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User Manual for Graphical User Interface Version 2.8 with Fire and Smoke Simulation Model (FSSIM) Version 1.2

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1.0 INTRODUCTION

The collaborative work of Hughes Associates, Inc. (HAI), the Naval Research Laboratory, and a group at Mississippi State University resulted in development of a simulation system including a Graphical User Interface (GUI) [1,2] for setting up simulations and for visualization of results. The simulation environment as shown in Figure 1-1 provides a runtime environment for a third-party Fire and Smoke Simulator (FSSIM) [3,4], developed by HAI. This user's manual provides documentation of the GUI and detailed discussion of features of the output display. For implementation details of the GUI, refer to its Theory Manual [5]. The CAD processing is a separate, complex piece of software which partially automates extraction of the AutoCAD data to reconstruct the 3D information and store it to the database [6]. The database schema will not be discussed in this document.

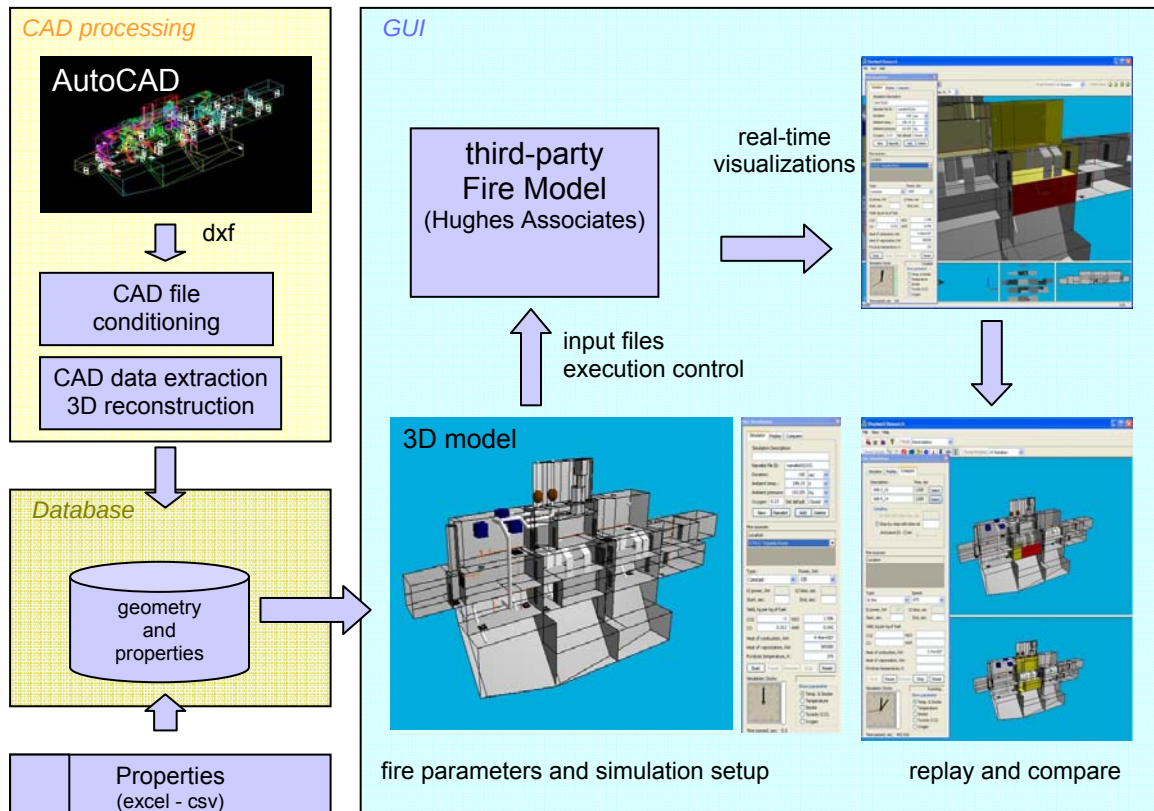


Figure 1-1 Simulation Environment

2.0 INSTALLATION AND RUNNING

Minimum Computer Requirements:

(Note that the video and main memory requirements are a function of the size of the geometry or number of compartments you wish to run. Also with the myriad of CPU, memory, graphics card, and operating system combinations, performance can vary greatly.)

System Summary:

- Operating System: Windows XP, or Vista or 2000 (not tested on older versions),
- Processor: 1.8 GHz Pentium 4 Processor or equivalent for desktop
1.7 GHz Pentium M or equivalent for laptop
- Total Physical Memory: 512 MB RAM

Display:

- Adapter Type: Any with great OpenGL acceleration
- Adapter RAM: 128 MB Video RAM
- Resolution: 1280x1024 screen resolution

Other requirements:

- a 3-button mouse (or mouse with wheel)
- MYSQL database software (recommend MySQL 4.1)

Checking Computer Requirements:

To check to see if your computer meets the minimum requirements given above, several of the parameters listed above can be determined by following these instructions. First, click on "**Start**" then click on "**All Programs**", then "**Accessories**", then "**System Tools**", then "**System Information**" to bring up the System Information window. When this window first appears, you should see the **System Summary** information in the right side of the window which contains the **OS Name**, **Processor** (which should include speed in MHz or GHz), and **Total Physical Memory**. To see graphics related parameters, in the left side of the window, click on the plus symbol beside the **Components** item to expand it, then select **Display**. Now the right side of the window should contain **Adapter Type**, **Adapter RAM** (Video RAM), and **Resolution**.

To install the software from the enclosed CD:

1. You should have administrative privileges on the computer to install the software. Double click setup.exe from the CD to start the installation. Click "Next" to choose the installation location, By default, it will install in "C:\Program Files\MississippiStateU\FireModelNetworkGUI_v2.8\". Keep clicking "Next" to

- finish the installation. The installation process will create a shortcut for the executable on the desktop and an entry under “Mississippi State University” in the Windows Programs menu.
2. This software depends on the MySQL database software, so if you do not already have it installed, follow the instructions under “MySQL Installation” below.
 3. From the command prompt (one way to access: click on “Start”, click on “Accessories”, click on “Command Prompt”), change to the directory where the CD contents were installed.
 4. From that prompt, type “**cd Application**”.
 5. From “...../Application>” prompt, type “**cd Databases**”.
 6. If you have added MySQL commands to your PATH (when the MySQL installation wizard was run and the step h.ii followed under installation on pg. 4), from “...../Databases>” prompt, type the command “**mysql --user=root < loadDemos.sql**”.
 7. Exit from the Command Prompt environment and go back into Windows environment.
 8. You can launch the application by double clicking the desktop shortcut “Shortcut to FireGUIv2.8.exe” or from the Windows menu
Start->All Programs->Mississippi State University->FireGUIv2.8.
 9. Alternatively, you can launch as follows. From Windows Explorer, change to directory where you have installed the software. Double click on "Application". Double click on "Executable". Double click on "FireGUIv2.8.exe" to run the application.

Note: If you would like to transfer all of the simulations from an older version of FireGUI, you may copy the entire *simrep* folder from the old installed location to the new location. i.e., copy the folder <old location>\Application\Executable\simrep to the
C:\ProgramFiles\MississippiStateU\FireModelNetworkGUI_v2.8\Application\Executable folder (or wherever you installed the software). This will replace the newly installed *simrep* folder which only contains a couple of demo runs for each geometry with your preexisting *simrep* folder.

Downloading and Installing MySQL

This document provides a brief guide to downloading and installing the MySQL database server software on a Microsoft Windows-based PC. It is recommended to have your system administrator install this, especially if you are unfamiliar with installation procedures.

Downloading

- 1) There is a lot of information and downloads available on the MySQL website, which can make navigating to the correct download link challenging. The following path can be followed to reach the correct download page from the MySQL homepage. (NOTE: As of this writing (Apr. 2008), the correct download

page is accessible via the following link: <http://dev.mysql.com/downloads/> Skip to Step 2, if this link works)

- a. Go to the MySQL homepage: <http://www.mysql.com/>
 - b. In the column on the right side of the webpage, select “**Downloads**”
 - c. This should bring you to the “**MySQL Downloads**” page.
- 2) Once at the “**MySQL Downloads**” page, look for the heading “**MySQL Community Server**”. Under this heading, there should be a section titled “**Older Releases:**” with a link for the “**MySQL 4.1 --Previous GA release**”. Follow this link.
 - 3) The page that comes up will provide numerous links to different operating systems. Scroll down the page until the heading “**Windows downloads**” is seen.
 - 4) Choose either the complete package (“**Windows (x86)**”) or the essentials package (“**Windows Essentials (x86)**”) by selecting the applicable “**Pick a mirror**” link.
 - 5) On the next page, fill out the requested information (if you like), or just follow the link to the downloads (on the bottom of the page).
 - 6) Select a download server (“mirror”) from which to download the software.

Installing

- 1) Unzip the downloaded file using a file decompression program (e.g. WinZip) or use the functionality built into Windows XP, if available.
- 2) Open the installer file (Setup.exe) by double clicking it. As suggested in the Network Model documentation, the default selections can be followed in the install process.
- 3) At the end of the initial install process, the checkbox for “Configure the MySQL Server” is checked by default. Leave this checked to configure the server when you finish the install process. Click “Finish”.
- 4) When going through the Server Configuration Wizard screens, most of the items can be left as defaults, though some will need to be altered as appropriate (namely, step h.ii. and step i below):
 - a. Configuration Type: “**Detailed Configuration**” (default)
 - b. Server Type: “**Developer Machine**” (default)
 - c. Database Usage: “**Multifunctional Database**” (default)
 - d. Drive for InnoDB File. Simply click the “**Next >**” button to keep the defaults
 - e. Approximate Number of Connections: “**Decision Support (DSS)/OLAP**” (default)

- f. Networking Options: “**Enable TCP/IP**” (checked by default)
- g. Character Set: “**Standard Character Set**” (default)
- h. Windows Options:
 - i. “**Install as Windows Service**” (checked by default)
 - ii. “**Include Bin Directory in Windows PATH**” (not checked by default). This item should be CHECKED.
- i. Security Options: “**Modify Security Settings**” (checked by default). This item should be UNCHECKED. This will gray out the other settings.
- j. On the next screen, the “**Execute**” button should be clicked to finish the configuration.

5) These steps complete the installation of MySQL. Below are instructions to quickly check for a successful installation.

Testing

- 1) After completing the installation wizard, in a command prompt window (see windows help if you don’t know how to do this) type “**mysql --user=root**” to see if it successfully connects to the database server. It should give you a prompt “mysql>”.
- 2) At the “mysql>” prompt, type “**show databases;**” to see the default databases. If you have been successful, you should see on your monitor at least the following (if previously installed you may see additional databases in the list):

```
mysql> show databases;
+-----+
| Database |
+-----+
| mysql    |
| test     |
+-----+
2 rows in set (0.06 sec)
```

- 3) Type "quit" to exit. Now you should be ready to continue with step #3 from the above section “To install the software from the enclosed CD”.

Directory Structure

Successful installation of the FireModelNetworkGUI software creates a directory called the FireModelNetworkGUI_v2.8 at the chosen location. This folder contains a subdirectory called Application (as shown in Figure 2-1). The Application directory contains three subdirectories: Databases, Executable, and Images.

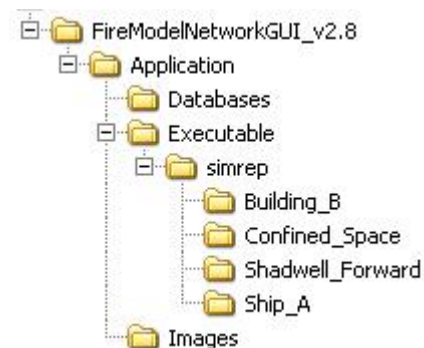


Figure 2-1 Directory Structure Created at Installation Location

The Databases directory contains four demonstration databases and a script to load them. The Executable directory contains the GUI executable plus its required dll files, two configuration files called Options.xml and dbconfig.txt, the HAI network model executable (version 1.2), and a subdirectory, simrep, which serves as a simulation repository for storage of results of simulations. The Images directory contains graphical images used by the GUI.

Software has been tested on the following which meet or exceed minimum computer requirements:

- 1) 2.6 GHz Pentium 4 desktop, 512 MB RAM, Windows XP, ATI Radeon Fire GL 8800 w/128 MB Video RAM, running at 1280x1024 screen resolution. This machine performs very well on all demo databases.
- 2) 1.7 GHz Pentium M laptop, 512 MB RAM, Windows XP, ATI Mobility Fire GL T2 w/128 MB Video RAM, running at 1400x1050 screen resolution. This machine performs very well on all demo databases.
- 3) Dual Processor AMD Athlon 2400+, 2 GB RAM, Windows 2000 SP4, Nvidia GeForce4 Ti 4400 w/128 MB Video RAM. This machine performs very well on all databases.
- 4) 2.3 GHz Intel Core 2 T7600 laptop, 3 GB RAM, Windows XP, ATI Mobility FireGL V5250 with 512 MB video RAM, running at 1400 x 1050 screen resolution. This machine performs very well on all demo databases.

Software was also tested on the following which fall below the minimum requirements in one or more categories:

- 1) 1.8 GHz Pentium 4 desktop, 256 MB RAM, Windows XP, Nvidia GeForce2 MX/MX 400 w/64 MB Video RAM, running at 1600x1200 screen resolution. This machine performed very well on graphics and satisfactory on simulations.
- 2) 2 GHz Intel Core 2 Duo laptop, 2GB RAM, Windows Vista Home, Nvidia GeForce 8400 MGS w/64 MB dedicated video memory and total 830 MB shared video memory, running at 1280 x 800 screen resolution. This machine performed well on graphics and simulations on all databases.
- 3) 2.4 GHz Pentium 4 laptop, 512 MB RAM, Windows XP, ATI Radeon 7500C w/32 MB Video RAM, running at 1280x1024 screen resolution. This machine performed satisfactory on Confined_Space; not as good on Building_B and Ship_A.
- 4) 2.8 GHz Pentium 4 laptop, 512 MB RAM, Windows XP, ATI Mobility Radeon 7500 w/32 MB Video RAM, running at 1024x768 screen resolution. This machine had difficulty loading the more complex geometries.
- 5) 1.6 GHz Pentium M, 768 MB RAM, ATI Mobility Radeon AGP w/16 MB Video RAM, running at 1024x768 screen resolution. This machine performed poorly on all databases.

3.0 QUICK START AND INSTALLATION TEST

This section provides a very simple example of the steps to run a simulation. Successfully following these steps and seeing simulation results similar to the final step should also verify that the installation was correct. Double-click the shortcut on the desktop “Shortcut to FireGUIv2.8” to start the application.

Step 1: The Database Selection dialog (shown in Figure 3-1) pops up. From the drop down menu, select the Confined Space database (Confined_Space) and click OK

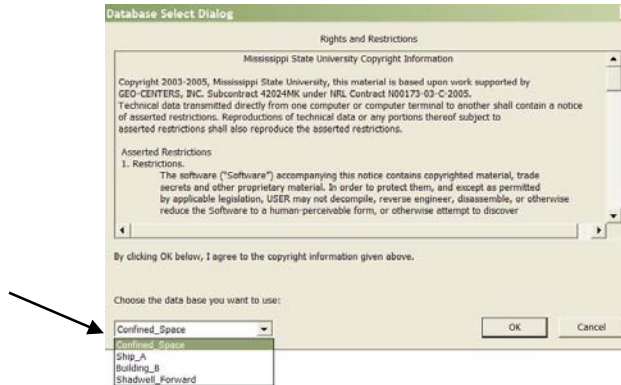


Figure 3-1 Database Selection

This should bring up the main Fire Model Network GUI window.

Step 2: Click the Fire Simulation button as shown in Figure 3-2.

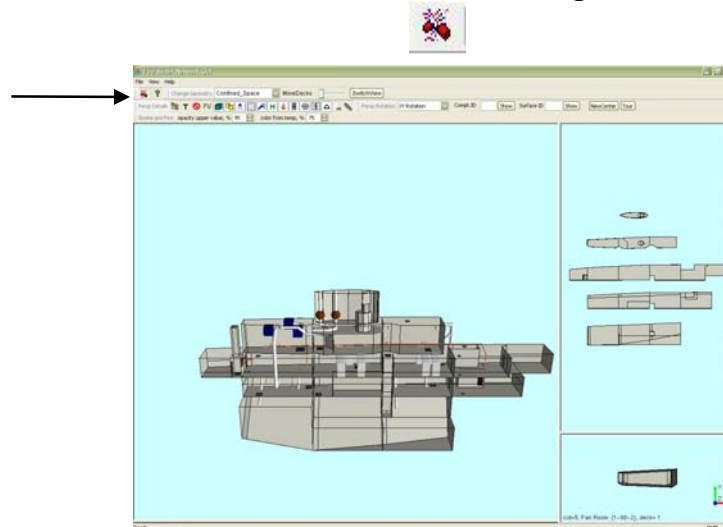


Figure 3-2 Fire Simulation Button Location

Two new popup windows should appear named Fire Simulation and Object State Editor.

Step 3: In the Fire Simulation popup (shown in Figure 3-3), by default one fire source has already been added and it defaults to the first compartment. Additional fire sources can be added with the *Add Fire* button, but for this test only use the one specified in the next step.

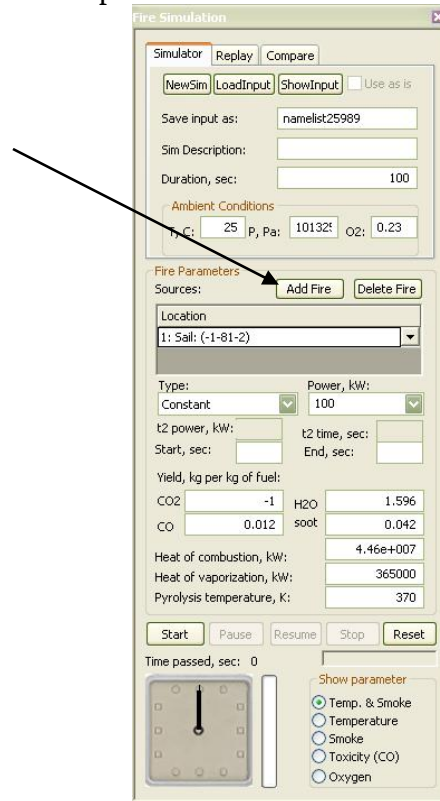


Figure 3-3 Fire Simulation Popup

Step 4: Change the fire source location to compartment 13, Torpedo Room (Figure 3-4)

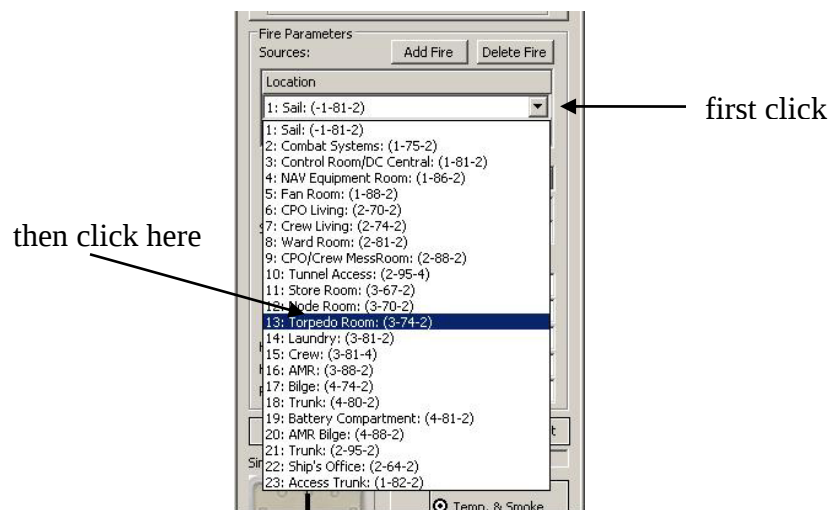


Figure 3-4 Selecting Fire Source

Step 5: Change the Power to 1000 (Figure 3-5)

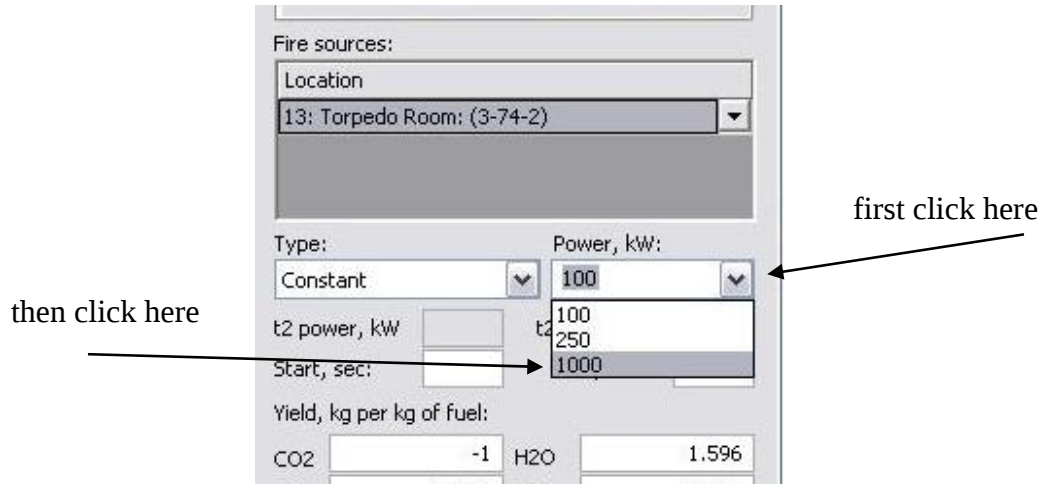


Figure 3-5 Power Settings

Step 6: In the object state popup window (Figure 3-6), check the *Include FrameBays* box. This currently applies only to the Confined_Space.

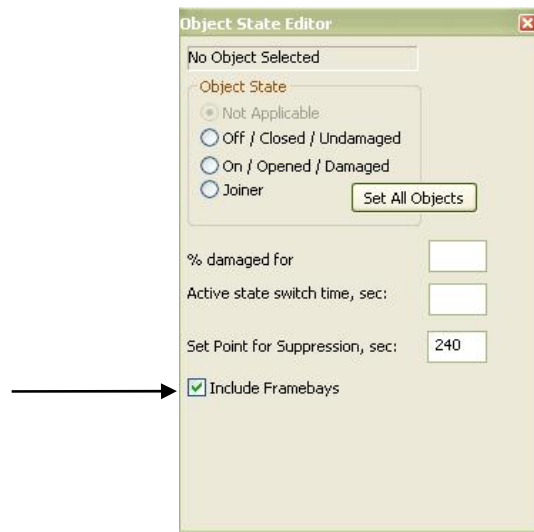


Figure 3-6 Including Framebays in the Object State Editor

Step 7: In the Fire Simulation popup (Figure 3-7), Click the *Start* button

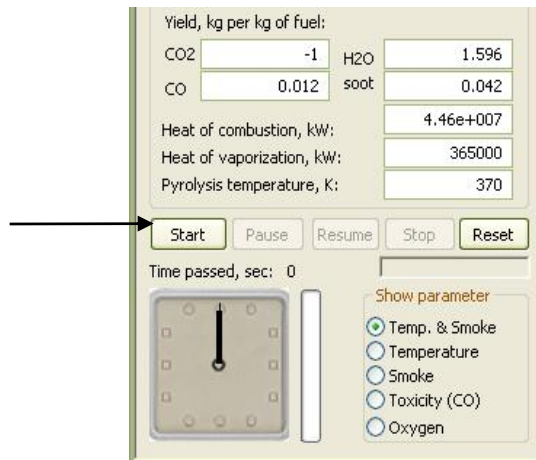


Figure 3-7 Start Button Location

Step 8: The program should start running and in a few seconds, you should see compartment 13 turn yellow, then red as simulation runs, and another compartment turn yellow as shown in Figure 3-8. This simulation should stop when the time reaches 100 seconds (the default time).

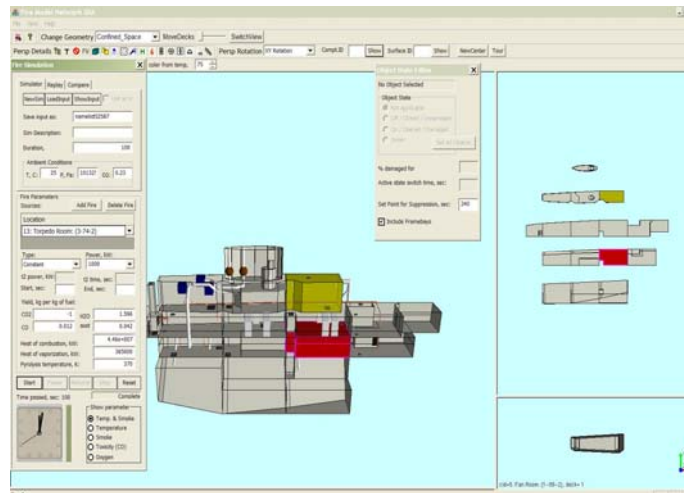


Figure 3-8 Simulation Visualization

The remainder of this document provides more details on setting up, running, and viewing simulations.

4.0 DATABASE SELECTION

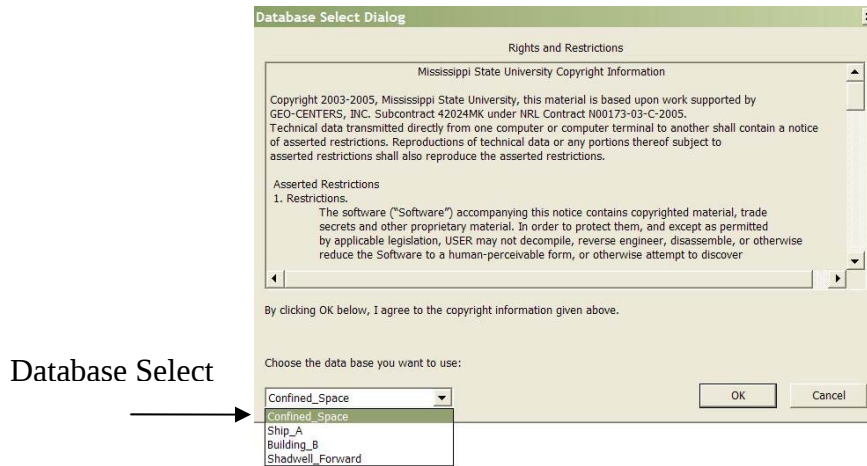


Figure 4-1 Database Selection

When the application is started, a dialog box (shown in Figure 4-1) is displayed for selecting the database. (For more details on the names which appear in the drop-down list see Section 12.1.) This dialog box also contains the copyright information.

5.0 GUI LAYOUT

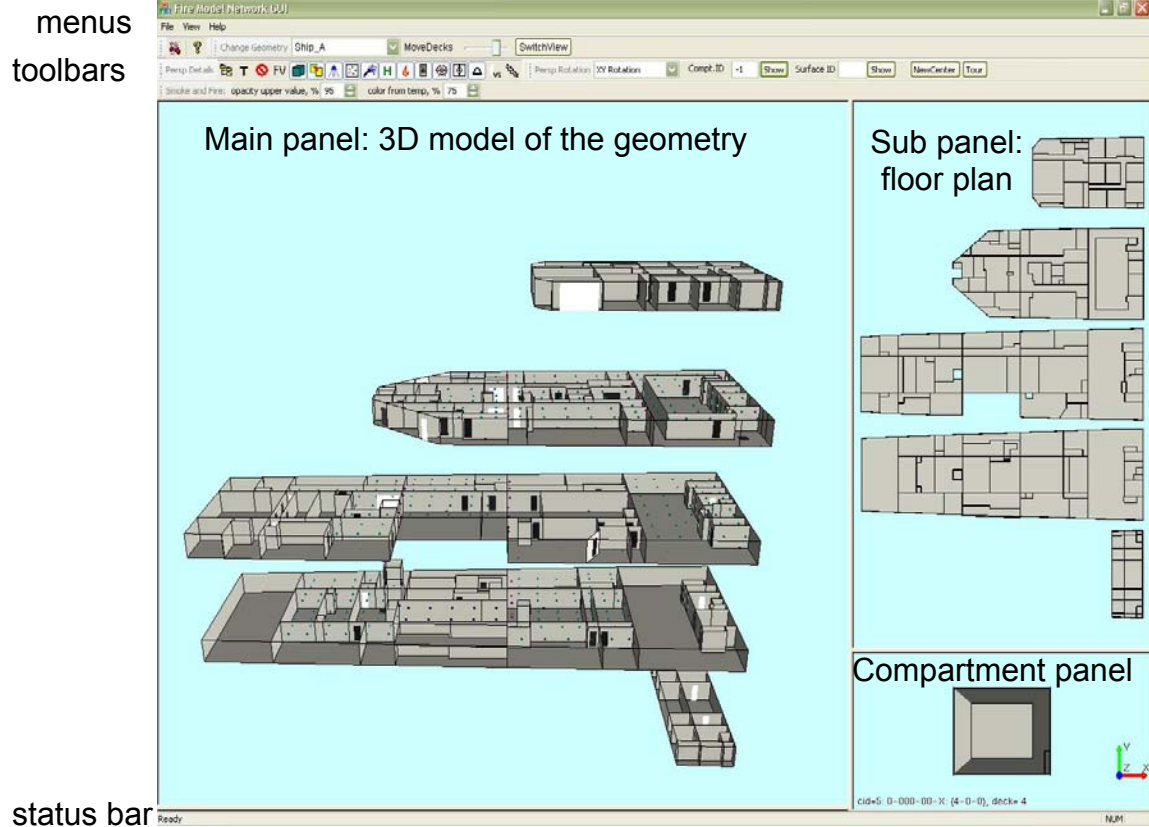


Figure 5-1 Graphical User Interface Layout

The GUI consists of six major components (Figure 5-1): menus, toolbars, status bar, main panel displaying the 3D model of the geometry, and two small panels displaying a single selected compartment and a floor plan view of the model.

5.1 Panels and Views

The main panel occupies the largest portion of the screen and normally displays the 3D model of the geometry. The other panels display another view of the ship or an individual compartment.

There are currently three views which can be displayed in the graphics panels: 1) A 3D model of the geometry which is used for selecting and setting the initial states of various objects (e.g., doors, fans, hatches) and displaying simulation results, 2) a 3D view of a single compartment which is used for selecting and setting states of a bulkhead which has been damaged, and 3) a floor plan view which shows a floor plan (similar to blueprint) of a ship or building. Section 13.0 explains in more detail the behavior of the different panels and views.

5.2 Resizing Panels

By default the main panel is larger than the other ones. It can be changed by dragging the borders to the desired locations (shown in Figure 5-2).

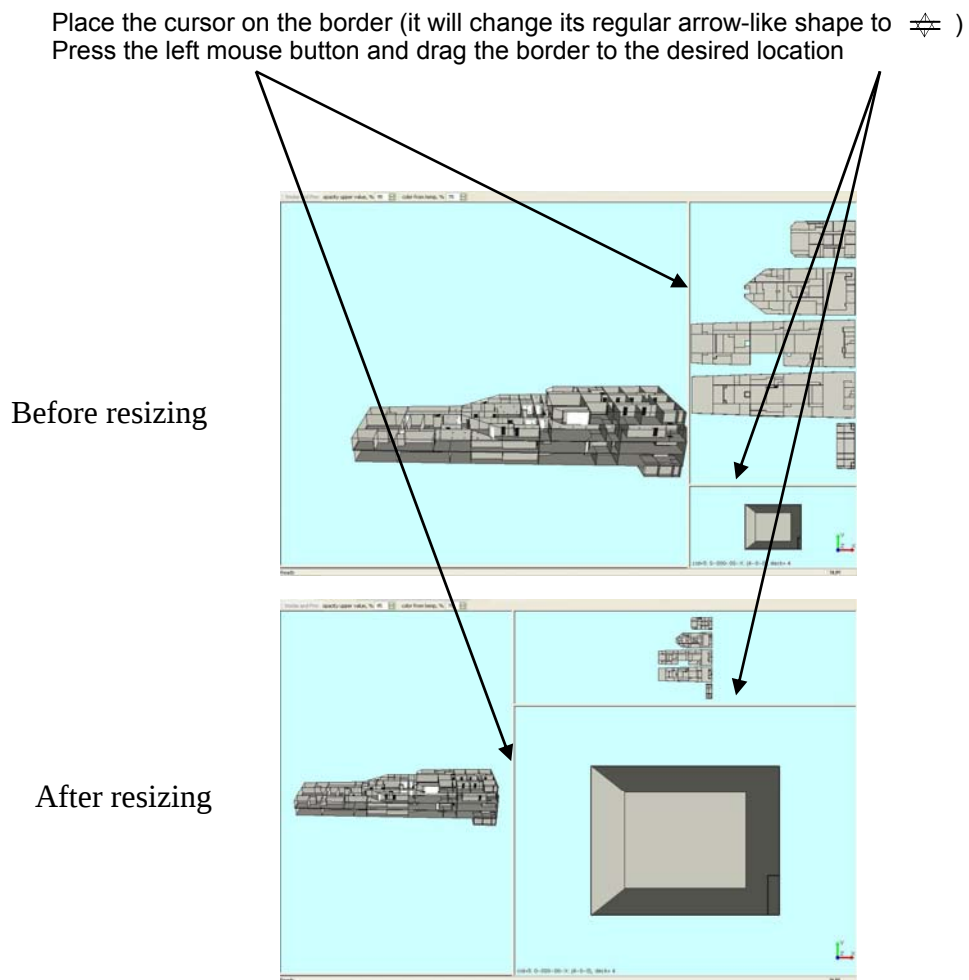


Figure 5-2 Panel Resizing

5.3 SwitchView

There is a *SwitchView* button (shown in Figure 5-3) which will switch the main panel's view with that of the sub-panel (the upper right panel). This provides a quick way to swap the plan view to the main panel for easier selection of compartments, and then to swap it back to 3D view as desired without having to resize the panels by dragging their borders.

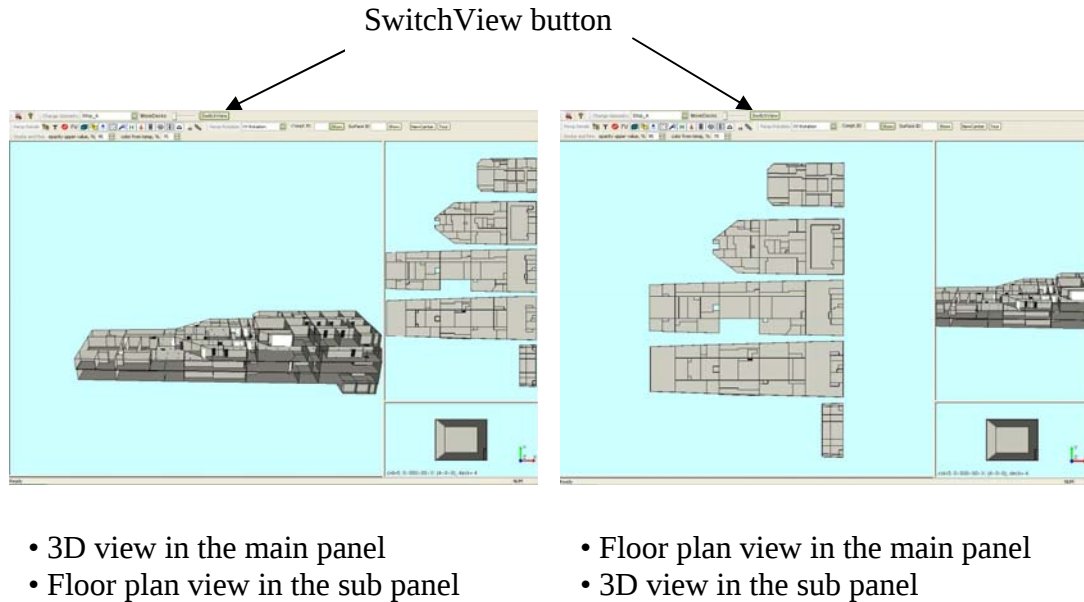


Figure 5-3 Switching Views

6.0 TOOLBAR

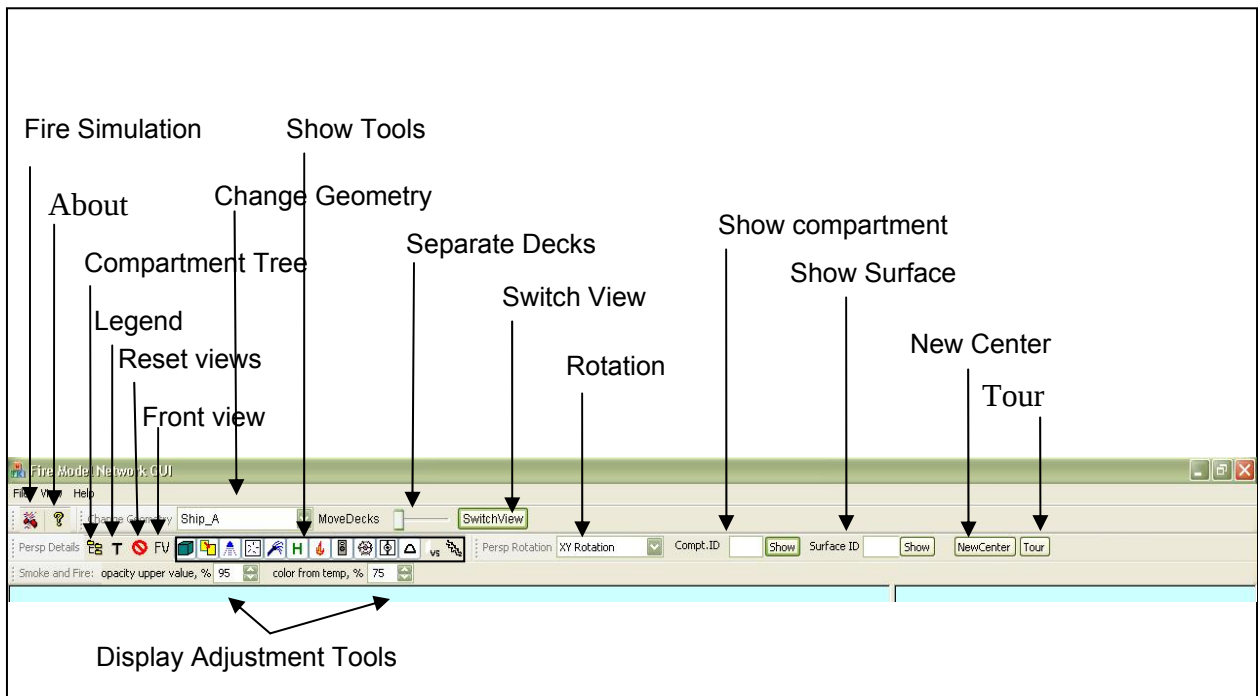
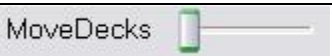
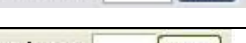
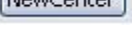


Figure 6-1 Toolbar Components

Figure 6-1 shows the location of the toolbar components. Below is a reference Table 6-1 showing the icon or symbol, name of the tool, description of the tool, and reference to the section which explains the details of the tool.

Table 6-1 Toolbar Components

Icon / Symbol	Tool Name	Description	Reference Section
	Fire Simulation	Opens two dialogs that are used to run, replay, or compare fire simulations	Section 8.0
	About	Same as Help → About menu. Shows information about the application	Section 12.0
	Change geometry	Changes the geometry (model) to the one selected in the drop down list	---
	Move (Separate) Decks	Slider to separate decks in the 3D view	Section 7.4
	Switch View	Switches between 3D view and floor plan view	Section 5.3

	Compartment Tree Browser	Provides a tree structure of checkboxes to show or hide the compartments or decks	Section 10.0
	Legend	Shows color map legend	Section 11.0
	Reset views	Resets views and panels to default positions	Section 7.5.1
	Front View	Sets front-view position of the geometry in the 3D view (for ships this sets view to starboard side)	Section 7.5.2
	Surfaces	Shows or hides surfaces (walls) to toggle between solid surfaces and wire-frame model	Section 9.1
	Edges	Shows or hides edges for each surface	Section 9.1
	Suppression	Shows or hides suppression system	Section 9.2
	Ventilation	Shows or hides ventilation system	Section 9.3
	Water Mist	Shows or hides water mist system	Section 9.4
	Inert Gas	Shows or hides inert gas system	Section 9.4
	Firemain	Shows or hides firemain system	Section 9.4
	Doors	Shows or hides doors and archways	Section 9.5
	Scuttles	Shows or hides scuttles	Section 9.6
	Hatches	Shows or hides hatches	Section 9.6
	Ratholes	Shows or hides ratholes	Section 9.7
	Virtual Surfaces	Shows or hides virtual surfaces	Section 9.8
	Damaged Surfaces	Shows or hides damaged surfaces (walls)	Section 9.9
	Rotation	Selects rotation mode for the 3D model	Section 7.1
	Show Compartment	Highlights the compartment with the given id	Section 9.10
	Show Surface	Highlights the surface with the given id	Section 9.11
	New Center	Calculates new center of the model that is used for rotations	Section 10.1

	Tour	Takes through a tour along a fixed path	Section 7.6
Smoke and Fire: opacity upper value, % 95 + - color from temp, % 75 + -	Display Adjustment	Adjusts visualization of smoke and fire	Section 14.0

7.0 GRAPHICAL INTERACTIONS

This section covers basic mouse interactions within the viewing windows, and a few other graphical elements (buttons and sliders) which control the display.

7.1 Rotate

The 3D model can be rotated by moving the mouse while keeping the left mouse button pressed (preferred method) or by using the cursor keys (arrow keys) on the key board. The up/down arrow keys rotate about the X axis; the left/right arrow keys rotate about the Y axis. Some users prefer the control given by using the arrow keys.

There are four modes of rotation that are controlled by the rotation tool shown in Figure 7-1.

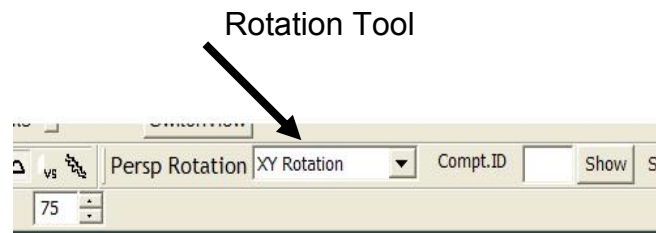


Figure 7-1 Rotation Tool

The modes are:

1. X Rotation
2. Y Rotation
3. X or Y Rotation
4. XY Rotation (default)

Note: The X and Y axis for Section 7.1.1 through Section 7.1.4 refer to the screen axes, not geometry axes. The screen X axis runs left and right, the screen Y axis runs up and down.

7.1.1 X Rotation

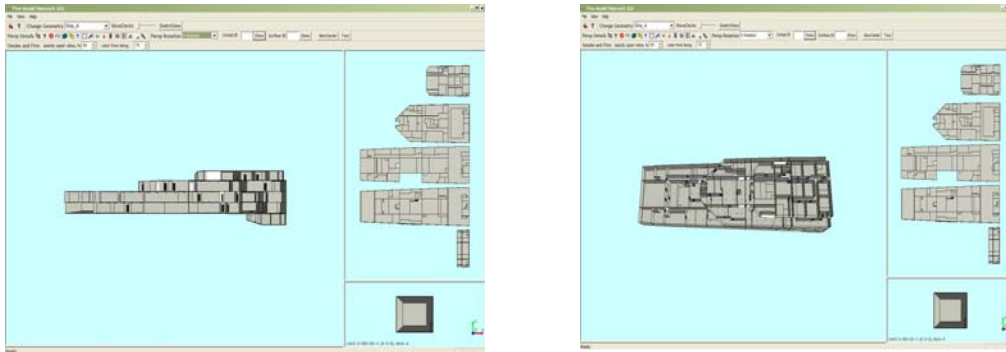


Figure 7-2 X Rotation

In this mode the ship model can be rotated only around the x-axis (horizontal one) by moving the mouse up and down. Left and right movements of the mouse are ignored. To make the above example clearer, the model has been first rotated to the front view position as shown in the left picture of Figure 7-2. The right picture of Figure 7-2 above shows the model rotated around the x-axis.

7.1.2 Y Rotation

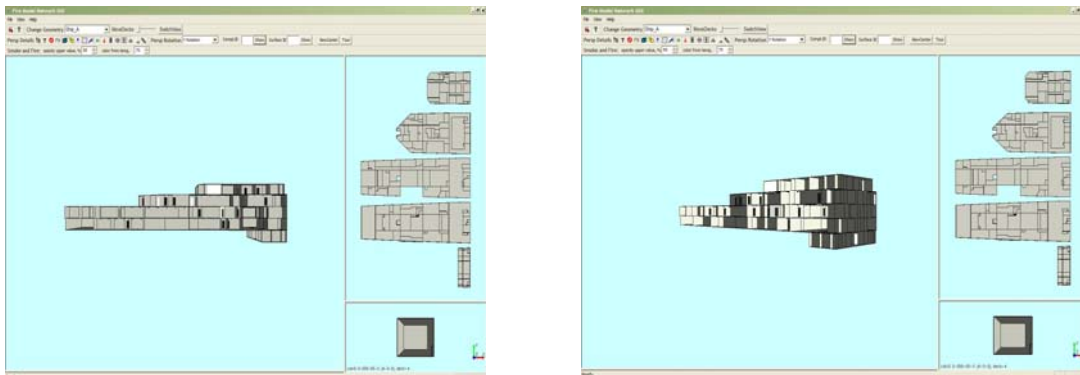


Figure 7-3 Y Rotation

In this mode the ship model can be rotated only around the y-axis (vertical one) by moving the mouse left and right. Up and down movements of the mouse are ignored. To make the above example clearer, the model has been first rotated to the front view position as shown in the left picture of Figure 7-3. The right picture of Figure 7-3 shows the model rotated around the y-axis.

7.1.3 X or Y Rotation

In this mode, the GUI picks the first mouse movement, after pressing the left mouse button. If it is up or down, it automatically switches to the *X Rotation* mode. If it is left

or right, it switches to *Y Rotation*. Releasing the mouse button returns the GUI rotation mode to the *X or Y Rotation*.

7.1.4 XY Rotation

In this mode, the ship model is rotated around the center of the model. The model can be rotated about both the horizontal and vertical axes simultaneously.

7.2 Zoom In and Out

The 3D model can be zoomed in and out by moving the mouse up and down, respectively, while keeping the middle mouse button pressed. Note that the mouse should be a three button mouse. If the mouse has a wheel as the middle button, press and drag it instead of rolling it. In Figure 7-4, the middle picture below shows the original scene at left zoomed in and the right picture shows the scene zoomed out. If you do not have a three button mouse, you may hold down the Shift key and press the right mouse button while dragging it up or down to zoom.

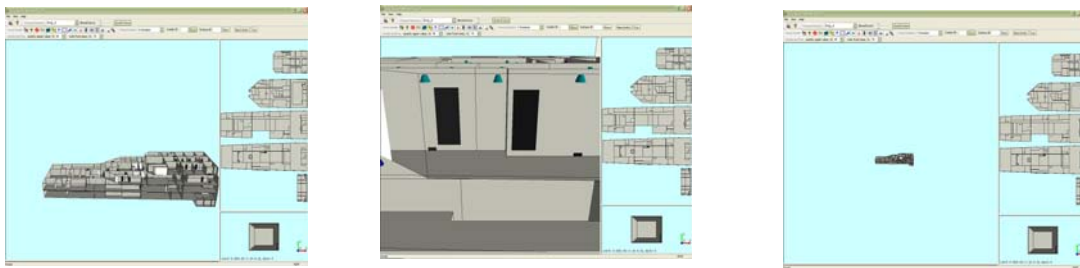


Figure 7-4 Zooming In and Out

7.3 Move/Translate

The 3D model can be moved inside the panel by moving the mouse, while keeping the right mouse button pressed as shown in Figure 7-5.

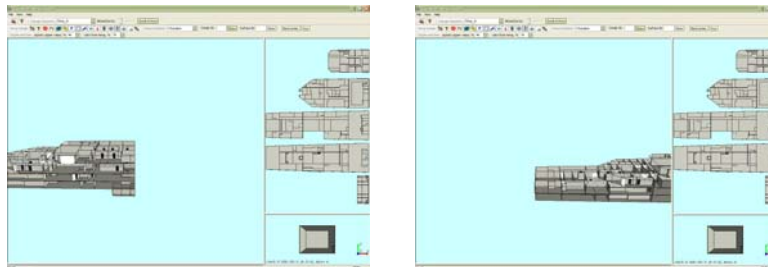


Figure 7-5 Translating Left and Right

7.4 Deck Separator Slider

The Deck Separator Slider (*MoveDecks*) shown in Figure 7-6 is provided as a feature to assist viewing of the interior of a 3D model. Compartments which have at least one surface which lies on the external boundary of the model (between the ship/building and the environment) can be viewed by simply rotating the model, since the surfaces of a compartment facing the viewer are made transparent. However, interior compartments completely surrounded by other compartments cannot be seen normally.

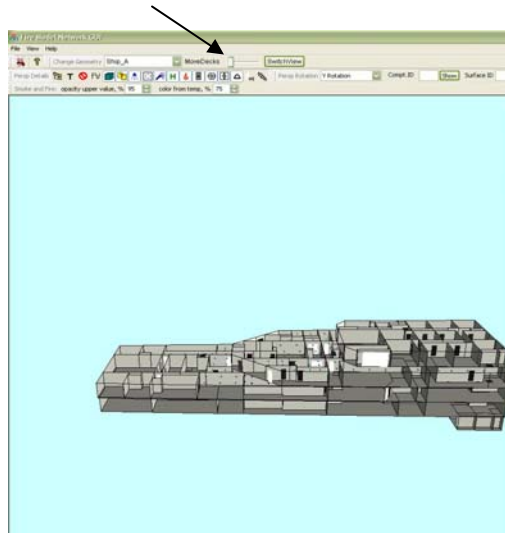


Figure 7-6 *MoveDecks* Slider at Initial Position

Dragging the slider bar to the right with the left mouse button pressed will introduce spacing between the decks/floors so that viewing of interior compartments is possible as shown in Figure 7-7. Returning the slider bar all the way to the left removes this spacing.



Figure 7-7 After Moving the *MoveDecks* Slider to the Right

7.5 Preset Positions

Sometimes after working with a model and performing rotation, zooming, and translation, the user can either become disoriented with respect to the model, can cause the geometry to move out of the viewing window, or simply desires to return the model to its default viewing position. Two buttons are provided to assist with restoration of particular views as shown in Figure 7-8. Any geometry and corresponding database could have different orientations depending on the decisions made by the AutoCAD drafter.

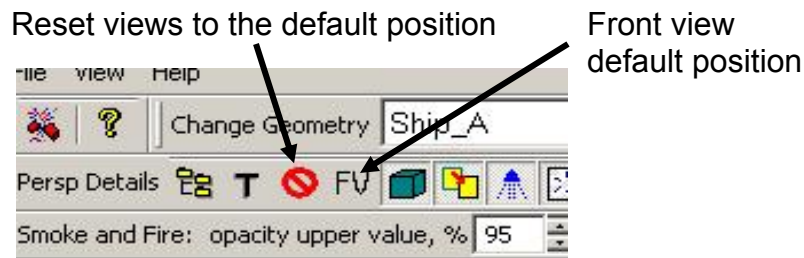


Figure 7-8 Reset and Front View Button Positions

7.5.1 Reset Views

This button resets the rotation, zooming, and translation to the default position in each panel and restores the panels to their default sizes. It also restores the MoveDecks slider to its initial position (no deck separation in the 3D view) and restores the compartment panel to its initial state. The default position is with the geometry centered in the panel, entirely visible, and viewed at an angle from the front and above (viewing angle with respect to the geometry x-axis is 90 degrees, and viewing angle is approximately 20 degrees above the geometry y-axis).

7.5.2 Front View Position

The front view position displays the scene in exact front view (i.e. the viewing angle with respect to the geometry x-axis is 90 degrees and with the geometry y-axis is zero). This position (shown in Figure 7-9) helps in rotating the scene easily to the required angle.

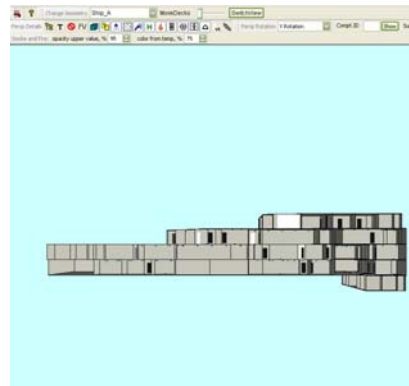


Figure 7-9 Front View Position

7.6 Tour Button

The *Tour* button is an experimental feature which performs some preprogrammed 3D model zooming and rotation. It could possibly be enhanced in the future to allow user programmable paths to be specified and replayed to give a “fly thru” effect for the model, allowing the user to start, stop, change direction, change camera viewing angle and change zoom speed. We welcome comments on this feature.

8.0 FIRE SIMULATION TOOL

In addition to compartments, a ship has active elements or objects like junctions (doors, hatches, scuttles), suppression systems, ventilation fans and bulkheads, whose states can be changed for a simulation. Creation of a new simulation begins with setting the states of the ship's active objects, setting simulation parameters (e.g. duration of the simulation and ambient environment parameters) and fire propagation parameters (e.g. number of fire sources and their strength) through the GUI. An input file is created and

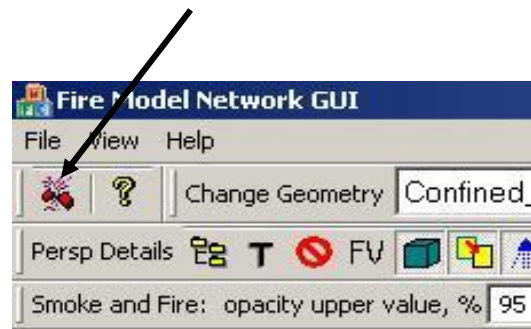


Figure 8-1 Fire Simulation Tool Location

passed to the network model which produces an output file. This output file is read by the GUI while it is being written by the network model and the results are visualized. Refer to Section 8.2.4 for details on how to share simulation data with another user.

By clicking on the Fire Simulation Tool (Figure 8-1), two new dialog windows pop up: the Object State Editor Dialog and the Fire Simulation Dialog as shown in Figure 8-2. One can move the pop up dialogs by dragging them to the desired location.

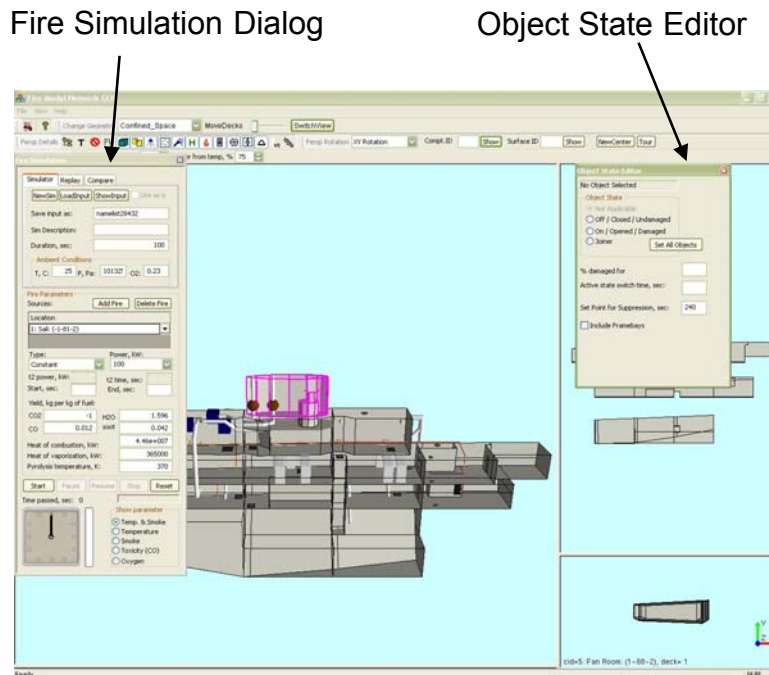


Figure 8-2 Fire Simulation and Object State Editor Popups

8.1 Object State Editor

The Object State Editor shown in Figure 8-3 appears when either the Fire Simulation tool button is clicked or when any object in any of the three panels (main, sub, or compartment) is clicked. Each active object may be in several different states depending on its type. A junction can be either in *opened* state or in *closed* state. A door has another special state called *Joiner* (refer to Section 9.5). A fan or damper can be *on* or *off* and a bulkhead can be *damaged* or *undamaged*. Using the state editor dialog, the user can set the state of any active object. Some objects' initial state at simulation start time persists throughout the entire simulation (e.g. junctions) whereas others' state may be changed by the simulator (e.g. fans or suppression systems turning on or off) during the run.

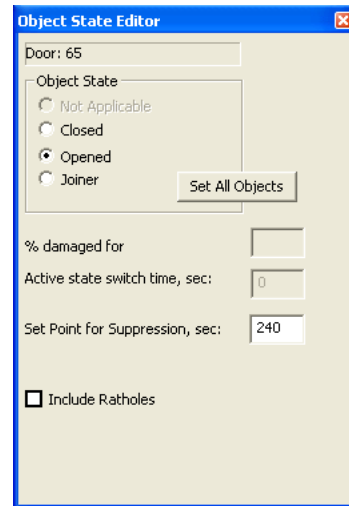


Figure 8-3 Object State Editor Dialog

To select an active object, click the left mouse button on the object (or place the mouse pointer on the object, press and hold SHIFT key and click right mouse button). The selection is confirmed by the changed name and ID in the top field in the Object State Editor dialog box. Once the object is selected, select the state by clicking on one of the options provided. Note that since the floor plan view does not show any active objects, they have to be selected only from the 3D view.

The change of state is visualized by a change in object color. In general, a light color corresponds to an *on/open/damaged* state and a dark color to an *off/closed/undamaged* state. For example, an open door is white, a closed door is black. An open damper is yellow, and a closed damper is brown. Note that the labels for the states of the active objects in the object state editor dialog change accordingly. For example, hatch and scuttle have *opened* and *closed* states, door has *opened*, *closed* and *joiner*, ventilation node has *on* and *off*, archway has *archway* and *smoke curtain*, and surface has *damaged* and *undamaged*.

8.1.1 Doors, Hatches, and Scuttles

Doors, hatches, and scuttles can be set to closed, or opened. In Figure 8-3, door 65 has been selected and set to open. Joiner state (refer Section 9.5) is applicable only to doors.

After any door, hatch, or scuttle is selected, choosing opened or closed, and clicking the *set all objects* button will set all objects of that type to that state. For example, clicking any hatch, then choosing opened, and clicking the *set all objects* button will set all hatches to *opened* state.

8.1.2 Archways (Smoke Curtains)

An archway can be changed from archway to a smoke curtain. Smoke curtains are treated as closed doors for simulation purposes. For a new simulation, all archways are in the archway state (i.e., on) and all doors and other objects are closed (or off).

8.1.3 Ventilation System

The ventilation nodes, like fans and dampers, can be turned on or off. The network model does not allow changing of states during runtime. However, a delayed change of status can be declared prior to the model execution using *Active State Switch Time* text box. For example, in Figure 8-4, the ventilation node 118 (fan) is scheduled to change its status from on to off after 60 seconds of simulation time. The change of state always means a transition from one state to the opposite: e.g. from open to closed or from off to on. The Switch Time is ignored by the network model for junctions and surfaces.

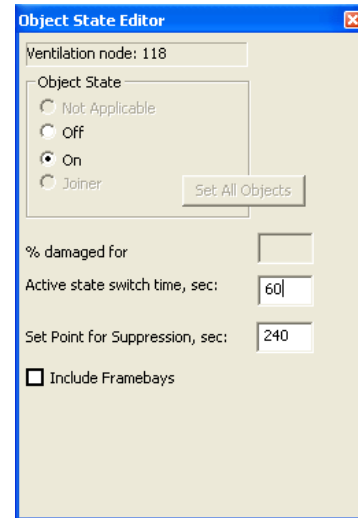


Figure 8-4 Ventilation Node Settings

8.1.4 Suppression System

Suppression nozzles are turned on only by the network model and so their states cannot be set by the user. A text box is provided for changing the set point for the suppression system. Set point is the time only after which the suppression gets activated. The default value is 240 seconds for Ship_A model. The model turns on the suppression system individually for each compartment. Conditions of preset temperature and preset time should be satisfied for the suppression system to turn on.

8.1.5 Surfaces

A surface (bulkhead/wall) can have a state of damaged or undamaged. Surfaces cannot be selected from the 3D scene; they can only be selected from the compartment panel (bottom right panel). To select a surface, first select the compartment that contains the surface. Rotate the compartment in the panel so that the surface is facing the user. Then click the left mouse button on the surface in the compartment panel to select that surface. You can also select by right clicking while keeping SHIFT key depressed. The selected surface is shown in green color in the compartment panel. The surface id is shown in the Object State Editor dialog. Change the state to *Damaged* and give the percentage area of the damage in the text box. To see the damaged surface shown in blue color in the 3D scene (not the compartment subpanel) turn on the Damaged Surfaces button  (Section 9.9). Note that even though the front surface(s) are transparent, you will be selecting them rather than the back surface(s). To select a back surface, rotate the compartment

until the back surface is facing you. For an interior surface, zoom in enough that you pass the front surface.

8.1.6 Ratholes and Framebays

De-Watering Ratholes in Ship_A or Framebays in Confined_Space can be included or excluded in the simulation using two check boxes on the Object State Editor. The checkboxes are shown only if the geometry has the corresponding feature as shown in Figure 8-5 for Ship_A. For more information on ratholes and framebays, see Section 9.7 and Section 9.3 respectively. All the ratholes act as a single unit. Therefore, changing the state for individual ratholes is disabled. All ratholes are shown in white color when included. Including or excluding Framebays does not provide any visual effects.

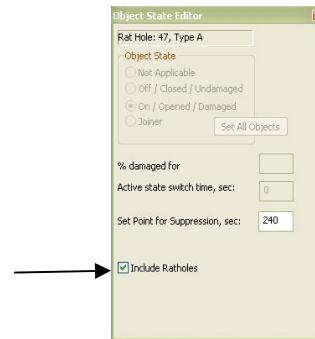


Figure 8-5 Ratholes Checkbox

8.2 Fire Simulation Dialog

The fire simulation dialog box shown in Figure 8-6 is used to set the simulation parameters. It has three tabs: *Simulator*, *Replay*, and *Compare* which are described further in the next sections. Note: If you do not see the entire dialog box as shown here (i.e. if the bottom is cut off), then increase the screen resolution (refer Section 2.0). You may also try hiding the Windows task bar which would give a little more screen space at the bottom for the dialog box.

Simulation parameters include name of the input file created for the particular run and a simulation description, the requested duration of the simulation, external conditions (ambient temperature and pressure), initial concentration of oxygen (assumed to be constant throughout the entire ship), and fire sources. The description and name of the input file are used for identification of the simulation for subsequent replay or comparison.

The simulation is executed by *Start*, *Pause*, *Resume*, and *Stop* buttons. The *Reset* button resets the visualization of simulation results in the GUI.

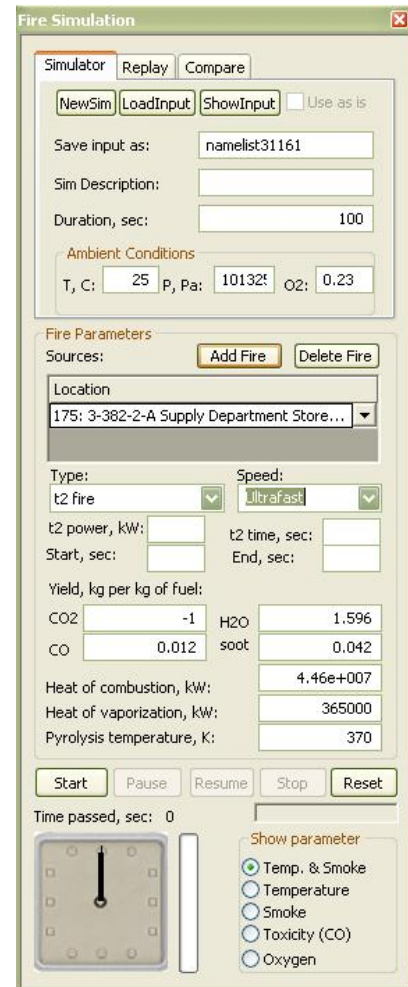


Figure 8-6 Fire Simulation Popup

Fire Sources

The controls in the central part of the GUI allow defining the fire source(s). Each fire source has a unique set of parameters that include location (to be selected from a drop-down list), fire type (*constant*, t^2 fire, and *usetype*), power or speed (depending on which fire type was selected), starting and ending times, fuel parameters and others. By default, a fire source is *constant* in time with a power of 100 Kwatts. Figure 8-6 shows a t^2 fire that is of ultrafast subtype. The *usetype* fire depends upon the database containing the compartment to usetype mapping (each compartment has a usetype specified when the database was built). The *ship_a* and *building_b* databases do contain this mapping for most compartments, but the *shadwell_forward* and the *confined_space* do not. Capability for the user to specify the compartment to usetype mapping will be implemented in a future version of the software.

A simulation can have several fire sources, each of which may have different settings. A new fire source is created by clicking the *Add Fire* button and can be removed by using the *Delete Fire* button. The *Add Fire* Button by default will create a fire source in the first compartment in the database, after which the user may select the desired compartment from the drop-down list and set the fire parameters for this fire source. In order to select

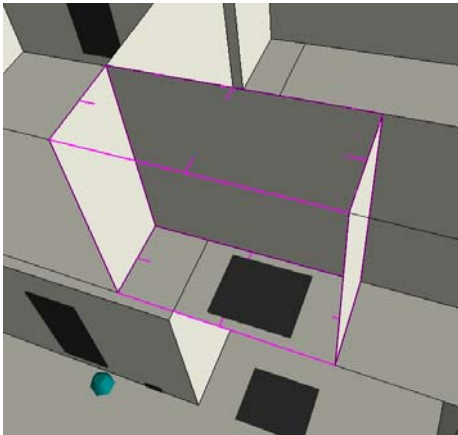


Figure 8-7 Fire Source Highlighting

from the drop-down list, sometimes it is easier if you know the compartment id which can be obtained in several ways. From the 3D view, one can left mouse click in the compartment (but not on an active object) and see the compartment's id in the first field of the object state editor (refer Section 8.1). Also by clicking in the Floor Plan view (refer Section 13.0), the compartment will be highlighted and its id shown in the compartment panel (refer Section 13.3) and in the Compt. ID text box (refer Section 9.10). Any compartment which contains a fire source is outlined with pink color edges by default and small tick marks extending into the compartment as shown in Figure 8-7. The tick marks enable a user to know whether or not a given compartment is on fire when totally surrounded by other compartments which are on fire. In other words, even if the compartment has pink edges but no tick marks point into it, then it is not on fire. During a fire simulation run, a compartment which initially is not on fire can catch on fire. In that case, it is shown with pink edges. Also, fire in a compartment may be extinguished by the suppression system in which case the pink edges are not shown. Thus apart from the propagation of heat and smoke, we can also see the propagation of fire from one compartment to another.

8.2.1 Running a simulation (Simulator tab)

Information from several different sources (the ship geometry stored in the database, the simulation parameters, and the state of the active objects from the GUI) is used to generate an input file (i.e. Fortran namelist file) for the network model.

The *NewSim* button opens a new simulation run and resets the current settings to their default values. The *LoadInput* button is used to load an input file. The *ShowInput* button generates the input file and opens it in notepad. This feature can be used for debugging purposes. The data fields (e.g. Save input as, Duration) have default values. The *Simulation Description* default value is the name of the input file if no description is given by the user. Ambient conditions such as temperature (*T*), pressure (*P*), and oxygen (*O2*) also have default values and can be changed by the user.

Instead of creating an input file from scratch, the *LoadInput* button can be used to load an existing input file to get the simulation settings used in that file. When the *LoadInput* button is clicked, the Available Inputs dialog (as shown in Figure 8-8) is opened with a list of available input files. After the desired file is selected from the list and the *Load*

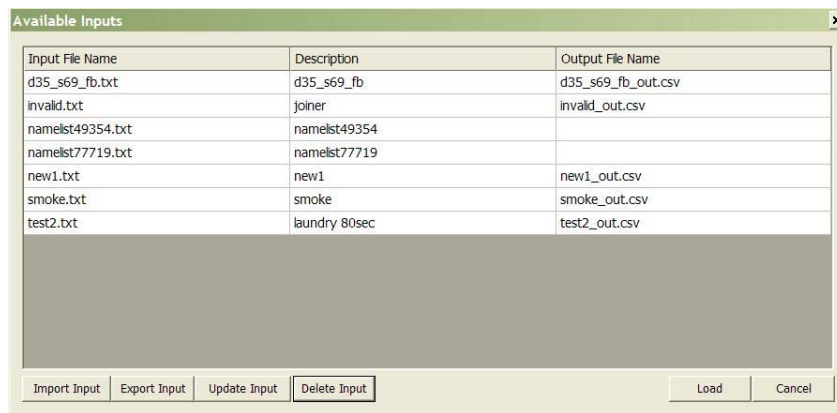


Figure 8-8 Available Inputs Dialog

button is clicked, the fire sources, simulation parameters like duration, and states of the active elements are loaded into the GUI and can be changed by the user thereafter. **If it is desirable to keep the original file unchanged, the “Save Input As” field should be changed to**

a new user supplied name. Otherwise, the original file would be overwritten whenever the *ShowInput* or the *Start* button is pressed. A warning popup appears to remind you that the file is about to be overwritten.

Note: Only the parameters that were set from the FireGUI will be loaded from the existing file. The other required parameters will be read from the database before recreating the file. One exception to this is when the *Use as is* checkbox is checked. In this case, the file is not overwritten or recreated, but submitted to the simulator without modification. Be aware that if you load an input file, change the settings and then check *Use as is*, your changes will be overwritten by the settings from the original file. Once you check *Use as is*, changing the simulation parameters or the active object settings is disabled. *Use as is* checkbox is only enabled after loading an input file.

The creation of the input file occurs **every** time the user clicks on the *Start* button or the *ShowInput* button and will overwrite any existing file having the same name unless the user has checked *Use as is*.

If the Start button was clicked, the Object State Editor is hidden and the status box located above the radio buttons is set to “Preparing ...” as shown in Figure 8-9. If incorrect data is entered (e.g. fire source not defined or duration is not an integer number), an error message box is shown and the status line is set to “Error...”

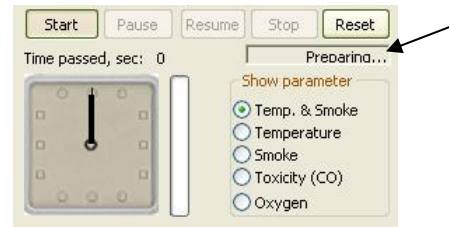


Figure 8-9 Status Box Location

After the file is successfully generated, the system starts the Network model and begins processing its output step by step. The simulation status in the status box is set to “Running..” and the simulation time is shown using an analog clock, a digital clock, as

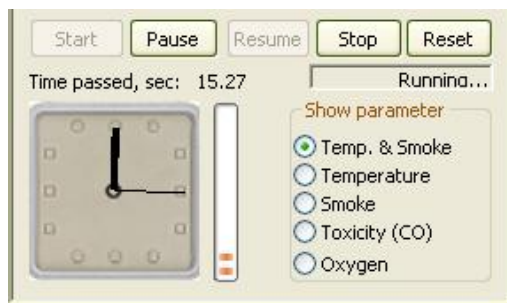


Figure 8-10 Simulation Running

well as a progress bar as shown in Figure 8-10. The digital clock provides exact time; the analog clock makes it easy to compare the rate of simulation with the real time, while the progress bar gives an estimate of how much time is left until the end of simulation. The user may pause or suspend this process, resume execution of a suspended simulation or stop it by clicking on the corresponding button. Results are visualized in both the 3D view and the floor plan view.

Show parameter

The results of the simulation are displayed either by changing the color of the compartment surfaces (temperature, toxicity, and oxygen concentration) or by changing the opacity of the compartment (smoke) as shown in Figure 8-11. Consequently, it is not possible to see simultaneously the temperature and concentration of other parameters like oxygen. The buttons to right of the analog clock allow selecting the parameter to be displayed: temperature and smoke, temperature, smoke, toxicity, or oxygen. Note also that if surfaces are hidden you may not be able to see the temperature display (e.g., if a compartment has an elevated temperature but no smoke, then the temperature display may not be visible until surfaces are displayed again).

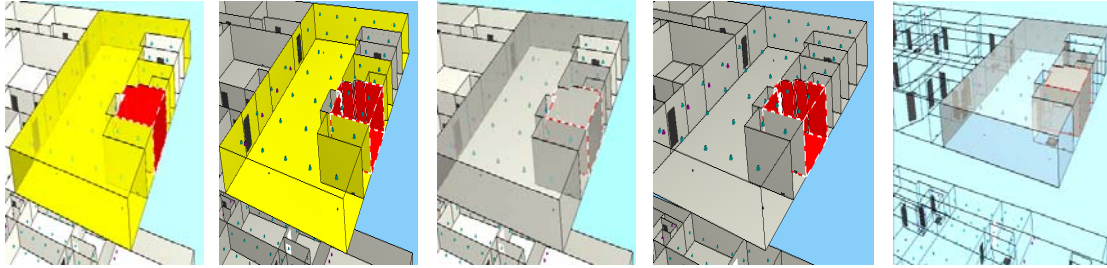


Figure 8-11 From left to right: Temperature and Smoke, Temperature only, Smoke only, Oxygen depletion, and Smoke only with bulkheads hidden

Suppression System Activation

The network model is a one-zone model, i.e. it produces only one value per compartment. Therefore, the suppression system is either activated or not activated for the whole compartment. Thus, a compartment with suppression activated is visualized with a white dashed edge. If that compartment is also the fire source location, it is displayed with a red and white dashed edge; otherwise, with a black and white dashed edge as shown in Figure 8-12 below.

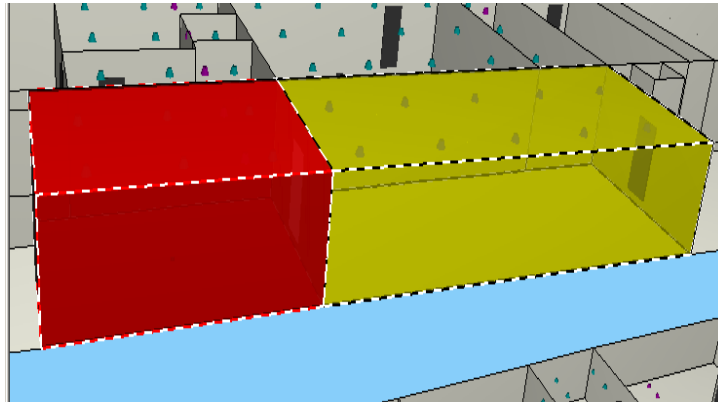


Figure 8-12 Suppression System Activation

Note that we need to run simulations beyond the set point time to see the activation of the suppression system (see section 8.1.4 for details).

8.2.2 Simulation Replay (Replay tab)

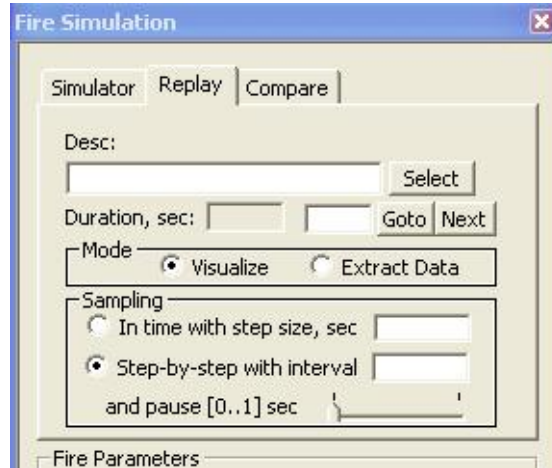


Figure 8-13 Replay Tab of the Fire Simulation Dialog

Since all simulations (both settings and results) are stored in the simulation repository, each simulation can be replayed at a later time by clicking the replay tab in the Fire Simulation Dialog as shown in Figure 8-13. In replaying, the results are read from an existing file and not generated in real time. There are two modes in replay: 1) Visualize and 2) Extract Data. Visualize mode is used to see the simulation results of a run. Extract data mode is used to extract data from the output of a run for quantitative analysis as described in Section 8.3. By default, visualize mode is selected.

To replay a simulation, the user must select from the list of available simulations. Click on the *select* button, and the Available Simulations Dialog shown in Figure 8-14 will pop up, which contains the names of the input files and the descriptions of the simulations.

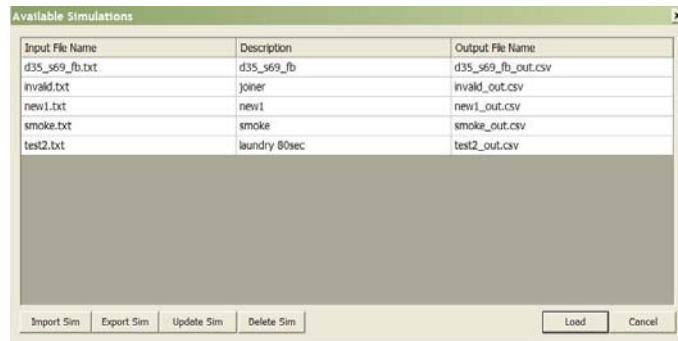


Figure 8-14 Available Simulations Dialog

Select a simulation (by clicking on the name of the input file or description). The selected simulation becomes highlighted. Click on *Load* to confirm the selection or *Cancel* to close the dialog window without selecting a simulation. The remaining four buttons are explained in Section 8.2.4. Note that this dialog shows simulations that have both the input file and its associated simulation output file (.csv) files. Thus, if an input file is created but not executed, it will not be shown in the available simulations.

After a simulation is chosen, the selected input file is read and the ship's active objects are set to the appropriate states. To start replaying, press the *Start* button. The functionality of the rest of the buttons is the same as described previously.

The replay tab also allows the user to control how the simulation is replayed. Replay (reading from a file) is much faster than real-time simulation. To slow down the replay, the user may request a delay (pause) between time steps. On the other hand, for very long simulations, the user may also request skipping time steps (e.g. displaying every tenth time step) making the replay even faster. Figure 8-15 points out the different options to control replay of a simulation.

The network model uses a variable time step during the simulation. While replaying, the user may select a constant rate of time steps (called time sampling which corresponds to a variable temporal rate) or a constant temporal rate (called step sampling with variable amount of time steps skipped).

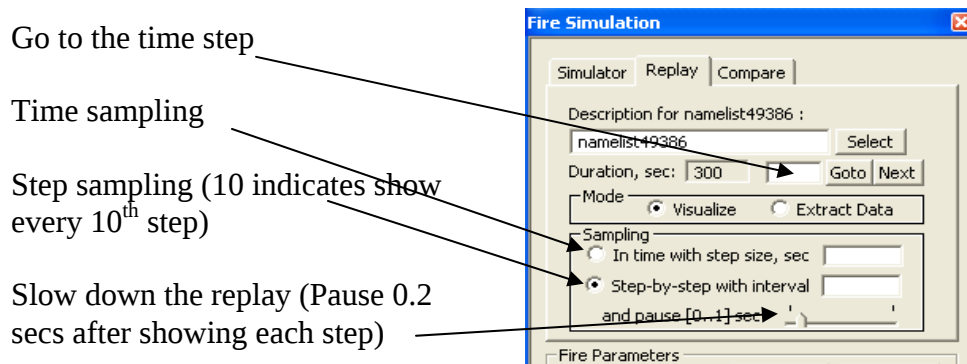


Figure 8-15 Various Components in the Replay Tab

The user may also skip the beginning of the simulation and jump directly to a specified simulation time by giving the time in the text box located to the left of the *Goto* button and clicking the *Goto* button. The *Next* button can be used to go to the next step.

8.2.3 Comparison of Two Simulations (Compare tab)

Comparison of two simulations is an extension of the replay mode to replay two simulations, simultaneously. When the *Compare* tab of the Fire Simulation dialog window is clicked (Figure 8-16), the panels are resized so that two panels with main view are shown each occupying half the screen.

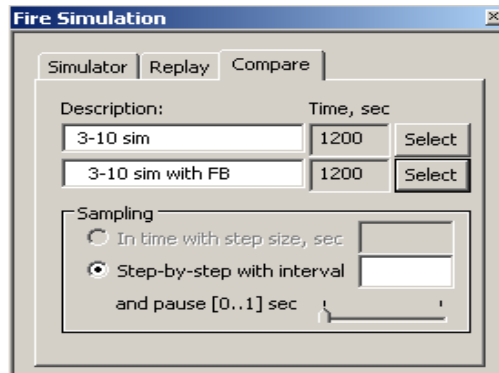


Figure 8-16 Compare Tab

Two previously run simulations are selected by clicking the two *Select* buttons or both runs can be selected simultaneously (use CTRL key to select multiple selections) from the same *Select* button. The simulations can be controlled in the same way as a simple replay (except that time sampling is disabled for comparisons). To see the fire parameters associated with each simulation, click in the description text box of that simulation; the fire location, type, power, etc. are displayed in their respective fields.

The simulations are replayed when the user clicks *start* button. Note that if two simulations have different durations, then the results are shown for the least duration (e.g. Sim1 runs for 100 sec and Sim2 run for 150 sec, then comparison is done only for the first 100 sec).

In compare mode, holding down the Ctrl key in conjunction with the normal mouse button actions (rotation, zooming, and translation) will simultaneously affect both compare panels rather than just the one the mouse is in.

Figure 8-17 and Figure 8-18 show comparison of previously run simulations in different views.

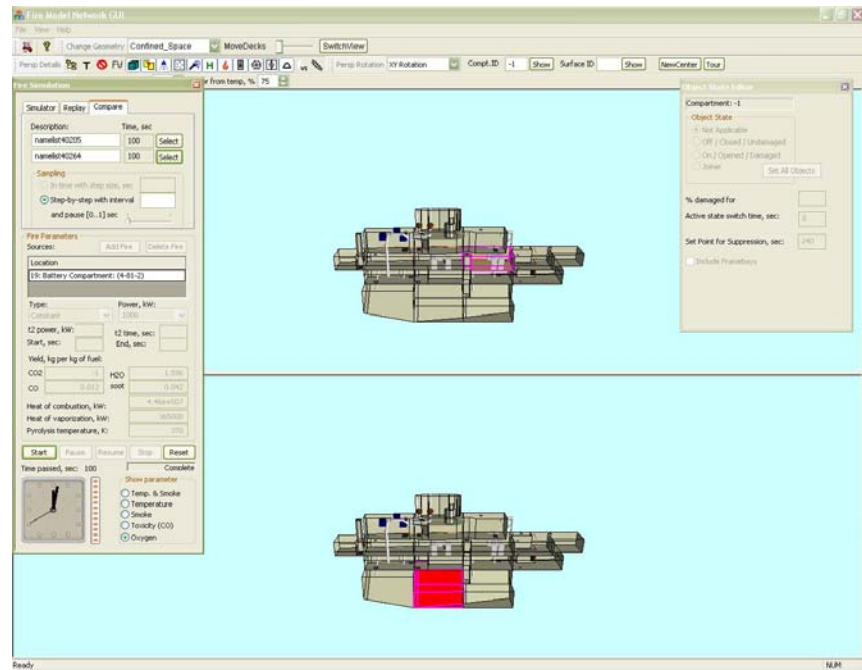


Figure 8-17 Comparison of Simulations in Confined_Space (Above with Framebays not Included, Below with Framebays Included)

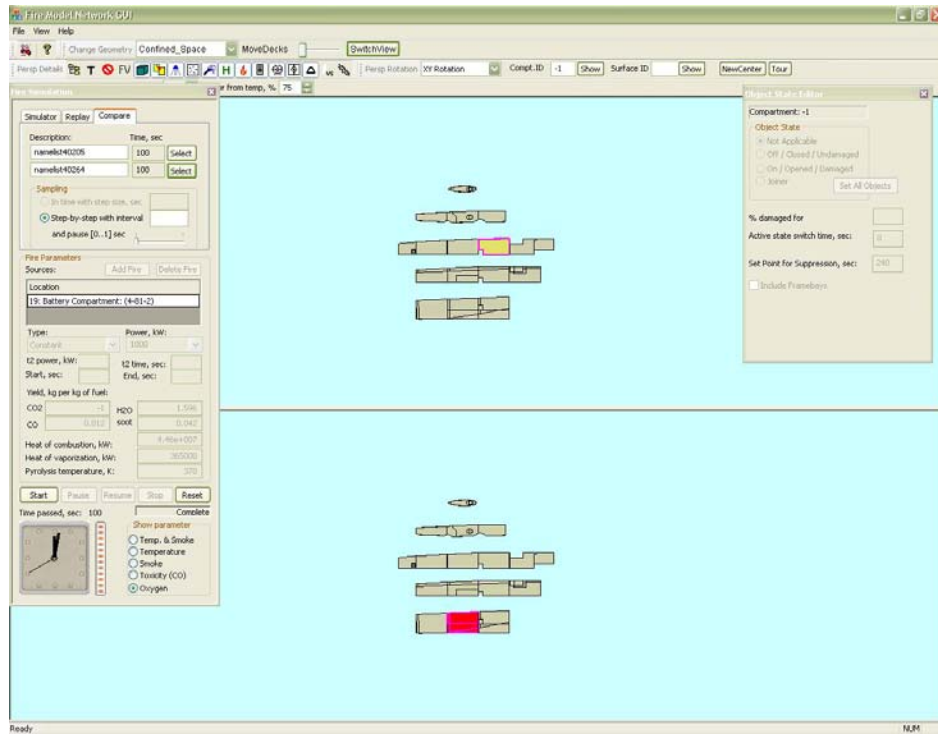


Figure 8-18 Comparison of Simulations in the Floor Plan View by Using the SwitchView Button for Confined_Space.

8.2.4 Importing, Exporting, Renaming and Deleting Simulations

The popup Available Inputs (as shown in Figure 8-8) or Available Simulations (as shown in Figure 8-14) has buttons for importing (e.g., from another user), exporting, updating, or deleting file(s). Import and Export popup dialog boxes are shown in Figure 8-19. Inputs refer to only an input file, whereas Simulations refer to a pair of files – the input and the associated output file. These operations can be performed on multiple files simultaneously (selected using CTRL or SHIFT key on the keyboard). When importing an input file or simulation, or exporting to give to another user, **please note** that the geometry database should be the same or problems or even a crash of the software is possible.

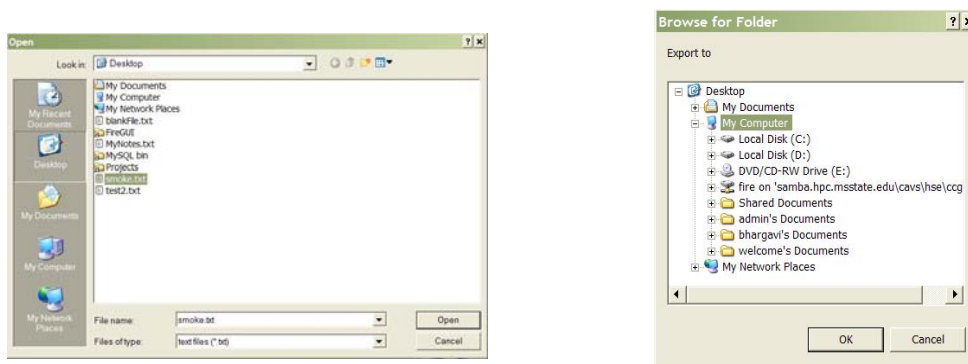


Figure 8-19 Import (Left) and Export (Right) Popups

For renaming, first double click on the Name and/or Description column and change the text as required. Then keeping this row selected, click the *Update* button. If the name column is changed then both the input file name and the associated output file name are renamed. Note that changing just the output file name has no effect.

8.3 Data Extraction for Quantitative Analysis

This feature provides extracting simulation output data for quantitative analysis of the results. The user can export the data for external analysis packages, such as Microsoft Excel in the form of a comma separated values (.csv) file. If Excel is not available, other applications such as Notepad may be used.

The raw results of all the simulation runs are stored in the simulation repository (*simrep*) directory and are stored in a format best suited for visualization. After a simulation run is complete, the user can visualize the results once again using the *ReplayTab* of the *Fire Simulation popup* dialog. The simulation output file contains full results of the simulation. In order to extract a subset of the data (one or a few compartments and one or a few variables) for analyzing the results of specific compartments quantitatively using plots, the new feature exports data in a format better suited to Excel (a .csv file) or other analysis applications.

8.3.1 Getting Started

In order to use the data extraction feature, the user needs to specify two locations which will be saved in the options.xml file:

1. The path to Excel or alternative application (*DataViewerPath*)
2. The path specifying where the extracted files will be stored (*ExtractArchivePath*)

Data Viewer Path

The location of the Excel executable file or alternative should be specified using the *General Options* dialog (Obtained from *File Menu -> General Options*) box as shown in Figure 8-20. To change the location, click the *Browse* button and choose the Excel location. Typically, the standard MS Excel installation is in the following place:

C:\Program Files\Microsoft Office\OFFICE11\EXCEL.EXE

Take help from your systems administrator if you cannot find the location of MS Excel or if you want to install Excel. In case the user does not have Excel installed on his/her computer, the extracted data can still be viewed using Windows notepad or any other application instead of Excel. To use notepad, choose the notepad.exe location (Typically *C:\Windows\NOTEPAD.EXE*). Please make sure that the *DataViewerPath* has the correct location before proceeding further.

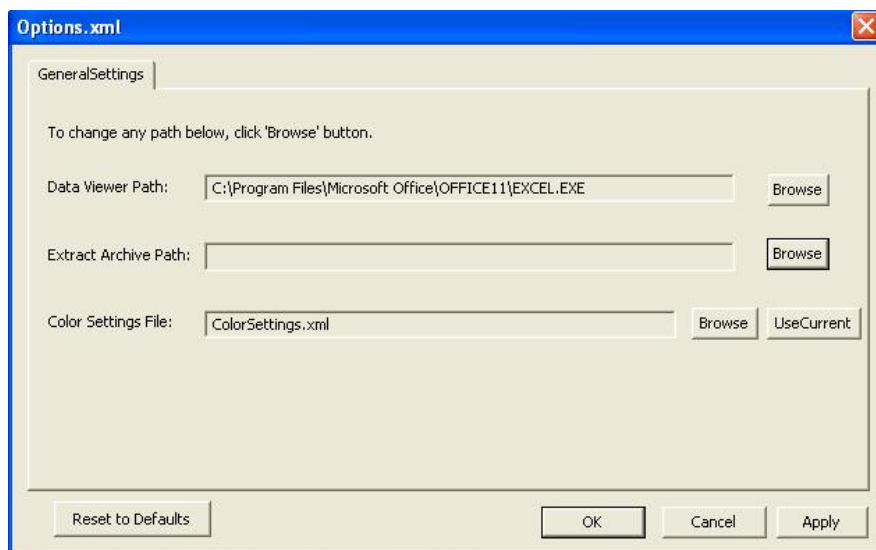


Figure 8-20 Options dialog to set the data viewer and extract archive path

Extract Archive Path

The extracted files are archived in the location specified by the *Extract Archive Path*. As you can see in the above Figure 8-20, initially this field is empty. To set this path, click Browse button and choose the desired location where you want to save the extracted data.

(If the path has not been set as of the first extraction attempt, the user will be prompted to set it.)

8.3.2 Extracting Data

The replay tab of the *FireSimulation* popup dialog has two modes as shown in Figure 8-21: 1) *Visualize* and 2) *Extract Data*. Visualize mode is the regular replay mode where sampling and other features operate as usual and are not affected. As soon as the *Extract Data* mode is clicked, the *Fire*

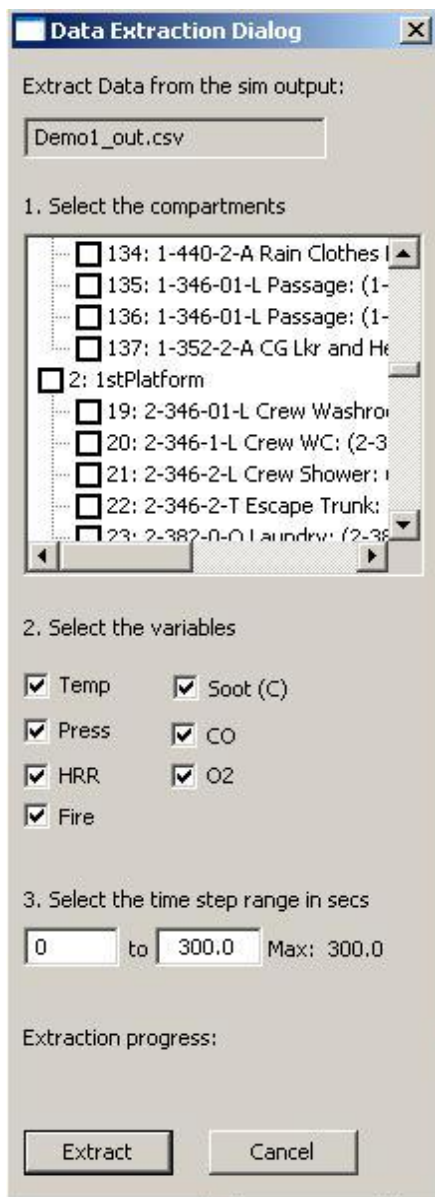


Figure 8-22 Data Extraction Dialog

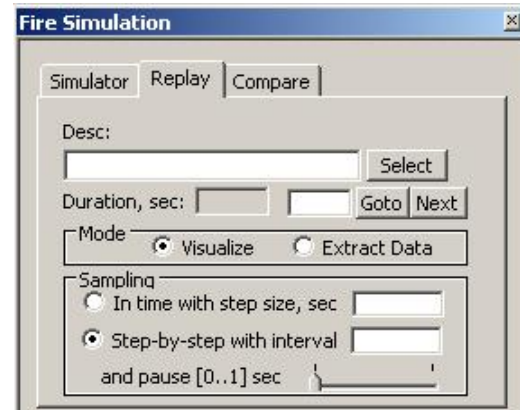


Figure 8-21 Replay tab showing two modes (Visualize and Extract Data). As soon as the Extract Data mode is clicked, this dialog is hidden and a new data extraction dialog pops up.

Simulation dialog and the *Object State Editor* dialog are hidden and a new *Data Extraction* dialog as shown in Figure 8-22 pops up.

After selecting the desired simulation from the *Available Simulations* dialog (obtained by clicking the *Select* button), select the *Extract Data* mode to open the *Data Extraction* dialog.

Three items required for extraction of the data are the compartments, the variables, and the time range.

Three items required for extraction of the data are the compartments, the variables, and the time range.

1. **Selecting compartments:** The user can select as many compartments as he/she wants. There are two ways to select the desired compartments:
 - a. First way is to click in the checkboxes of the tree in the data extraction dialog (Figure 8-22) to select or deselect the compartments.
 - b. Second way is to click on the desired compartment in the 3D scene to select it. When the user clicks on any compartment in the 3D scene, the label of that compartment is highlighted in the tree and a check mark is placed for that compartment.

In order to deselect any selected compartments, the user has to uncheck the checkboxes by clicking in them from the tree. The user cannot deselect by clicking in the 3D scene.

2. **Selecting variables:** The user can select any variables by clicking on the checkboxes. All variables are selected by default.
3. **Selecting the time range:** The user can select any range of the time (from 0 to the max time step) in seconds by giving a start time step and an end time step in the edit boxes. The default is 0 to the max time step.

After all the above are selected, the *Extract* button has to be clicked to start the data extraction process.

8.3.3 Saving the Extracted Data

Once the *Extract* button has been pressed, a *Save As* dialog box (shown in Figure 8-23) is displayed with the *ExtractArchivePath* as the default location, a unique name with the simulation name as the prefix for the file name to be extracted, and a default file extension as .csv (comma separated values). All or any of these three (file location, file name, and file extension) can be changed according to the user's preferences. If the user chooses a different location to archive the files, that location is used as the default the next time any file is extracted until the application is closed. Once the application is started again, the *ExtractArchivePath* last stored in the *options.xml* file is used as the default location for storing the extracted files.

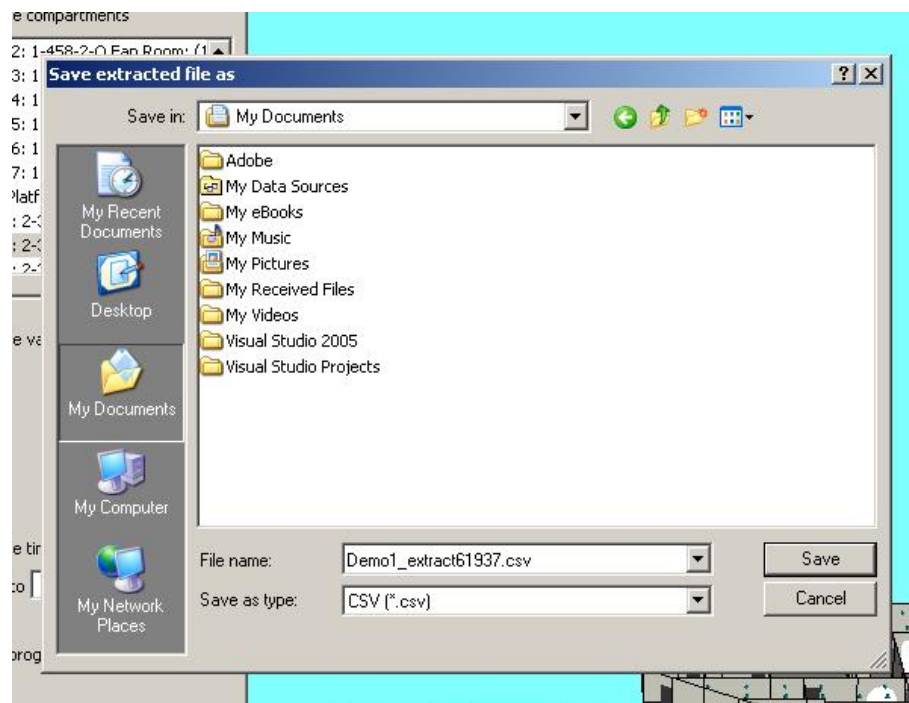


Figure 8-23 *Save As* dialog where the user can change the file name, location, and file extension

The progress of extraction is displayed at the bottom of the extraction dialog in the *Extraction progress* label. The extracted data is written into the specified file in the given location and is displayed to the user using the application specified as the Data Viewer automatically. For example, Figure 8-24 shows an Excel file displaying the temperature data for two compartments (19 and 20) from time step 0 to 300 seconds.

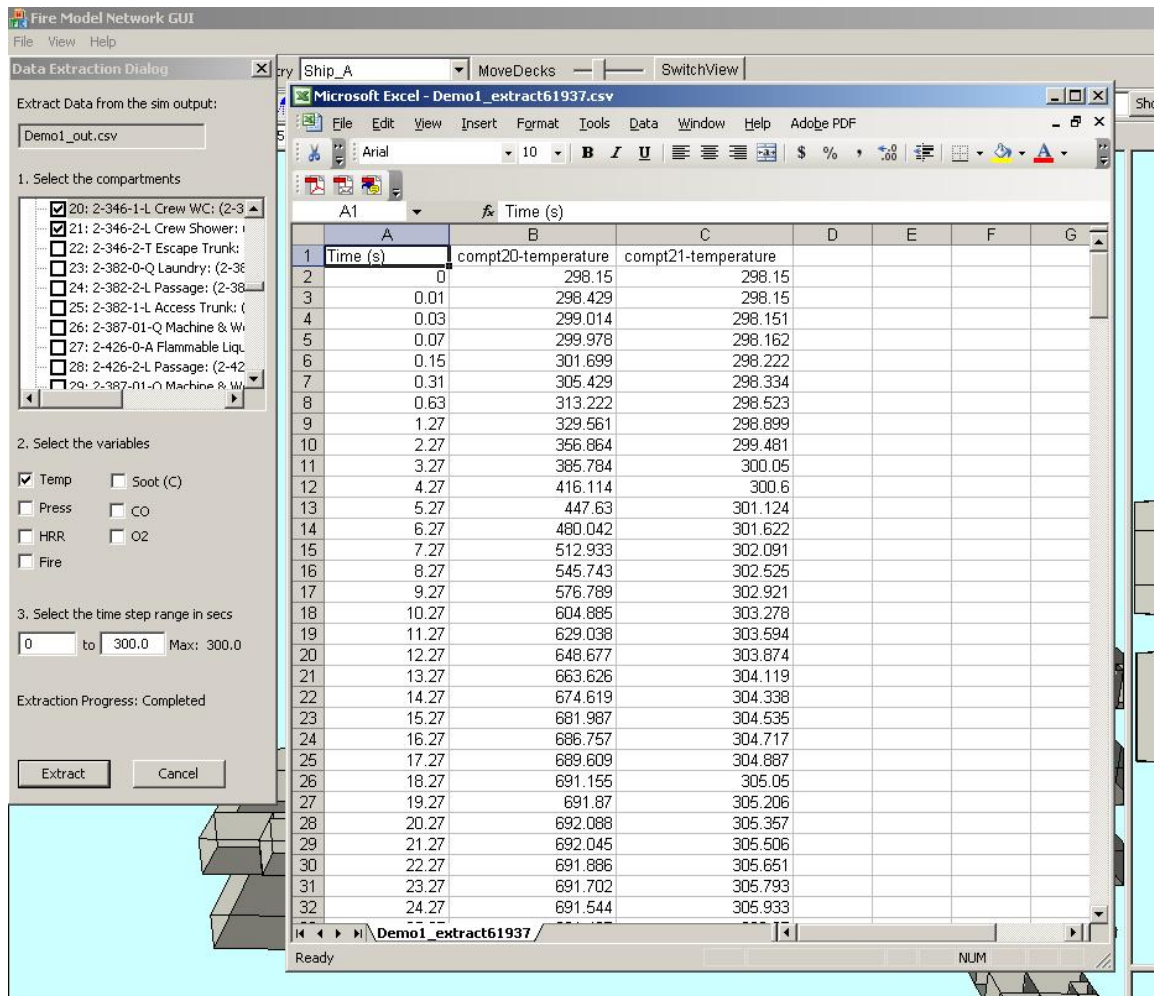


Figure 8-24 Sample data extraction file shown as Excel spread sheet

Note: The values of the variables like temperature, pressure, etc are in the same units as used by *FSSIM V1.2* i.e., time is in seconds (s), temperature is in Kelvin (K), pressure is in Pascal (Pa), Heat release and Fire size are in kiloWatts (kW), yield soot is in kg soot/kg gas, yield CO is in kg CO/kg gas, and yield O2 is in kg O2/kg gas.

FireModelNetworkGUI extracts the raw data as output by *FSSIM* and does not do any conversion of the units.

Once the extraction is complete, the user can select different parameters from the extract dialog and click the extract button to create another extraction file or he/she can click the *Cancel* button to go back to the Fire Simulation dialog. Another simulation output can be selected from the *Replay Tab* and the extraction process can be repeated.

Note: MS Excel has a limitation that it cannot load more than 256 columns or 65000 rows in a single sheet. So if the extracted file exceeds these limitations, it will not be displayed completely in Excel.

9.0 SHOW TOOLS

A ship or a building has subsystems (e.g. junctions and ventilation) apart from compartments and surfaces. A junction is referred to as any opening; therefore, doors, archways, scuttles, hatches, and ratholes are all different types of junctions. The subsystems for the example databases are as follows: Confined_Space has doors, hatches, scuttles, firemain, and ventilation including framebays; Ship_A has doors, hatches, scuttles, ratholes, and suppression; Building_B has doors and stairs modeled as hatches. Shadwell_Forward has doors, hatches, scuttles, firemain, ventilation, inert gas, and watermist systems but firemain, ventilation, inert gas, and watermist systems are excluded from simulations. Note that not all models (geometries) have all subsystems. When a model does not have a particular subsystem and the corresponding show tool button is clicked, no action is taken.

Using Show Tools (Figure 9-1) one can select different subsystems (details) to be shown or hidden. By default, all subsystems except virtual surfaces and damaged surfaces are shown, i.e. all Show Tools but two are turned on.

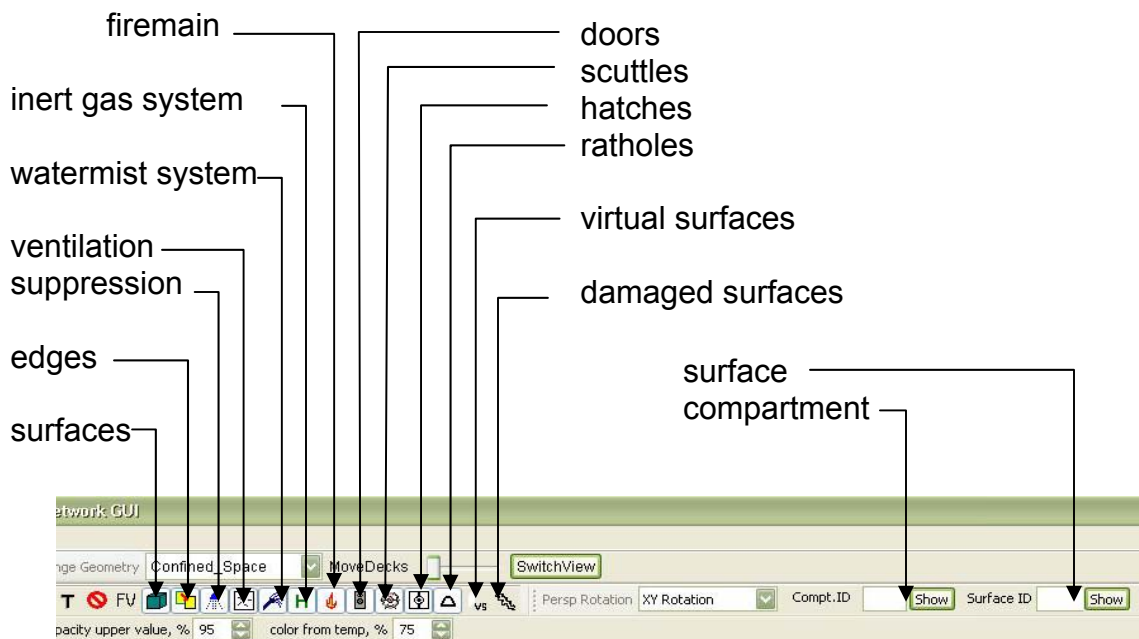


Figure 9-1 Show Tools

All buttons of the Show Tool act as toggles: consecutive clicks on the buttons switch the display of the corresponding subsystem on and off. A lighter gray background with a depressed look for the button indicates that the display is switched on, and a grey

background with a non-depressed look indicates that it is off. In the above picture, all buttons of the Show Tool except virtual surfaces and damaged surfaces are switched on.

9.1 Surfaces and Edges



Surfaces button



Edges button

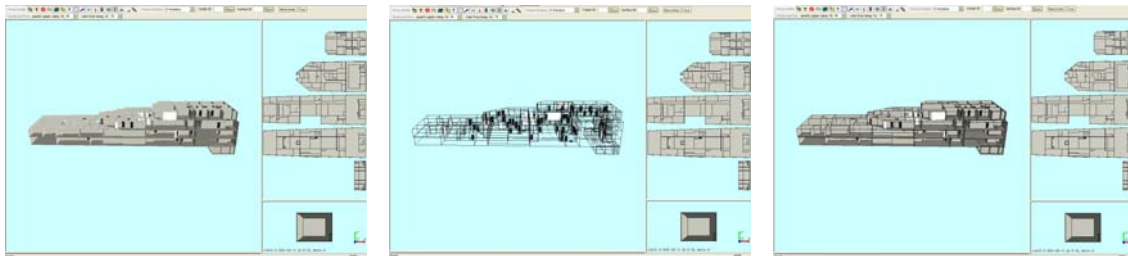


Figure 9-2 From Left to Right: Surfaces Only, Edges Only, Both Surfaces and Edges

In Figure 9-2, the left picture shows only surfaces (surfaces button turned on, edges button turned off), the middle one shows only the wire frame (surfaces button turned off, edges button turned on), and the right shows both (surfaces and edges buttons turned on).

9.2 Suppression System



Suppression system button

The suppression system button toggles the display of the nozzles (Figure 9-3).

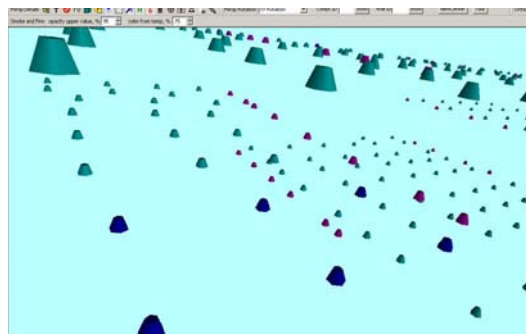


Figure 9-3 Suppression System Nozzles

The suppression system has three types of nozzles as shown in Figure 9-4.

1. AM-18 (sidewall nozzle used for Primary Damage Area cooling) type nozzle displayed as magenta cones
2. AM-11 (thermally actuated general Class A area light hazard suppression nozzle) type nozzle displayed as cyan cones
3. AM-4 (open machinery space nozzle, UL Listed for flammable liquid hazards) type nozzle displayed as blue cones

AM-4 type nozzle (open machinery space nozzle, UL Listed for flammable liquid hazards)

AM-11 type nozzle (thermally actuated general Class A area light hazard suppression nozzle)

AM-18 type nozzle (sidewall nozzle used for Primary Damage Area cooling)

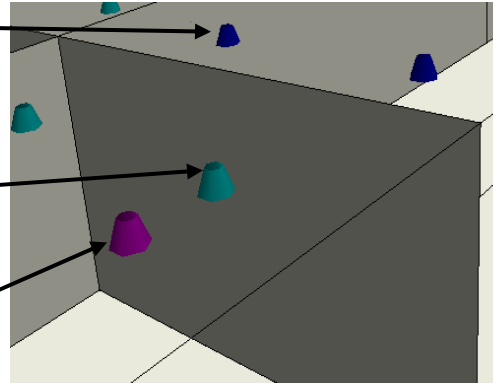


Figure 9-4 Different Types of Suppression Nozzles

When the suppression system is active for a compartment, the compartment is shown with white dashed edges. See Suppression System Activation in Section 8.2.1 for more details.

9.3 Ventilation System



Ventilation system button

Figure 9-5 below shows the ventilation system zoomed in. Fans are shown as blue cubes and dampers are shown as brown spheres. When a fan is on, it is shown in bright blue color and, when a damper is opened, it is shown in yellow. See Section 8.1 for setting the state on or off.

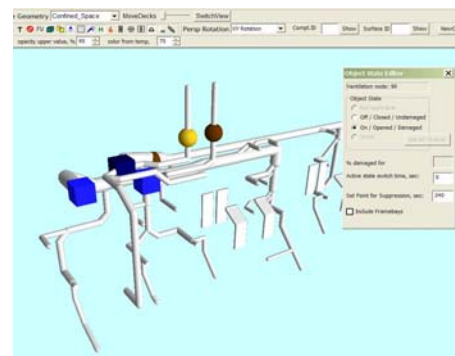
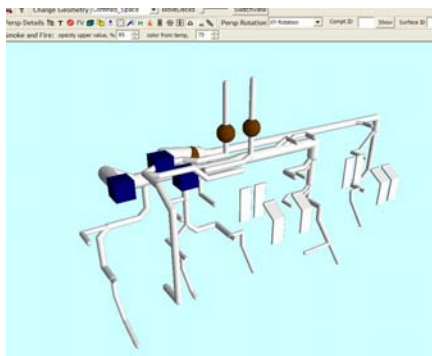


Figure 9-5 Left: Ventilation System; Right: Two Fans On and One Damper Opened

The ventilation system has Framebays which are a Confined_Space specific feature. Framebays were added to the model to simulate openings between the decks and hull of a confined space through which heat, smoke, and other combustion products can travel. Framebays are displayed as vertical, flat, ventilation sections. For example, framebays connecting two compartments are shown in Figure 9-6. Refer Section 8.1.6 to know how to include or exclude the framebays from the simulation.

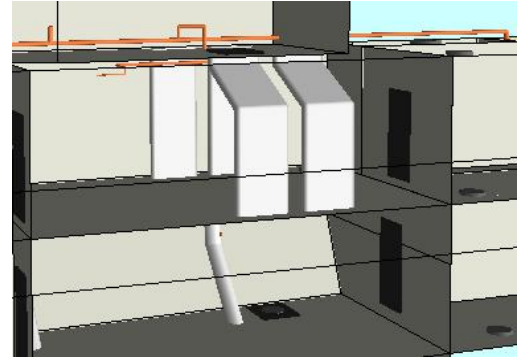


Figure 9-6 Ventilation System Framebays

9.4 Firemain, Watermist, and Inert Gas Systems



Firemain button



Watermist button



Inert gas button

Figure 9-7 below shows firemain system, watermist system and inert gas system.

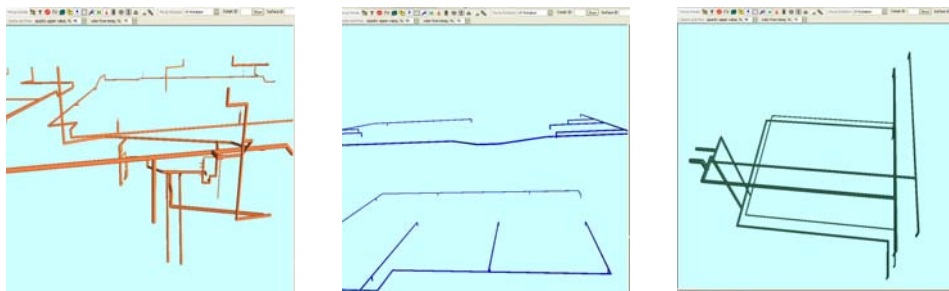


Figure 9-7 From Left to Right: Firemain system, Watermist System, and Inert gas System

9.5 Doors and Archways



The *Doors* button shows or hides doors and archways. Closed doors are represented in black color while opened doors are represented in white color and archways are shown with an arch above them as shown in Figure 9-8. A door can also be a Joiner; in which case, it is represented with a sphere in the middle. Joiner state is used for the Confined_Space to simulate a closed door but with a vent grate that is always open (the joiner door). Archways are by default open and can be changed to a smoke curtain (treated as closed doors for simulation) as shown in Figure 9-9. Section 8.1 describes how to change the state of a junction.

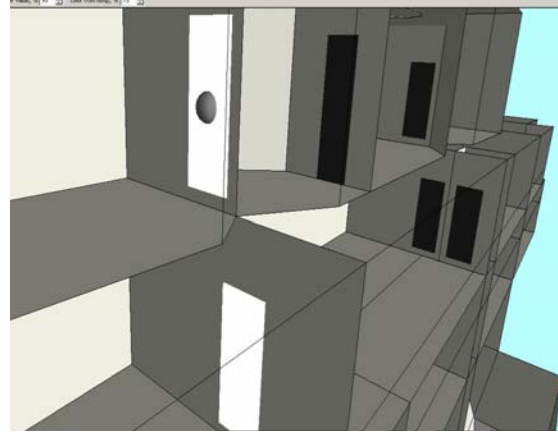
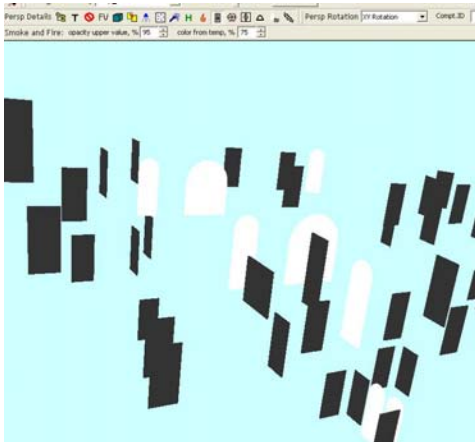


Figure 9-8 Left: Doors and Archways; Right: Upper Door set as Joiner and Lower Door as Opened

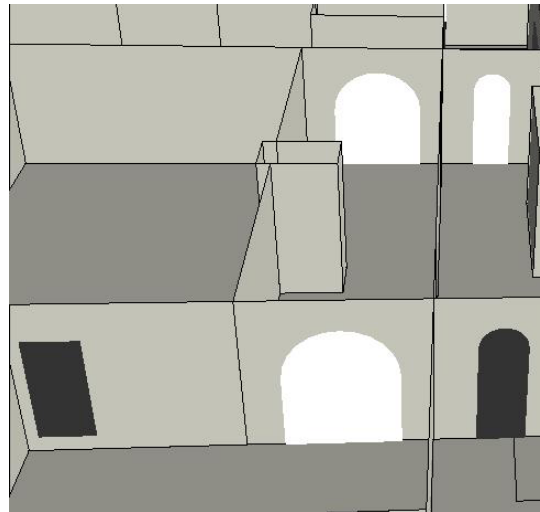


Figure 9-9 Three archways (in white color) and one Smoke curtain (bottom right in black color) and a closed door (bottom left).

9.6 Scuttles and Hatches



Scuttles button



Hatches button

Scuttles are represented as circular disks and hatches as rectangular slabs as shown in Figure 9-10. They are black in color when closed and white when opened. Section 8.1 describes how to change the state of a junction.

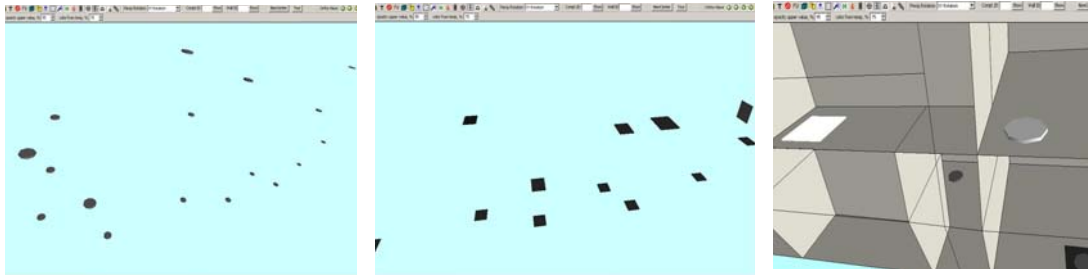


Figure 9-10 From Left to Right: Scuttles, Hatches, and Upper Hatch and Scuttle Opened

9.7 Ratholes



Ratholes button

Ratholes were added to the test area as shown in Figure 9-11 to facilitate draining of water due to activation of mist suppression.



Figure 9-11 Ratholes

There are three types of ratholes shown in Figure 9-12:

1. De-Watering Type A ratholes that connect compartments of the same deck. These are displayed as cuboids.
2. De-Watering Type B ratholes that connect a compartment and environment. These are displayed as short horizontal cylinders.
3. De-Watering Type C ratholes that connect compartments of different decks. These are also displayed as short vertical cylinders.

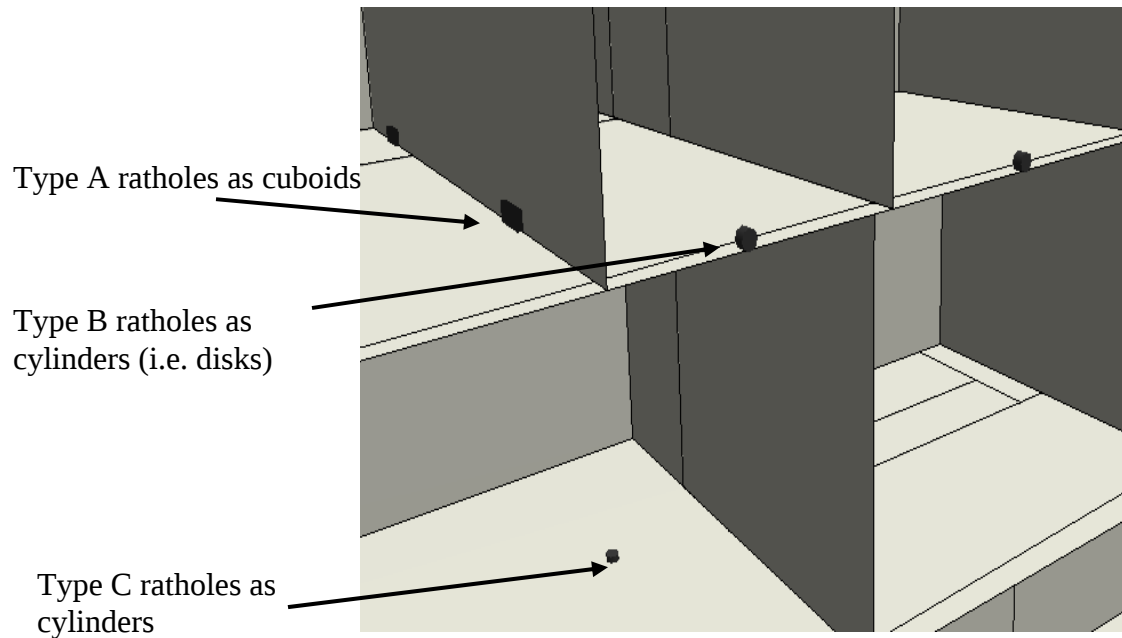


Figure 9-12 Types of Ratholes

Ratholes cannot be opened or closed individually. The “*Include Ratholes*” checkbox in the Object State Editor Dialog (refer Section 8.1.6) changes all the ratholes to be opened or closed. All ratholes are white in color when opened.

9.8 Virtual Surfaces

 Virtual Surfaces button

Figure 9-13 below displays virtual surfaces (artificial bulkheads/walls) as white semi-transparent surfaces. These virtual surfaces were obtained from splitting some odd shaped compartments (mainly hallways) into sub-compartments connected through junctions to aid the network model. The splitting was done in CAD files before the geometry extraction and the virtual surfaces cannot be changed by the FSSIM GUI user.

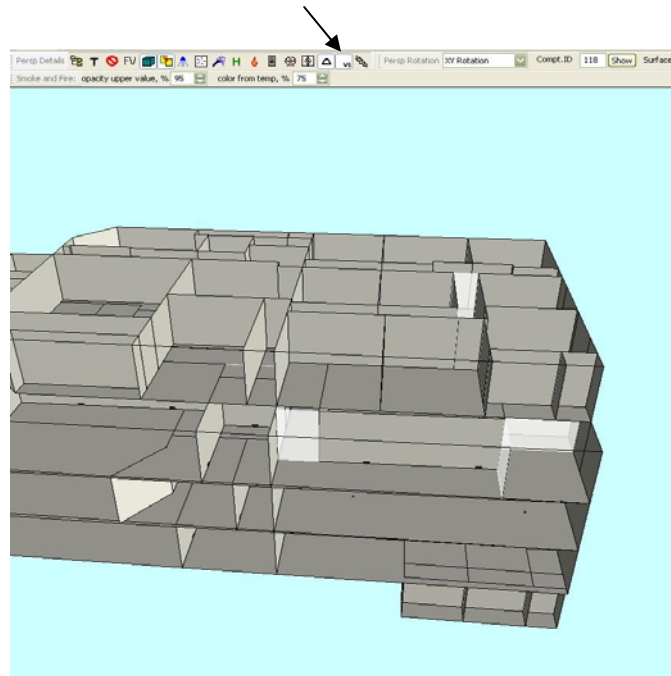


Figure 9-13 Virtual Surfaces

9.9 Damaged Surfaces



The *Damaged surfaces* button highlights the damaged surfaces in blue color as shown in Figure 9-14. Section 8.1 describes how to set the surfaces to be damaged.

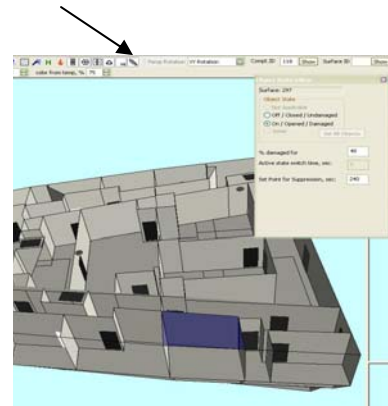
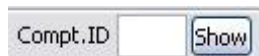


Figure 9-14 Damaged Surface

9.10 Show Compartment Tool



When the compartment number or id is provided in the text box and the *Show* button is pressed, the selected compartment is highlighted in the 3D view and in the floor plan view. The compartment is also shown in the compartment panel and the id is shown in the Object State Editor (refer Section 8.1). If the compartment tree browser (refer Section 10.0) is open, the compartment node in the tree is also highlighted. Show compartment tool has the same effect as clicking on a compartment in the floor plan or in the 3D view. Figure 9-15 below illustrates this feature. To deselect the highlighted compartment, clear the text box or enter -1 for the compartment number and click the *show* button.

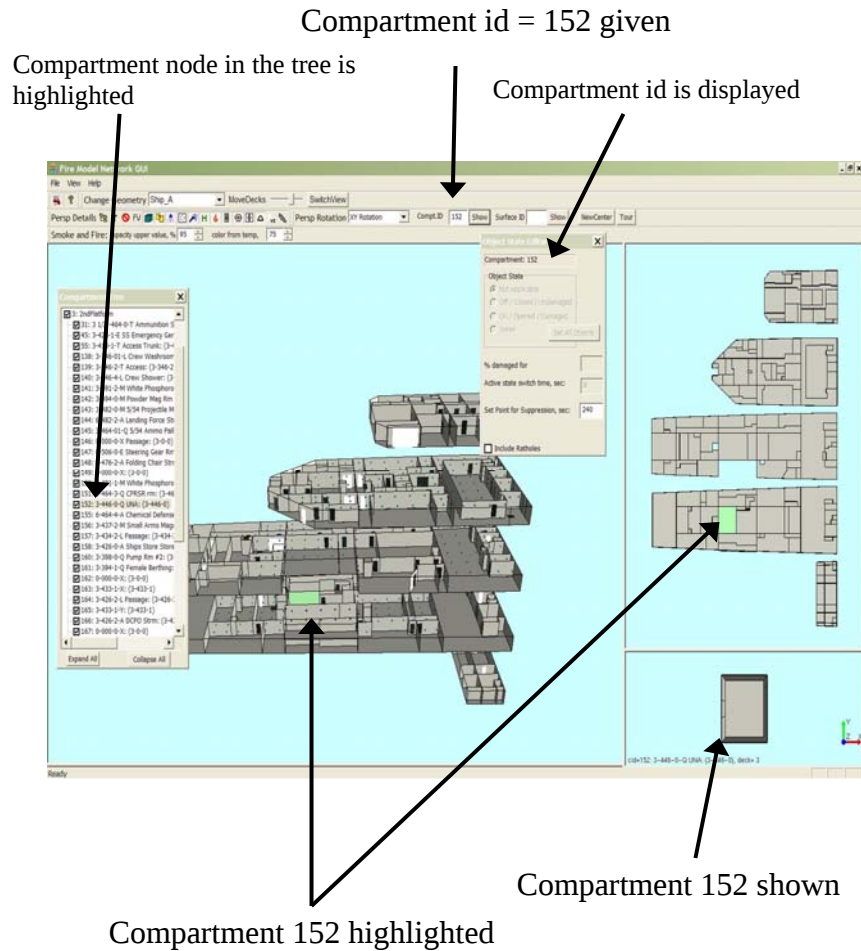


Figure 9-15 Illustration of Show Compartment Tool Feature

9.11 Show Surface Tool



The surface is highlighted in the 3D view when the surface id is provided in the text box and the *Show* button is pressed. Note that the *damaged surfaces* button is automatically turned on when *Show* button is pressed. In Figure 9-16 below, you see two surfaces highlighted to show the horizontal surface 885 because the decks are separated; therefore, the floor of the upper deck and the ceiling of the lower deck are highlighted. A vertical surface would only appear as a single highlighted surface.

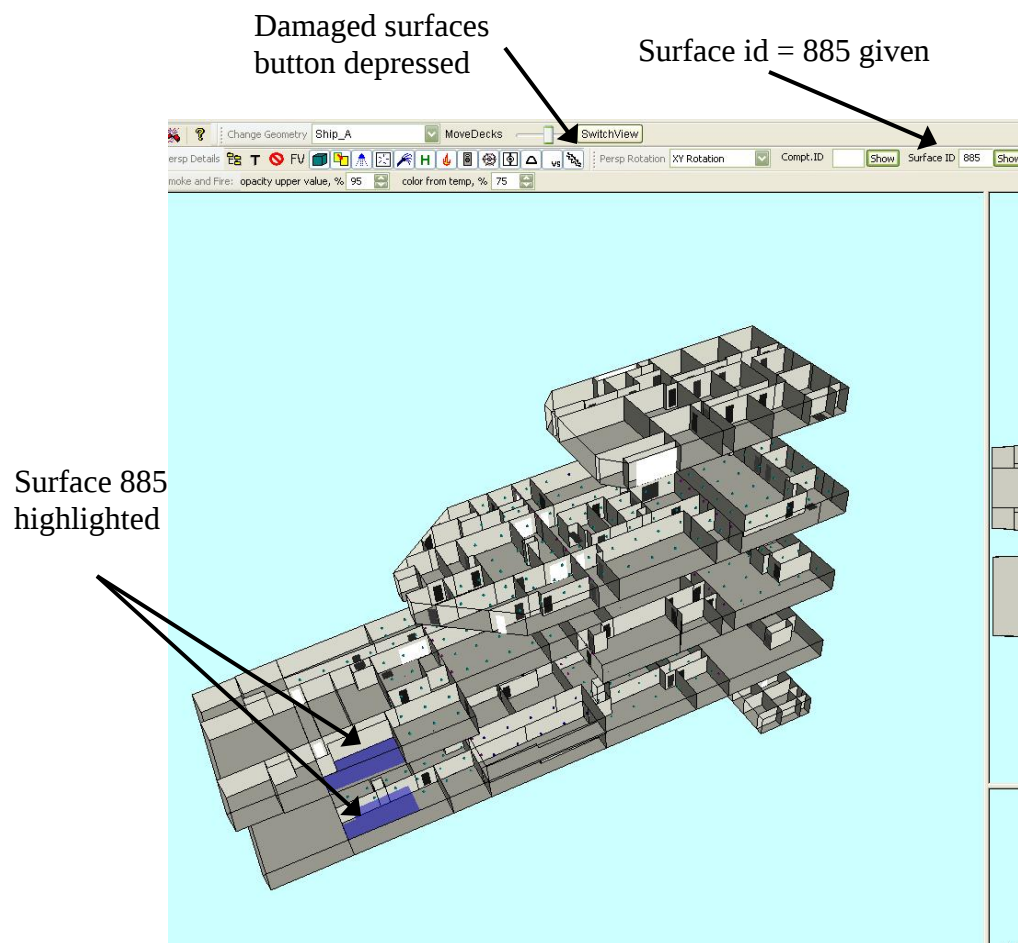


Figure 9-16 Functioning of Show Surfaces Tool

10.0 COMPARTMENT TREE BROWSER

By clicking on the *Compartment Tree Browser* button



, shown in Figure 10-1, a new dialog window (shown in Figure 10-2) pops up showing the list of compartments arranged by decks. Using this dialog, the user can select any compartments or decks to be displayed or hidden. Only checked elements are displayed in the 3D view and in the floor plan view; by default, all elements except the closed deck element (external surfaces) are checked.

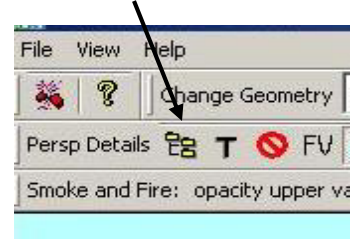


Figure 10-1 Compartment Tree Browser Button Location



Figure 10-2 Compartment Tree Browser Dialog

The *Expand All* button expands the tree completely and the *Collapse All* button collapses the tree to show only the deck names. Double clicking on any deck node expands that deck node to show all the nodes (compartments) under it as shown in Figure 10-2 on the left side.

Any combination of compartments or entire decks can be selected or deselected using the check boxes. For example, in Figure 10-3 below, for Ship_A only deck no. 2 is checked in the tree and both 3D view and floor plan view show only deck no. 2.

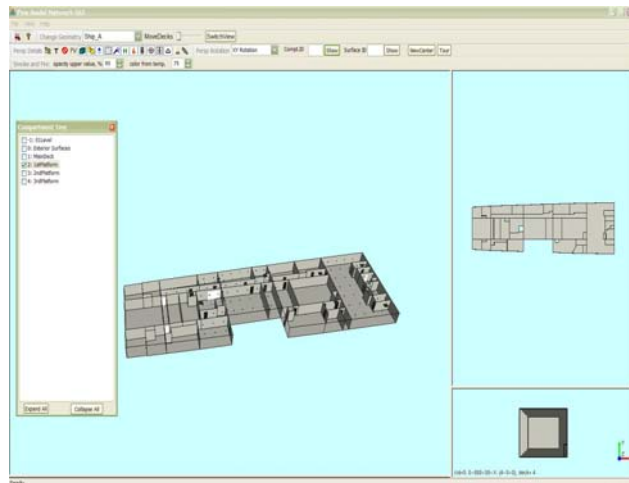


Figure 10-3 Only Deck No. 2 Selected

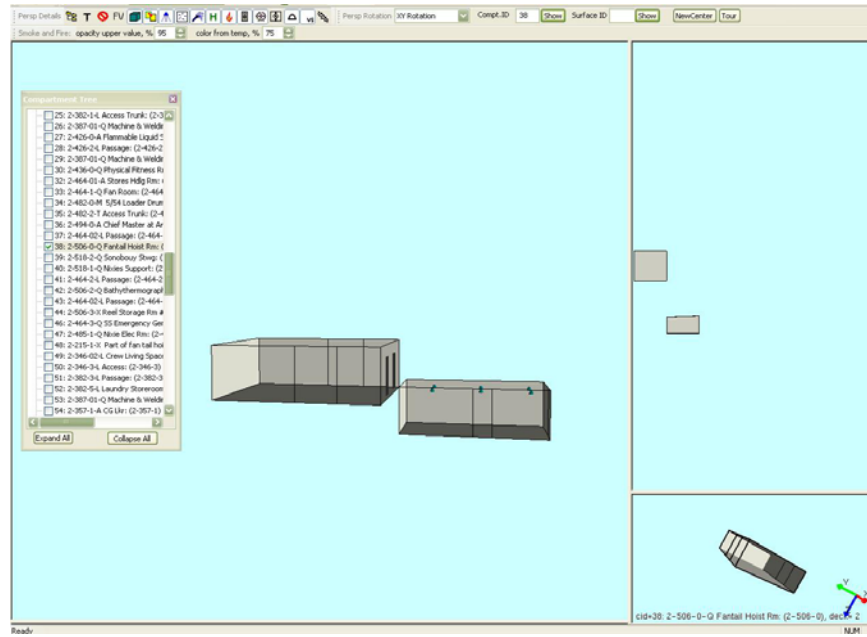


Figure 10-4 Compartment Selection

In Figure 10-4 above, 2 compartments (144 in deck 2nd platform and 38 in deck 1st platform) are selected.

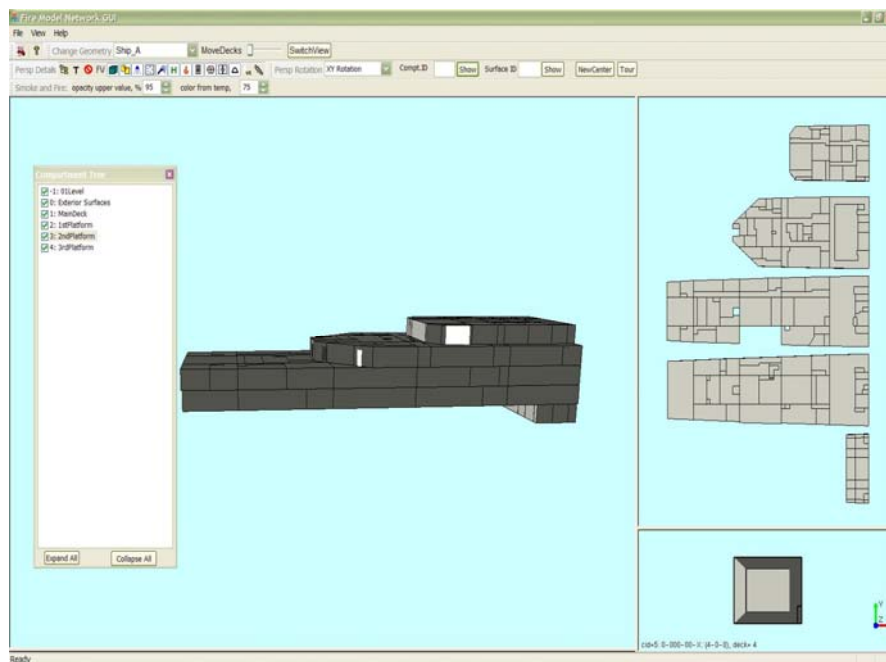


Figure 10-5 Exterior Surfaces Selection

By selecting the *Exterior Surfaces* checkbox, the exterior surfaces of the ship are displayed (Figure 10-5). Normally these surfaces are shown as transparent and only the edges of the surfaces are shown so the user can view the interior of the compartments.

If you click on the compartment label of a node (not the checkbox) in the tree, the compartment is updated in the compartment panel, highlighted in green color in 3D panel and floor panel, and the id is displayed in the Show compartment text box (refer Section 9.10).

10.1 NewCenter Button

When only a few compartments are displayed and the user rotates the scene, the compartments revolve around the geometric center of the entire ship instead of rotating around the displayed compartments. If the only compartments displayed are located far from the center of the ship and rotation about their geometric center is desired, the *NewCenter* button as shown in Figure 10-6 can be used.

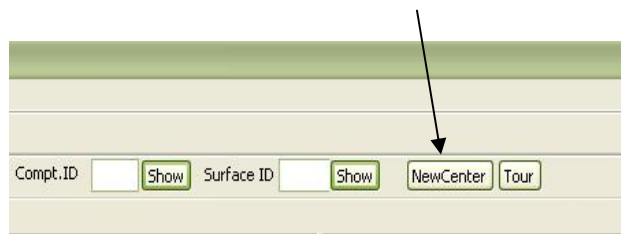


Figure 10-6 New Center Button Location

The *NewCenter* button computes a new geometric center which is an average of all the centers of the displayed compartments. The rotational center of the entire geometry can be restored when the *NewCenter* button is clicked while displaying the entire geometry.

11.0 LEGEND TOOL

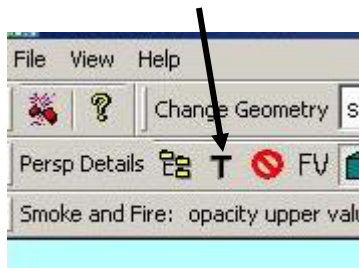


Figure 11-1 Legend Tool Button Location

The Color Map Legend tool (Figure 11-1) displays the legend for color mapping of temperature, visibility, toxicity, or oxygen. Only one parameter is shown at a time with the exception of temperature and visibility which can be shown simultaneously. To select a parameter, click on the drop down list and choose from the list. If the legend dialog box is open and the user changes the show parameter using the buttons to right of the analog clock in the Fire Simulation dialog, the legend is updated to reflect the displayed parameter. The visibility legend shows a white vertical bar in the middle which disappears as the visibility decreases (observed toward the top of the legend).

Figure 11-2 below shows the legend for Temperature and Visibility.

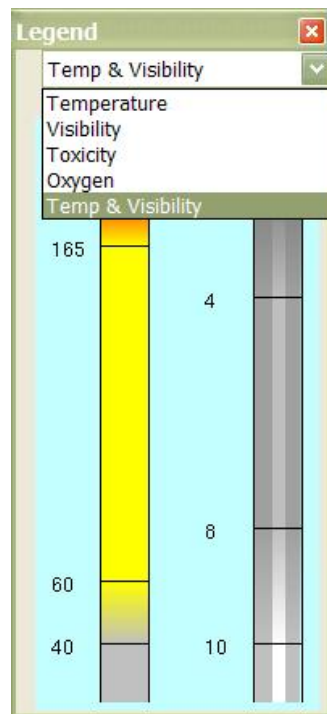


Figure 11-2 Legend for Temperature and Visibility

12.0 MENUS

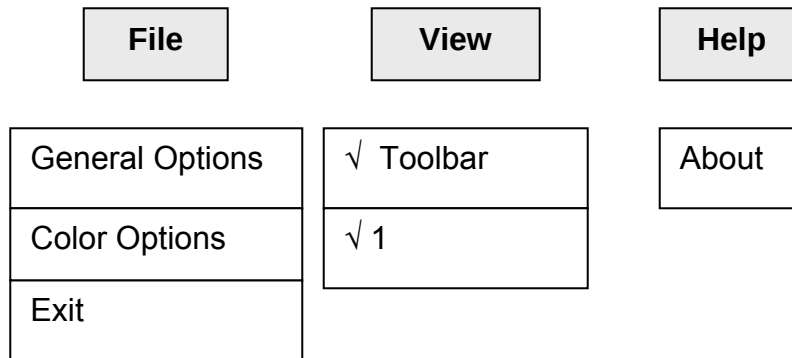


Figure 12-1 Menus

There are three menus: File, View, and Help as shown in Figure 12-1.

File

Options consists of two files: a) *Options.xml* and b) *ColorSettings.xml*. Two separate popup dialog boxes *General Options* and *Color Options* to modify the files respectively are provided. These popup dialogs can be opened from *File* menu as shown in Figure 12-2. *General Options* lets the user change general settings and *Color Options* lets the user change color schemes. *Exit* exits the application.

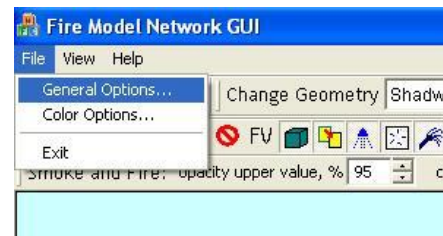


Figure 12-2 File Menu

View

The Toolbar option allows hiding the toolbars (click on the menu option to toggle). The menu item "1" is not used.

Help

The *About* menu displays the credentials of the application, version number, copyright information, and contact information (Figure 12-3).



Figure 12-3 About Dialog

12.1 General Options Dialog

The application uses several options that are stored in an xml file called '*options.xml*' which is located in the same directory as the application executable. When the application is initialized, '*options.xml*' is read and the values are used. If the '*options.xml*' file is not found, the application creates it with default values. This xml file contains information about simulation results directory location, input (namelist) file extension, and name of the database configuration file (i.e., file containing the list of databases). These values can be changed by editing the xml file manually. The name of the database configuration file defaults to '*dbconfig.txt*' and contains the names which appear in the drop-down list of the *Database Selection* dialog box at application startup and in the *Change Geometry* drop-down list at the top of the application window. The database names should match the installed database names.

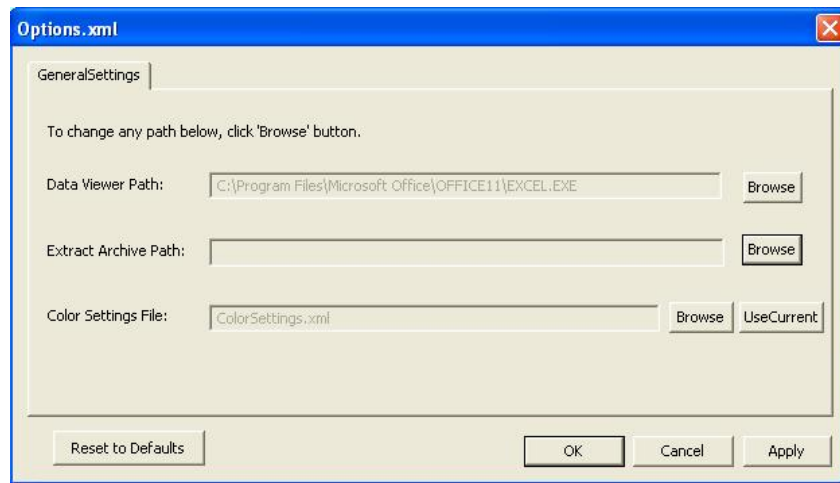


Figure 12-4 General Options Dialog

The *General Options* dialog box as shown in Figure 12-4 provides an interface to change some of the values in the *Options.xml* file. The user can set different path variables by clicking the *Browse* buttons and choosing the desired file or path.

The '*Data Viewer Path*' contains the path to the executable file for data viewer (Microsoft Excel or any other). The '*Extract Archive Path*' specifies the location where the extracted data from the simulation output files is stored. Refer to Section 8.3.1 for more details. The '*Color Settings File*' specifies the default XML file for color settings. When the application starts, this file is loaded into the color maps. After the default file is loaded, it can be changed by loading another color settings file from the *Color Options* popup as explained in Section 12.2. The *Use Current* button sets the current color

settings file from the *Color Options* dialog as the default file to be loaded when the application starts the next time.

The ‘*Reset to Defaults*’ button resets all values in the *Options.xml* file to default values. *OK* will overwrite the file (*Options.xml*) with the changed values and closes the dialog box. *Apply* overwrites the file but keeps the dialog box open. *Cancel* will discard the changes that are not yet written to the file and closes the dialog box.

12.2 Color Options Dialog

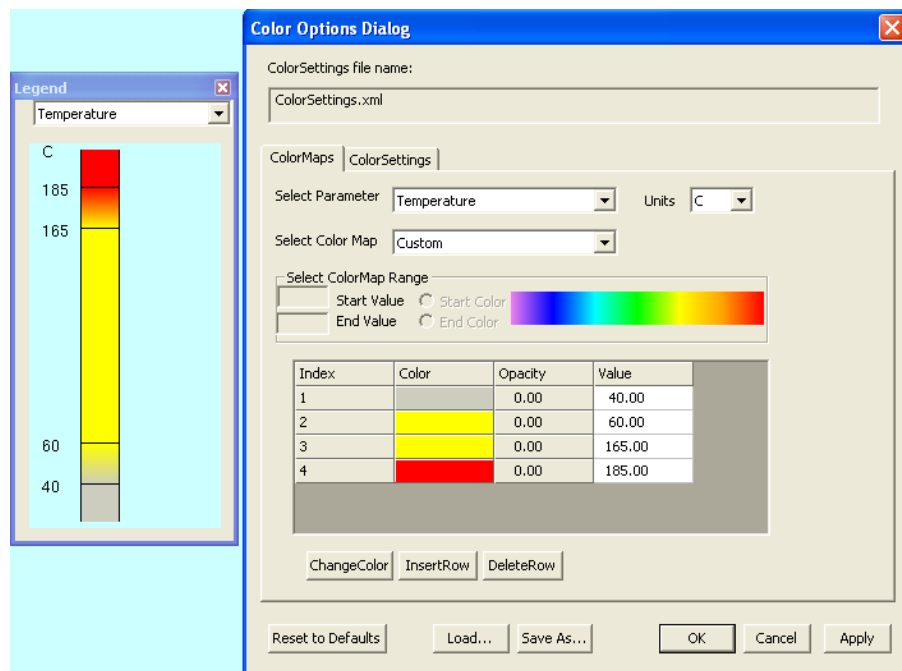


Figure 12-5 Color Options Dialog

This dialog provides an interface for changing the values of color settings file. When the *Color Options* dialog as shown in Figure 12-5 is opened, a preview legend is also shown. This preview is updated as soon as any change is made in the color map. The name of the XML file used as the *ColorSettings* file is shown at the top of the dialog. The ‘*Reset to Defaults*’ button resets all the values of the current file to default values. The *Load* button is used to load another *ColorSettings* file. The ‘*Save As*’ button is used to save the current file in a different location and/or as a different file name. Once the file has been loaded or saved as a different file, the *Color Options* dialog will start using the new file, whose name is reflected in the title bar. *OK*, *Cancel*, and *Apply* buttons work similarly as in the *General Options* dialog.

This dialog box has two tabs 1) *Color Maps* 2) *Color Settings* as explained below.

12.2.1 Color Maps Tab

Simulation results are visualized by mapping data values to colors (referred to as color mapping). The *Color Maps* tab allows one to modify the color map values and colors for four parameters: temperature, toxicity (carbon monoxide concentration), oxygen concentration, as well as opacity for smoke visualization.

For example the default color map for temperature is as follows:

- Below 40C (default units are Celsius C) -- no color is shown (only default compartment surface color) as the conditions do not impact activities of humans.
- Between 40C and 60C -- color intensity increases from default surface color to yellow, i.e. transition between a safe region and a region where humans need protective equipment.
- Between 60C and 165C -- color stays constant yellow. In this region the color does not show any differences to varying temperatures, as long as the values are in the range where humans with protective equipment are safe.
- Between 165C and 185C -- color goes from yellow to red (transition between the limited access and no access regions).
- Above 185C -- color remains at saturated red indicating uninhabitable areas for humans.

Toxicity and Oxygen are also shown by coloring the compartment surfaces. The loss of visibility due to smoke is visualized by opacity rather than color.

Color Map Representation

Before proceeding further, let us understand how a color map is represented. A color map contains several rows with color (or opacity) and a value associated with that color. A given color is at its full intensity at its given value. Above that value, the color slowly graduates to the next specified color value. The first entry always has the wall color and

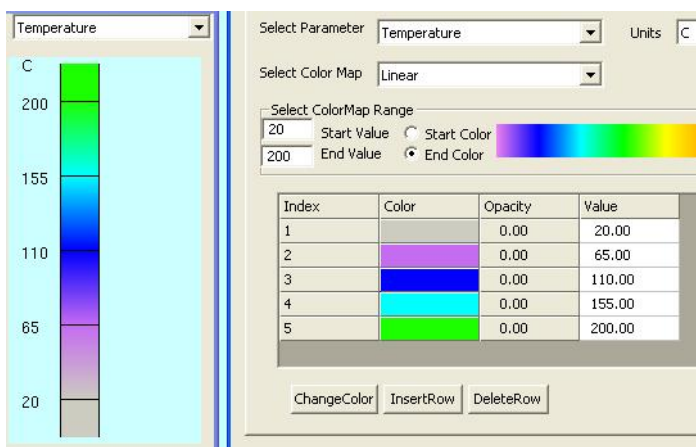


Figure 12-6 Linear Color Map

its value represents the starting point for the color gradation. The following Figure 12-6 shows a sample linear color map.

At value 20, the gray color starts to graduate into the purple color and at 65, the color is pure purple. After 65, the purple color slowly transforms into the next color i.e., the blue color. Blue is at maximum intensity at value 110 and graduates to the next color above its value in the table.

For a step color map, there should be two consecutive rows with same color but different values. Figure 12-7 shows a sample step color map.

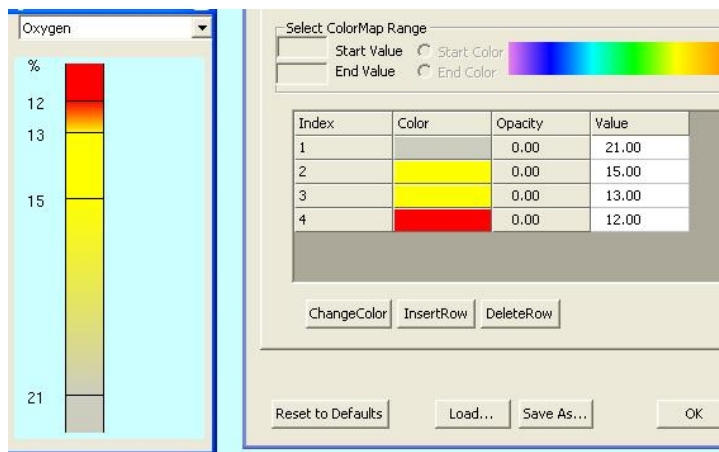


Figure 12-7 Step Color Map

Both row 2 and 3 have yellow color with different values. This means that the color becomes intense yellow at value 15 and stays the same until value 13. Below 13, the color transitions from yellow to red.

Note: All values in any color map should be monotonic (i.e., either in decreasing or in increasing order). In any color map, there should be at least two rows. The first row has the

wall color and another row has some other color and value. For visibility, instead of color, opacity values are specified which range from 0 to 1 (0 is transparent and 1 is opaque).

Color Map Tab Controls

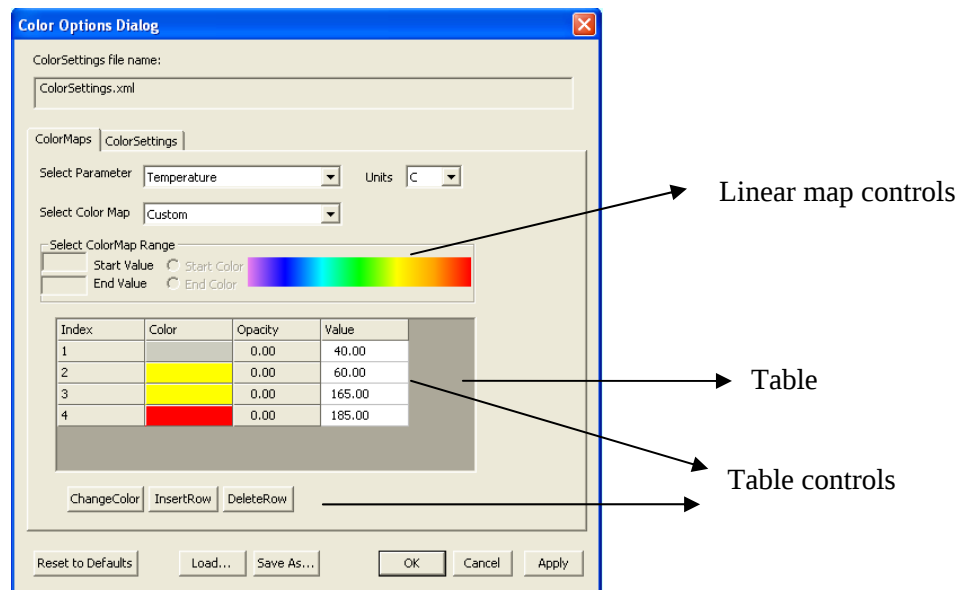


Figure 12-8 Color Maps Tab

Figure 12-8 shows the color maps tab. Using the 'Select Parameter' drop down list, color map parameters like temperature, visibility, etc., can be selected. Units can be changed

using the *Units* drop down list. The selected color map is shown in the table. The '*Select Color Map*' drop down list is used to change the existing color map type to a new one. It provides the starting point to edit the color map in the following three ways.

- 1) Default Step will reset the table to the default step map.
- 2) Linear will provide two rows and enables the linear map controls. The user can set the linear map by providing a *Start Value* and selecting the *Start Color* button, and then clicking on the desired color in the spectrum and repeating the same for the end color (i.e., set *End Value*, choose *End Color*, and click on the spectrum). The range between the start and end value is divided equally among the chosen colors. The number of rows present in the table after selecting a start color and an end color will generally vary between 3 and 8 rows, with the predefined spectrum colors (violet, blue, cyan, green, yellow, orange, and red) .
- 3) Custom map provides two default rows in the table.

The table is filled with the new map and can be modified as desired using the table controls. Note: Once the color map is stored from the table, its type is shown as a custom color map and the starting type (default step or linear) is not remembered.

Editing the Table

The table contains four columns. The *Index* column shows the sequence number of the color. The *Color* column shows the color. When viewing the table for the visibility parameter, the color is always the wall color. *Opacity* applies only to visibility and is disabled for other parameters. The *Value* column specifies the value at which the specified color is at its full intensity. The value field can be edited by double clicking in that field. Values should always be either in ascending or in descending order.

A row has to be selected by clicking on it before using any of the following buttons. *ChangeColor* button is used to change the color of the selected row. Click the button and choose any desired color from the color chooser box. *InsertRow* inserts a row with default values after the selected row. *DeleteRow* will delete the selected row.

After editing, the user may continue with other parameters by selecting from the '*Select Parameter*' drop down list or the user may click *OK* or *Apply* to write the modified color map to the file shown in the title bar, or click *Save As* to save under a different name.

How color mapping is done:

The color starts at range1 and increases until range2, i.e. the color is at its full intensity at range2. For step mapping, give gaps between ranges (Figure 12-9). For linear mapping, give continuous ranges (Figure 12-10).

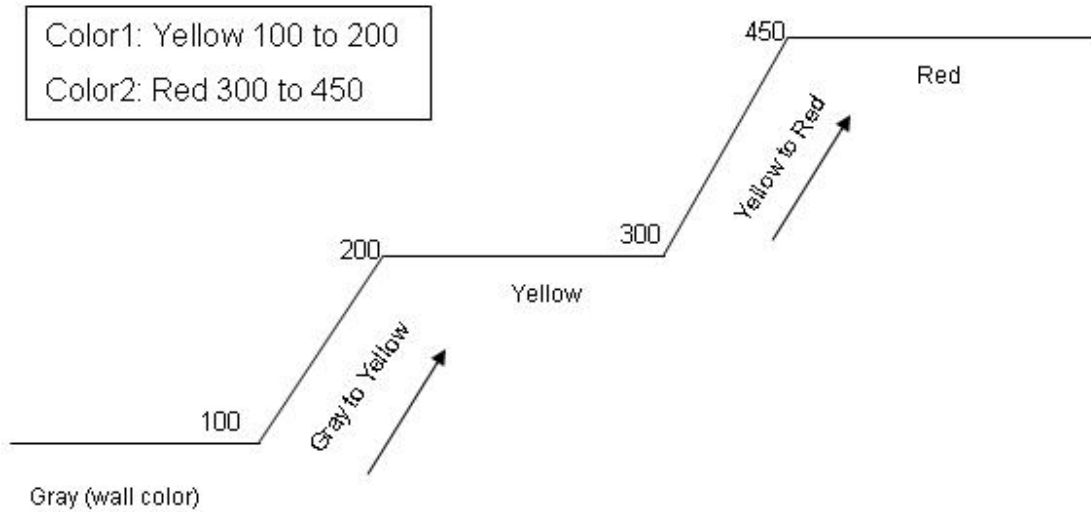


Figure 12-9 Step Color Mapping

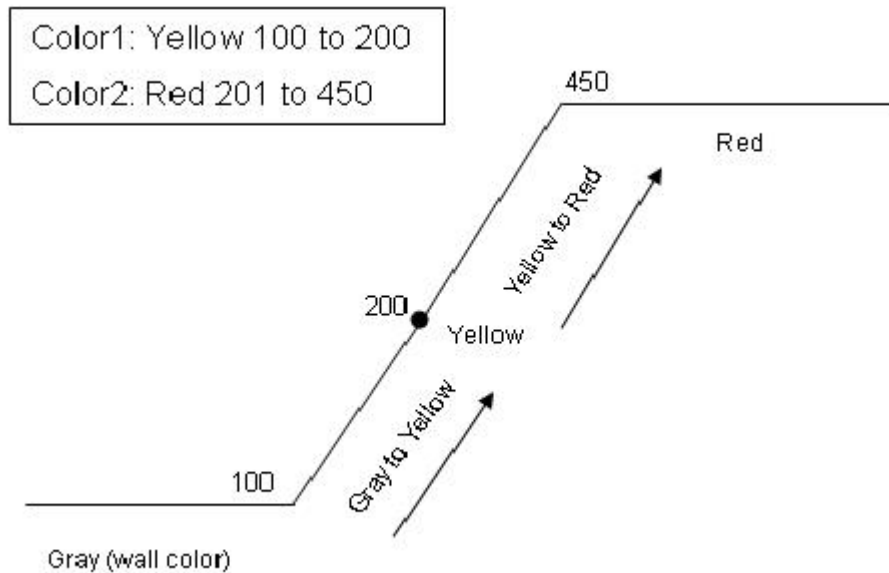


Figure 12-10 Linear Color Mapping

12.2.2 Color Settings Tab

This tab (shown in Figure 12-11) is used to change the GUI background color, compartment wall color, and fire source color by clicking the associated *Select* button and choosing the desired color from the color chooser box. The fire source color is used to outline the compartment that is on fire. Click *OK* to save and close the color options dialog. Note: It is advisable not to change the wall color.

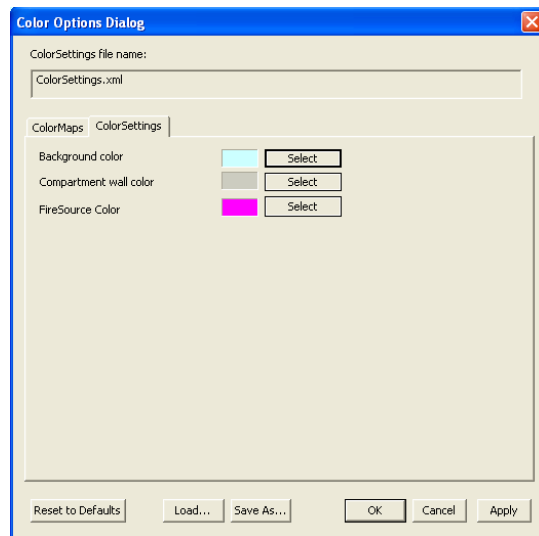


Figure 12-11 Color Settings Tab

13.0 PANELS

The panels on the right side of the GUI provide additional views of the ship supplementing the 3D model display in the large main panel (Figure 13-1). Further details on each of the panels and views are available in the following sections.

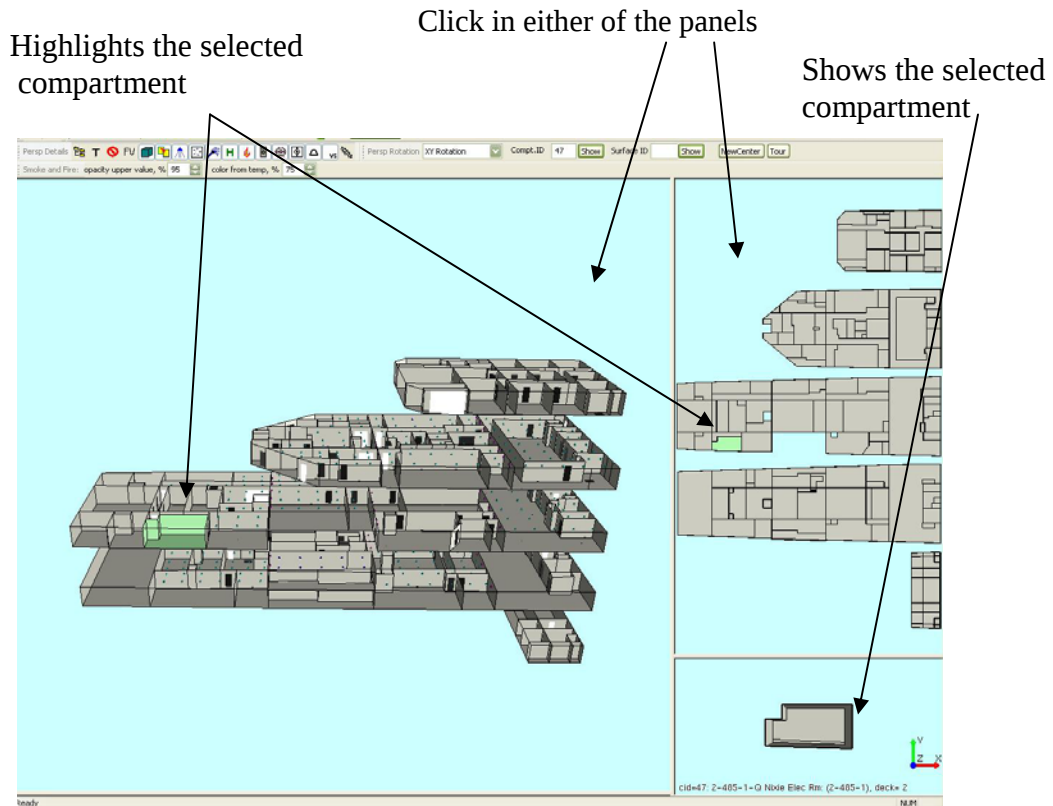


Figure 13-1 Different Panels

13.1 Main Panel

The Main panel displays by default the 3D model of the ship (Figure 13-2). The Main panel is the primary place where the results of the fire and smoke simulation are visualized. In addition, setting the state of the ship when displaying the 3D view is also performed in this panel (i.e. state of doors, hatches, and scuttles are set).

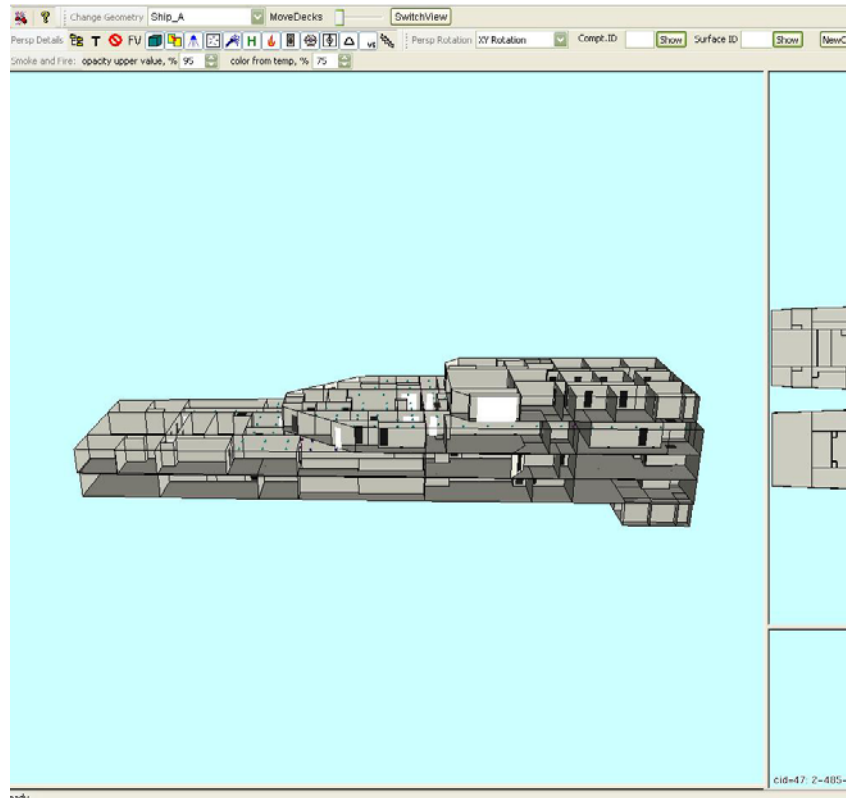


Figure 13-2 Main Panel

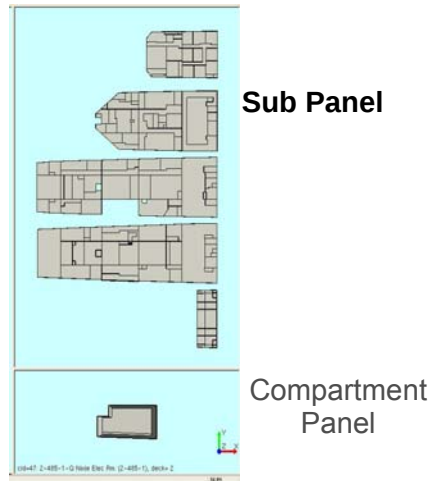
The 3D model can be rotated, zoomed in and out and moved inside the panel (refer Section 7.0). The view can be further customized by selecting particular fragments of the ship (refer Section 10.0), and particular ship subsystems (e.g. suppression and ventilation as described in Section 9.0).

Note that the front bulkheads that obstruct the view into the inside of the ship are removed. When the ship model is rotated 180 degrees, the front bulkheads become back ones, and vice versa. Therefore, the removal of the bulkheads is done on-the-fly, depending on the position of the ship. The external bulkheads can be restored using the Compartment Tree Browser (refer Section 10.0).

As mentioned in the *SwitchView* button section (Section 5.3), the Main Panel's 3D view may also be swapped with the Sub Panel's Floor Plan view described below.

13.2 Sub Panel

The Sub Panel (Figure 13-3) displays by default the Floor Plan view (similar to a blueprint) of a ship or building. This provides a convenient way to select an individual compartment for display in the Compartment panel and to be highlighted in both the Floor Plan and the 3D views.



This Floor Plan view allows zooming and moving by using the mouse; however, rotation is disabled, since a floor plan is designed to be viewed from the top and the left mouse button is used for picking a compartment. Simply click the left mouse button on a compartment to highlight and display it.

Figure 13-4 below illustrates zooming in and out of the floor plan view panel.

Figure 13-3 Sub Panel Location

If the Floor Plan view is selected to be viewed in the Main Panel via the SwitchView button, then the 3D view is displayed in the Sub Panel (refer Section 5.3).

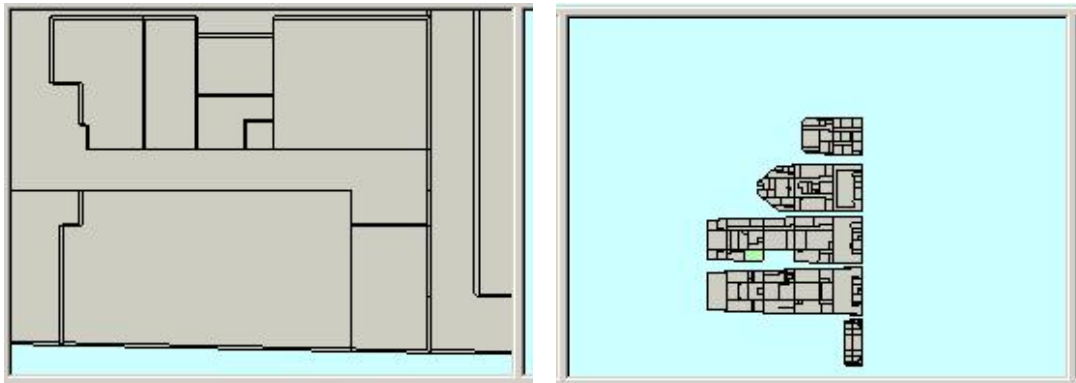
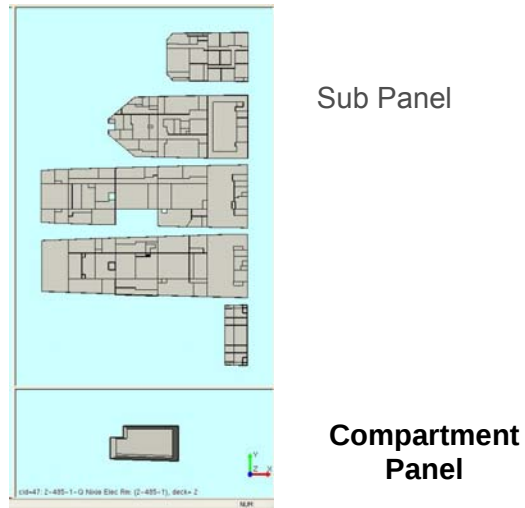


Figure 13-4 Zooming the Floor Plan View

13.3 Compartment Panel

The Compartment panel (Figure 13-5) shows a single compartment view. This allows more detailed viewing of the surfaces (walls) which make up the compartment and is where the selection of individual surfaces for specifying damage occurs. See Section 8.1.5 for more details. In this view, the compartment can be rotated, zoomed, and moved similar to the main 3D view with the left, middle, and right mouse buttons.



The compartment to be displayed is selected in the Floor Plan view (Section 13.2), 3D main view (Section 13.1), Compartment Tree Browser (Section 10.0), or Show Compartment Tool (Section 9.10). In the bottom right corner of the panel the compartment id, name, and deck number of the selected compartment are displayed. The current orientation of the compartment is displayed in the right bottom corner.

Figure 13-5 Compartment Panel (Right bottom)

14.0 DISPLAY ADJUSTMENT TOOLS

Simultaneously displaying color (temperature) and opacity (smoke) is challenging. If one allows the condition of no visibility (i.e. visibility below a threshold) to be represented as a totally opaque compartment, then the temperature will be represented by a fully saturated (i.e. bright) color. This is counterintuitive, since a compartment full of smoke is expected to be dark. On the other hand, if we allow the compartment full of smoke to be very dark, then the information about the temperature is lost, because color is not visible. A compromise must be found.

Before color (or opacity) mapping, the parameters to be displayed are normalized (using the range values described in section 12.2.1). Then, somewhat arbitrarily, the high value of temperature is mapped to 75% of color saturation, and the high value of visibility is mapped to 95% of opacity as shown in Figure 14-1. These experimentally selected values result in a realistic representation of smoke while providing perceptible information about the temperature.

Using the Display adjustment tools, this mapping can be adjusted to the user's liking.

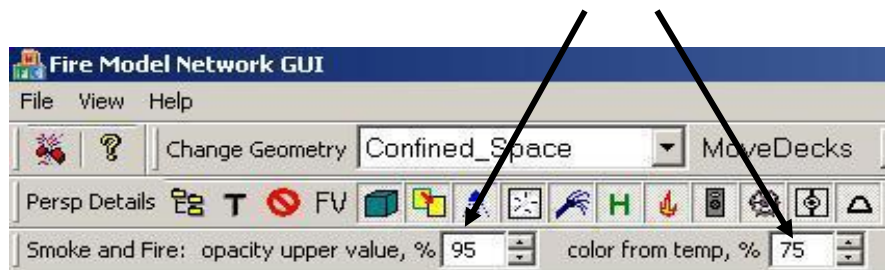


Figure 14-1 Display Adjustment Tool

15.0 SUMMARY

This manual describes the functionality of the Fire Model Network GUI 2.8 developed by Mississippi State University in conjunction with Hughes Associates, Inc. and the Naval Research Laboratory. The GUI provides an environment to setup, run, and visualize fire and smoke simulations.

For further support, please contact Tomasz Haupt at haupt@cavs.msstate.edu

16.0 REFERENCES

- [1] Haupt, T., Henley, G., Sura, B., Kirkland, R., Floyd, J., Scheffey, J., Tatem, P.A., and Williams, F.W., "User Manual for Graphical User Interface Version 2.4 with Fire and Smoke Simulation Model (FSSIM) Version 1.2," NRL/MR/6180--06-9013, December 18, 2006.
- [2] Henley, G., Haupt, T., Parihar B., and Williams, F., "FireGUI: A Software Tool for Predicting Fire and Smoke Spread on Ships," ASNE Symposium: Shipbuilding in Support of the Global War on Terrorism, Apr 14-17, 2008, Biloxi, MS. (URL: http://www.navalengineers.org/Events/Pascagoula2008/documents/1.4.AASNE2008_Paper_FireGUI_Henley_etal.pdf).
- [3] Floyd, J., Hunt, S., Williams, F., and Tatem, P., "Fire + Smoke Simulator (FSSIM) Version 1- User's Guide," NRL/MR/6180-04-8806, March 31, 2004.
- [4] Floyd, J., Hunt, S., Williams, F., and Tatem, P., "Fire + Smoke Simulator (FSSIM) Version 1- Theory Manual," NRL/MR/6180-04-8765, July 16, 2004.
- [5] Haupt, T., Shulga, D., Sura, B., Durvasula, S., Tatem, P., and Williams, F., "Simulation Environment for Onboard Fire Network Model Version 1.0-Theory Manual," NRL/MR/6180-04-8800, May 12, 2004.
- [6] Haupt, T., Henley, G., Tatem, P.A., and Williams, F.W., "Creating a Digital Ship Model from AutoCAD Drawings", NRL/MR/6180-05-8882, June 8, 2005.

APPENDIX A: OVERVIEW OF V2.8 NEW FEATURES (SINCE V2.4)

Data extraction for quantitative analysis

A new feature has been introduced for extracting simulation output data for quantitative analysis of the results. Using the new data extraction feature, the user can export the data for external analysis packages, such as Microsoft Excel in the form of a comma separated values (.csv) file. Refer to Section 8.3 for more details.

Archways can be changed to smoke curtains

A new feature in this version provides the capability to change archways into smoke curtains. Previously archways were visualized as open doors and their state was always open. Now they are shown with an arch above them and their state can be changed from archway to smoke curtain. Smoke curtains are treated as closed doors for simulation purposes. Refer to Section 8.1.2 for more details.

Separation of color settings from options file

Previously, *Options.xml* had both color settings values as well as other configurable variables. In this version, the Options file is split into two files a) *Options.xml* and b) *ColorSettings.xml* and two separate popup dialog boxes *General Options* and *Color Options* to modify the files respectively are provided. By keeping color values in a separate file, the user can share his/her edited color maps with different users. Refer to Section 12.0 for more details.

User friendly color map editing

Color map editing has been made more user friendly by providing a simpler interface for editing values and to add or delete colors. Also, the preview legend is dynamically updated as the user types in the values. Refer to Section 12.2 for more details.

Different setup to install the software

For the previous versions, the CD contents had to be copied to a desired location to install the software. From this version onwards, a setup.exe file has to be run to install it. This is the standard way to distribute any software created using Microsoft's Visual Studio .NET 2005. Refer to Section 2.0 for more details.

Note: When loading a previous simulation as a starting point for running a new simulation, normally the only data read from the simulation file is data which can be changed by the GUI (such as states of doors, hatches, scuttles, fire source and parameters); all other data is read from the database. In V2.8, as a preparatory step for an upcoming feature, the fuel, usetype categories (fuel loading), and compartment-to-usetype mappings are now being read from the simulation file.

