

ME6404 – Fall 2016 Lab 1B - Tower Crane

Objectives:

- Develop a basic understand of the laboratory equipment.
- Change the speed of the crane.
- Record the time response of the system and measure the effect on the pendulum swing.

Lab Tasks:

Move the crane trolley a set distance using 3 different speeds. You will be giving the crane a pulse velocity command, as illustrated by the dashed line in Figure 1. However, due to the acceleration limit, the actual velocity of the crane will be a trapezoid, shown by the solid line. Speed is specified in terms of percent, with 100% being 0.14 m/s. Acceleration and deceleration are approximately 1.20 m/s^2 . Use speeds of: 50%, 75%, and 100%.

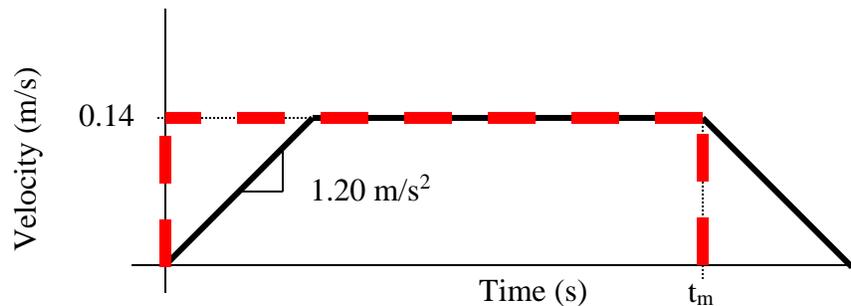


Figure 1: Drive System Velocity Profiles: Red Dashed - Command, Black Solid - Actual

For each trial, move the trolley 30 cm along the jib, i.e. in the **RADIAL** direction. Given that each trial uses a different velocity, the move time in each case will be different.

1. Calculate the move time, t_m , for each of the three speeds. Figure 1 shows the move time, t_m , in relation to the velocity profile. Keep in mind that the ramp acceleration is constant for all three cases.
2. Execute the velocity profiles on the crane and record the results.

Lab Procedure:

Tower Crane Operation

1. Login with the admin account, password: inputshaping
2. Open the shortcut “**Tower Crane GUI**” on the desktop. The interface shown in Figure 2.
3. In the **Operating Mode** drop down box, **A**, select **Remote User** and click on **Activate Mode**.
4. Use the **Start** and **Stop** buttons in **B** to begin/end moving the trolley.
5. In **F**, make sure the Command Shaper drop down box reads “**Standard/Unshaped**”.
6. In **C**, there are buttons for hoisting the hook **UP** and **DOWN**, for slewing the crane counter-clockwise **CCW** and clockwise **CW**, and for moving the trolley in the radial

direction **IN** and **OUT**. Alternatively, you can also use the joystick and buttons on the black control box. Position the crane such that during the test the crane has enough room to move without hitting an edge of its workspace. You should only need to use **IN** and **OUT** for this lab.

- Use the readouts in **D** to accurately maneuver the crane. Use the **Up/Down** buttons to hoist the hook to approximately **1141mm** (within 10mm). This is the readout “Hoist Pos (mm)” in **D**.

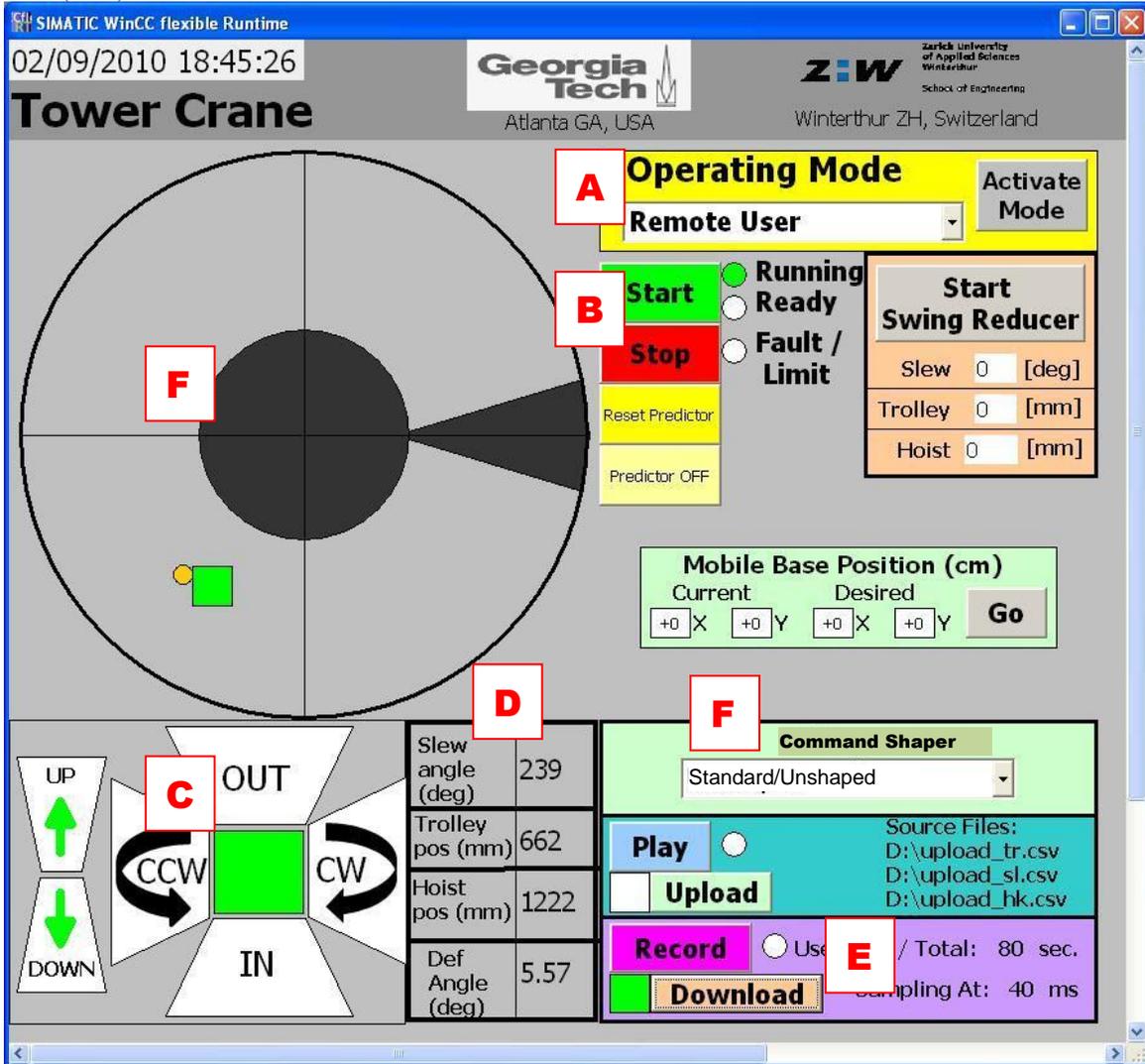


Figure 2: Tower Crane GUI

- Choose “**ME6404**” from the Command Shaper menu, **F**. This option will allow you to issue the pulse command like in Figure 1.
- To modify the velocity profile, open “SIMATIC manager” from the desktop. The “**Tower Crane Nov 2011**” project should be open. If not, use File>Open>Browse... and browse to file path “D:\Tower Crane GUI and PLC program 2016\Tower Crane Nov 2011” it should be one of the last ones opened.
- Navigate to the **DB6 ME6404** data block as shown in Figure 3 and double click.

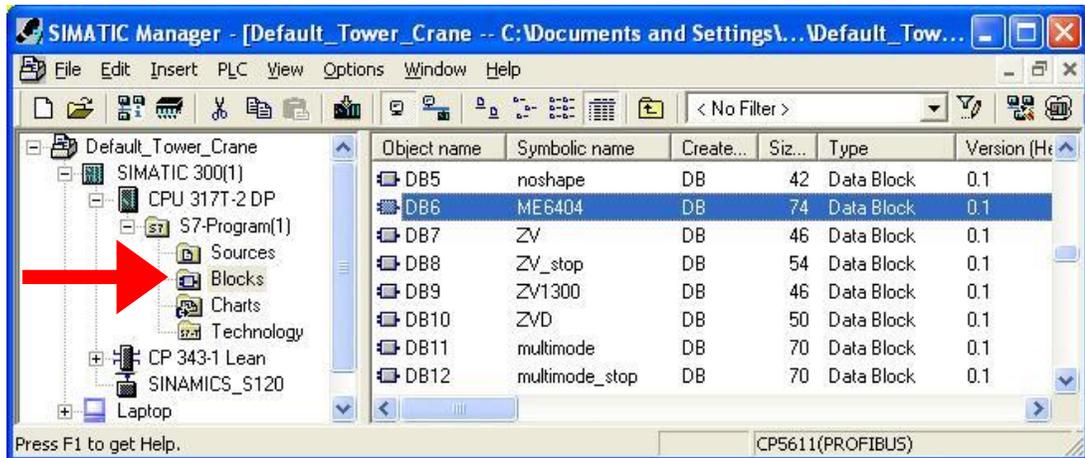


Figure 3: Simatic Manager

- Click on “**View>Data View**” and you should see the following window, shown in Figure 4. You will need to change the numbers under the “**Actual Value**” column.

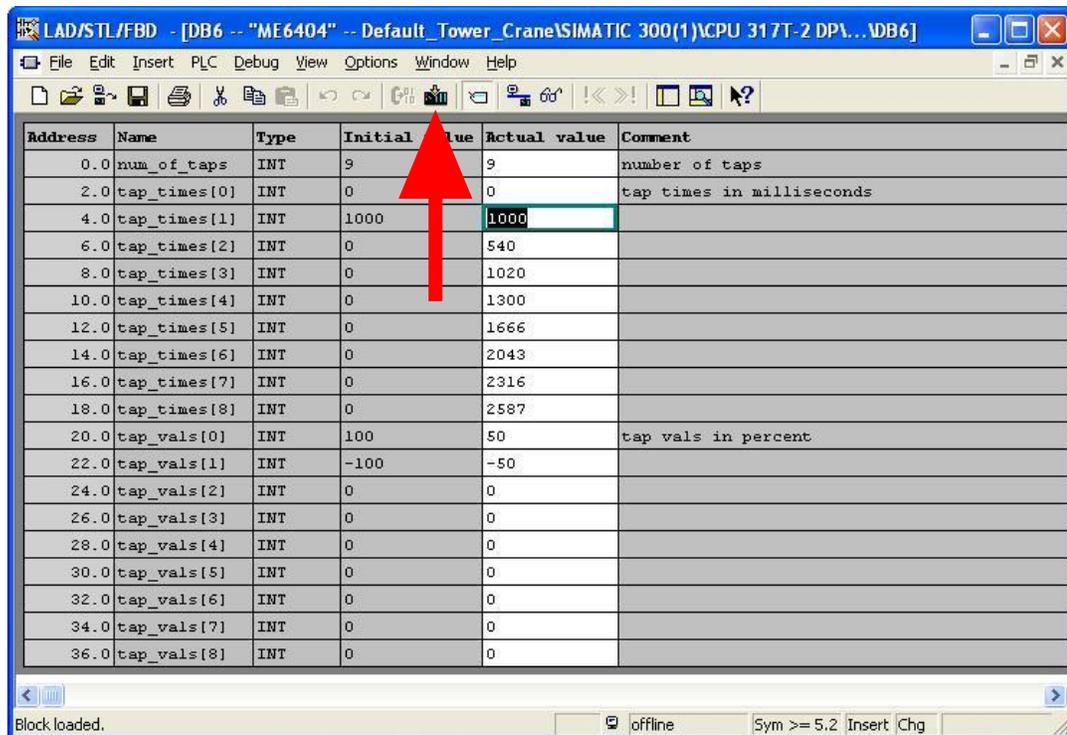


Figure 4: Modifying Velocity Profiles

- Modify “**tap_times[1]**” to change the length of the velocity profile. This number should be equal to your move time, t_m , in milliseconds. The value for all other “**tap_times[n]**” should be zero.
- “**Tap_vals[0]**” and “**Tap_vals[1]**” specify the speed of the velocity profile, in percentage. “**Tap_vals[0]**” should always be positive, and “**Tap_vals[1]**” should be the negative of “**Tap_vals[0]**”.

14. When you are done, click on the “**Download**” button shown by the arrow shown in Figure 4.
15. Go back to the GUI (Figure 2), and move the crane to an area so that there is enough space to run the entire velocity profile.
16. Change the Velocity Profile drop down menu **F** is “**ME6404**”. The crane is now ready to execute the pulse velocity command that you have designed.
17. Click the **RECORD** button at **E** to begin recording data. Make sure the hook is not swinging. **CLICK** and **HOLD** the **OUT/IN** button. The crane should move for the specified time and then stop. When you **RELEASE** the button, the crane should go back to where it began. Click **RECORD** again when you have finished the move. Record about 4-5 oscillation periods.
18. Click **DOWNLOAD** in **E** to Email the data to yourself (this takes a few seconds). The data is in Excel .csv format and contains the slewing and radial move velocities, as well as the hook deflections in the tangential and radial directions. If the internet connection is not working or if you don’t want to work with emails you can find the .csv field in the directory D:/Download/ (remember, you still need to press the **DOWNLOAD** button to update that file)

Book Sessions Using Google Calendar

- Login: me6404gatech@gmail.com, password: singhose6404
- Book your session in the appropriate calendar under “My calendars”. Be aware that the lab may be unattended during after-hours.

Lab writeup:

Discuss your work in less than 1 page of text. Include only relevant graphs to demonstrate your conclusions.

The text must cover:

- what you did
- what were the results

Following the text should be a set of plots. The plots must include:

- the crane velocity time history for each of the 3 tests
- the payload oscillation for each of the 3 tests

You should think carefully about the plots that you include in your report – these must be neat, clear, non-redundant, and convey the desired message in an efficient manner. Use large fonts and labels on the plots so that they are easy to understand. Furthermore, in the text, you should comment appropriately on the plots and say what is significant about them. A sample graded report (from a lab done on the bridge crane) is included on the following page.

The Report is due at the Beginning of Lab Next Week.

Generally try to avoid 1st person in technical reports. But, something like, "We performed experiments to determine..." is OK

Do not refer to multiple plots all at the same time. Introduce and discuss them 1 at a time.

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ME 6404
Lab 1

In this lab, I operated a crane through a 30cm path three times, each time with a different maximum velocity. An overhead camera displayed the movement of the payload hanging below the trolley as the trolley moved along its path, and encoders recorded the movement of the trolley and the bridge. The payload moved along the trolley's axis as opposed to the axis of the bridge which is perpendicular to the trolley's axis. The recorded trolley deflections are represented in the following graphs for paths taken at maximum velocities of 30%, 60%, and 100% of maximum trolley speed.

The oscillations in Figure 1 show an amplitude of about 13mm while the trolley is moving from its starting point through the 30cm path. The larger oscillations that occur after 9 seconds are when the trolley is returning to its start position, so are not relevant. At 60% of maximum speed in Figure 2, the oscillations increase to 75mm, so a 100% speed increase resulted in a 477% rise in oscillations. At 100% speed in Figure 3, the oscillations improve slightly to a 65mm amplitude for the first peak, then the subsequent peaks are closer to 45mm amplitudes. This data demonstrates that faster motion has the potential to create more residual vibrations in the system, but after a certain maximum velocity, the vibrations can be reduced. The amount of vibrations generated are a function of both the move distance and the maximum velocity, so by holding the move distance constant at 30cm, this lab focused on how maximum velocity alone affects the system.

You should be discussing residual vibration and not the transient

Figure captions (titles) go only at the bottom

Do not show irrelevant procedures or discuss and data

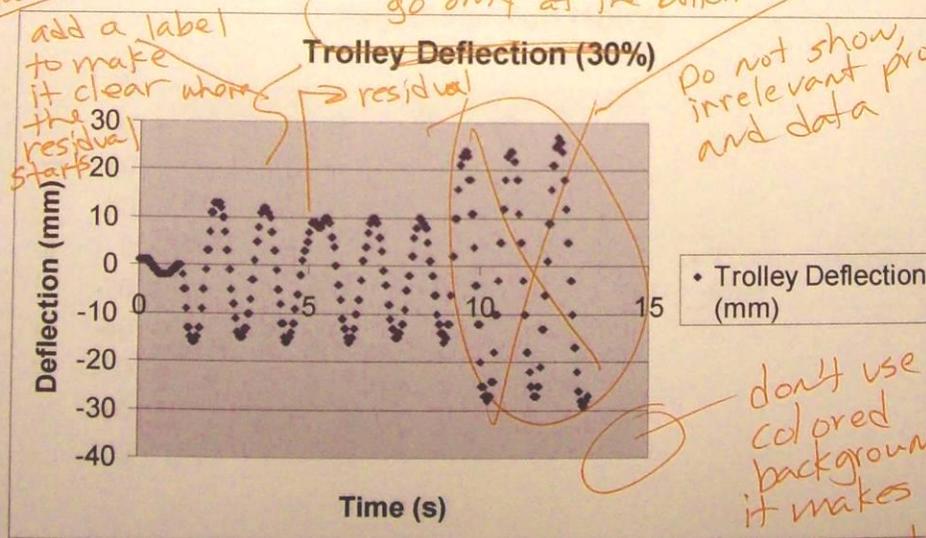


Figure 1: Deflection at 30% Speed

- you were also required to plot and discuss the encoder time history