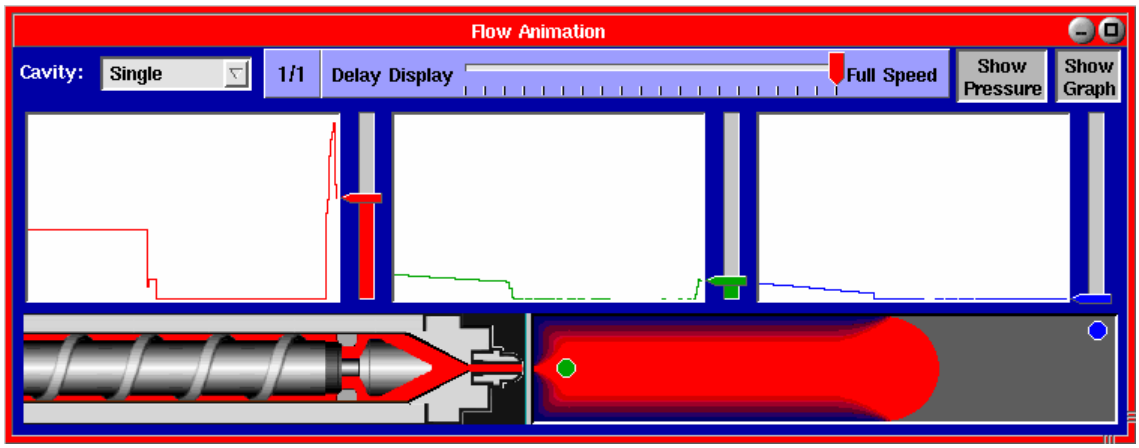
Flow Animation Tool for eDART™

Introduction and Purpose

The eDART software release 8.6 introduces a new tool named "Flow Animation". This tool paints a visual representation for how the screw is moving in the barrel and the flow front is moving in the cavity in real time with data from sensors. We found that some of the obstacles to understanding in-cavity control and processing are due to the difficulty of conceiving what is going on inside the mold and barrel. Students who have seen the animation as it runs synchronously with the machine have suddenly been able to make the connection between screw motion, flow, pressure and graphs. This usually takes much longer with static pictures used in instruction.



The intent of this tool is to try to show how the screw motion and material do not entirely follow each other directly. With cavity pressure sensors (especially Post Gate) you can show how the material compresses and continues to flow even when the screw stops. In fact, some students have found value in just seeing the screw move and turn because they had not been able to picture what was going on inside the barrel.

Furthermore the Flow Animation also shows how pressure is seen at each end of the cavity and in the injection unit. These pressures are shown first as pressure bars (like manometers) and then expanded to show the pressure graphs. This helps those less familiar with graphs to understand where they come from.

Starting Flow Animation

Drag into Architect

Use the usual Architect methods to drag the Flow Animation tool from the Analysis tab in the Architect to one of the following workspaces:

- The current mold to attach to only that mold
- The System tab workspace to put it on the main menu.
- The System tab / E-Dart System / Molds folder to make it start when any mold is running.

You may want to put it on the eDART's main menu for showing or teaching at will but so that it can be closed easily when you are finished.

Signals Required

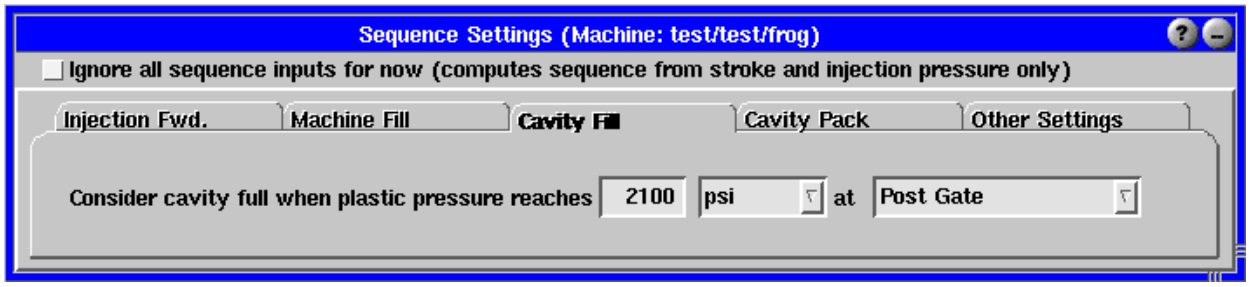
The Flow Animation requires at least injection volume (taken from *Stroke / Injection*) and injection pressure (*Plastic Pressure / Injection*). Without these signals the Flow Animation tool will wait for them. If you have a signal wired to screw run (*Seq. Module Input / Screw Run*) then it will also show the screw turning during recovery.

The *Machine Sequence / Fill* signal must go off before the cavities are full. Generally if you have a stable process the Sequence Settings software will set a volume for you. You can also set the volume by positioning the Cycle Graph cursor at the point of slow-down to pack, right clicking and clicking "Set Fill Volume at Cursor" on the menu. If the fill volume is reached after the cavities are full then the Flow Animation cannot properly show in-cavity filling.

Signals Recommended

If you have pressure sensors then the Flow Animation tool will present a better picture of flow than without. Post Gate sensors produce the best estimate of flow.

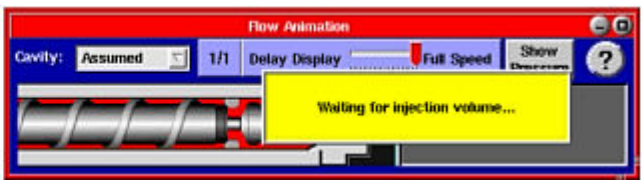
If you do have pressure sensors then you must tell the eDART what represents a full cavity. This setting is on the Sequence Settings tool's "Cavity Fill" tab. Select the sensor location that is available and is best for detecting a full cavity. This would normally be the End of Cavity location. If your mold only has sensors elsewhere then select one of those locations (Post Gate or Mid Cavity). Then adjust the threshold level to the best estimate of a full cavity.



In the example above we had no End of Cavity sensors so we used 2100 psi at Post Gate for fill.

Initial Display

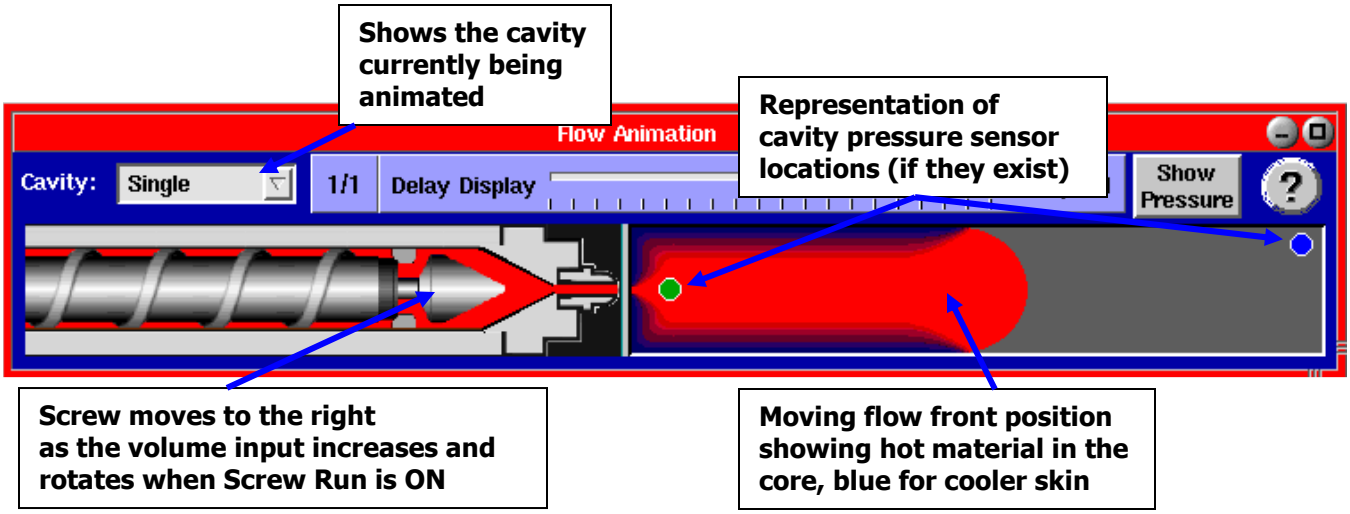
On startup you will usually see the Flow Animation display itself as shown below.



These two images show the yellow "Waiting…" box that will remain until the signals needed (pressure, volume) become active. The Flow Animation checks for those signals at the end of each cycle. Until the machine cycles at least once it does not know what signals are there.

Explanation of Behavior

After the machine is cycling the Flow Animation tool detects any cavity pressure sensors and uses them to compute when the cavity is full. It then builds a representation of flow as best it can with the data provided. The following diagram explains all of the various actions of Flow Animation before you use any controls.



Cavity Selection

The "Cavity:" initially begins with the cavity called "Assumed". The flow front moves as a very rough estimate of what it might do based on volume and pressure. This works without cavity pressure sensors but is not as interesting since it is a crude estimate.

Flow Animation looks for cavity fill times (*Process Time / Cavity Fill #...*) as based on the Sequence Settings above. When it finds one it changes the "Assumed" to the name of one of the cavities. If your mold is a single cavity with just one sensor at each location Flow Animation inserts the word "Single".

Sensors Shown

If there are cavity pressure sensors, whether used for fill time or not, Flow Animation paints them on in roughly the locations they would exist: Post Gate near the gate, Mid Cavity in the middle and End of Cavity in the corner. It uses the colors that are currently in use on the Cycle Graph.

Flow Front Behavior

The flow front moves in response to an equation that estimates its position through real-time calculation. It does the best with Post Gate sensors since it can watch both the injection pressure and gate pressure as the cavity fills. When the screw slows down you can then see how the flow front continues to move forward because it is compressed and decompresses by continuing to flow, sometimes even when the screw bounces back.

Computation Is Based on the Previous Cycle

The Flow Animation tool needs to know the cavity fill time in order to estimate when the flow front will arrive at the end of the cavity. The rest of the flow rates are scaled to fit the fill time. But it cannot know the fill time until the cavity is filled at least once. Thus it uses the cavity fill time from the previous shot in order to draw the flow for the next shot.

If you are making a lot of adjustments in speeds, transfer positions etc. then the Flow Animation may not make any sense. You need to have at least two stable cycles in order to see a reasonably useful animation on the second cycle.

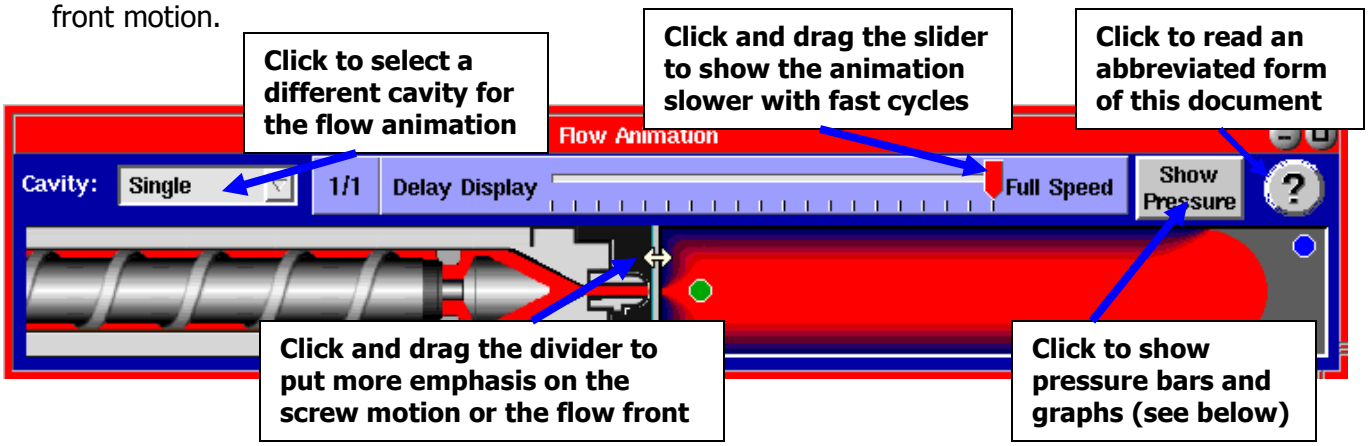
Representation of Fill-Only Shots

In order to represent fill-only shots the Flow Animation tool first needs to know what a full shot looks like. Like the above (one cycle behind) it needs to have a cavity fill time at least once in order to compute the flow rates.

If you wish to demonstrate short shots first make full parts in a steady way for at least two shots. Then turn off hold (or pack and hold) in order to make fill-only parts. The Flow Animation tool uses the last good cavity fill time to represent the short shot.

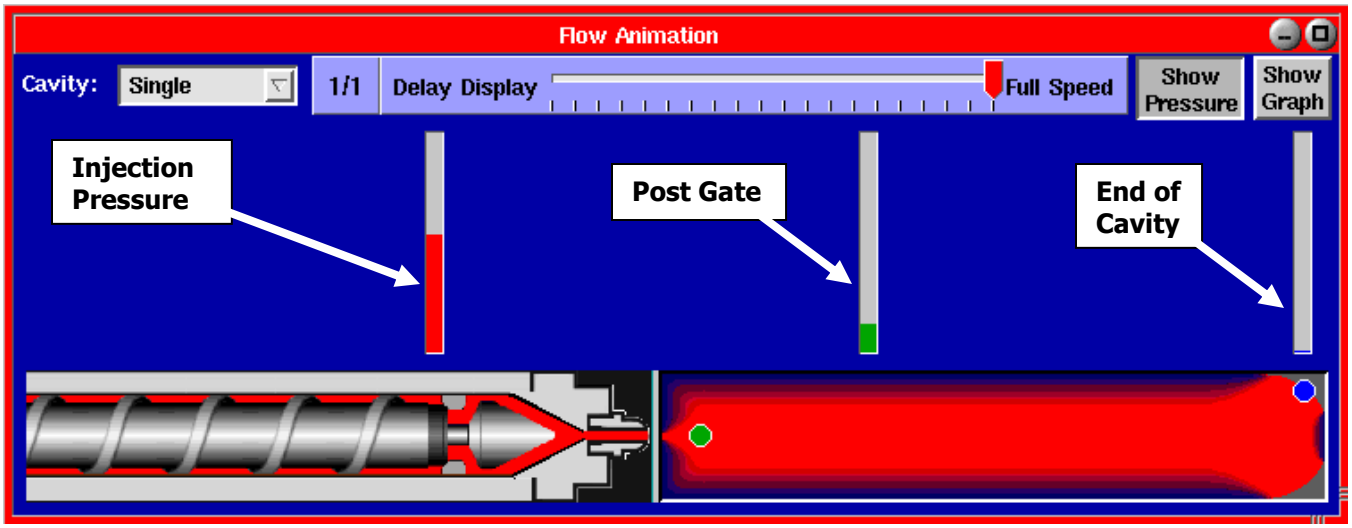
Controls

These screen captures highlight the control features that you can use to expand on just the flow front motion.



"Show Pressure"

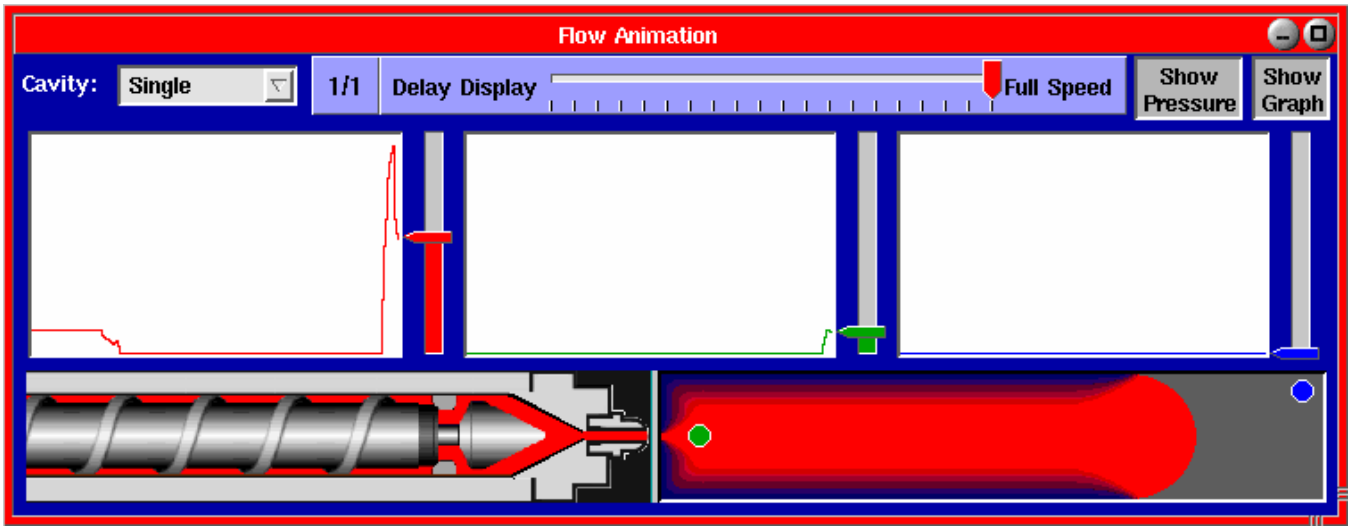
Clicking the "Show Pressure" button expands the screen to the form shown below. When demonstrating this we describe how the pressure bars represent little "manometers" or sight gauges that show how much pressure there is at each position. It can be hard to follow them as they rise and fall very quickly. You can use the "Delay Display" slider to slow down the display rate so that you can watch the bars rise and fall. The pressure bars are all scaled to the injection pressure bar.



Notice how this screen capture is just before the cavity is full. So you can see pressure at the gate and much higher pressure at the injection unit but almost no pressure at the end of the cavity. This can help explain pressure losses in plastics vs. hydrostatic materials such as water.

"Show Graph"

After discussing the pressure losses and observing them rise and fall slowly you can click the "Show Pressure" button to add the graphs as shown below. The explanation for those new to graphs is that a graph (e.g. the eDART's Cycle Graph) is simply made by attaching a colored pencil to the top of the pressure bar and letting it draw a line as the paper goes by. This has helped some people connect the graphs with the pressure in the cavity.



Notice that the above capture was made just after the machine slowed down from fill speed to pack speed in a Decoupled III process. The cavity is not even close to the typical "90 – 95%" we teach in class. You will find if you slow down the display so that you can see it that the flow front continues to expand because it is compressed like a caulking gun. It reaches equilibrium with pack speed just before the cavity is full. At that time the pressure begins to rise at the end of the cavity as the part is packed.

Limitations

Connection to Actual Parts

Someone will probably pull a fill-only part out of a mold and be concerned that it doesn't look exactly like the animation shows (as a percentage full). Do not be surprised. The Flow Animation tool is designed for teaching; for connecting moving images to abstract concepts. It is not a precise representation of any particular mold, much less the complex cavity geometries that make actual parts beyond the complexity of a simple plate. Remember to use it as such and not try to extract more information than it can produce.

Flow Animation over Networks with Phindows

We would rather you not use Phindows to show the flow animation. It may be acceptable to some extent over a 100 Mb network that has little traffic on it. On slower (10 Mb) networks or heavily loaded ones the number of graphic draw commands exceeds what can be pumped over the wire. You will get some weird delayed drawings or partial drawings that sometimes cannot be cleaned up easily. Also the controls can be hard to operate with the large data flow over the net.

Odd Event Fills in Pressure Bars

There is an unresolved error that sometimes causes the pressure bars to get completely filled in and not erase themselves. If this happens you can turn the pressure bars or graphs off and they may repaint themselves properly. You can also slightly resize the Flow Animation window.

We have not found the root cause of this yet since it appears to be in the operating system drawing code. We shall try to have it fixed in a future release.