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Control Simulator 8 Quick Start

**Essential features of CS8 and
how to build a simple model.**

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1. INTRODUCTION

CS8 is a software package designed to simulate various subsea hydraulic control system situations involving long supply or control lines that are of current interest in the oil and gas industry. The purpose is to estimate the time required to move valves, to fill accumulators, and to confirm that the hydraulic power will be delivered successfully.

Long supply or control lines are critical components in the design of CS8. CS8 carefully models frictional drops, fluid compression, line expansion, time delays, and inertial forces. All CS8 models involve long supply lines.

CS8 simulates fluid flow, pressure, valve positions and accumulator state throughout a system by taking device parameters and a set of initial conditions, and then moving forward in small time steps, recomputing the state of the system after each time step. The vast majority of the models are based upon well established theoretical equations of motion and fluid flow. With the exception of the commonly used Darcy friction factor for pressure drop, and compressibility curves for real gasses, empirical relations and curve fits are not used. So CS8 is widely applicable to systems of any practical scale due to the use of fundamental differential equations of motion.

2. BASIC STRUCTURE AND DEFINITIONS

The hydraulic networks simulated by CS8 consist of devices (nodes) connected by lines. In addition to the explanations in the text, consult Appendix 1 for the definitions of specific terms.

2.1 The Project

A single file that holds a collection of components and cases that are related to one another is called a project. As explained in detail later, components are pieces like a hose or a valve, and a case is a model of a hydraulic circuit including its initial conditions so that its response can be simulated.

2.2 Devices

A device is a collection of one or more components serving a particular function in a CS8 model. Components and devices each have rigidly pre-defined internal structures. Example: A hydraulic umbilical is a device, as is an HPU.

There are three main types of devices: sources, lines, and discharges as described in section 2.3. Each particular type of device has a distinctive icon in the user interface. CS8 models are built by choosing and connecting devices together and selecting the components within the device.

The only structural choice the operator has is to pick which lines and devices to use, and how many lines will branch from a given source or discharge device.

A device normally has one inlet and one or more outlets for connecting to other devices.

2.3 Cases

Devices that are connected into a tree structure are called a case. At the root of the tree is always a source device. The outlet of a source feeds the inlet of a line. The outlet of the line then connects to the inlet of a discharge device.

Sources and discharges can only connect to lines. All source and discharge devices have one or more outlets, and all discharges have at least one inlet to which a line can be connected. This allows you to construct daisy-chained or branched systems.

A case in which each of the inlets and outlets of every device is connected to another device is complete and can be run to produce a simulation. The simplest case consists of a source device, a line, and a discharge device connected together. For example, a case might simulate the pressurizing of all of the accumulators in a system.

2.4 Library of Components

Lines and devices are constructed of library components and project properties. A component is an object that has certain properties associated with it, no matter how it is used. For instance, a piece of steel tubing has an internal diameter and a wall thickness that are always the same no matter how it is used. Such properties define a component.

Other properties that are necessary to the simulation but not a fixed property of the component (such as the length of a steel tube) appear as part of the device the component is used in.

2.5 Conventions

Fluid may, in general, flow in either direction in lines and devices. In general, flow entering an inlet or leaving an outlet is considered to be positive flow.

Pressures may be entered or displayed as gauge pressures (like psi) or absolute pressures (like psia). Gauge pressure is normally interpreted to be the pressure relative to the local static head of control fluid. For source devices, gauge pressures are relative to the atmosphere. For some discharge devices, gauge pressures may be relative to the sea. These exceptions are clearly noted.

3. INSTALLATION

All versions of CS8 after 21 April 2011 are distributed as an installation CD image for automatic installation. You also need a license file, which is supplied separately. To run CS8, you must have at least the following files, all in the same folder:

CS8.exe

CS8engine.exe

A license file: “*your company name*”.*cs8lic*

In addition, the installation CD image will install support files (usually “*some name*”.*cs8proj*) and documentation (“*some name*”.*pdf*). These files evolve. Check back with the web site from time to time to see if there are any updates.

3.1 Folder Structure

The installation program puts all of the files in the Program Files folder. In most versions of windows, this is usually:

C:\Program Files\Interlink_Systems_ILS\CS8

On 64-bit version of Windows it is usually:

C:\Program Files (x86)\Interlink_Systems_ILS\CS8

The Program Files folder will contain at least two other folders:

C:\Program Files\Interlink_Systems_ILS\CS8\Examples

C:\Program Files\Interlink_Systems_ILS\CS8\Validation

Do not edit the projects in these folders. If you want to experiment with them, make a copy of them in your Documents or MyDocuments folder. Vista and Windows 7 do not allow users who are not administrators to save to the Program Files folder.

The Validation folder contains a CS8 project with several cases that compare CS8 simulations with either CSI simulations (to show compatibility with the older CSI) or actual test data. In the same folder is a CSI database that contains the project that produced the reference data.

Do not save your project data files in any of the folders just mentioned. I suggest that you create a new folder for each project so that all input and output data for a project will be isolated in one place, rather than mixed with other projects and program data. This makes it easy to locate and backup the files associated with a particular project. I suggest the following data structure:

MyDocuments\CS8 Projects*Client Name*\Project Name

3.2 Shortcuts

The installation program creates shortcuts on the Start menu and on the Desktop. On the Start menu there are also shortcuts for the pdf documentation files. To read them you must have the latest version of Adobe Reader installed on your computer.

4. STARTING A CS8 PROJECT

To start CS8, simply double click the shortcut icon, or you may double click the file CS8.exe from within Windows Explorer.

If CS8 finds a license file in the folder with the executables, it will start and give you a blank window with a main menu across the top of the window. Your options at this point are to choose New or Open from the File main menu item.

If CS8 cannot find the license file, you will get an error message.

4.1 New

Choosing File, New lets you create a blank project. From this point you can enter the data for your components and cases. This can be tedious since you have to enter everything. It is normally better to start by opening a demonstration project or a project that you create and save specifically as a template to start from (see section 10 General Tips).

4.2 Open

Choosing File, Open allows you to open an existing project file. If you are opening the file to use it as a starting point for another project, then immediately choose File, Save Project As to save a copy with a new name. *If do not do the Save Project As immediately, you might forget and later write over your starting project (especially if auto-save is on).* **Keep backups.**

5. PARTS OF A PROJECT

Open the project “CS8 Example Project”. It should be included in the support files that you got with CS8. You will then see two windows appear: the Project Toolbar, and the Project Manager. You may minimize either window, but they will always be visible in some form whenever a project is open. When minimized, they appear as icons at the bottom of the main window. Double clicking the icon will return the window to its normal size.

5.1 Project Toolbar

The Project Toolbar contains devices that you can drag and drop onto a case window to build up cases to be simulated. Sources are on the left, followed by long lines, the discharge devices, and finally other tools on the right. Devices having icons enclosed by red parentheses () are not complete devices, but additional functions (such as an accumulator) that can be added to another device. This is covered in more detail in section 6 Dealing with cases.

5.2 Project Manager

The project manager allows access to things common to the whole project including default engineering units, comments, and the component library.

To edit comments and default engineering units, double click the upper right icon that looks like a piece of notebook paper.

To create or edit a library component, first click the icon on the left representing the type of component you are interested in. A list of existing library components of that type appear in the box to the right.

To add a new component of the selected type, click the New button.

To edit an existing component, double click its name in the list, or single click its name in the list and then click the Edit button.

To remove a component from the library, single click its name in the list and then click the Delete button. You will not be allowed to delete a component that is in use in one of the cases. If the component is in use, you will get an error message including a list of the places the component is used.

To see where (or if) a component is used, left click the component name to highlight it and then click the Where Used button.

5.3 Building the Library

A component must be defined in the library before you can use it in a case. The intended process is to completely populate the library with components, and then define the cases. In the real world, you will probably go back and forth. To make the back and forth easier, the device editors usually include a quick link to create new library components. Watch for a button labeled “New Components”.

You may enter your components in any order. But resistance elements depend upon having tubing definitions, and the resistance paths depend upon having resistance elements. So the preferred order for entry of library components is

- Tubing and/or hose
- Resistance elements
- Resistance paths
- Valves, accumulators, and fluids

The only way to edit parameters of a library component is to use the Project Manager.

5.4 Importing Library Components

Release 9 introduces the ability to import library components from another project. This is a quick way to populate your library.

To import components, first click the icon on the left representing the type of component you are interested in. Then click the Import button. A dialog box will pop up allowing you to choose the project that contains the components you want to import. Select the project file and press OK.

You will then get a list of components available for import. Click one to highlight it and press Import. Alternatively, you can press Import All if you want all of the components to be imported to your project.

It is possible that you already have the component in your project. If so, CS8 will ignore the import. For this to happen, the component in your project has to exactly match the one you are trying to import.

It is also possible that you have a component in your project that has the same name as the one you are trying to import, but it is not exactly the same. In this case, CS8 will append a revision number (like r1) to the end of the name of the imported component. You will see a dialog box reminding you of this if it happens.

If you do not like the new name of the imported component, change it immediately before you use it in any cases. It will be more difficult to change later since changing the name of a component only creates a new one.

6. DEALING WITH CASES

Cases are managed by using the Case main menu item. Assuming that you have “CS8 Example Project” open, use Case, Open to open the case named “Open the Pilot”. This is a small example that shows all of the parts of a case.

6.1 Parts of a Case window

Across the top of the case window are four icons. They are, from left to right:

- a) comments specific to this case
- b) timing related parameters such as print interval and the resolution of the simulation
- c) the default fluid to use
- d) the Run button to start a simulation

The remainder of the case window holds the devices you will simulate with lines to connect them together and define the structure. A case consists of one source device, one or more line devices, and one or more discharge devices. There must be a discharge device on the outlet of each line for the simulation to run.

6.2 Creating a Case

To create a new case, select Case and then New from the main menu. In the Create New Case dialog box that comes up, type in a unique new case name and click the Create button. A case window will appear that is empty except for a document device, time device, and fluid.

6.3 Adding devices to a case

There are two ways to add a device to a case: drag-drop, and copy-paste.

6.3.1 Drag-drop

To drag-drop, click on a device icon in the Project Toolbar, hold the left mouse button down and drag the icon onto a case window, then release the mouse button. The mouse cursor will have the shape of a circle with a slash if you are over a place that you cannot drop the device, and will have the shape of an arrow with a square if you can drop it. Then double click the new device to set its parameters.

Some devices (those that include red parentheses in the icon) can only be dropped onto another device, rather than the window, such as an accumulator to drop onto a manifold. In these cases, the mouse cursor will indicate when the mouse is over a place where it can be dropped by changing to a rectangle with an arrow.

6.3.2 Copy-paste

To copy-paste, right click a device already in a case window. From the popup menu, choose the copy option. Then right click in the blank area of a project and choose “paste” from the popup

menu. You may paste into any case that is in the project. Then double click the new device to set any of its parameters that need to change.

The advantage of copy-paste, is that drag-drop gets you a device with blank data. Copy-paste gets you a copy of all of the details you have filled in. For instance, if you have 3 identical trees, use drag-drop to create the first one. Then fill in all of the parameters, restrictions, valves, etc, and finally use copy-paste to make two more copies of the complete tree definition.

6.4 Lines

All cases have to include at least one line. Lines are intended to model the long umbilicals in a project on which the transients like water hammer, fluid compression, tubing expansion, etc. are important. It is extremely tempting to also use lines to simulate short flying leads. This will cause you big problems.

If the longest line in your project is 25km for instance, do not use the line model for any lines shorter than 1 to 2.5 km. If you do, the simulation will run very slowly. And if you use a line that is too short, you will get a warning that the number of segments in the line has been altered. If this happens, the answer may be inaccurate or the simulation may completely fail.

The dynamics on the short lines are usually negligible compared to the long ones, so the short ones should be modeled as resistance elements, not lines. In general, avoid lines that less than about 0.5 to 1% of the length of the longest line.

Note that it is not the “shortness” itself that is the problem, it having a very large ratio between the lengths of the longest and shortest lines.

6.5 Edit a device

To edit the parameters for a device in a case, you may double click the device, or you may right click the device and choose the “edit” option from the popup menu. Note: some devices, like the manifold, may have more than one area to edit. The base device is all in black. A part of a device (such as an accumulator) that is enclosed in red parentheses has its own editor. Click the mouse at a place within the device box corresponding to the part of the device that you want to edit.

6.6 Remove a device from a case

Right click the device, then select “cut” from the pop up menu. The device is removed from the Case and copied to the clipboard.

6.7 Making connections between devices

The devices have little black dots on them. Those are connectors; the left is the inlet side, the right is the outlet side. Source devices have no inlets. A device may, in general, have any number of outlet connections.

Hover the mouse cursor over a connection point. If it is available for a connection, the mouse cursor will change to a hand with a pointing finger. Press the left mouse button and drag the mouse cursor to the connection point you want to connect to. If it is available to be connected, the mouse cursor changes to a rectangle with an arrow. Release the left mouse button. A line should appear between the connection points indicating that a connection has been made.

6.8 Deleting connections between Devices

To remove a connection between devices, right click the connection point (black circle) at either end of the line and then follow the instructions.

6.9 Rearranging Connections

If you want to change the order of the outlet connections on a device or you want to add a new one in the middle, you can always delete the connections and redraw them. But here is a quicker way to do it. Either increase the number of connections or delete a connection to get an empty connection. You may then use the mouse to drag individual connections to any free connection point on the same device using the following process

Hover the mouse cursor over a connection point that has a connection already made to it. The mouse cursor will change to a hand with a pointing finger. Press the left mouse button and drag the mouse cursor to the connection point you want the connection to change to. If it is available to be connected, the mouse cursor changes to a rectangle with an arrow. Release the left mouse button. A line should move from the connection it was on to the new connection. The connection it was on will then be empty.

Note, that changing the connections does not alter or rearrange the restrictions inside of the manifold device. If the lines have different resistances, then you will have to make sure to keep the right restrictions with the right lines.

7. RUNNING A CASE SIMULATION

Each case has a Run icon near its top. Click that Icon to start the simulation. If there is a problem with the case, such that a simulation cannot be run, you will get a dialog box explaining the problem.

If the simulation can be run, the Run button will change color and show a clock hand running around. Also, the Compute Engine will bring up a progress dialog box.

You may have more than one case running at a time or you may edit one case while another is running.

8. VIEWING TABULAR NUMERIC OUTPUT

When the simulation is finished, the Case window returns to its normal appearance. At this point, you view output files by right clicking on the device of interest and selecting a view option from the popup menu.

In general, each device produces one or more output files specific to that device. There is a lot of data produced by even a small simulation and you may need to look in more than one file to get the data you need.

Earlier versions of Control Simulator produced a single output file and you may prefer to have all of the output of interest grouped into a single file. You can do this by creating a single plot of all of the data you are interested in. In addition to being able to see that plot, you can view all of the numeric data that went into making the plot in the same columnar format as all of the other numeric output.

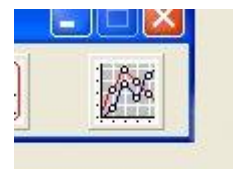
9. VIEWING OUTPUT AS A PLOT

CS8 allows very quick, easy plotting of simulator results. Plots are the most useful way to view CS8 output even if you prefer seeing the raw numeric data because they allow you to view a particular subset of the output data all in one place.

A plot may contain any number of data traces. Dissimilar data (such as pressures, flows, and valve position) can be displayed on one plot, as can reference or test values. You may never want to use Excel for plotting Control Simulator output again.

9.1 Add the plotting device to a case

To be able to plot output for a case, simply drag the plotting icon (shown at the right) onto the case like you drag any other device. Each plot device creates one plot. You may place any number of plotting devices on the case. As with any other device, you edit its parameters by double clicking the plot device icon. You view the plot by right clicking the icon.



9.2 Fill in parameters

9.2.1 Run the simulation first

The CS8 plotting device reads CS8 output files to plot from. You should run the simulation once before trying to set up a plot. This way, there will be output files for you to select from.

9.2.2 The Plot Editor

When you double click the icon after dropping it onto a case, you will see a Plot Editor window. This window allows you to completely define the plot. The “Name” field determines the name of the device as displayed in the Case window. This lets you distinguish one plot device icon from another.

Use the Plot Area tab to set up a title, the labels for the left and bottom axes, and similar parameters that may be added in the future. Note: you will not normally include a unit of measure in your axis labels. CS8 will do this automatically if the “Unit from column header” box is checked.

Use the Source Data tab to set up the individual plot traces that will be on the plot, as described below

9.2.3 Add traces

On the Source Data tab, use the Add button to add new traces. Each trace becomes a column in the tabular numeric output file for the plot.

For each trace there is a set of data on the right that determines what data will be plotted and what the trace will look like. Click on the name of the trace under “Traces on this plot” to see and edit the data for the trace.

9.2.3.1 Legend

The legend gives a name to the trace, which will appear in the legend box to the right of the plot itself.

In all CS8 numeric data files, the unit of measure appears at the top of the column of numbers. If you check “Unit from column header”, then the unit of measure will be included in the legend along with the name of the trace. If you use this feature, then the unit of measure need not appear in the vertical axis label and you can easily mix data having different units of measure. *(If you do not include the unit of measure in the legend, then it should be included in the label for the vertical axis, and all traces should have the same unit of measure.)*

9.2.3.2 Data File

Double click the file name box or the Browse button to get a list of files available for plotting. (Available files will include all files in the output folder from the case, and all files with extensions csv or txt in the same folder with the project file. See the following section on data files.)

In addition to picking a file name, you must select which columns to use for the X (horizontal axis) and Y (vertical axis) values. The X column will normally be 1 for the simulated time. To help in seeing which columns to use, click the “View File” box to see the numeric file using Notepad. You can also use the Select by Symbol buttons to select a column by its column header.

9.2.3.2.1 Data Files created by CS8

All output data files created by CS8 are in a folder that has a name of the form *casename.cso*.

Example: suppose you have a project file named DeepWaterField.cs8proj in the folder c:\CS8projects\AcmeOil-DeepWater. Suppose also that the DeepWaterField project has a case named HydraulicESD. Then running the simulation of HydraulicESD will create the folder

c:\CS8projects\AcmeOil-DeepWater\HydraulicESD.cso
that holds all of the output files from the simulation.

9.2.3.2.2 Data Files not created by CS8

You may plot traces from files not created by CS8. This is useful if you are comparing CS8 output to older CSI data or to test results¹.

Files not created by CS8 must be in one of two formats:

- 1) CS8 output file format and having the extension csv
- 2) CSI output file format and having the extension txt

The best place to put these files is in the folder along with the project file. You may also place them in the case output folder. If you do that, then the file names must begin with *_Ref_* or they will be deleted at the start of a simulation of the case.

9.2.3.3 Line

The data points may optionally have a line connecting them. You can choose its color and its thickness (Wgt) in pixels.

¹ You can even use CS8 simply as a plotting program. A case may consist only of a plot device and some non-CS8 data files.

9.2.3.4 Symbol

Each data point may optionally be marked by a symbol. You can select the symbol, its size in pixels, and its color.

If there are so many data points that the symbols on the plot become an overlapping blur, you can space the symbols out by specifying a non-zero spacing. A spacing of 0 means to plot a symbol at every data point. A spacing of N means to not plot another symbol closer than N pixels from the previous symbol. Try a spacing of 15-35 to see how it works.

9.2.3.5 Scale

You may apply a scale factor and an offset to the numeric Y data before it is plotted. There are many reasons to do this. For instance, to plot flow and pressure on the same plot, you may want to multiply flow values by 100 or 1000. To plot negative values, you may want to scale by a negative number so that the plot is of positive numbers. The plotted value is as follows:

$$\text{Plotted } Y \text{ value} = \text{Scale} * (\text{numeric } Y \text{ value from the file}) + \text{Offset}.$$

NOTE: The scale factor and offset are not applied to the data in the tabular numeric file for the plot. In that file, you see the numeric data exactly as the simulation produced it.

Normally, scale and offset will be 1 and 0, respectively, so that the numeric data is plotted without change. If the scale factor and offset are anything other than 1 and 0, then they will appear in the legend automatically.

A similar scale and offset can be applied to the X (horizontal) axis. This is mainly for use in plotting reference data that maybe has a time scale in hours, or a test that has a time origin that is offset from the time covered by the simulation.

9.2.3.6 Function

The scale and offset above can be applied to the following functions of Y:

Y: This is the normal mode of simply plotting the Y value.

$\pm\sqrt{|Y|}$: This takes the square root of the absolute value of Y. In addition, the sign of the result is positive if Y is positive, and negative if Y is negative. You can use this to compute a flow when Y is a pressure drop. You would make the scale factor be $C_v/\sqrt{S_g}$.

$|Y|$: if Y goes negative and positive, you can use this to make it always positive.

+Y²: This function squares Y. In addition, the sign of the result is positive if Y is positive, and negative if Y is negative. You can use this to compute a pressure drop when Y is a flow rate. You would make the scale factor be $Sg/(Cv^2)$.

9.3 Display the plot

To display a plot, right click the plot component icon and select “View data plot” from the menu.

You do not have to close the plot unless you want to. If the plot is visible when you edit its parameters, it will update automatically when you close the Plot Edit window. If the plot is visible when the simulation is run, it will update itself automatically when the simulation is finished.

9.4 Display the tabular numeric data

To display a plot’s tabular numeric data, right click the plot component icon and select “View data table” from the menu. Alternatively, view the plot, and then press the View Table button.

CS8 displays the tabular data file using Windows Notepad. If you edit the plot parameters or rerun the simulation, the contents of the Notepad window are NOT updated. You must close the window and then view the tabular data again.

9.5 Copy and past into other software

In one corner of the plot there is a “Copy” button. Clicking that button places an image of the plot onto the Windows clipboard. From there you can paste it into Word, email, or other programs that allow you to paste pictures.

The picture of the plot can be either a Windows metafile or a bitmap. Depending on where you are trying to paste it, one may work and behave better than the other. You may select which one to use by selecting the Options and then Plotting items of the main menu. Bitmap is likely to be the better choice.

10. GENERAL TIPS

10.1 Numeric data entry

The numeric data fields consist of a number followed by a unit of measure (such as 1500 psi). The unit of measure is required and allows you to mix English and metric units at will. You may enter and edit data using the techniques normally used for any Windows text box. But there are several additional options available for changing the numeric value and unit of

measure in a particular field. This section describes the special features and characteristics of these fields that support the entry of engineering units.

10.1.1 Completely Manual Entry

You may highlight and type over the characters in a numeric field just like you would in any Windows text box. You may also use the Del and Backspace keys to remove characters and then type in something new.

When you press Enter or Click on another field, the control will check your entry for proper form and unit of measure and display an error dialog if a mistake is found. If you type in an unknown or improper unit, or CS8 cannot understand what you are doing for whatever reason, you will get an error message.

10.1.2 Editing the Number

Move the cursor over the number and Double-Click. The highlighting that results will include only the number, allowing you to simply retype the number without changing the unit of measure. Whether you use a period or comma for the decimal point is controlled by the regional settings in Windows. You cannot change this from CS8. When entering numbers, you must use the decimal character that conforms to the regional settings selected for Windows on your particular computer. Do not type a thousands separator character (Example: enter 1000 not 1,000).

10.1.3 Editing the Unit of Measure

Move the cursor over the field and Right-Click. A menu will appear that contains all valid units of measure allowed for the field. Click the unit you want to change to. The menu will disappear and the numeric part will be scaled to the new unit of measure. For instance, "0 C" will become "32 F" when you select F as the new unit of measure. Note: if you change to a different type of unit, such as inches to gallons, CS8 may, on some fields, change the number part to 0. If this happens, then simply type in a number matching the new unit of measure.

You may also Double-Click the unit part (which causes it to become highlighted) and then type in a new unit. However, if you do this, the new unit must be recognized as a valid unit for this field or you will see an error dialog box. Also, the numeric part will not be rescaled when you change the unit this way, but the resulting number will be checked for range.

10.1.4 Changing the Display Format

You may change the formatting and number of decimal points. To do this, Right-Click anywhere in the field box. You will get a pop up list that includes the selections: Floating and Fixed Format. If you Click on Floating, the display will adjust itself between simple floating

point and scientific notation. If you Click on Fixed Format, then you will be able to select a number of decimal places and a minimum number of digits to include to the left of the decimal. The selection you make for each field is remembered with the saved project file.

10.1.5 Calculator Functions

Any place that you can enter a number, you can enter an arithmetic expression. The numeric field recognizes the operators + - * / and ^ (exponentiation), and allows parentheses like most common algebraic calculators. It also knows the symbol “pi”.

For example, assume you are entering the volume of a cylinder 10" long and 3" in diameter. Instead of entering “70.69 cu-in”, you can enter “(0.25*pi*3^2)*10 cu-in”. Or, if you have 13 bottles with 4.6 liter volume, you can enter the total volume as "13*4.6 L". When you press Enter or Click another field, the expression is evaluated and replaced by the resulting number.

10.2 Naming components in the library

There are two schools of thought on naming library components. Each has good and bad points.

10.2.1 Use the component Name

The most obvious way to name a component is with its real name. For instance, a tube may be named: ‘3/8” x 0.065” stainless’. This is obvious and easy to do.

There are two problems with using the component name. First (continuing with the tube example), if you got the wall thickness wrong, then, when you fix the wall, you also have to change the name. Changing the name creates a new component with the new name. You have to search each device in each case to find where the old tube name was used and change it to the new name. This is tedious. You can find them all by trying to delete the old component and using the error message to guide you. If you do not want to delete the old component, then you can use the Where Used button to locate all occurrences.

In a similar vein, if you decide to use 1/2” tubing in several places, instead of 3/8”, then you must define a new 1/2” tube and then find all of the places you want to use it (which may not be all of the places it is used), changing from the 3/8” to the 1/2”. Again, tedious. But obvious.

A way to lessen the problem is to give the tube a more generic name, like ‘3/8” 10kpsi’. When you name a component, think about what changes may be made down the line and give it the most general name possible, consistent with easy identification. A particularly useful generalization is to name the component based on its function as described in the next section.

10.2.2 Use the component function

Name the component according to its function in the project or case. For instance, instead of calling a valve 2 1/16" 10K gate valve, call it Upper Master. Then use Upper Master for all valves serving that function. A lower master would use a valve named Lower Master, even if the upper and lower masters actually have exactly the same parameters.

This is lovely, because if you change your mind about what actual valve to use for the upper master, you simply edit that library entry and, poof, all occurrences of Upper Master in all cases will use the new valve parameters.

The drawback is that if you use this project as the starting point for a new one, the name may not make sense in the new project. For instance, "Sunshine well infield umbilical" may be perfect for project A, while there is probably no Sunshine well in project B.

10.3 General purpose library

If you have components that you use repeatedly, make a project that has those components already defined and use it as a starting point for new projects. Simply open it and then choose File, Save As to create a new version for your new project. Be sure to Save As immediately so you do not inadvertently mess up your master project. Keep Backups.

10.4 General purpose case

The normal use of a Case is to build a model of a system for simulation purposes. But a Case can also simply be a repository for special devices for use in the project. The devices would not be connected to one another and not form a structure that can be simulated. For instance, a tree with its accumulator and valves could be loose in a Case called "Devices", ready to be copied and pasted into other Cases.

10.5 Simulation Accuracy

Odd output values at the beginning of a simulation may not be real. Values printed during the very first 1 or two time steps are often questionable because of the way initial conditions are set up. Some components start out with somewhat arbitrary values due to the difficulty of choosing starting values and they quickly reach a proper value when the simulation starts. This is particularly applicable to values output at time=0. I often do not even print the time=0 values.

Also, the mathematical valve opens instantly, whereas real valves do not. The more gradual opening of the real valve will dampen the real transient somewhat.

The following hints apply to accuracy:

Dividing the line up into at least 50-100 reaches gives good run speed and accuracy ("Minimum # reaches" field on the time device). Too few and the simulation can become unstable, so I limit the minimum number. Too many and execution time goes way up with no change in the answer. Increasing the number of reaches decreases the time step.

Time steps should be short relative to the time it takes to move a valve or fill an accumulator or operate other devices.

If you are wondering about accuracy, double the minimum number of reaches and see if that changes the answer significantly. If not, then the lower number of reaches is sufficient.

Real transients last a specific time. If you double the number of reaches (which halves the time step) and your transient changes drastically or halves in duration, then it is probably a glitch, not something real.

The above applies to instabilities as well. If you get crazy oscillations, increase the number of reaches and see if that settles it down.

APPENDIX 1 - DEFINITION OF TERMS

Case - A collection of interconnected devices for which you can actually run a simulation.

Click - With the mouse cursor over an object, press and release the left mouse button once.

Component – A functional building block used to construct devices from which to build cases. Components are kept in a library that is part of a project. The properties used to describe a particular component are predefined and fixed, no matter how or where the component is used. Ex: the diameter of tubing is a component property.

Device - A predefined hydraulic circuit that can be added to a case to build up a circuit to simulate. Ex: a manifold.

Discharge Device – A device that goes on the end of a line that is farthest from the master control point.

Double Click - With the mouse cursor over an object, rapidly press and release the left mouse button twice.

Drag and Drop – Position the mouse cursor over the object to drag. Press and hold the left mouse button while you move the mouse cursor to where the object needs to be. Then release the left mouse button.

Hover – Position the mouse cursor over an object.

Icon – the picture representing a device.

Inlet – A connection point on the side of a device or long line that is closest to the master control point. Fluid may flow into or out of an inlet, with fluid flowing in being defined as positive. In CS8, inlets are normally on the left side of the icon.

Library – The part of a project file that holds components for use in building cases. Components in the library are only defined once when you put them in the library. Thereafter, the components are referenced by name to build devices and cases.

Line – A relatively long conduit for conveying hydraulic fluid. In CS8, “lines” refer to long tubes or hoses where the dynamics of pressure waves, compression of fluid, and expansion of the line are important to the simulation. A pressure disturbance at one of a line is not immediately felt at the other end. Short pieces of tubing or hose should be modeled as resistance elements or paths.

Long line – see Line

Outlet – A connection point on the side of a device or long line that is farthest from the master control point. Fluid may flow into or out of an outlet, with fluid flowing out being defined as positive. In CS8, outlets are normally on the right side of the icon.

Path – A number of resistance elements in series.

Project – A single file containing a library of components and any number of cases to be simulated.

Resistance Element – A simple flow restriction combined with a relatively short section of tubing. The length of the tubing is short enough that it can be assumed to always be in steady state flow, with the dynamics and transients being negligible.

Right Click – With the mouse cursor over an object, press and release the right mouse button once.

Source Device – The device in a case that serves as the master control point. A case can have only one source device with at least one line coming out of it to feed the rest of the system. Source devices have no inlets.