Google Mobile Phone App for Compressor Performance

Group 19

Product Specifications and Project Plan

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KUNIHIKO TAIRA [signature] Oct. 14, 2011.

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Introduction:

This deliverable outlines our products target specifications and our plan to complete these and other objectives in a timely manner. The product specifications are based on the most up-to-date information available to us and are subject to change due to developments in research or as a request from our contractor. We have added the subtopics app development/infrastructure and sensor selection that are unique to our project to give a more specific insight as to our goals and intentions. Also included are a QFD chart and Gantt chart, to indicate connections between engineering specifications and customer needs and to efficiently display our projected schedule, respectively.

Customer Needs:

The customer, GE, has asked us to create a system that will collect air flow data from a compressor and store the data on a mobile application. The system must be non-intrusive to the compressor and must be able to be setup within five minutes or less. It will be designed to be used as a preliminary diagnostic tool. Our application will be the first used to diagnose the compressor and based on the data collected the user will decide whether there is no problem or if more diagnostics are needed. The purpose of this is to avoid using the more expensive diagnostic equipment unless absolutely necessary. For this reason the mobile application must be able to not only store the data, but also display the data in P-V/P-T graphs that will allow the user to easily analyze the data and make an appropriate decision. It is highly desired for the system to be as portable as possible as well as wireless.

Target Specifications:

The single parameter that we need to measure is the velocity of the fluid in the inlet and outlet pipes. Given the fluid velocity, pressure can be calculated. Since volume of the cylinder is known, a Pressure-Volume curve (P-V Curve) can be generated, which is how GE engineers begin to diagnose problems with HSR compressors. Figure 1 shows a generic P-V curve similar to the one we will be generating (though ours will look different and contain additional information).

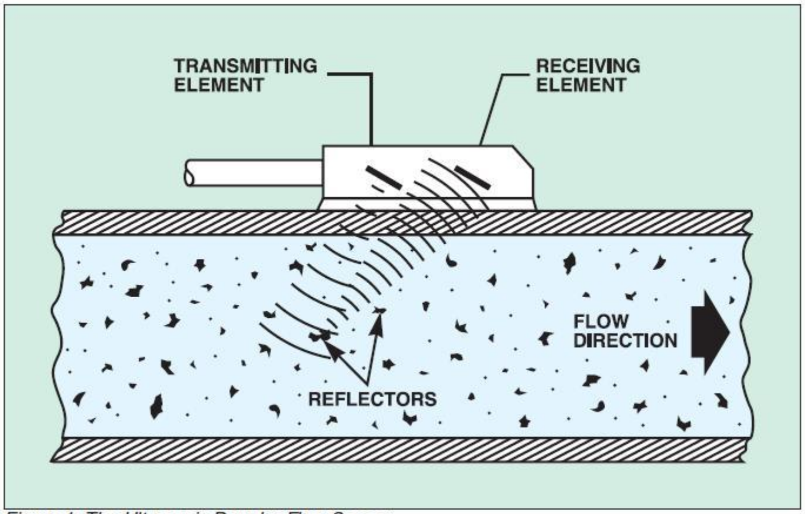


Figure 1: The Ultrasonic Doppler Flow Sensor

Figure 1 - Generic P-V Curve
http://www.omega.com/prodinfo/Ultrasonic_Fig1.html

The raw data will be plotted as velocity vs. time, but it is essential to convert this data into a P-V diagram right in the phone, since this is what the engineers need to analyze first.

Budget:

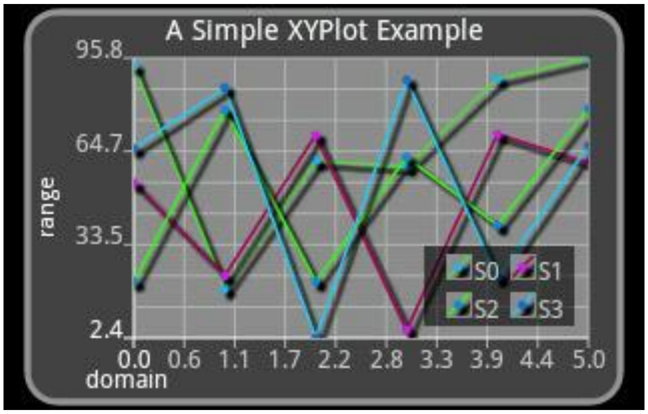
The budget set aside for this project by GE is $2000. Initially, there seems to be only a few items that need to be purchased such as the BeagleBoard, sensors and a USB wireless network adapter. Android development software is open-sourced and free to use so that will not add to the budget. The most expensive items will likely be the sensors. If we happen to come up with a superior idea that would set us over this budget, our sponsor has already agreed to meet and discuss possible readjustment.

Concepts:

Since we are fundamentally measuring velocity in a pipe, there are numerous options for testing our system. One idea would be to blow compressed air through a small pipe and attempt to measure it. Another option is to utilize the wind tunnel in Dr. Alvi's labortorary. We could measure the velocity of the air flowing near a pitot tube, and compare our value with the velocity read by the pitot tube. As we further research and decide on what type of sensors we are able to use, we can better decide how to test our prototype setup, as the equipment that we use will likely dictate feasibility of different methods.

App Development/Infrastructure:

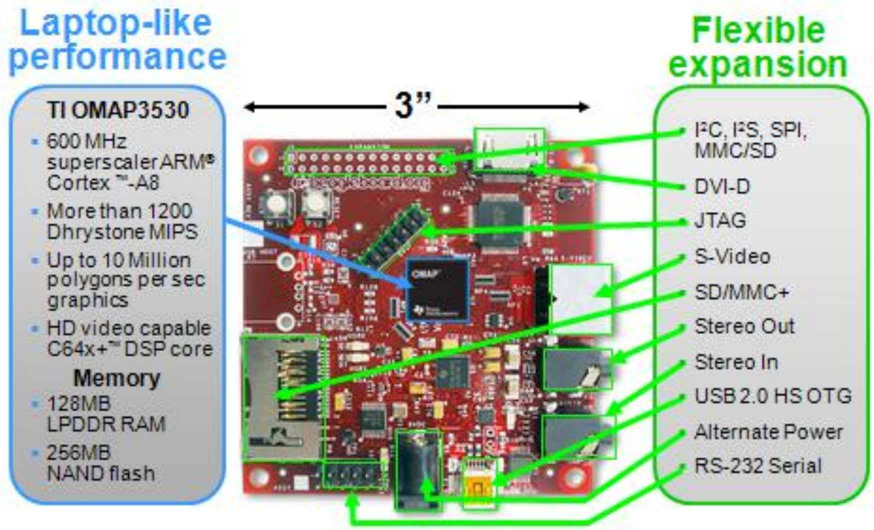
The Android platform will be used in order to retrieve and display data regarding compressor performance. Android applications are open sourced Java based programs that can be used on smart phones and tablets that have the Android operating system installed on them.
There are already several graphing applications out there that are free to use and modify such as androidplot.com. An application such as this will need to be modified in order to retrieve the data being sent from the compressor and customized to fit the needs of our project. Features such as adding a static line to the screen of what the performance should look like and switching between measurements can be implemented. Figure 2 depicts what one of the plots will look like on the Andriod phone.



Android Plot Example

Figure 2 - Generic P-V Curve
http://androidplot.com/wiki/File:2x2ex1.jpg

Data will need to be sent to the android application from another source. This source will need to be a microcontroller unit of some sort, such as a BeagleBoard. As seen in figure 3,the BeagleBoard has the specifications required to take in data from sensors and send it to the android application. Several interfaces such as USB, JTAG and RS-232 can be used to communicate with the sensors. As for sending the data out to the android application, a USB wireless network adapter will be added to the board and configured. The board will be programmed accordingly to properly take in data from the sensors and send it to the correct destination via the USB wireless network adapter.



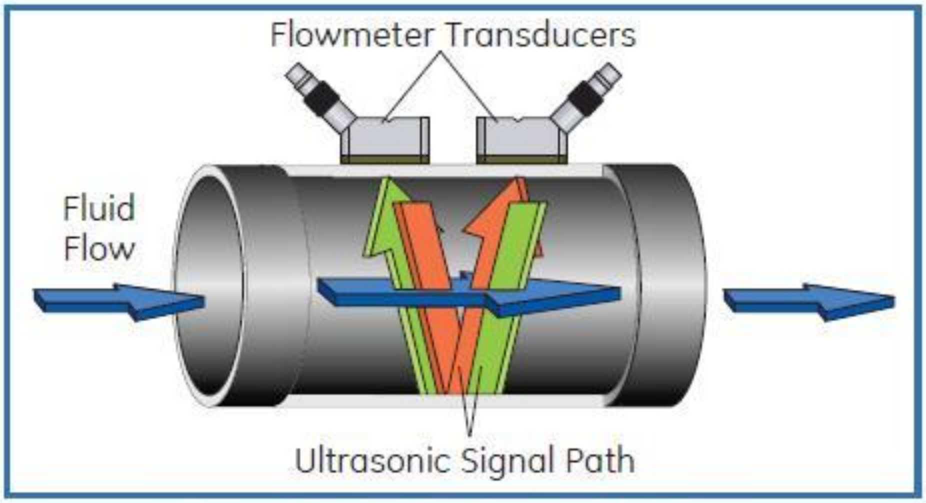
BeagleBoard

Figure 3 – Beagle Board
http://beagleboard.org/static/BBSRM_latest.pdf

Sensor Selection:

Our selection of sensors is based primarily on monitoring velocity of a fluid unobtrusively through metal piping. This sensor must detect the velocity of a fluid without interacting with it in a manner that disturbs or impedes the fluid flow. There are few options, the most obvious being an ultrasonic flow sensor. Ultrasonic flow sensors use the Doppler Effect to measure the velocity of particles suspended in fluid flow. When the ultrasonic waves emitted from the transmitting element resonate on small objects (reflectors) the frequency shifts in a manner directly proportional with the rate of flow. The receiving element then measures the difference in frequency and outputs it as a difference in voltage. The limiting characteristic of these sensors is the required reflector size. Modern Doppler sensors require the measured to contain at least 100 PPM of 100 micron or larger suspended particles or bubbles.

In our case, we are analyzing a "clean fluid", or a fluid with smaller particle sizes than those required by normal ultrasonic flow sensors. The solution to this issue is Transit Time Ultrasonic Flow Meters (TTUFM), which is the figure to the left. They use two transducers, one sending bursts of sound energy downstream and another sending an equivalent burst upstream in respect to the flow direction. Since sound energy in a moving liquid is carried faster when it travels in the direction of fluid flow, the time differential between the two bursts will give an accurate representation of flow velocity independent of particulate reflecting matter.



Transit-time flow measurement technique

For accuracy beyond that of TTUFMs, Multi-path TTUFMs will offer better representations of fluid velocity. The accuracy will increase with the addition of more transducer paths. Further research and experimentation will be necessary to figure out which implementation is most appropriate.

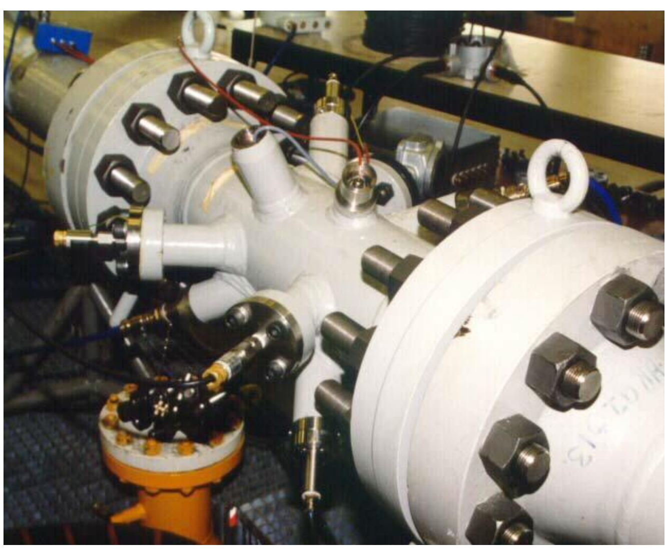


Figure 4 – USM spool piece
http://www.gerg.info/publications/tm/tm11.pdf

Simliar to figure 4, there is a high-quality sensor option for experimentation, the GE Parametric Transport PT878 to which I have provided a link below (1). It is a GE product which should make acquisition of a flow sensor simpler, although if cost is independent of the GE branding, this sensor would be prohibitively expensive. There are other options available at a lower price, such as the OMEGA FDT-30 series (2).

(1) http://www.instrumart.com/products/10266/ge-panametrics-transport-pt878

(2) http://www.omega.com/ppt/pptsc.asp?ref=FDT-30_Series&ttID=FDT-30_Series&Nav=

(3) http://www.gerg.info/publications/tm/tm11.pdf

(4) http://www.instrumart.com/assets/108/pt878.pdf

(5) http://onlinelibrary.wiley.com/doi/10.1002/ppsc.200601067/pdf

QFD Chart:
Quality Function Deployment

		Engineering Specifications				
		Mounting System Selection	Microcontroller Selection	Sensor Selection	Software Selection	Network Selection
Customer Needs	Easily detachable					
	Compatible with an Android Phone					
	Easy to read interface					
	Retrieve information and plot live data					
	No modifications to piping					

Green boxes indicate a connection between engineering specifications and customer needs. Retrieving information and plotting live data will be addressed in all the engineering specifications. Therefore, this will be our main focus for delivering a solution to the problem.
The Gannt Chart provided in the next section is the schedule for the project in the current semester. Once additional details about the next semester are provided, the Gannt Chart will be updated to reflect the changes.

Special Events	Start	End
Labor Day	9/7	9/7
Veterans Day	11/13	11/13
Thanksgiving Break	11/26	11/28
End of Semester	12/13	12/13
Christmas Break	12/18	1/6

	Start	End	% Compl.
Ice Breaker	9/6	9/12	
Research	9/6	9/11	100%
White Paper	9/8	9/12	100%
Presentation	9/8	9/12	100%
Practice	9/11	9/14	100%
Needs Assessment / Project scope	9/14	9/29	
Needs Assessment	9/12	9/14	100%
Project Scope	9/14	9/29	100%
Problem Statement	9/14	9/25	100%
Justification/Background	9/14	9/26	100%
Objective	9/16	9/27	100%
Methodology	9/16	9/27	100%
Project Specification/Procedures/Plan	9/29	10/13	
Introduction	9/29	9/8	100%
Customer Needs	9/29	10/6	100%
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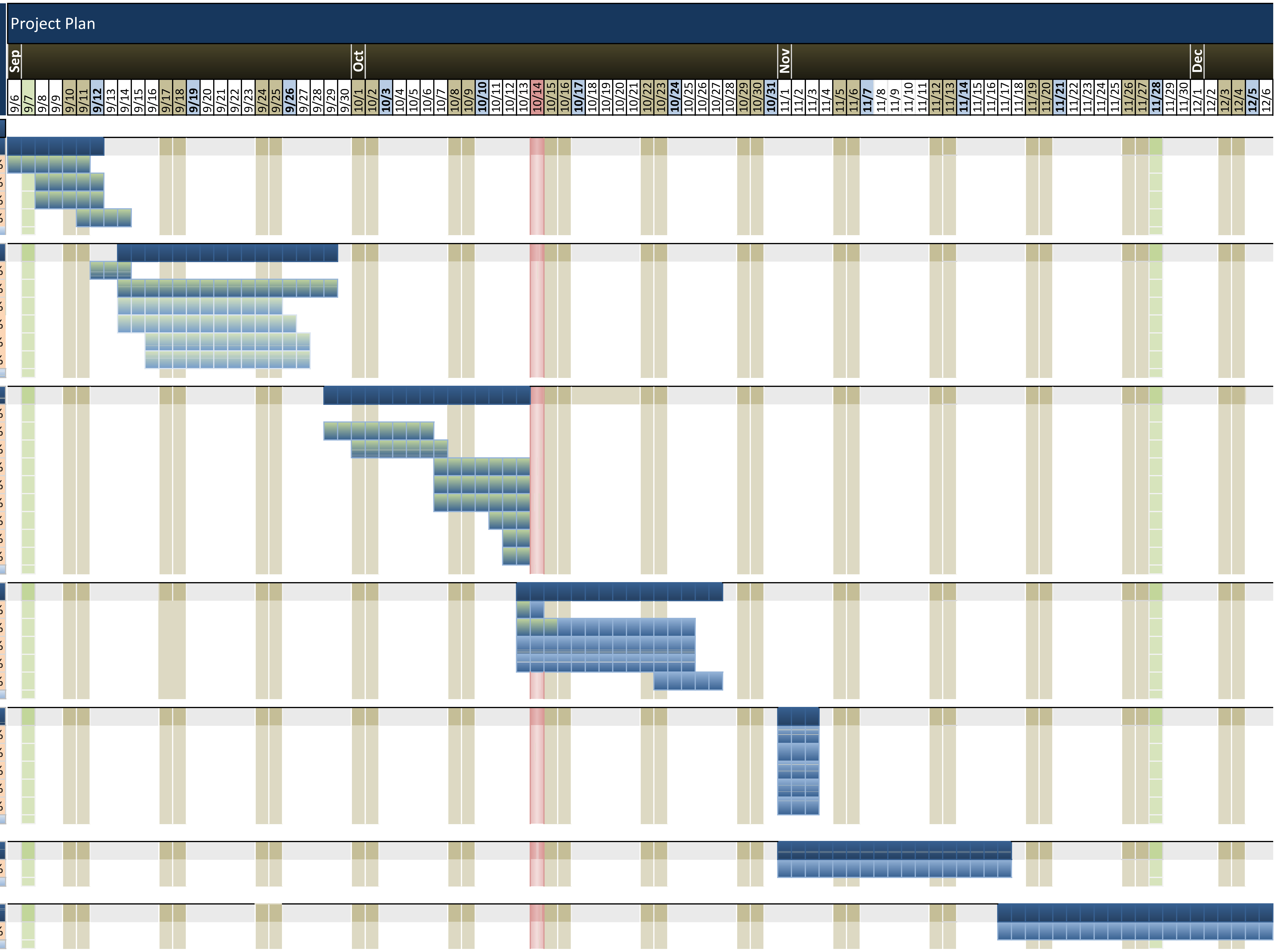

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