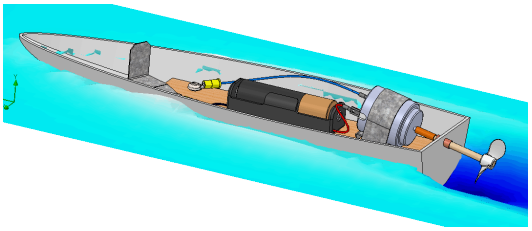
# Chapter 28 Boat
# Flow Sim

## A. Enable Flow Simulation.

Step 1. If necessary, open your BOAT **ASSEMBLY** file.



Step 2. If necessary, enable Flow Simulation, click the **flyout of Options**  on the Standard toolbar and click **Add-Ins**.

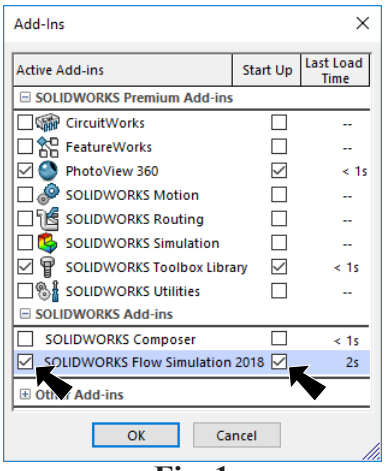



Fig. 1

Step 3. In the dialog box, scroll down to **Flow Simulation** and place a check in the check box under **Active Add-Ins** and **Start-Up**, **Fig. 1**. Click OK.

## B. Create Project.

Step 1. Click **Flow Simulation** tab  on the Command Manager toolbar.

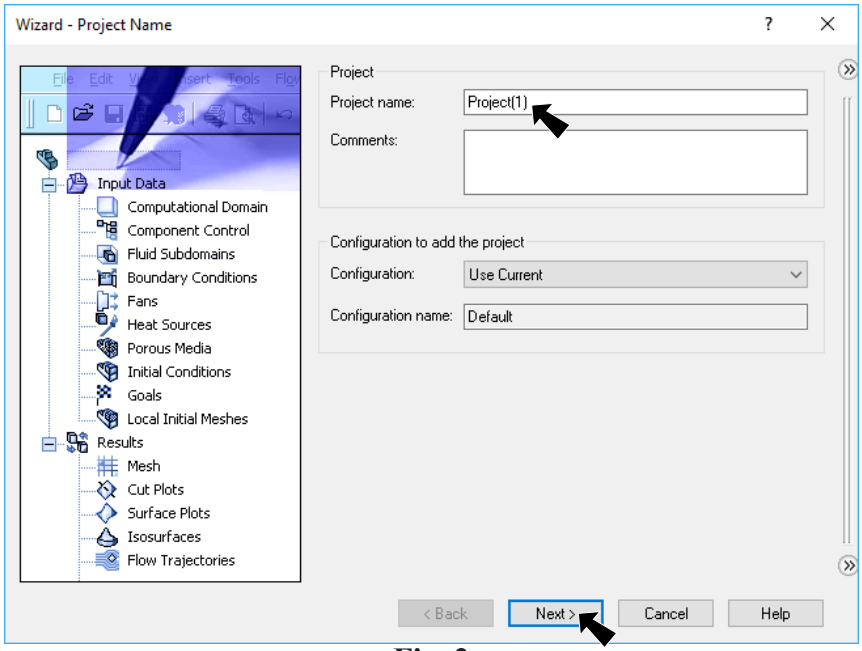



Fig. 2

Step 2. Click **Wizard**  on the Flow Simulation toolbar.

Step 3. Use **Project(1)** for Project name, **Fig. 2**.

Step 4. Click Next.

Step 5. **Unit System:** Select **SI (m-kg-s)** for Unit system, **Fig. 3**.

Step 6. Under Parameter: **Velocity** units **Mile/hour**.
**Length** units **Inch**.

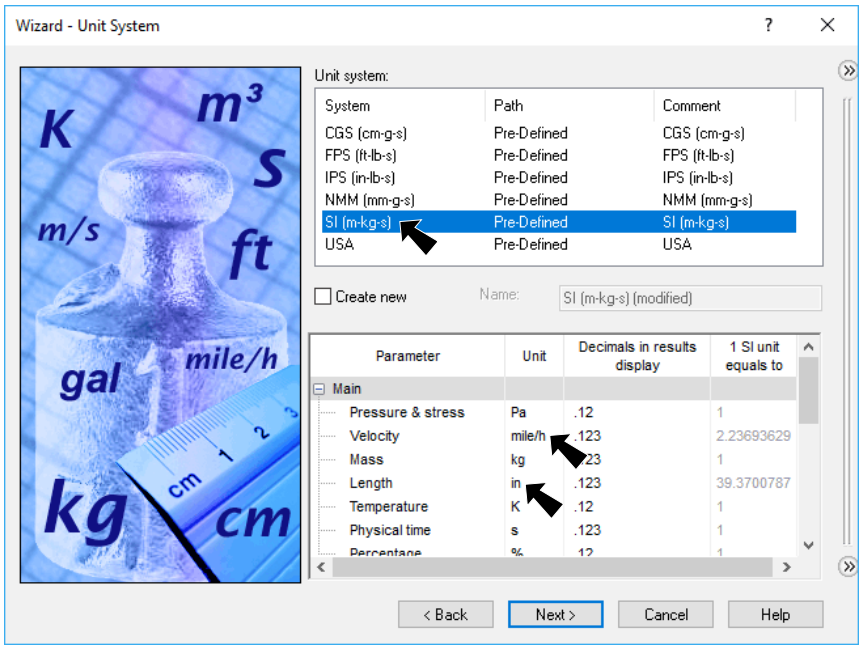



Fig. 3

Step 7. Scroll down Parameters, expand **Loads & Motion** and set **Force** units to **Gram force**, **Fig. 4**. Gram force unit is p.

Step 8. Click Next.

Step 9. **Analysis Type:** Under Analysis type, select **External**, **Fig. 5**.

Step 10. Under Consider closed cavities,
check **Exclude cavities without flow conditions**
check **Exclude internal space**.

Step 11. Under Physical Features,
check **Time-dependent**
set **Total analysis time 15 s**
**Output time step .2 s**
check **Gravity**
check **Free surface**.

Step 12. Click Next.

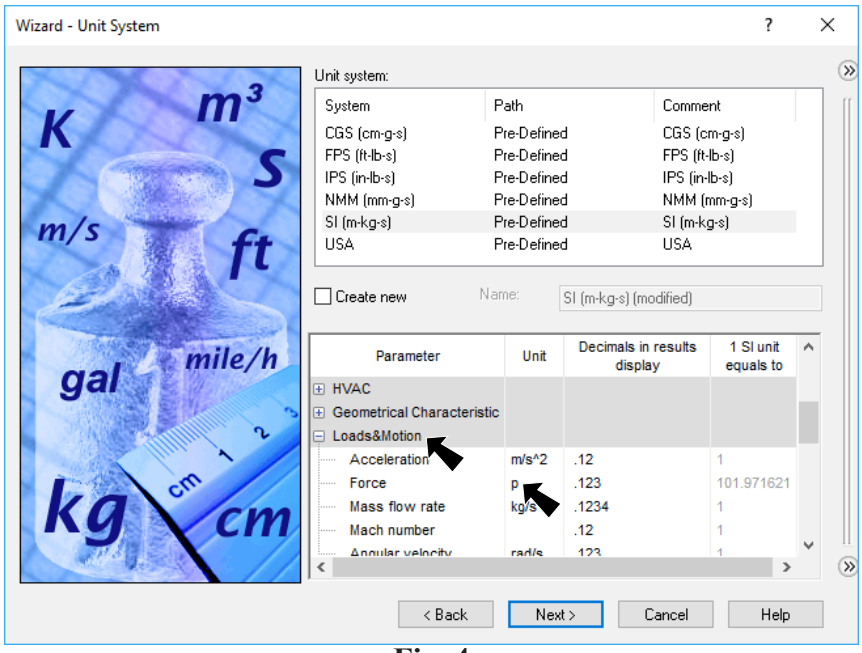



Fig. 4

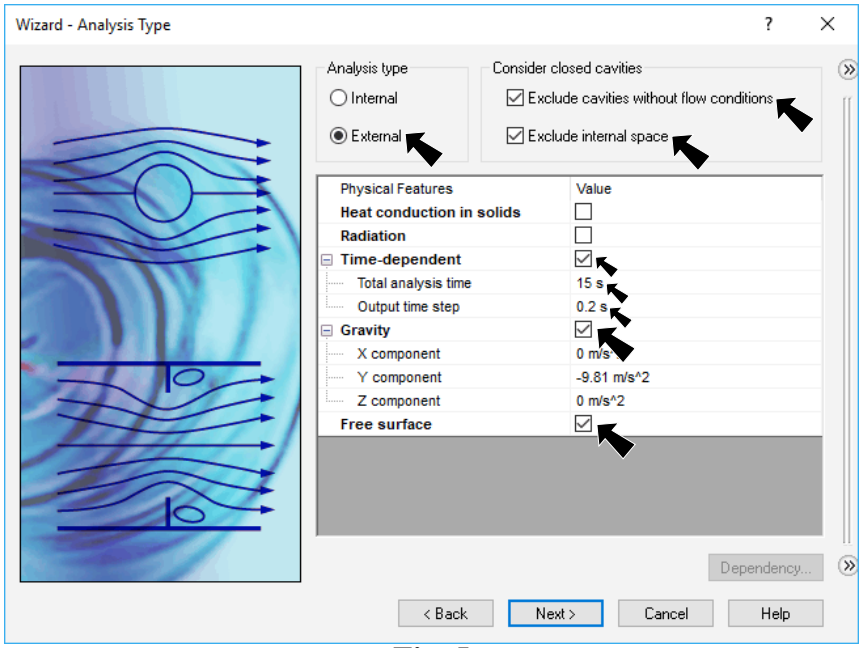



Fig. 5

Step 13. **Default Fluid:**
Expand **Gases**,
select **Air**,

then click **Add** button,
**Fig. 6**.

Expand **Liquids**, scroll down to bottom and select **Water**,

then click **Add** button,
**Fig. 7**.

Confirm **two** Project Fluids, **Fig. 8**.

Step 14. Click Next.

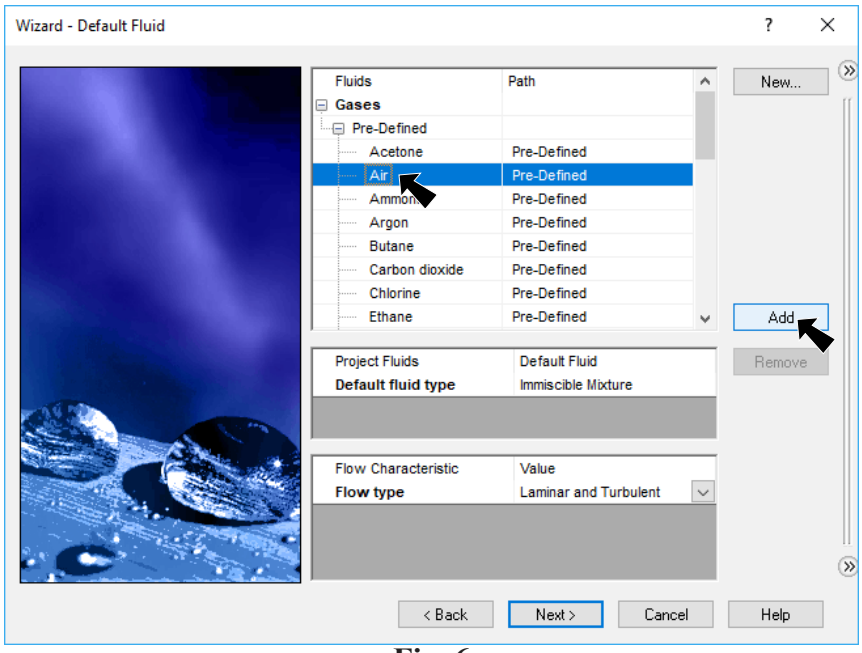



**Fig. 6**

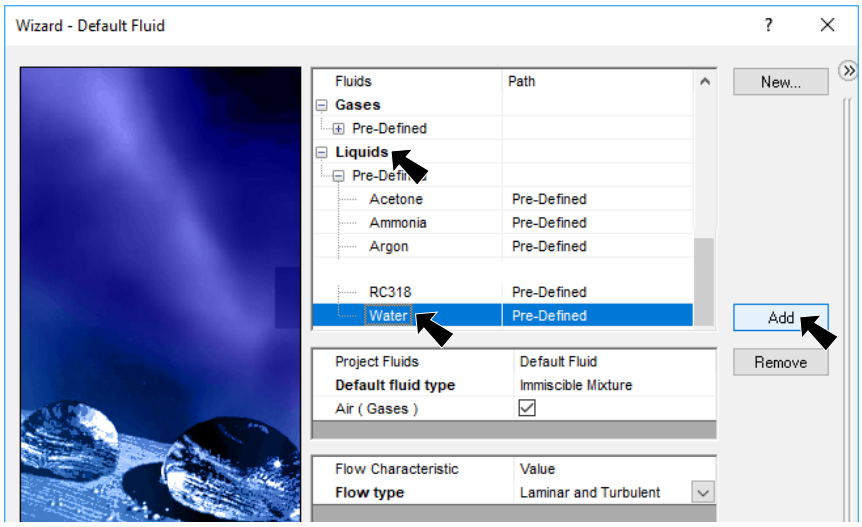



**Fig. 7**

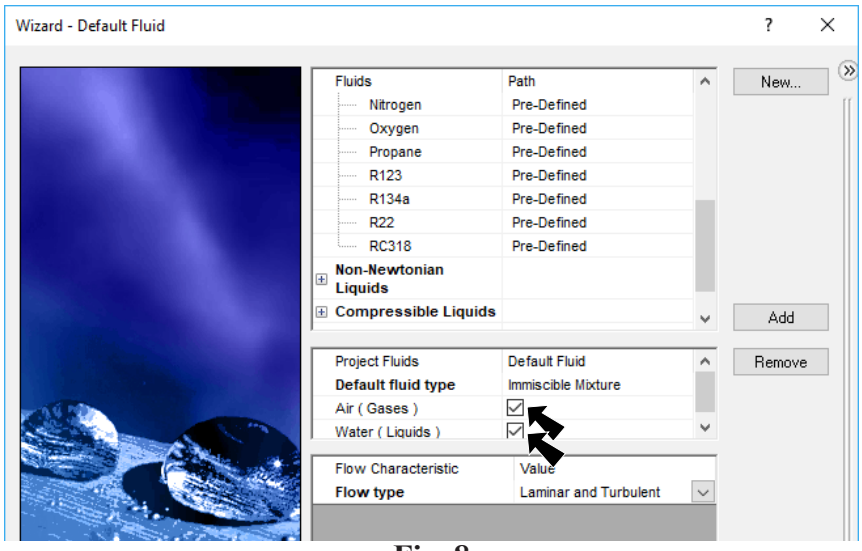



**Fig. 8**

Step 15. **Wall Conditions:**
Use the default values for wall condition, **Fig. 9**.

Step 16. Click Next.

Step 17. **Initial and Ambient Conditions:**
Under Velocity parameters select **Velocity in Z direction** and click **Dependency** button, **Fig. 10**.

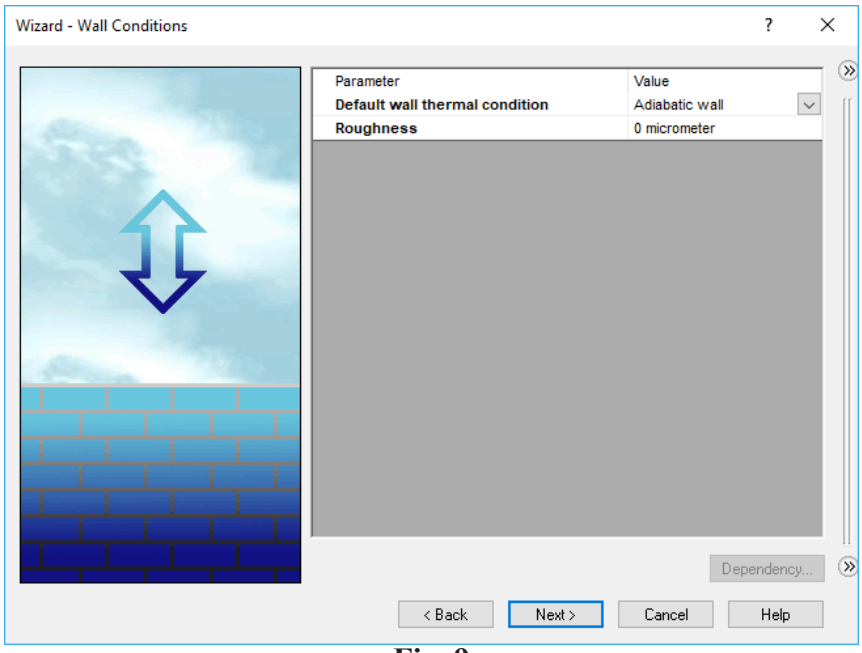



**Fig. 9**

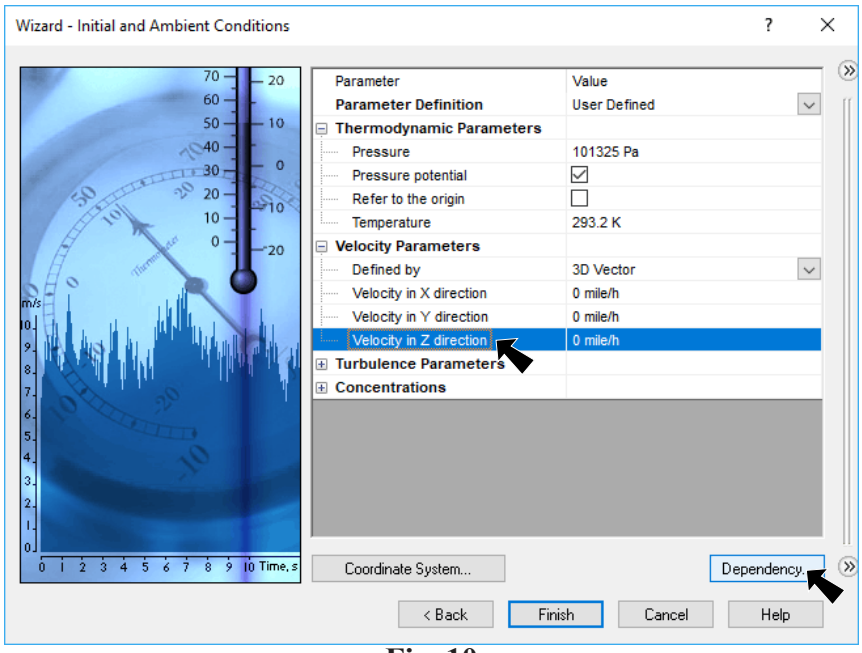



**Fig. 10**

Step 18. In the Dependency dialog box, **Fig. 11**
under Dependency type
select **F(time) - table**
Under Table of values:
set values

| Value t | Values f(t) |
|---|---|
| **0** | **0** |
| **4** | **-5** |
| **8** | **-15** |
| **12** | **-15** |
| **15** | **-10** |

**Negative**

Click the **Chart** button
Click OK.

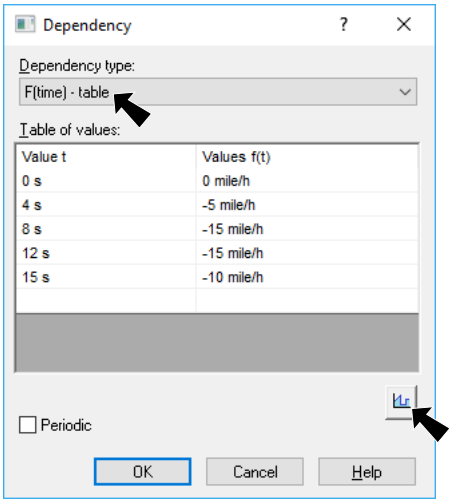



**Fig. 11**

Step 19. Back in Initial and Ambient Conditions
Expand
**Concentrations**
select **Initial fluid**
and
click **Dependency**
button, **Fig. 13**.

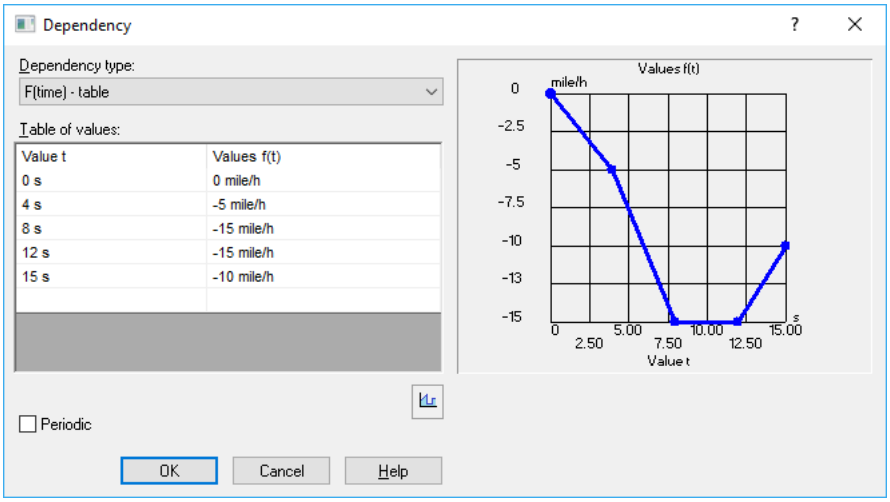



**Fig. 12**

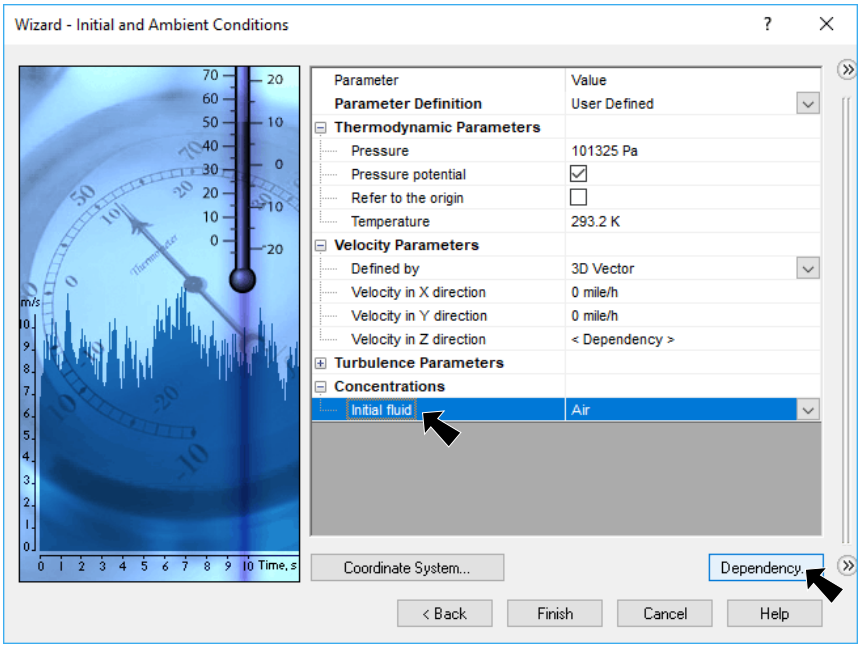



**Fig. 13**

Step 20. In the Dependency dialog box, under Dependency type: select **F(h) - table** Under Table of values: set **1.1 in. Air** This is were the water stops and the air begins. Click OK.

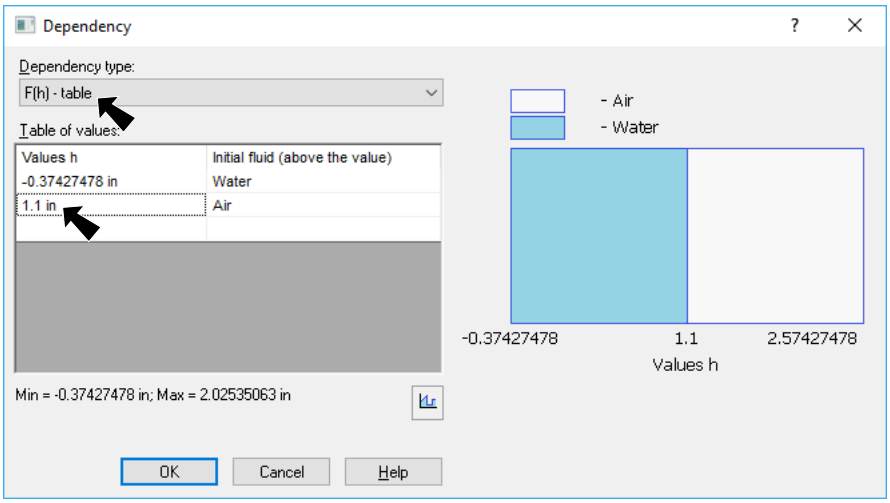



**Fig. 14**

Step 21. Click Finish.

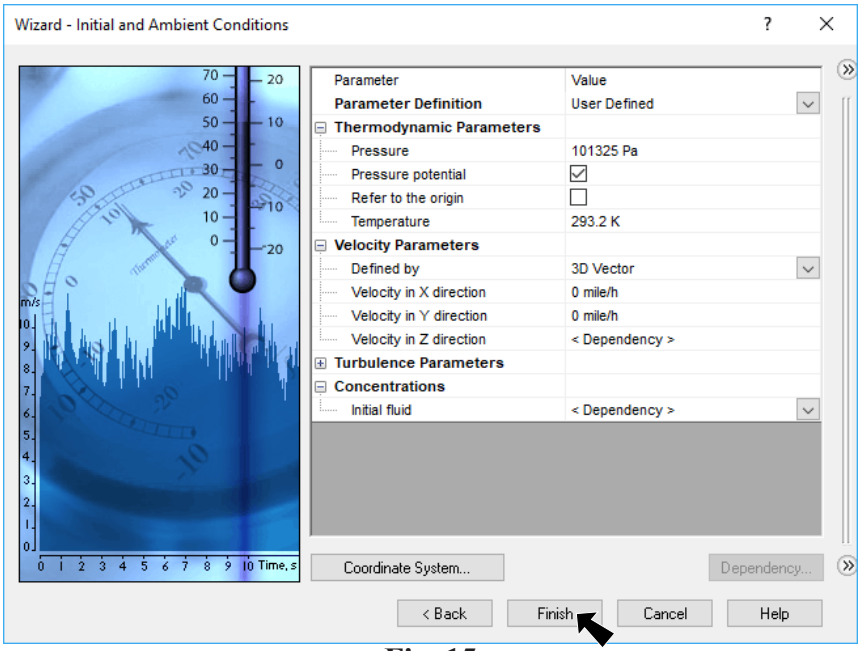



**Fig. 15**

## C. Computational Domain.

Step 1. Click Tools Menu > Flow Simulation > Computational Domain.

Step 2. Set values as shown here and **Fig. 16**.

**X max 3.5**
**X min -3.5**

**Y max 3.5**
**Y min -2.35**

**Z max 3.8**
**Z min -16**

click OK ✔.

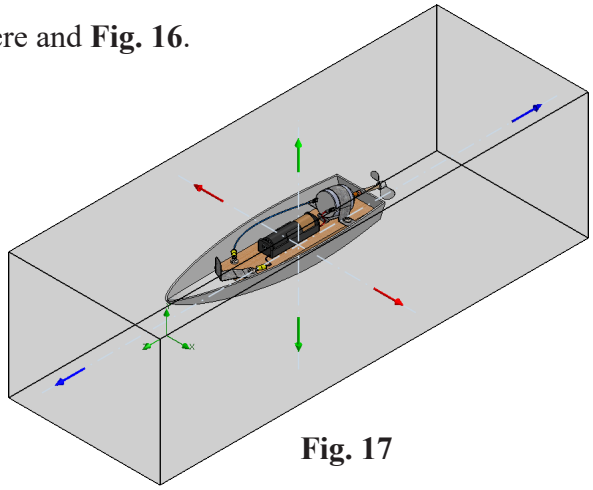


**Fig. 17**

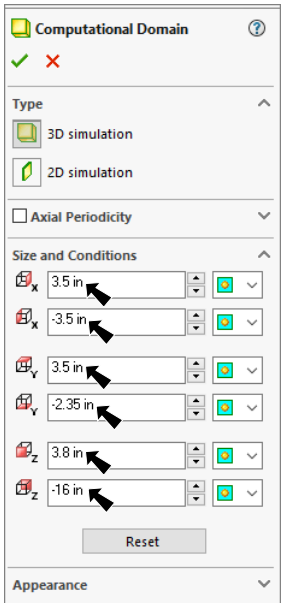



**Fig. 16**

## D. Insert Global Goals.

Step 1. Click **Flow Simulation Features** 

on the Flow Simulation toolbar and click **Global Goals** from menu.

Step 2. In the Global Goals Property Manager:
scroll down the Parameters to **Force (Y)**, **Fig. 18**
and **check:**
**Force (Y)**
**Force (Z)**
click OK ✔.

Step 3. Rename goals to **Lift** and **Drag**, **Fig. 19**.
To rename, click **Force (Y)**, press **F2** key and key-in **Lift**, then rename **Force (Z)** to **Drag**.
Rename:
**GG Force (Y) 1 to Lift**
**GG Force (Z) 1 to Drag**

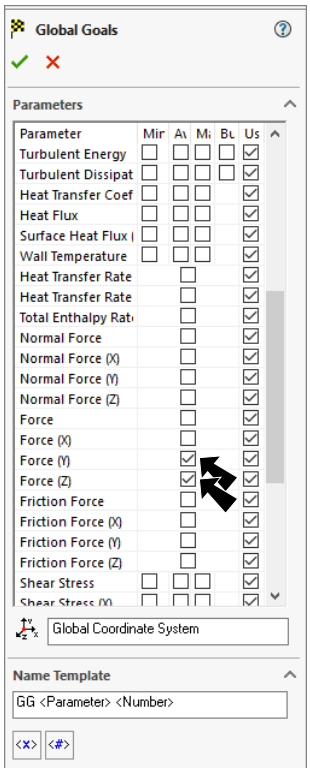



**Fig. 18**

Step 4. Save. Use **Ctrl-S**.

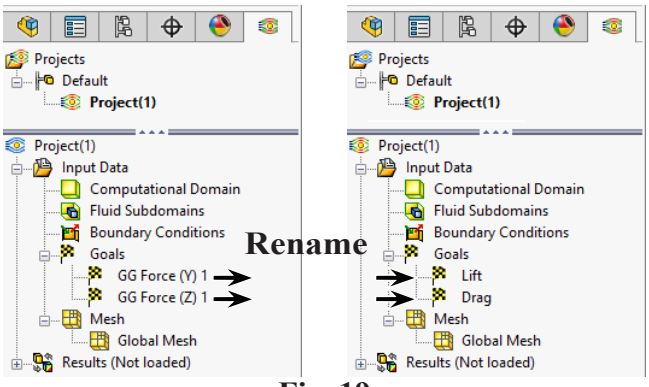



**Fig. 19**

## E. Calculation Control Options.

Step 1. Click Tools Menu > Flow Simulation > Calculation Control Options.

Step 2. In the Calculation Control Options dialog box:
confirm **Physical time** is **15 s**, **Fig. 20**.

And Lift and Drag are set as goals.

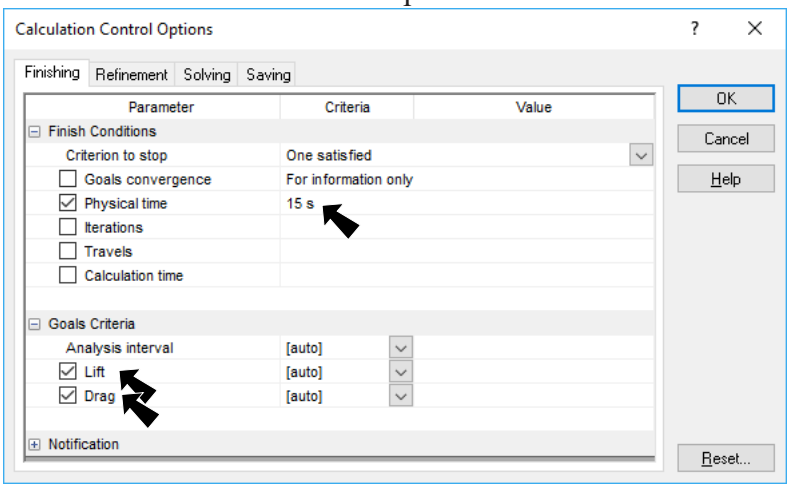



**Fig. 20**

Step 3. Click **Saving tab** at top of dialog box, **Fig. 21**

under Full Results
confirm **Period is set to .2** (seconds)

under Selected Parameter (Transient Explorer)
check **Periodic**

click **browse Customize Parameter List** ... in the Pressure, Temperature table cell.

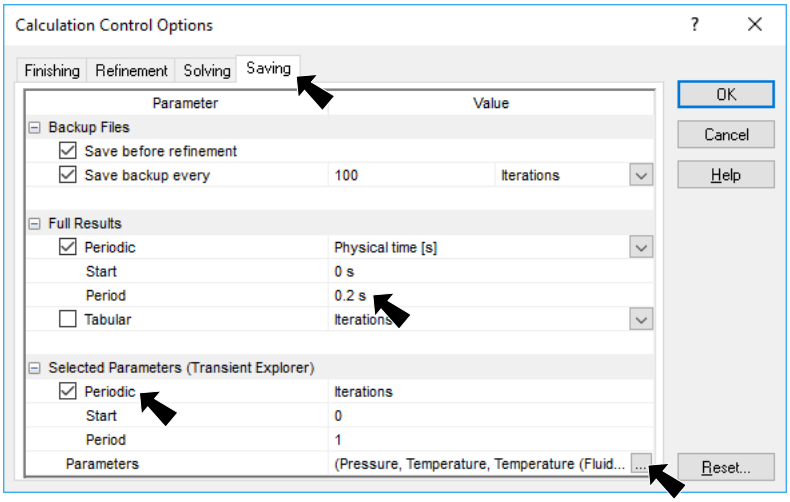



**Fig. 21**

Step 4. In the Customize Parameter List dialog box:
under Main, **Fig. 22**
check **Volume Fraction of Air**
check **Volume Fraction of Water**
click **OK**

click **OK** back in Calculation Control Options dialog box.

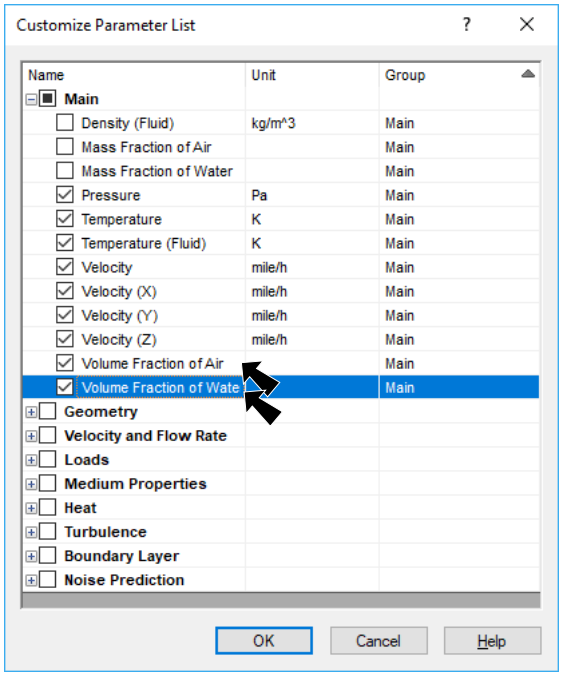



**Fig. 22**

Step 5. Save. Use **Ctrl-S**.

## F. Run Analysis.

Step 1. Click **Run** 

on the Flow Simulation toolbar.

Step 2. Click **Run** in the Run dialog box, **Fig. 23**.

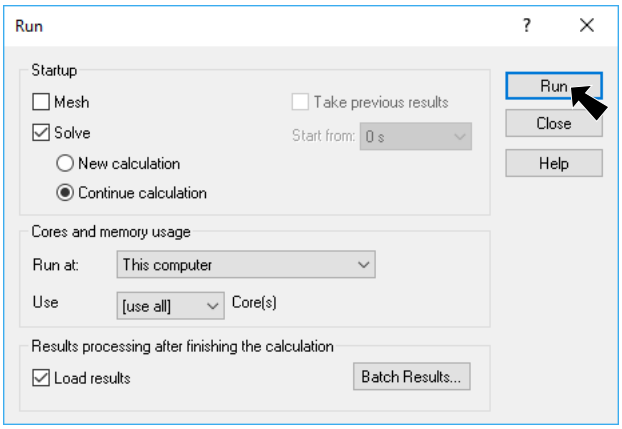



**Fig. 23**

## G. Solver.

Step 1. In the Solver dialog box you can view Calculation time left, **Fig. 24**. The CPU time runs around 28 minutes.

Step 2. When the calculation is done view the drag in the Solver, click Insert Menu > Goal Table, **Fig. 25**. Our drag was **-151.65**.

Step 3. Close the Solver dialog box, click File Menu > Close.

Step 4. Save. Use **Ctrl-S**.

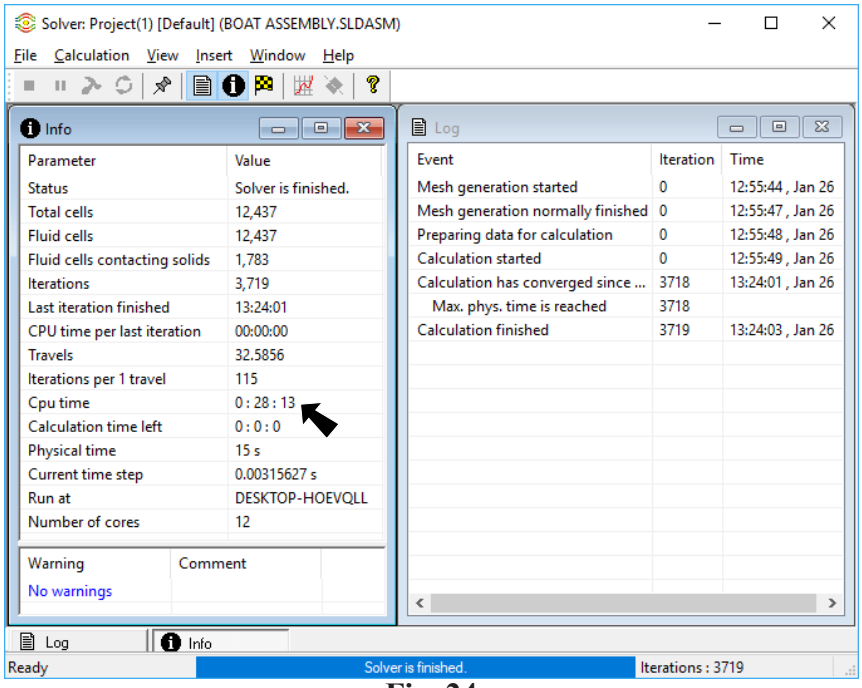



**Fig. 24**

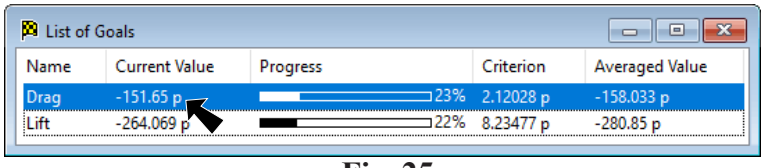



**Fig. 25**

## H. Cut Plot.

Step 1. Click **Right** on the Standard Views toolbar. (**Ctrl-4**)

Step 2. **Right click Computational Domain** in Flow Simulation tree and click **Hide**, **Fig. 26**.

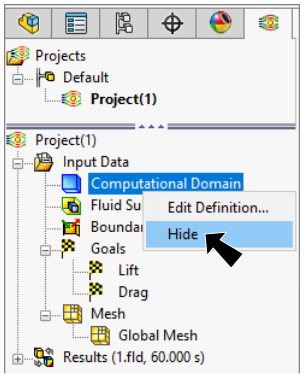


**Fig. 26**

Step 3. Click **Cut Plot** on the Flow Simulation toolbar.

Step 4. In the Property Manager set:

click **Detailed Preview** at the top Property Manager, **Fig. 27**

under Selection

select **XYZ Planes**

select **YZ Plane**

under Display

select **Contours**

under Contours

Parameter **Velocity**

click **Adjust Minimum and Maximum**

**Maximum** **15**

**Minimum** **0**

Number of Levels **25**

click OK .

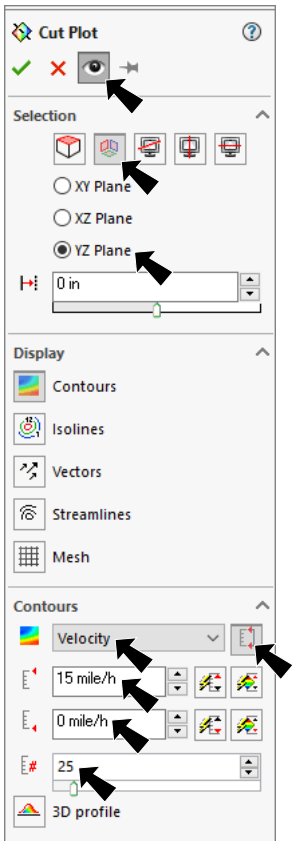


**Fig. 27**

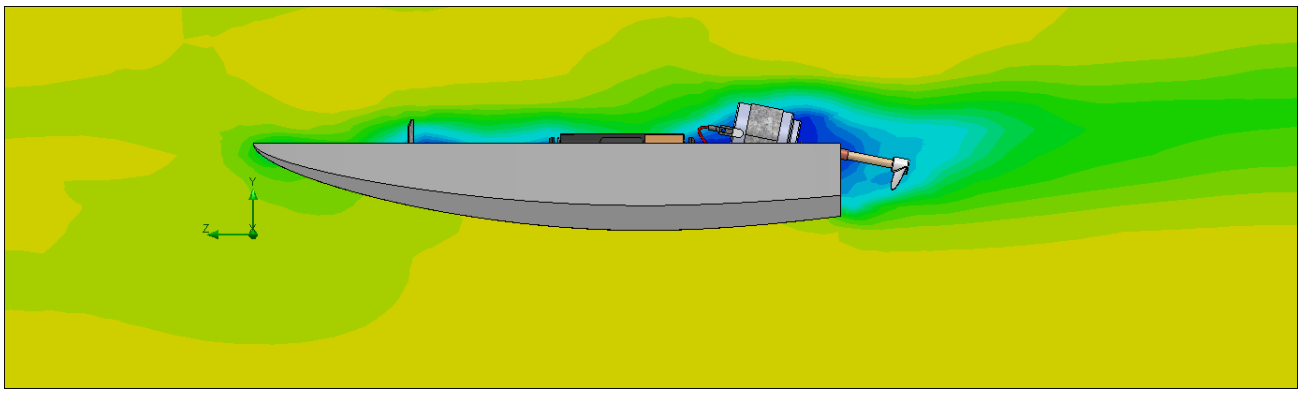


**Fig. 28**

## I. Transient Explorer.

Step 1. **Right click Results** in Flow Simulation tree and click **Transient Explorer**, **Fig. 29**. The Transient Explorer takes a moment to load.

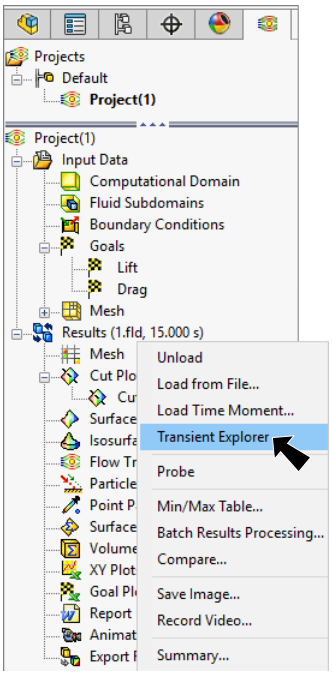



Fig. 29

Step 2. In the time scale in the graphics area, **Play** and **Pause**, **Fig. 30**. Drag the Time Bar through the animation.




Fig. 30

Step 3. After viewing the Surface Plot, expand Results in Flow Simulation tree and expand Surface Plots. **Right click Cut Plot 1** and click **Hide**, **Fig. 31**.

Step 4. Save. Use **Ctrl-S**.

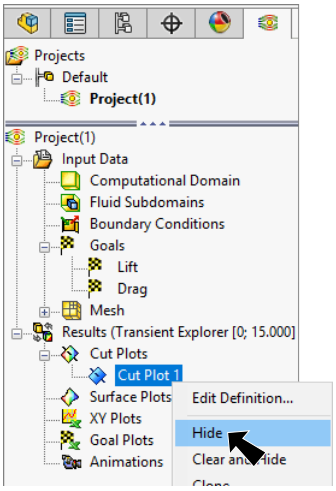



Fig. 31

## J. Surface Plot.

Step 1. Click **Surface Plot** on the Flow Simulation toolbar.

Step 2. In the Property Manager set:
under Selection, **Fig. 32**
check **Use all faces**
under Display
select **Contours**
under Contours
Parameter **Pressure**
click **Adjust Minimum and Maximum**
note **Maximum** and **Minimum** values
click OK .

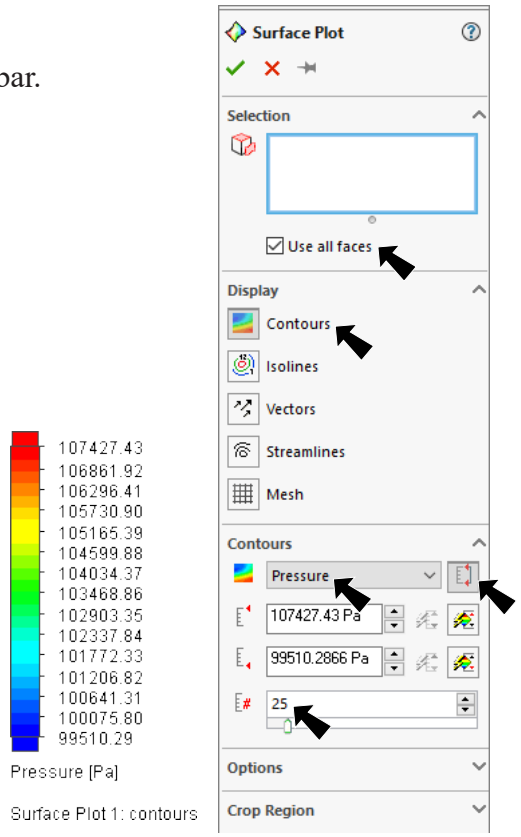



Fig. 32

Step 3. In the time scale, **Play** and **Pause**, **Fig. 33**.
Drag the Time Bar through the animation.

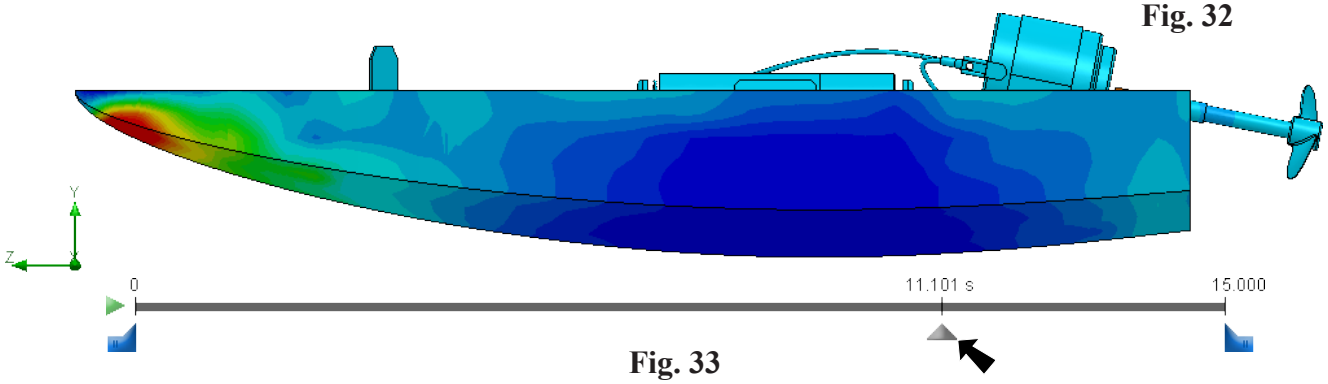



Fig. 33

Step 4. After viewing the Surface Plot, **right click Surface Plot 1** and click **Hide**, **Fig. 34**.

Step 5. **Right click Results** in Flow Simulation tree and click **Transient Explorer** to turn off, **Fig. 35**.

Step 6. Save. Use **Ctrl-S**.

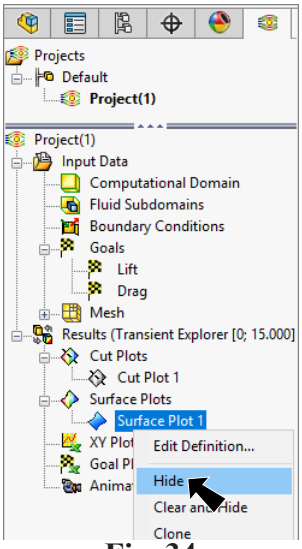



Fig. 34

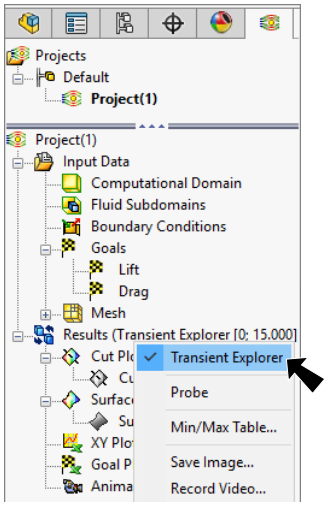
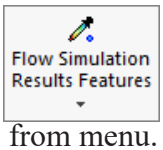



Fig. 35

## K. Isosurfaces.

Step 1. Click **Flow Simulation Features** 

on the Flow Simulation toolbar and click **Isosurfaces** from menu.

Step 2. In the Property Manager set:

click **Detailed Preview** at the top Property Manager, **Fig. 36**

under Parameter

select **Volume Fraction of Water**

under Value 1

set Value **.8**

under Appearance

Color by **Y (cartesian)**

click **Adjust Minimum and Maximum**

click **Reset to Plot Max**

click **Reset to Plot Min**

Number of Levels **100**

click OK .

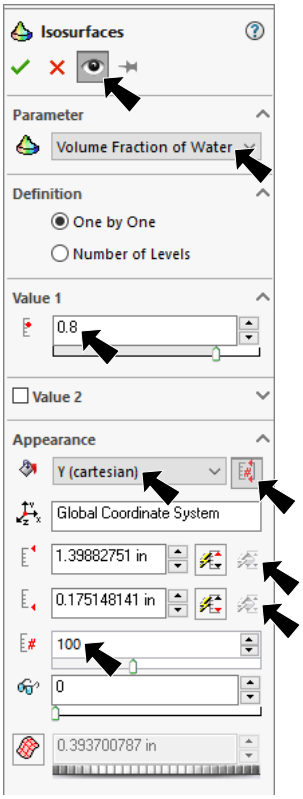



Fig. 36

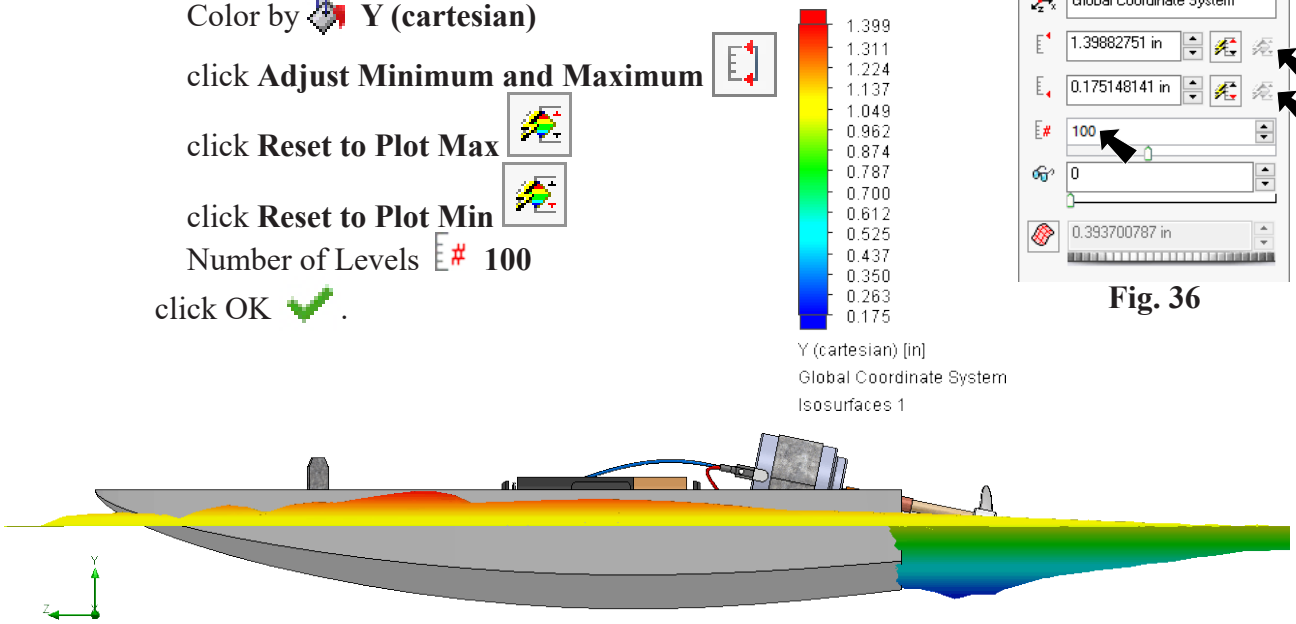



Fig. 37

## L. Edit Color Bar.

Step 1. **Double click** the **Color Bar** in the graphic area, **Fig 38**.

Step 2. In the Color Bar Property Manager:
under Settings, **Fig. 39**
expand Palette
select the **Blue-White palette** (6th from bottom)
click OK ✔.

Step 3. Rotate view, **Fig. 41**. Here I use the down arrow two times.

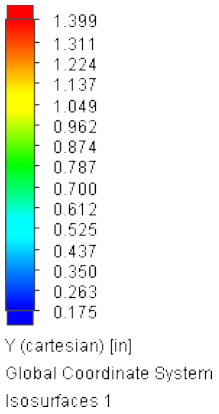



Fig. 38

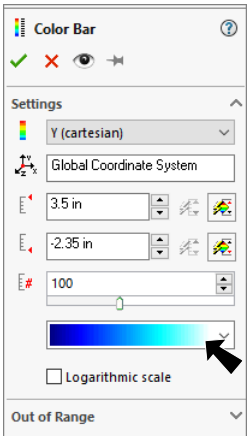



Fig. 40

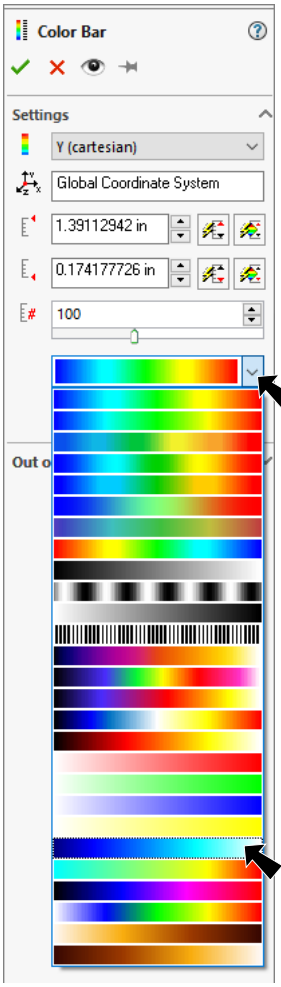



Fig. 39

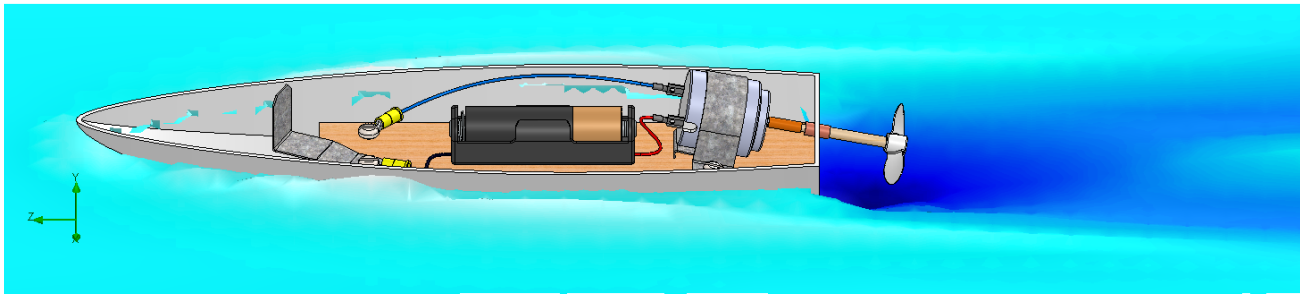


Fig. 41

## M. Animate Isosurfaces.

Step 1. **Right click Isosurfaces** in Flow Simulation tree and click **Animation**, **Fig. 42**.

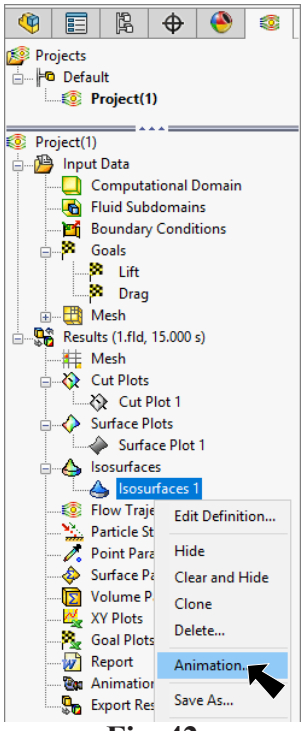



Fig. 42

Step 2. Click **Wizard**  at the top of the Animation tree at the left side of the animation tool's main screen, **Fig. 43**.

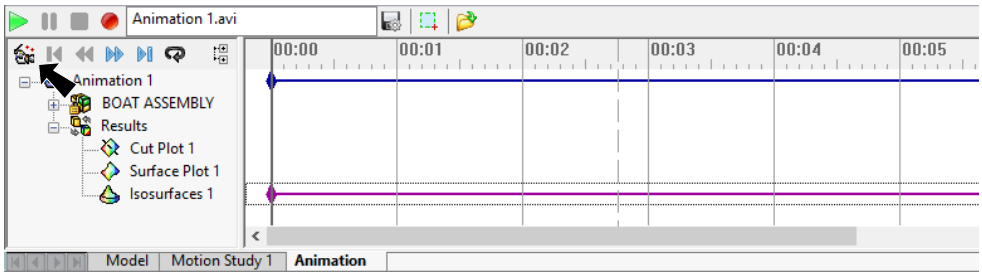



Fig. 43

Step 3. In the Animation Wizard page 1 set:
**Animation time 15 s**, **Fig. 44**.
check **Delete all existing tracks**
click **Next**.

Step 4. In the Animation Wizard page 2:
click **Next**, **Fig. 45**.

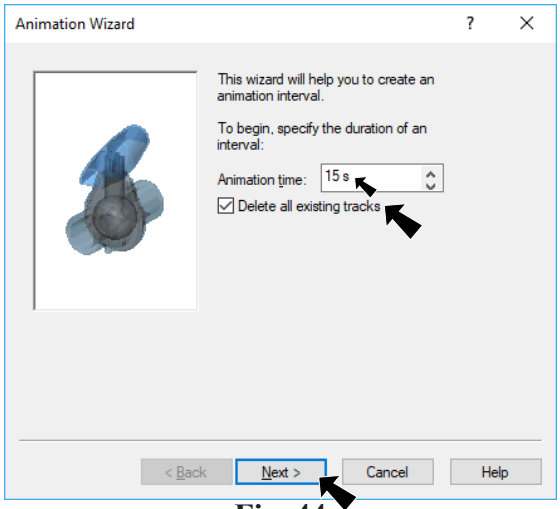



Fig. 44

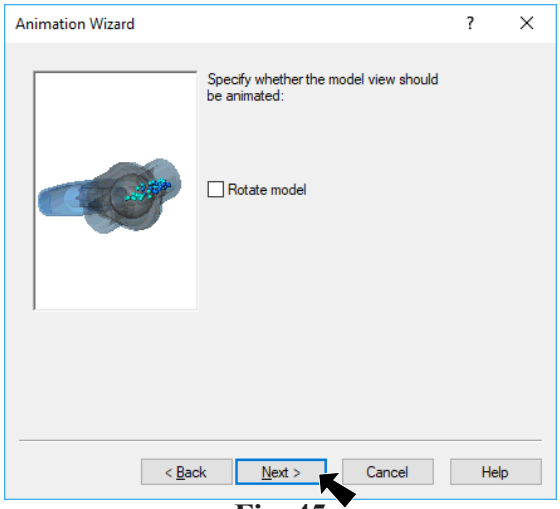



Fig. 45

Step 5. In the Animation Wizard page 3:
select **Scenario**
click **Next**, **Fig. 46**.

Step 6. In the Animation Wizard page 4:
under Results, **Fig. 47**
select **Proportional distribution**
click **Finish**.

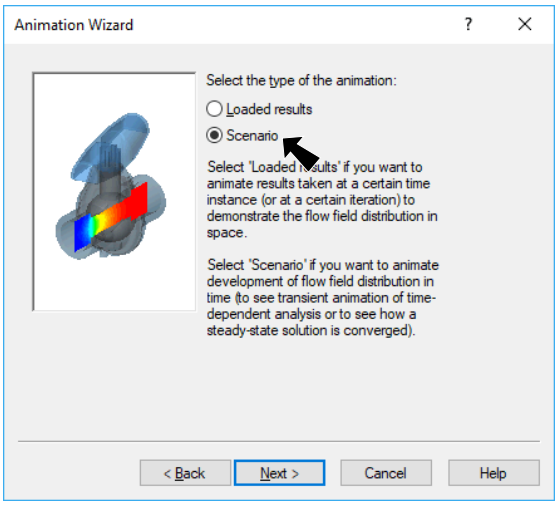



Fig. 46

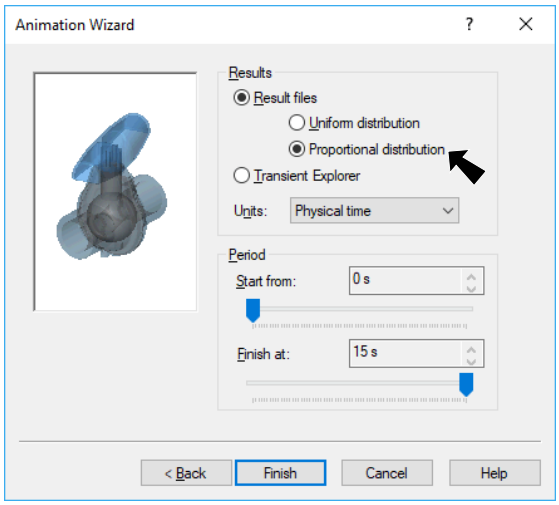



Fig. 47

Step 7. Click **Zoom Out**  in lower right corner of the Timeline to shorten TImeline, **Fig. 48**.

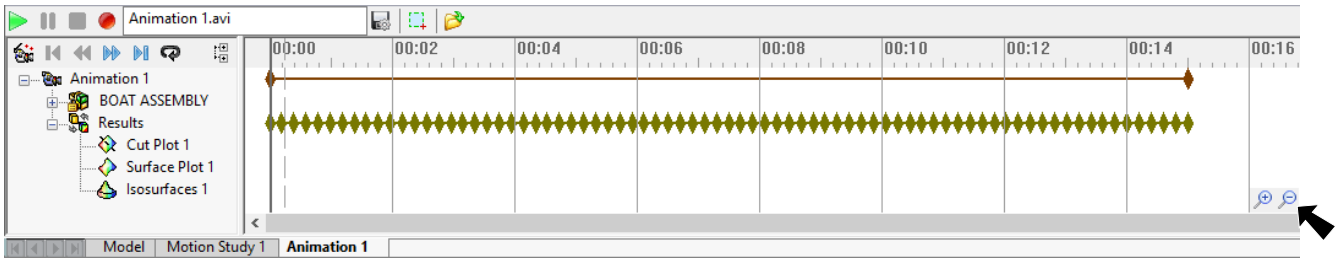



Fig. 48

Step 8. **Right click** at **Time = 0** (start) in the **Isosurfaces 1** Timeline and click **Insert Control Point**, **Fig. 49**.

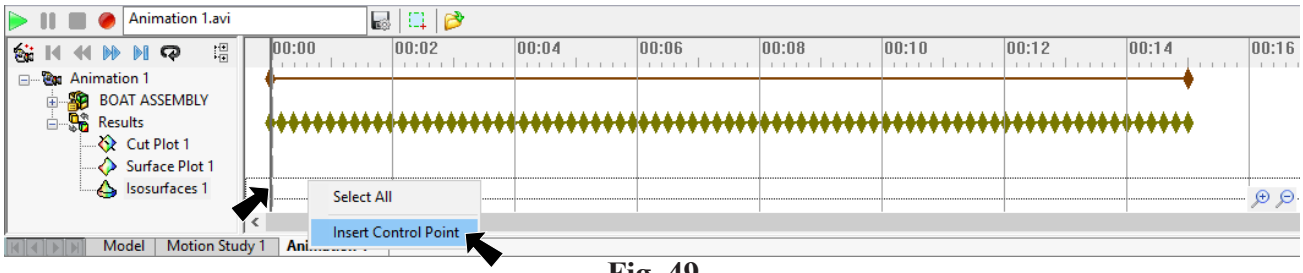



**Fig. 49**

Step 9. Drag the second control point out to **Time = 15 seconds** and click in the timeline, **Fig. 50**.

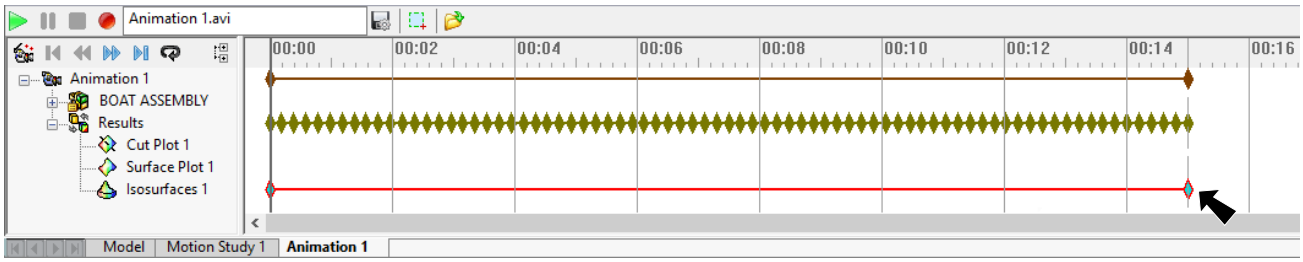



**Fig. 50**

Step 10. Click **Play** in animation control panel and then **Stop**, **Fig. 51**.

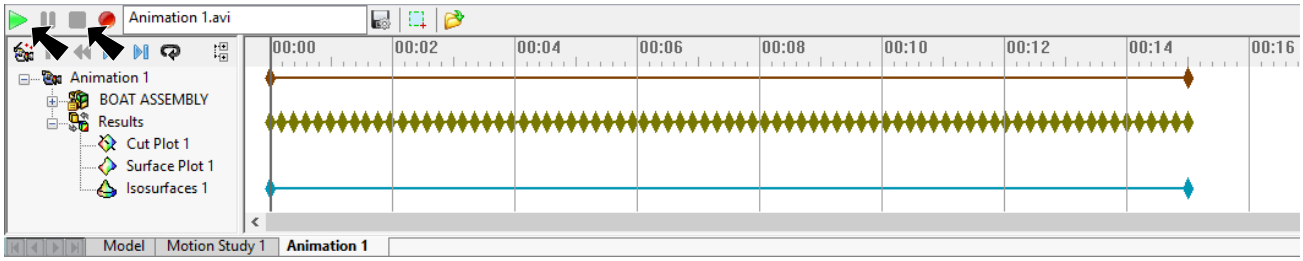



**Fig. 51**

## N. Create Isosurfaces Animation Movie.

Step 1. In the Animation control panel turn on **Capture Region**, **Fig. 52**.

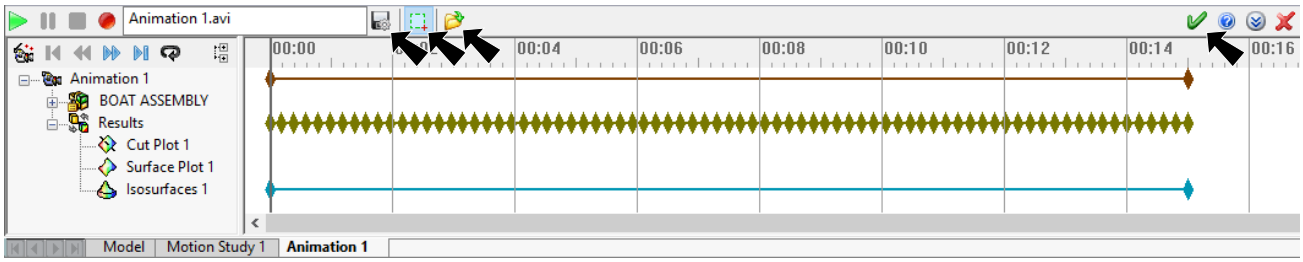



**Fig. 52**

Step 2. Drag the red frame capture region in the graphics area to resize/move capture region, **Fig. 53**.

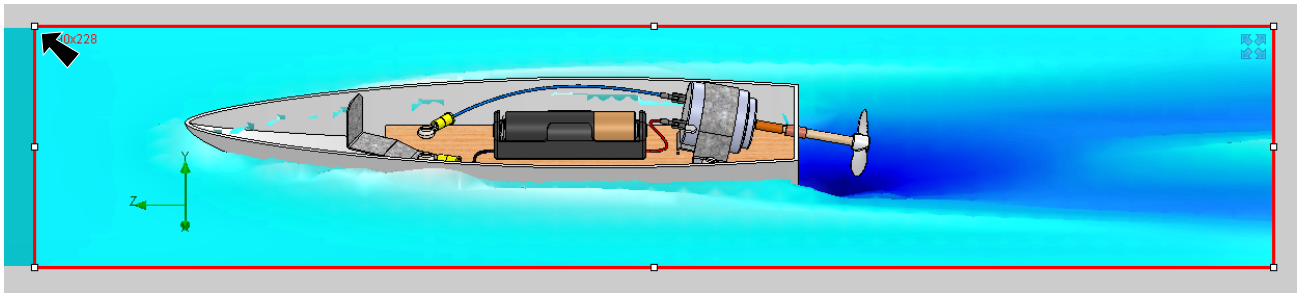


**Fig. 53**

Step 3. Click **Save Setting** to review the animation file settings, **Fig. 52**.

Step 4. Click **Record**.

Step 5. Click **Open Folder** to view Animation AVI file.

Step 6. To exit, click **OK** in Animation control panel at the right end of Timeline.

Step 7. Hide the Isosurfaces, **right click Isosurfaces 1** in Flow Simulation tree and click **Hide**, **Fig. 54**.

Step 8. Save. Use **Ctrl-S**.

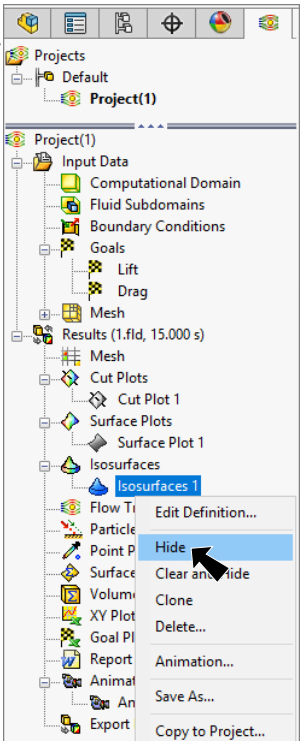



**Fig. 54**

## O. Flow Trajectories.

Step 1. Click **Flow Trajectories** on the Flow Simulation toolbar.

Step 2. In the Flow Trajectories Property Manager:

under Starting Points, **Fig. 55**

select **Pattern**

**Select References** by selecting **all outside faces of hull**, **Fig 56**. To view rear, hold down middle mouse button (wheel) and drag to rotate view.

**Number of Points** **20**

under Appearance

**Draw Trajectories As** **Spheres**

**Width** **.08**

Color by **Pressure**

click **Adjust Minimum and Maximum**

click **Reset to Plot Max**

click **Reset to Plot Min**

**Number of Levels** **12**

click OK .

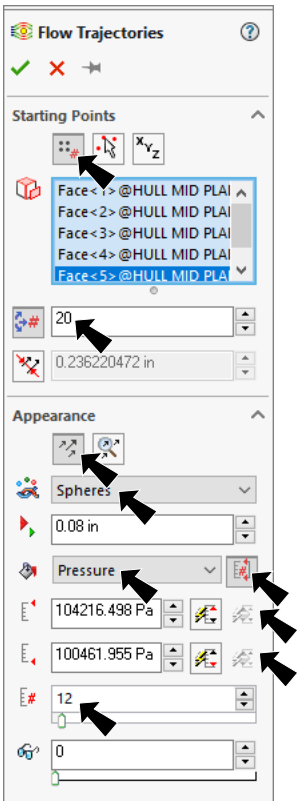



Fig. 55

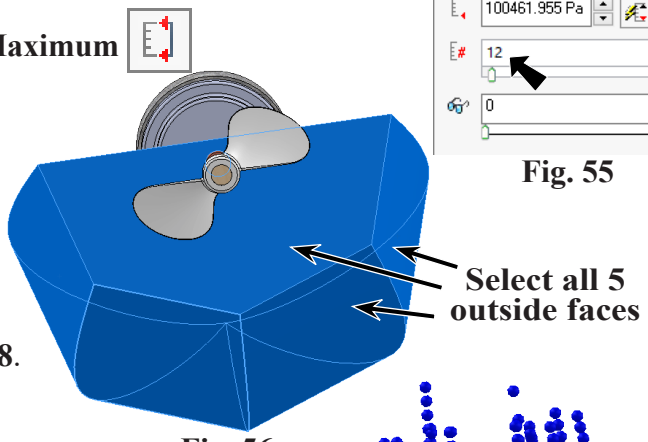



Fig. 56

Step 3. Rotate view to see side of hull, **Fig 58**.

Step 4. Save. Use **Ctrl-S**.

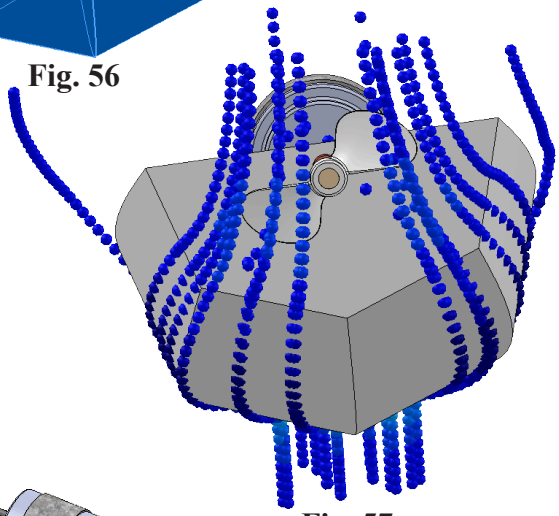


Fig. 57

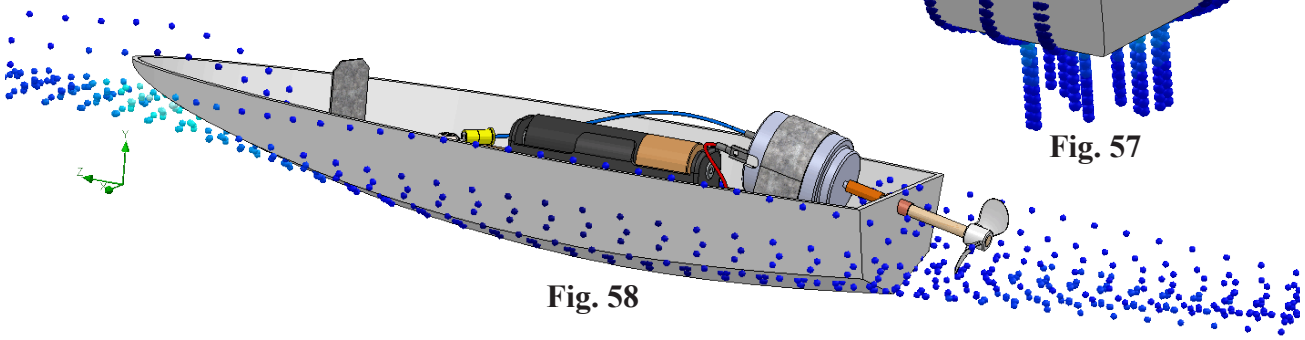


Fig. 58

## P. Edit Color Bar to Default.

Step 1. **Double click** the **Color Bar** in the graphic area, **Fig 59**.

Step 2. In the Color Bar Property Manager:
under Settings, **Fig. 60**
expand Palette
select the **top palette**
click OK ✔ .

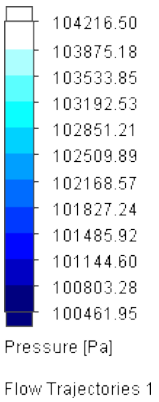



**Fig. 59**

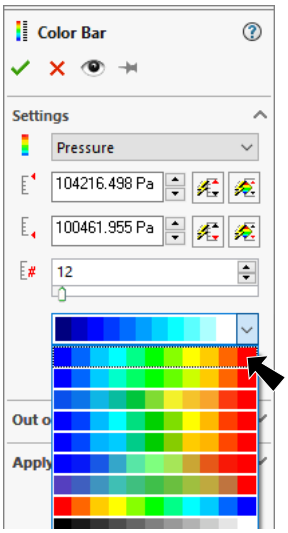



**Fig. 60**

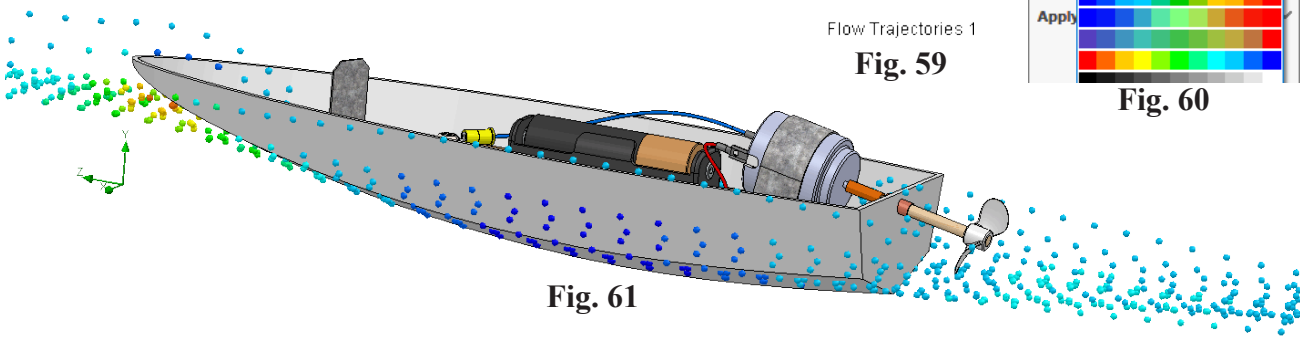


**Fig. 61**

## Q. Animate Flow Trajectories Movie.

Step 1. **Right click Flow Trajectories 1** in Flow Simulation tree and click **Animation**, **Fig. 62**.

Step 2. Click **Play** in animation control panel, **Fig. 63**.

Step 3. In the Animation control panel turn on **Capture Region**.

Step 4. Drag the red frame capture region in the graphics area to resize/ move capture region, **Fig. 64**.

Step 5. Click **Record**.

Step 6. Click **Open Folder** to view Animation AVI file.

Step 7. To exit, click **OK** in Animation control panel at the right end of Timeline.

Step 8. Save. Use **Ctrl-S**.

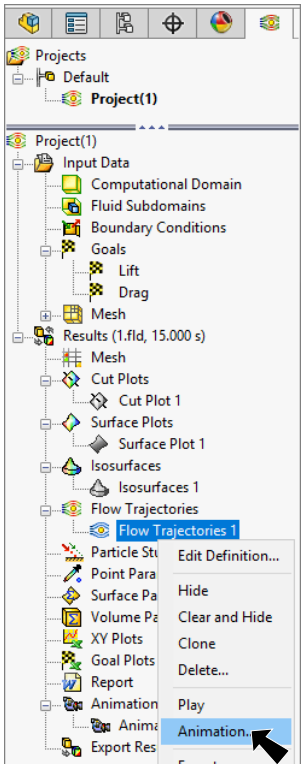



Fig. 62

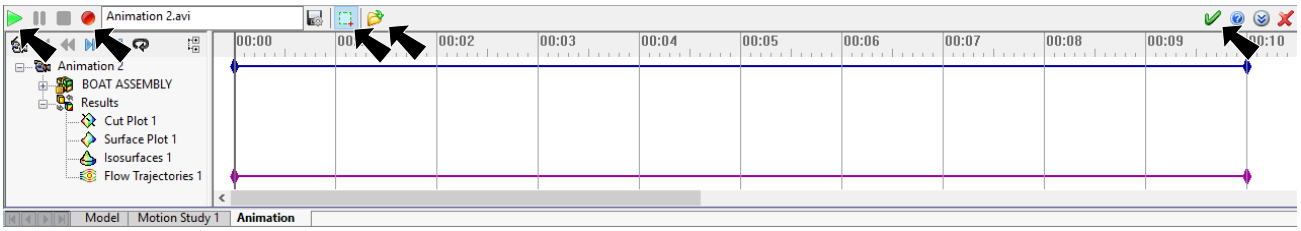



Fig. 63

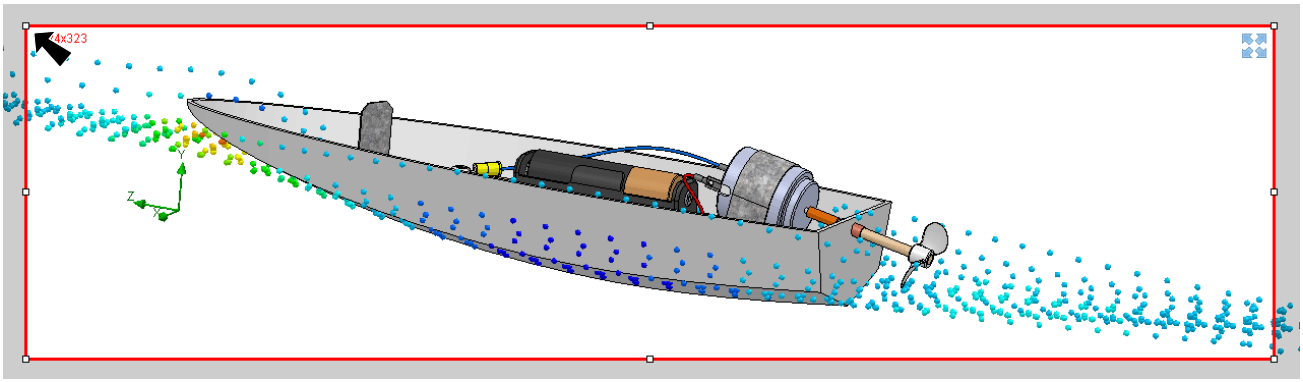


Fig. 64