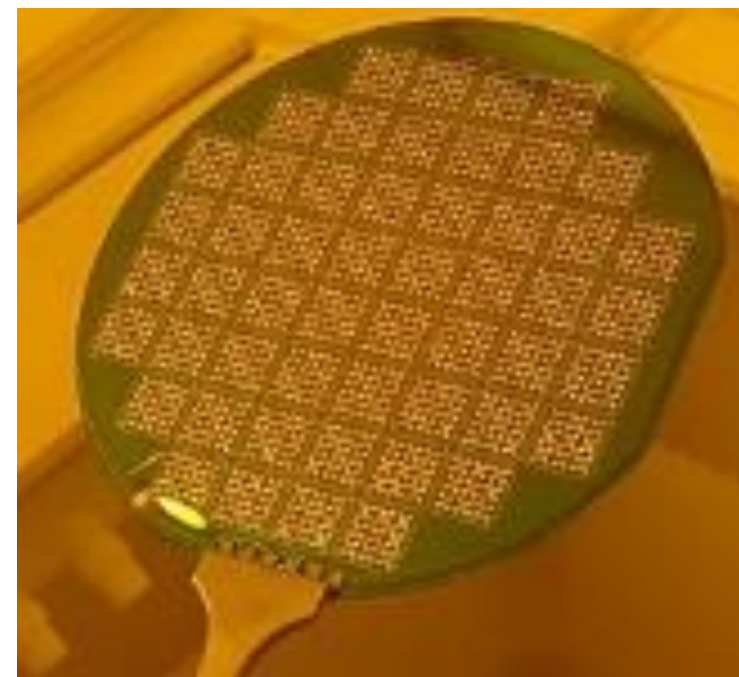
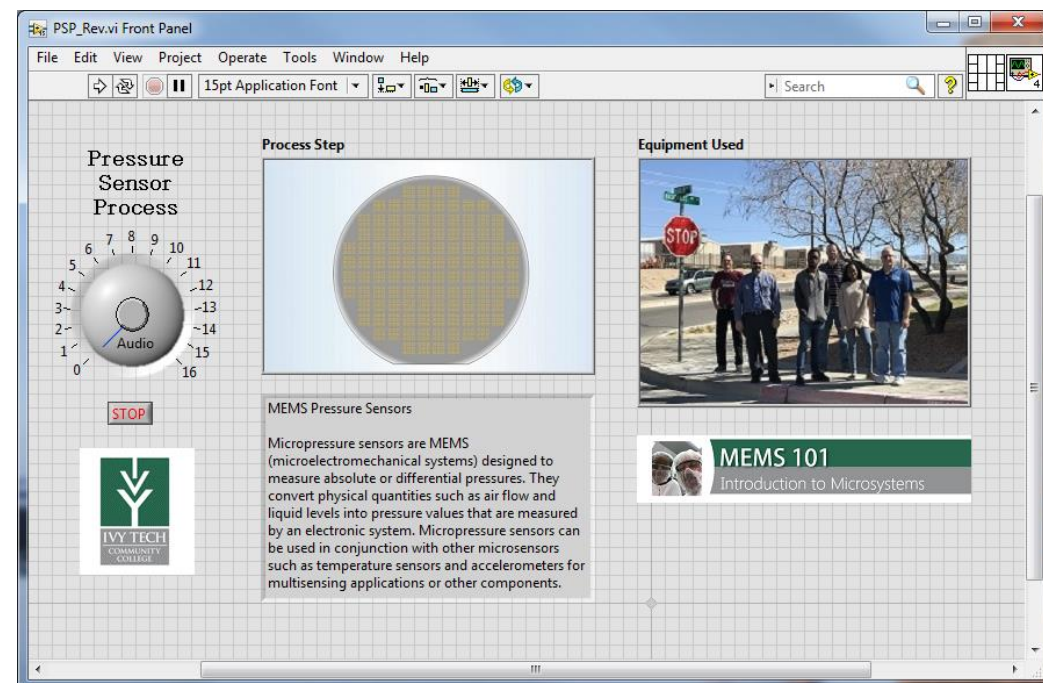


# Using LabView to Teach MEMS Fabrication Process (DUE 1400470) Ivy Tech, Northeast – Engineering, Andrew Bell

Abstract – This poster will discuss the development of a teaching aid using LabView. The MEMS fabrication process for the Pressure Sensor Process is created with the help of SCME and contains audio, process step and equipment pictures. The LabView program was developed based on student work in the MEMS 101 – Introduction to Microsystems course developed at Ivy Tech Community College, This course introduces students to MEMS fabrication and LabView programming. The program can be downloaded for free as an executable program @ <http://www.ivytech-mems.org/files/PSP Install.zip>





# MEMS 101

Introduction to Microsystems



LabView Pressure Sensor Process

Published

These are the requirements

- 1.) Must show all steps for the Pressure Sensor build
- 2.) Need pics of each piece of equipment used
- 3.) Need audio for each process step
- 4.) Can use video but must include pics of equipment used
- 5.) Process Steps should be "selectable"

[MTTC PS Process LM Presentation.pptx](#)

[MEMS Pressure Sensor Fabrication.mp4](#)

[MEMS Pressure Sensor Backside Etch.mp4](#)

[MEMS Pressure Sensor Operation.mp4](#)

Assignment – develop a LabView program that captures the Pressure Sensor (Fabrication) Process

It should include

- 1.) pictures of the process steps
- 2.) words that describe the process steps
- 3.) pictures of the equipment used for each step
- 4.) audio for each step
- 5.) process steps should be "selectable"

Video would also be nice.

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MEMS Pressure Sensor Fabrication

MEMS Pressure Sensor Backside Etch

MEMS Pressure Sensor Operation

MTTC PRESSURE SENSOR PROCESS

Process Storyboard  
(Process parameters may change due to process improvements)

Slide 1 of 32



<https://www.youtube.com/user/SCME2012/videos>  
<http://scme-support.org/index.php/category-02/mttc-pressure-sensor-process/mttc-pressure-sensor-process-presentations>





Pictures of the process were captured from the MEMS Pressure Sensor Fabrication YouTube video using Camtasia Studio



Picture of the equipment were taken from photos taken at SCME in the spring of 2016.

Text was collected from multiple sources from SCME and a free online Text to Speech program was used to create audio files using the English Daisy voice. Audacity was also used to edit the sound files as needed.



		<p><b>MEMS Pressure Sensors</b> Microelectromechanical systems (MEMS) are designed to measure absolute or differential pressures. They convert physical quantities such as air flow and liquid levels into pressure values that are measured by an electronic system. Micropressure sensors can be used in conjunction with other microsystems such as temperature sensors and accelerometers for multifunctional applications or other components.</p>	<p>The source of this text is page 7 of Whittaker Under Dissertation Activity: mem_Whittaker_ACT01_01_Sep2016.docx</p>
		<p><b>Wafer</b> The silicon wafer acts as a starting point for the alignment of the sensor in the silicon substrate. The alignment of the wafer crystal relative to the silicon substrate determines the orientation of the subsequently grown silicon crystal. The wafer is cylindrical in shape, 31.4 mm (approximately 1.25 inches) in diameter and several centimeters thick. Once loaded, the wafer is ground to a perfect cylinder. The cylinder is sliced into thin wafers using diamond coated wires. Each slice is polished to create silicon wafers, also referred to as substrates. Microsystems are constructed on or within these substrates depending upon the type of process used.</p>	<p>The source of this text are slides 48 and 49 of Crystallography: the MEMS</p>
		<p><b>Silicon Nitride Deposition</b> A chemical vapor deposition (CVD) process is used to deposit a thin film of silicon nitride on the silicon substrate. CVD is the most widely used deposition method. Films deposited through CVD are a result of the chemical reaction between the reactive gases and between the reactive gases and the atoms of the substrate surface.</p>	<p>The source of this text is slide 10 of Pressure_Sensor_Model_Presentation</p>
		<p><b>Photorealist Coat</b> A photorealist material (photoresist or resist) is applied to the substrate surface.</p>	<p>The source of this text is slide 21 of Pressure_Sensor_Model_Presentation</p>
		<p><b>Photorealist Exposure</b> The photorealist is exposed using a light source, such as Deep UV (ultraviolet, Near UV, or a ray).</p>	<p>The source of this text is slide 21 of Pressure_Sensor_Model_Presentation</p>
		<p><b>Photorealist Develop</b> The exposed photorealist is dissolved with a chemical developer.</p>	<p>The source of this text is slide 21 of Pressure_Sensor_Model_Presentation</p>
		<p><b>Reactive Ion Etch</b> In dry etch, the wafer is exposed to a plasma chamber suspended in a RF (radio-frequency) magnetic plasma. Collisions between the gas molecules and energized electrons create "ions" (charged nuclei) of electrons, ions and radicals.</p>	<p>The source of this text is slide 31 of Overview_Presentation</p>
		<p><b>Photorealist Strip</b> In the develop process, portions of the photorealist are dissolved by a chemical developer. With positive resist film, some resist remains on the wafer. With negative resist, the unexposed resist is dissolved while the exposed resist remains.</p>	<p>The source of this text is slide 21 of Photolithography_Overview_Instrument_Guide</p>
		<p><b>L10F Resist Coat</b> L10F is a process not often taught in semiconductor process classes. In the case of the L10F process, the process is used on its back. Two layers of resist are first coated on the substrate. 1) LOR or L10F Resist followed by 2) PR or photo-resist.</p>	<p>This was taken from the SCME website @ <a href="#">Site: Surface Micromachining - L10F Process</a></p>
		<p><b>Photorealist Coat</b> Two layers of resist are first coated on the substrate. 1) LOR or L10F Resist followed by 2) PR or photo-resist.</p>	<p>This was taken from the SCME website @ <a href="#">Site: Surface Micromachining - L10F Process</a></p>
		<p><b>LOR and PR Exposure</b> The photorealist is processed with light and</p>	<p>This was taken from the SCME website @ <a href="#">Site: Surface Micromachining - L10F Process</a></p>
		<p><b>LOR and PR Develop</b> developed exposing the substrate where the resist is to be deposited.</p>	<p>This was taken from the SCME website @ <a href="#">Site: Surface Micromachining - L10F Process</a></p>
		<p><b>Chrome and Gold Deposition</b> Chrome and Gold Deposition is a process not often taught in semiconductor process classes. In the case of the L10F process, the process is used on its back. Two layers of resist are first coated on the substrate. 1) LOR or L10F Resist followed by 2) PR or photo-resist.</p>	<p>The source of this text is slide 21 of Pressure_Sensor_Model_Presentation</p>
		<p><b>PR Strip - L10F</b> Chrome and Gold Deposition is a process not often taught in semiconductor process classes. In the case of the L10F process, the process is used on its back. Two layers of resist are first coated on the substrate. 1) LOR or L10F Resist followed by 2) PR or photo-resist.</p>	<p>This was taken from the SCME website @ <a href="#">Site: Surface Micromachining - L10F Process</a></p>
		<p><b>LOR Strip</b> Once the patterned resist is a sacrificial material, it is removed along with the metal that was deposited on top.</p>	<p>This was taken from the SCME website @ <a href="#">Site: Surface Micromachining - L10F Process</a></p>
		<p><b>RIE Anisotropic Etch</b> Silicon in the wafer substrate is selectively removed using anisotropic etchant. The silicon removed is directly beneath the WY etching mask. This process allows for progressively precise sensors to be manufactured at high volume.</p>	<p>The source of this text is slide 21 of Pressure_Sensor_Model_Presentation</p>
		<p><b>Pyrex 7740 Glass Anodic Bonding</b></p>	<p>This info was in the MEMS Pressure Sensor (Whittaker Assessment)</p>

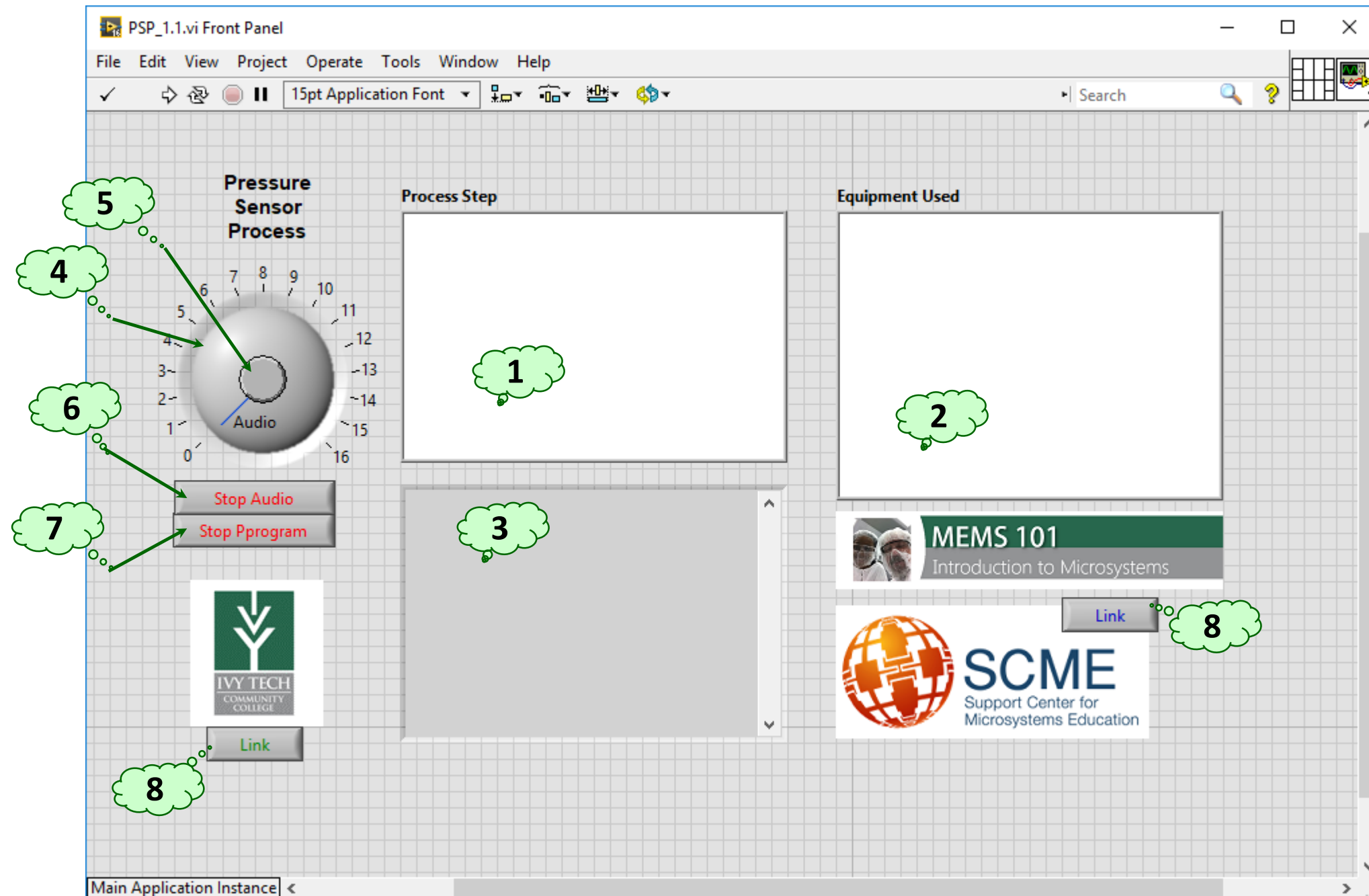
SCME was asked to review the information and they (Matt Pleil) provided additional information and corrections.

Information was shared via email and a html file with links to photos was provided.

Once all the process information was collected a LabView GUI was created that showed

- 1.) The photo of the process step
  - 2.) The photo of the equipment (with students)
  - 3.) A Text Box of the Process Step information
  - 4.) A Process Step Selector knob was added
  - 5.) An audio enable button was added to play wav files
  - 6.) An audio stop button was added to stop the audio output
  - 7.) A stop button was added to terminate the program
  - 8.) Several cool link buttons
- for more info

# LabView GUI





# LabView Program

1.) Uses 17 Case Structures to access 17 sets of data

2.) Application Directory VI

3.) Build Path Function

4.) Read JPEG File VI

5.) Draw Flattened Pixmap VI

6.) 2D Picture Control

7.) Read from Text File Function

8.) String Indicator

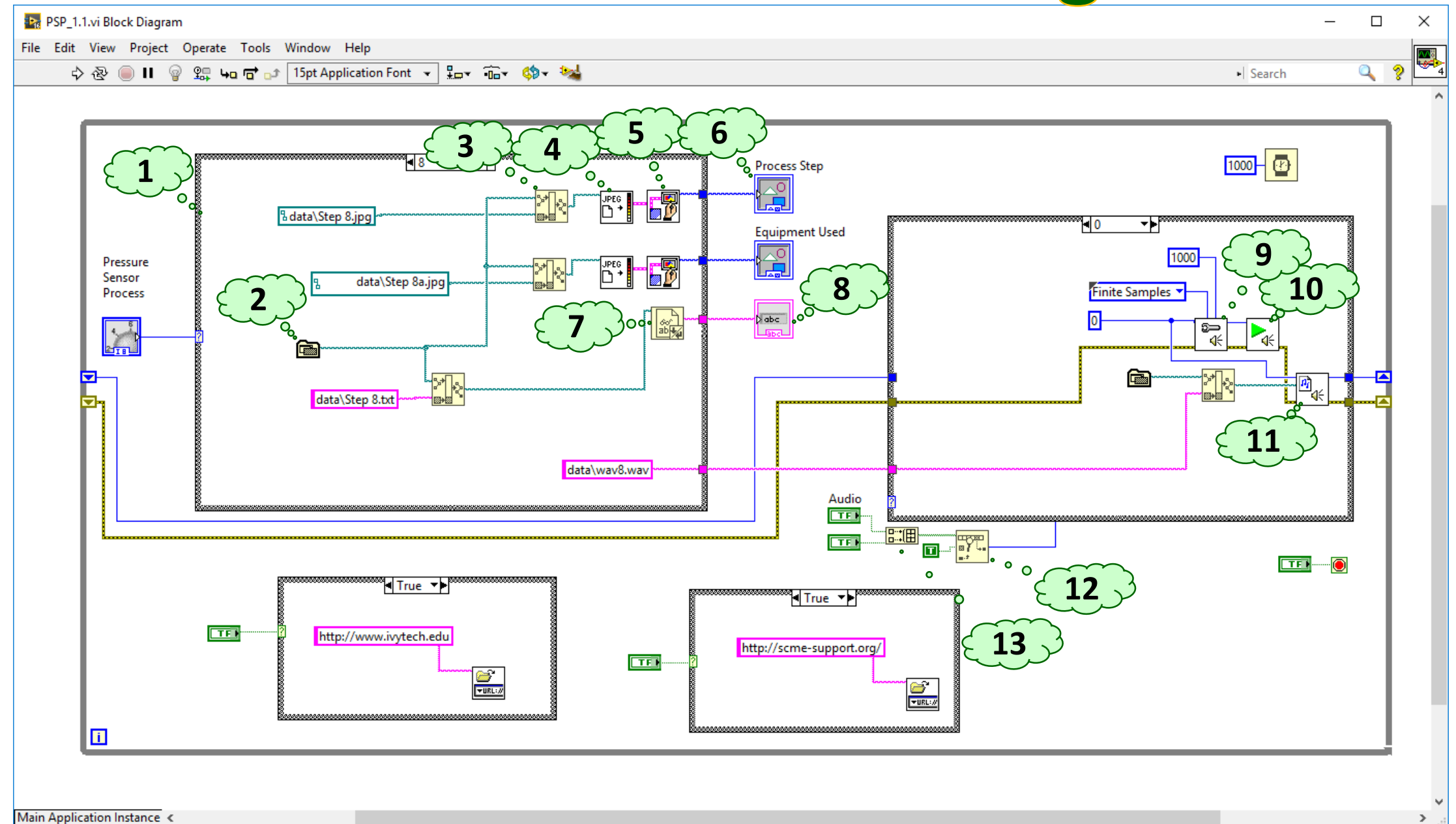
9.) Sound Output Configure VI

10.) Sound Output Start VI

11.) Play Sound File VI

12.) Search 1D Array Function

13.) Build Array Function



An install file is created that contains an executable program with all the support files to include all the data files and runtime file so you DON'T need LabView to run

These are all the data files included used in the program. There are 68 files used to create the content of this learning module program ...

Name	Date modified	Type	Size
2017-03-13 11.44.51a.jpg	8/1/2017 6:20 PM	JPG File	47 KB
Step 0.jpg	7/11/2017 12:15 PM	JPG File	15 KB
Step 0.txt	7/13/2017 3:06 PM	Text Document	1 KB
Step 1.jpg	7/11/2017 12:07 PM	JPG File	9 KB
Step 1.txt	10/19/2017 6:26 PM	Text Document	1 KB
Step 1a.jpg	7/13/2017 8:59 AM	JPG File	22 KB
Step 2.jpg	7/11/2017 12:08 PM	JPG File	25 KB
Step 2.txt	10/19/2017 6:27 PM	Text Document	1 KB
Step 2a.jpg	7/13/2017 9:02 AM	JPG File	25 KB
Step 3.jpg	7/11/2017 12:08 PM	JPG File	11 KB
Step 3.txt	10/19/2017 7:09 PM	Text Document	1 KB
Step 3a.jpg	7/12/2017 4:42 PM	JPG File	44 KB
Step 4.jpg	7/11/2017 12:09 PM	JPG File	20 KB
Step 4.txt	10/19/2017 6:28 PM	Text Document	1 KB
Step 4a.jpg	7/12/2017 4:43 PM	JPG File	53 KB
Step 5.jpg	7/11/2017 12:14 PM	JPG File	19 KB
Step 5.txt	10/19/2017 6:28 PM	Text Document	1 KB
Step 5a.jpg	7/12/2017 4:44 PM	JPG File	47 KB
Step 6.jpg	7/11/2017 12:14 PM	JPG File	17 KB
Step 6.txt	10/19/2017 6:29 PM	Text Document	1 KB
Step 6a.jpg	7/12/2017 4:44 PM	JPG File	46 KB
Step 7.jpg	7/11/2017 12:14 PM	JPG File	18 KB
Step 7.txt	10/19/2017 6:29 PM	Text Document	1 KB
Step 7a.jpg	10/19/2017 7:03 PM	JPG File	48 KB
Step 8.jpg	7/11/2017 12:14 PM	JPG File	13 KB
Step 8.txt	10/19/2017 6:30 PM	Text Document	1 KB
Step 8a.jpg	7/12/2017 5:02 PM	JPG File	47 KB
Step 9.jpg	7/11/2017 12:15 PM	JPG File	13 KB
Step 9.txt	10/19/2017 6:30 PM	Text Document	1 KB
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Step 10.jpg	7/11/2017 12:15 PM	JPG File	20 KB
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Step 13a.jpg	7/12/2017 4:55 PM	JPG File	43 KB
Step 14.jpg	7/11/2017 12:16 PM	JPG File	16 KB
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Step 14a.jpg	7/13/2017 8:45 AM	JPG File	46 KB
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Step 15a.jpg	7/12/2017 4:42 PM	JPG File	34 KB
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Step 16a.jpg	7/12/2017 5:04 PM	JPG File	43 KB
wav0.wav	10/19/2017 8:56 PM	WAV File	1,208 KB
wav1.wav	10/19/2017 9:02 PM	WAV File	2,079 KB
wav2.wav	10/19/2017 9:02 PM	WAV File	1,068 KB
wav3.wav	10/19/2017 9:02 PM	WAV File	1,414 KB
wav4.wav	10/19/2017 9:03 PM	WAV File	1,544 KB
wav5.wav	10/19/2017 9:03 PM	WAV File	1,019 KB
wav6.wav	10/19/2017 9:03 PM	WAV File	1,239 KB
wav7.wav	10/19/2017 9:03 PM	WAV File	1,744 KB
wav8.wav	10/20/2017 6:20 PM	WAV File	1,145 KB
wav9.wav	10/20/2017 7:15 PM	WAV File	652 KB
wav10.wav	10/20/2017 7:23 PM	WAV File	1,128 KB
wav11.wav	10/20/2017 7:36 PM	WAV File	1,727 KB
wav12.wav	10/20/2017 7:39 PM	WAV File	1,607 KB
wav13.wav	10/20/2017 7:47 PM	WAV File	1,536 KB
wav14.wav	10/20/2017 7:51 PM	WAV File	772 KB
wav15.wav	10/20/2017 8:20 PM	WAV File	2,886 KB
wav16.wav	10/20/2017 8:10 PM	WAV File	666 KB

An install file is created that contains an executable program with all the support files to include all the data files and runtime file so you DON'T need LabView to run. Install program is 220MB and runs on a Windows platform.

Current version will install on your computer and create an icon that will launch the Pressure Sensor Process Program (PSP\_1.1.exe).



- <http://www.scme-nm.org/>
- <http://scme-support.org/>
- <http://www.ivytech-mems.org/>
- <http://faculty.ivytech.edu/~abell118/>