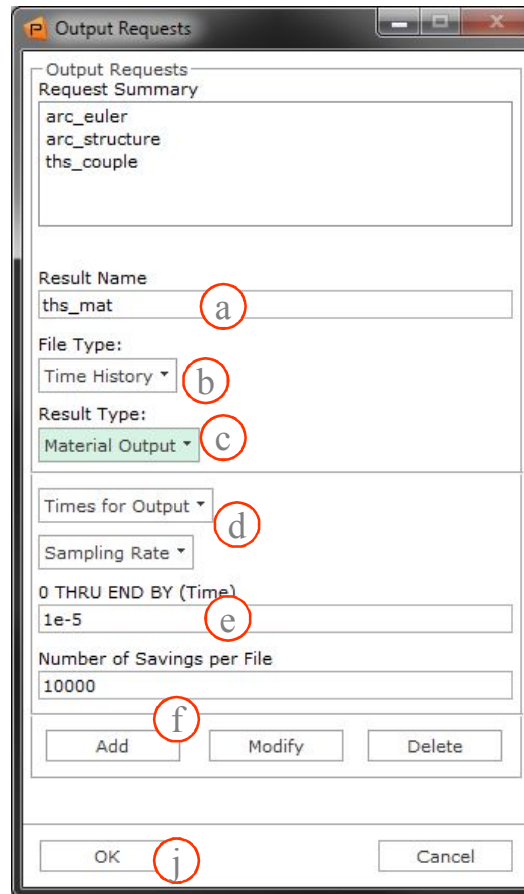
- a) Enter **ths_couple** for Result Name.
- b) Select **Time History** for File Type.
- c) Select **Coupling Surface Ths Output** for Result Type.
- d) Select **Times for** Output
- e) Enter **1e-5** for 0 THRU END BY (Time)
- f) Click **Add**.
- g) Select **couple** for Select Surfaces for Output.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



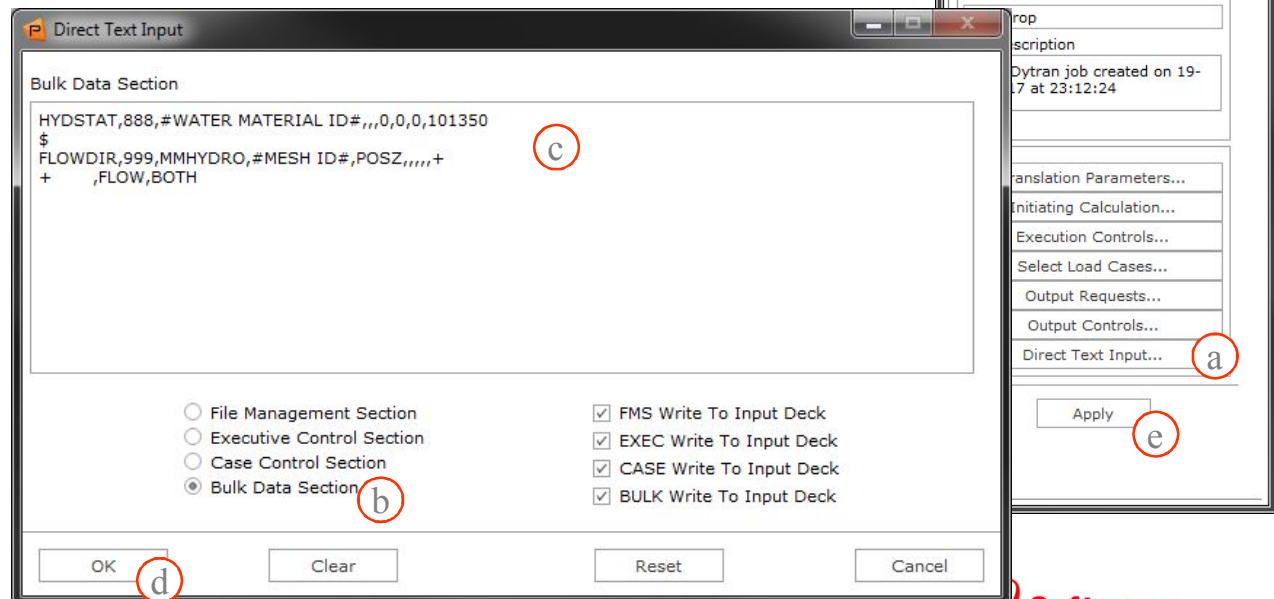
Step 12.8 Analysis: Analyze / Input Deck

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
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
$
FLOWDIR,999,MMHYDRO,6,POSZ,,,,,+
+ ,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]
```

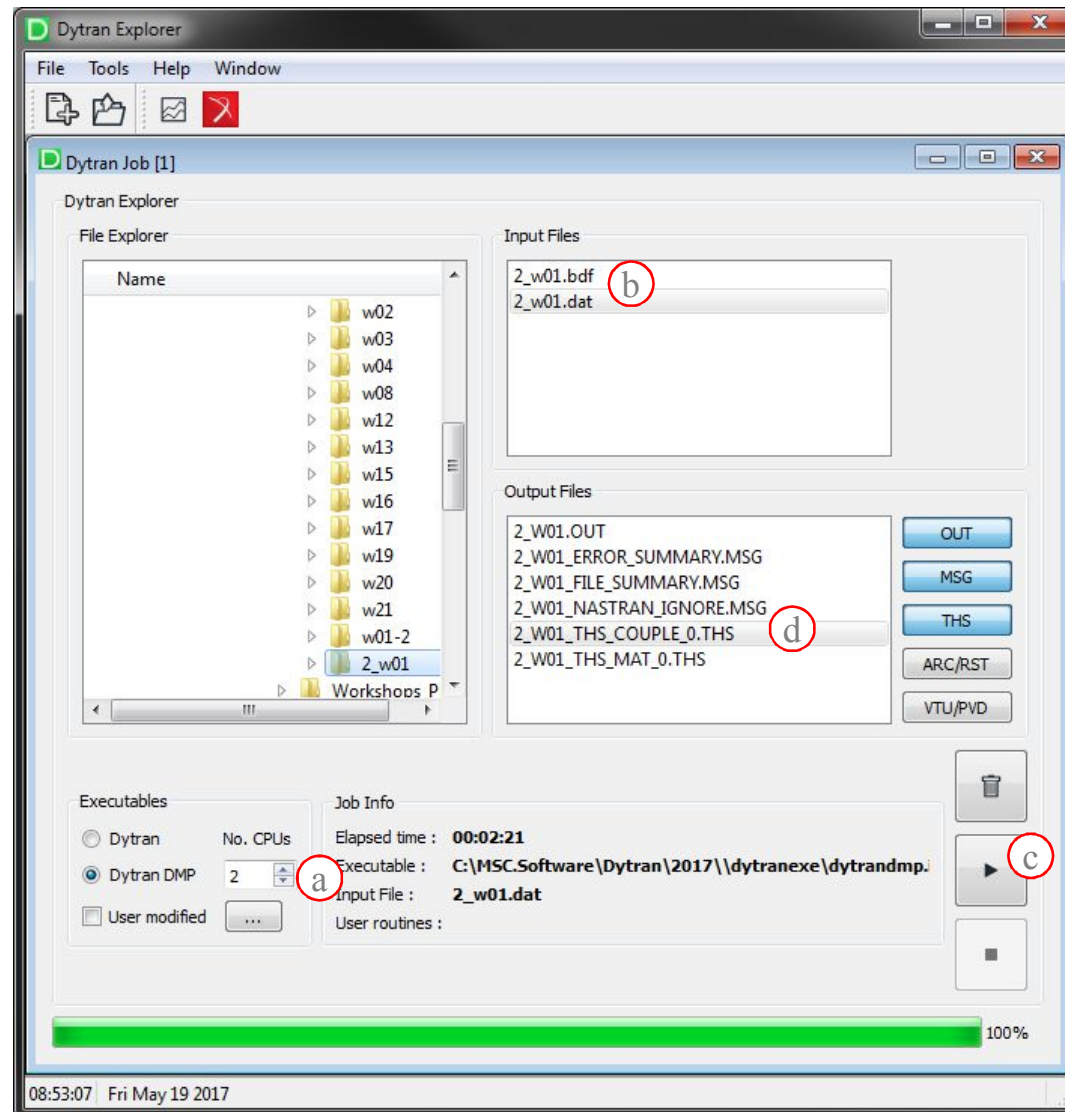
Execute this workshop:

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

Step 14. Dytran Analysis on Windows

Execute Dytran

- a) Select **DytranDMP** executable 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.





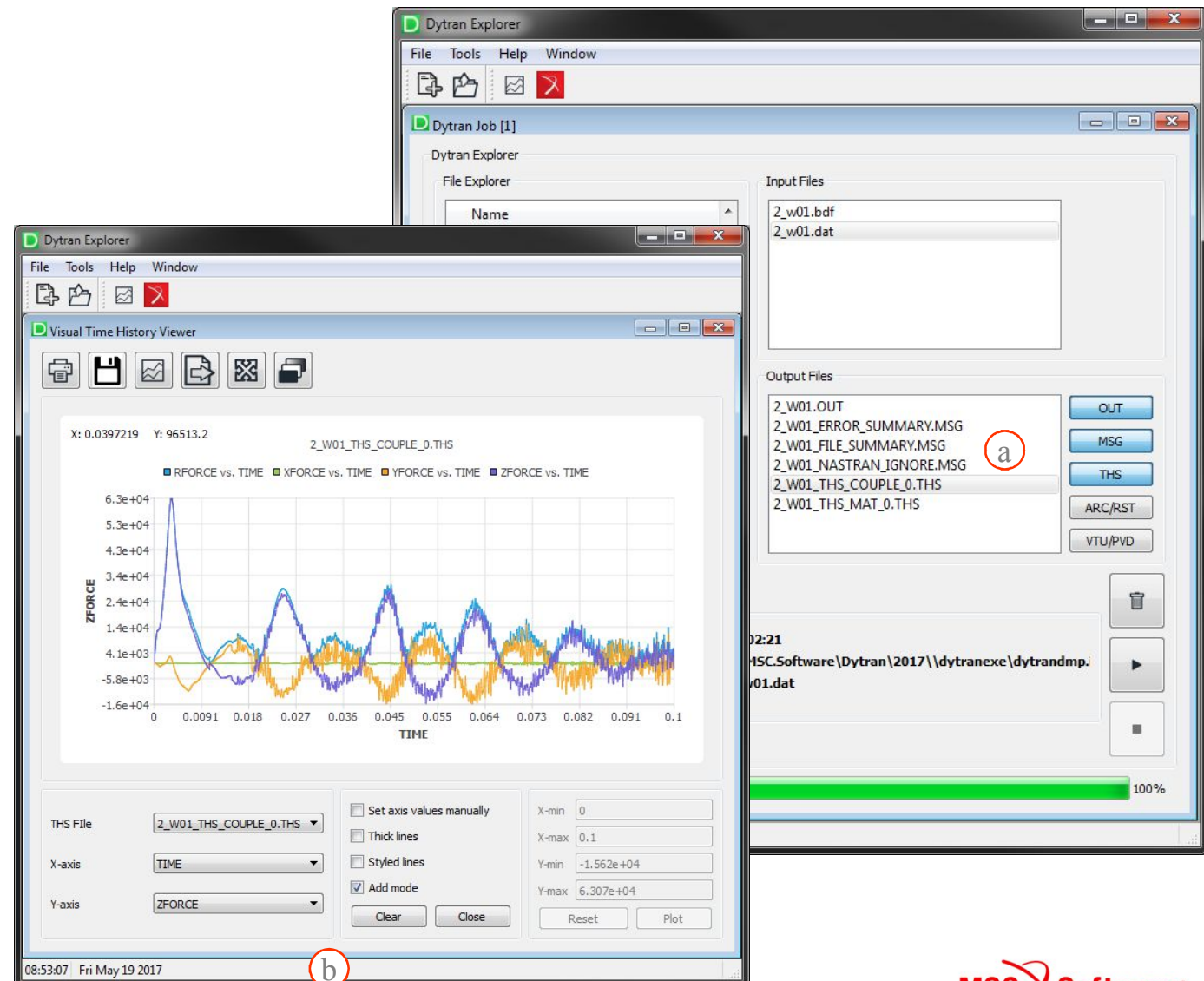
SECTION 6 INTERRUPT

Dytran FSI Results Processing

Step 15. Dytran Time History

Viewing time histories are possible directly by Dytran Explorer

- Double Click the **COUPLE.THS** file shown in the Output files window.
- Select **all results** for the Y-axis



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>
```

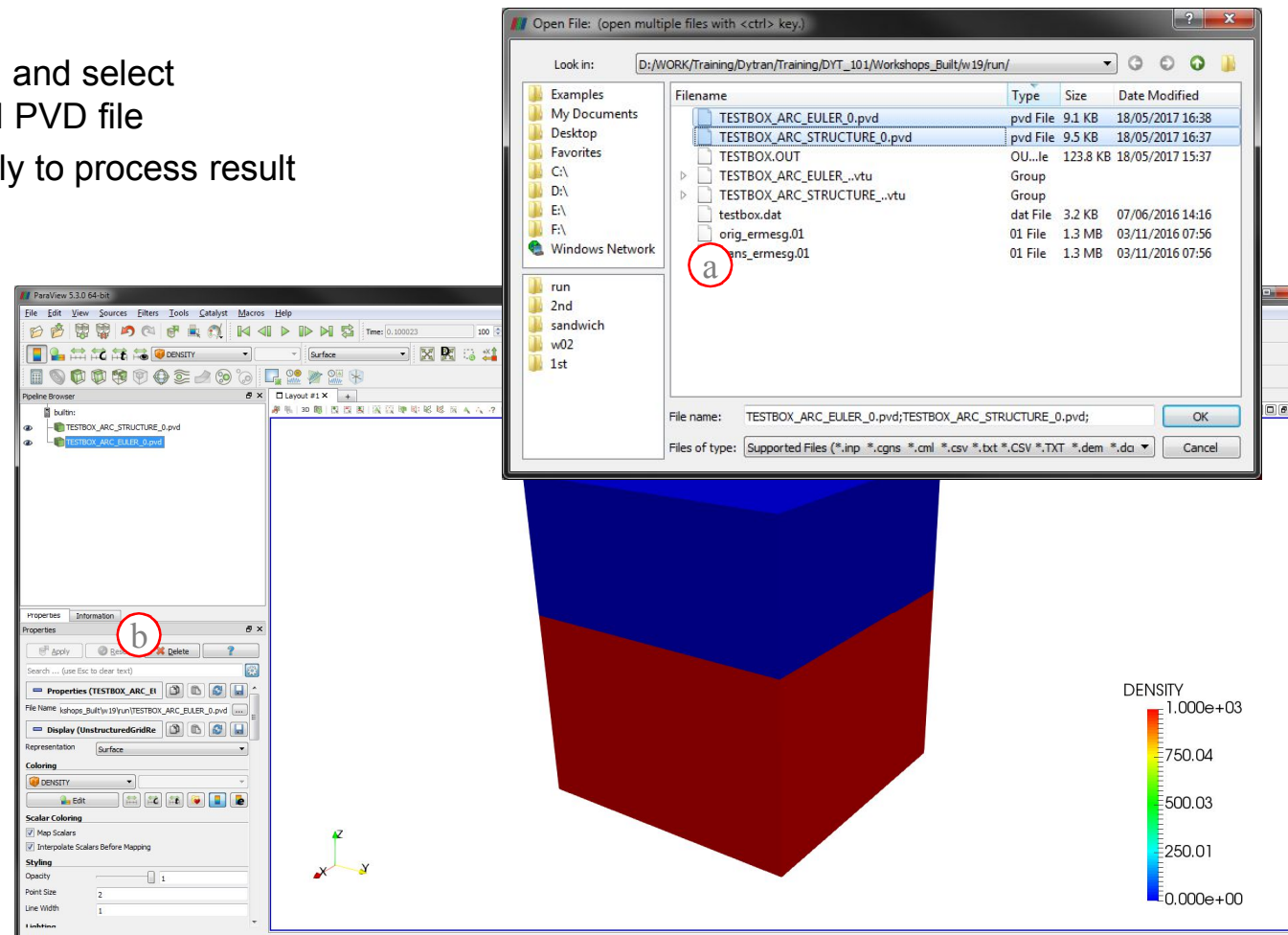
- **Includes THS to CSV Converter**

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

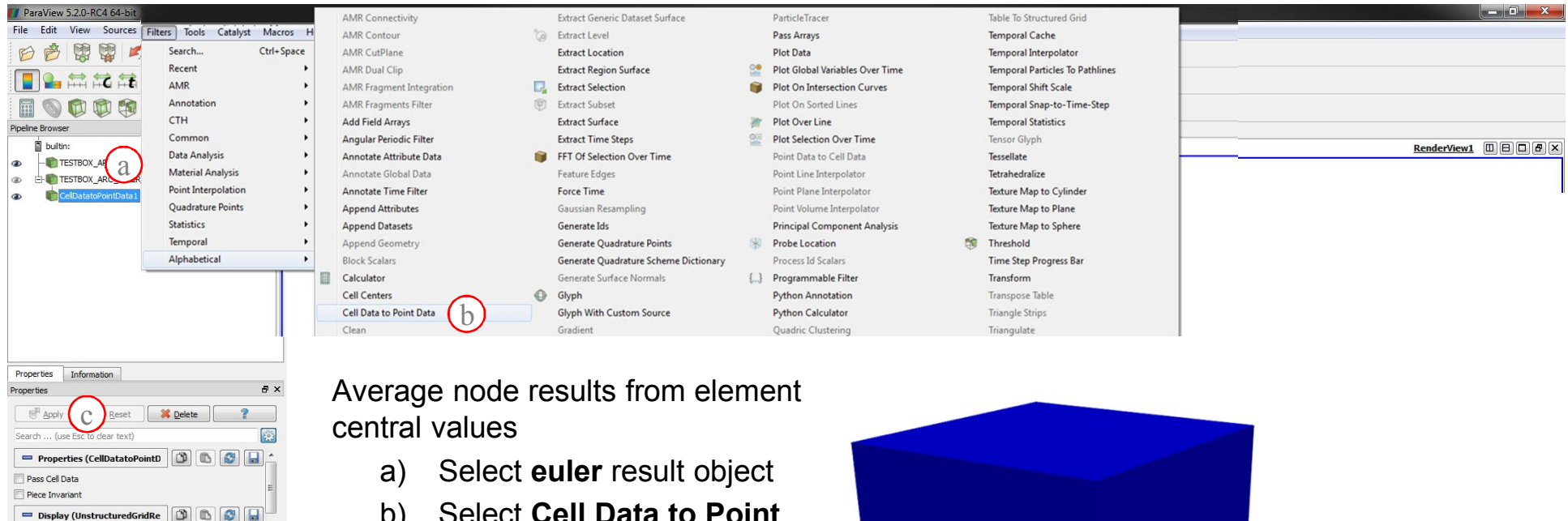
# Step 17.1 Process Results in Paraview

## Open Paraview

- File Open and select converted PVD file
- Click Apply to process result

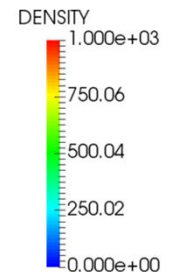
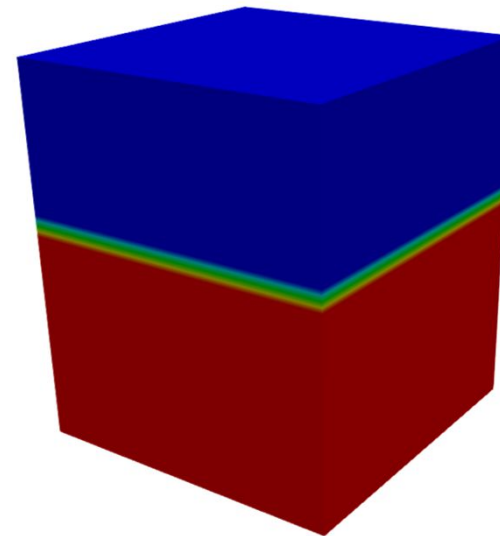


# Step 17.2 Process Results in Paraview



Average node results from element central values

- a) Select **euler** result object
- b) Select **Cell Data to Point Data** filter
- c) Click **Apply**



# Step 17.3 Process Results in Paraview

ParaView 5.3.0 64-bit

File Edit View Sources Filters Tools Catalyst Macros H

Search... Ctrl+Space

Recent

AMR

Annotation

CTH

Common

Data Analysis

Material Analysis

Point Interpolation

Quadrature Points

Statistics

Temporal

Alphabetical

Pipeline Browser

builtin:

TESTBOX\_ARC\_STR

TESTBOX\_ARC\_EUL

CellDataToPointData1

IsoVolume1

Properties Information

Apply Reset Delete

Search ... (use Esc to clear text)

Properties (IsoVolume1)

Input Scalars

FMATPLT3

Minimum 0.5

Maximum 1.1

Display (UnstructuredGridRe)

Representation Surface

Coloring

VEL Magnitude

Edit

AMR Connectivity

AMR Contour

AMR CutPlane

AMR Dual Clip

AMR Fragment Integration

AMR Fragments Filter

Add Field Arrays

Aggregate Dataset

Angular Periodic Filter

Annotate Attribute Data

Annotate Global Data

Annotate Time Filter

Append Attributes

Append Datasets

Append Geometry

Append Reduce

Block Scalars

Calculator

Cell Centers

Cell Data to Point Data

Clean

Clean Cells to Grid

Clean to Grid

Clip

Clip Closed Surface

Clip Generic Dataset

Compute Derivatives

Compute Quartiles

Connectivity

Contingency Statistics

Contour

Contour Generic Dataset

Convert AMR dataset to Multi-block

Extract Component

Extract Edges

Extract Generic Dataset Surface

Extract Level

Extract Location

Extract Region Surface

Extract Selection

Extract Subset

Extract Surface

Extract Time Steps

FFT Of Selection Over Time

Feature Edges

Force Time

Gaussian Resampling

Generate Ids

Generate Quadrature Points

Generate Quadrature Scheme Dictionary

Generate Surface Normals

Glyph

Glyph With Custom Source

Gradient

Gradient Of UnstructuredDataSet

Grid Connectivity

Group Datasets

Group Time Steps

Histogram

Image Data To AMR

Image Data to Point Set

Integrate Variables

Interpolate to Quadrature Points

Intersect Fragments

Iso Volume

K Means

Outline Curvilinear DataSet

ParticlePath

ParticleTracer

Pass Arrays

Plot Data

Plot Global Variables Over Time

Plot On Intersection Curves

Plot On Sorted Lines

Plot Over Line

Plot Selection Over Time

Point Data to Cell Data

Point Line Interpolator

Point Plane Interpolator

Point Volume Interpolator

Principal Component Analysis

Probe Location

Process Id Scalars

Programmable Filter

Python Annotation

Python Calculator

Quadratic Clustering

Random Attributes

Random Vectors

Rectilinear Data to Point Set

Rectilinear Grid Connectivity

Reflect

Resample AMR

Resample To Image

Resample With Dataset

Ribbon

Rotational Extrusion

Ruler

SPH Line Interpolator

Surface Flow

Surface Vectors

Synchronize Time

Table To Points

Table To Structured Grid

Temporal Cache

Temporal Interpolator

Temporal Particles To Pathlines

Temporal Shift Scale

Temporal Snap-to-Time-Step

Temporal Statistics

Tensor Glyph

Tessellate

Tetrahedralize

Texture Map to Cylinder

Texture Map to Plane

Texture Map to Sphere

Threshold

Time Step Progress Bar

Transform

Transpose Table

Triangle Strips

Triangulate

Tube

Warp By Scalar

Warp By Vector

Youngs Material Interface

Create Isovolume for water

- Select **cellDataToPointData** result object
- Select **Isovolume** filter
- Set Input Scalar to **FMATPLT3** and range between **0.5** and **1.1**
- Click **Apply**
- Change Fringe

