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Using Motion Analyzer V4.73

Using Motion Analyzer: Hands-On Lab

Training Lab Manual

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Using Motion Analyzer V4.73

About This Hands-On Lab

This lab introduces you to Rockwell Automation's motion sizing and system analysis software, Motion Analyzer. The software allows you to enter information about the moving axes of your machine (the load and the actuator that is moving it) as well as your required move or cycle profile in order to select the appropriate servo motor and drive combination. SolidWorks users can import their system models directly, without having to recreate them in Motion Analyzer. Motion Analyzer additionally allows machine designers to optimize their machine design using advanced analysis tools.

You will enter the information for (3) common types of mechanical actuators and search for a valid motor and drive combination for each. The following sections explain what you'll be doing in this lab session, and what you will need to do to complete the hands-on exercises.

What You Will Accomplish In This Lab

As you complete the exercises in this hands-on session, you will:

- Learn how to use Motion Analyzer software
- Learn what type of information is required by the software
- Gain exposure to the advanced analysis and optimization tools in Motion Analyzer

Who Should Complete This Lab

This hands-on lab is intended for individuals who:

- Would like to learn more about sizing motion systems
- Would like to learn more about using Motion Analyzer software

Lab Materials

For this Hands-On lab, we have provided you with the following materials that will allow you to complete the labs in this workbook.

Hardware

This hands-on lab uses no hardware.

Software

This hands-on lab uses the following software:

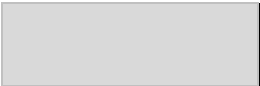
- Motion Analyzer V4.6 (available for download at www.ab.com/motion)
- OPTIONAL: Motion Selector V4.5.1 (also available for download at www.ab.com/motion)

Lab Files

- This hands-on lab requires no additional files.
- A "Motion Application Data Checklist" document is provided for reference. Print this file to gather the required information for each axis of motion and use it when working with Motion Analyzer on your next motion system.

Document Conventions

Throughout this workbook, we have used the following conventions to help guide you through the lab materials.

This style or symbol:	Indicates:
Words shown in bold italics (e.g., <i>RSLogix 5000</i> or <i>OK</i>)	Any item or button that you must click on, or a menu name from which you must choose an option or command. This will be an actual name of an item that you see on your screen or in an example.
Words shown in bold italics, enclosed in single quotes (e.g., ' <i>Controller1</i> ')	An item that you must type in the specified field. This is information that you must supply based on your application (e.g., a variable). Note: When you type the text in the field, remember that you do not need to type the quotes; simply type the words that are contained within them (e.g., Controller1).
	The text that appears inside of this gray box is supplemental information regarding the lab materials, but not information that is required reading in order for you to complete the lab exercises. The text that follows this symbol may provide you with helpful hints that can make it easier for you to use this product. Most often, authors use this "Tip Text" style for important information they want their students to see.

Note: If the mouse button is not specified in the text, you should click on the left mouse button.

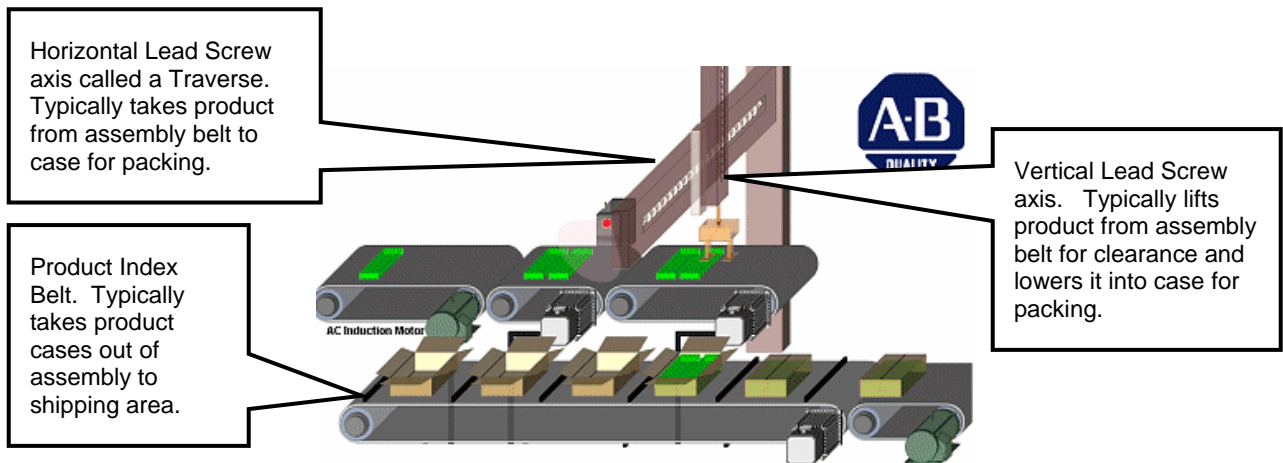


Fig.1 Typical Pick and Place Machine

Lab 1: Sizing a Belt Driven Actuator (20 minutes)

This lab session addresses the sizing and selection of (3) different axes of motion:

- A belt driven indexing conveyor
- A horizontal lead screw actuator
- A vertical lead screw actuator

A Pick and Place machine example (see Fig. 1) will be the source of data for each of the labs. Pick and Place machines are used in the consumer products industry for a wide variety of product transfer applications. The machine typically takes a product or products from machines such as wrappers, cartoners or fillers, and places them into a case, which then is ready for palletizing or shipment.

About This Lab

In this lab, you will use Motion Analyzer to select a servo motor and drive for the Pick and Place machine's Product Index Belt. You will:

- Learn how to navigate in Motion Analyzer software
- Setup Motion Analyzer's default values to suit your needs
- Create a new application
- Enter the required data for the Product Index Belt application

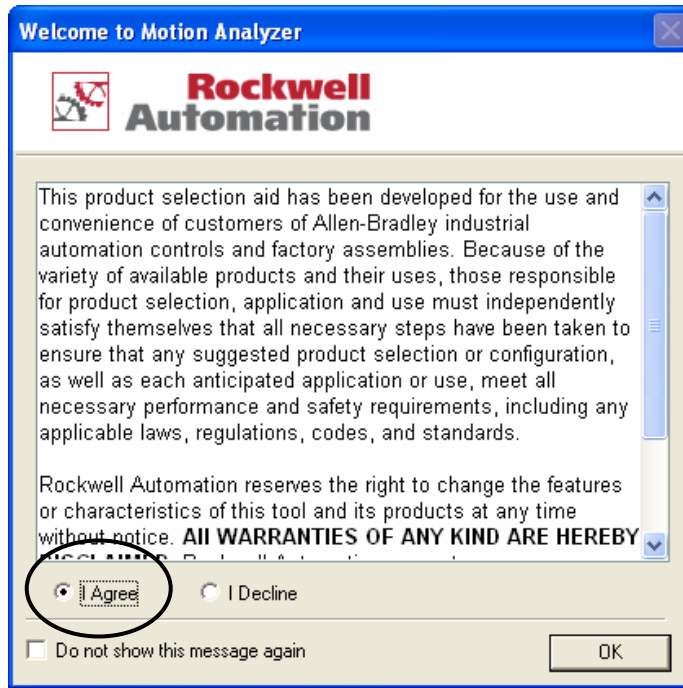
Follow the steps below to complete Lab Section 1.

Navigation in Motion Analyzer Software

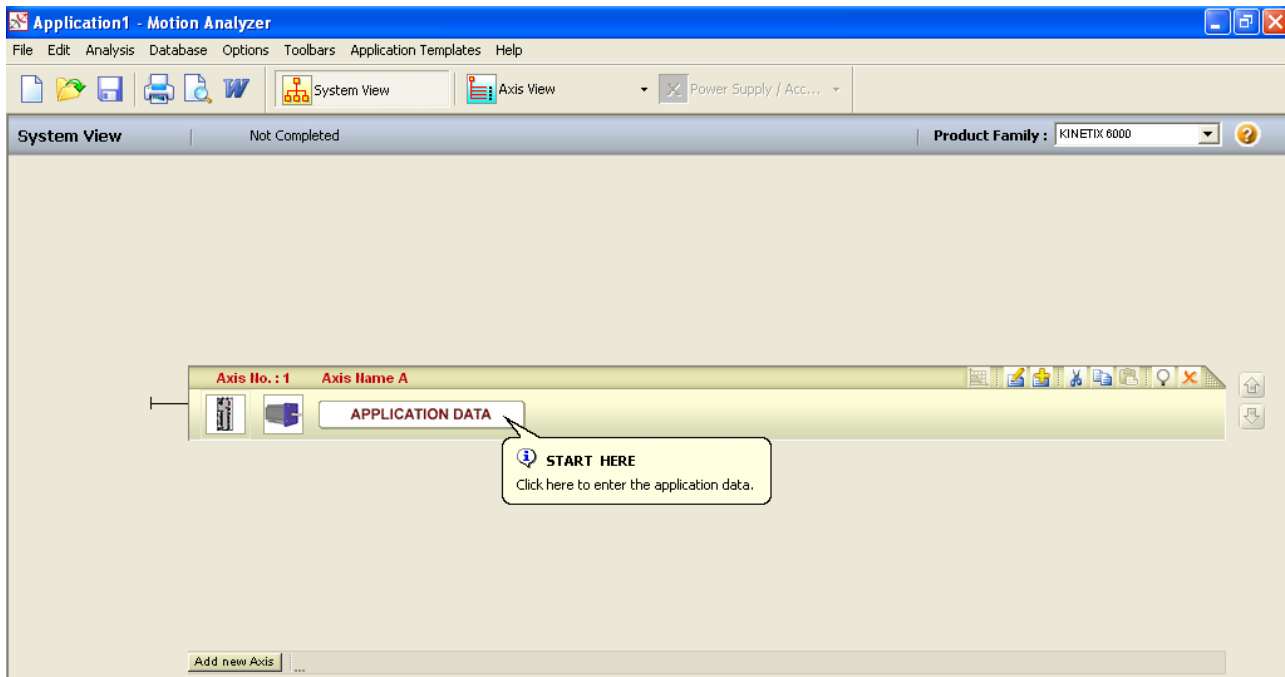
1. Open ***Motion Analyzer*** sizing software by double-clicking on the desktop shortcut, or by selecting ***Start > Programs > Rockwell Automation > Motion Analyzer > Motion Analyzer.***



2. After reading the terms, select **I Agree** and press the **OK** button.



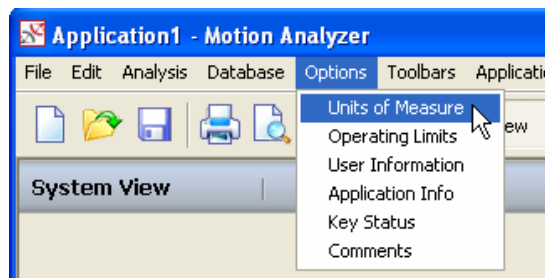
Motion Analyzer will open to a new application:



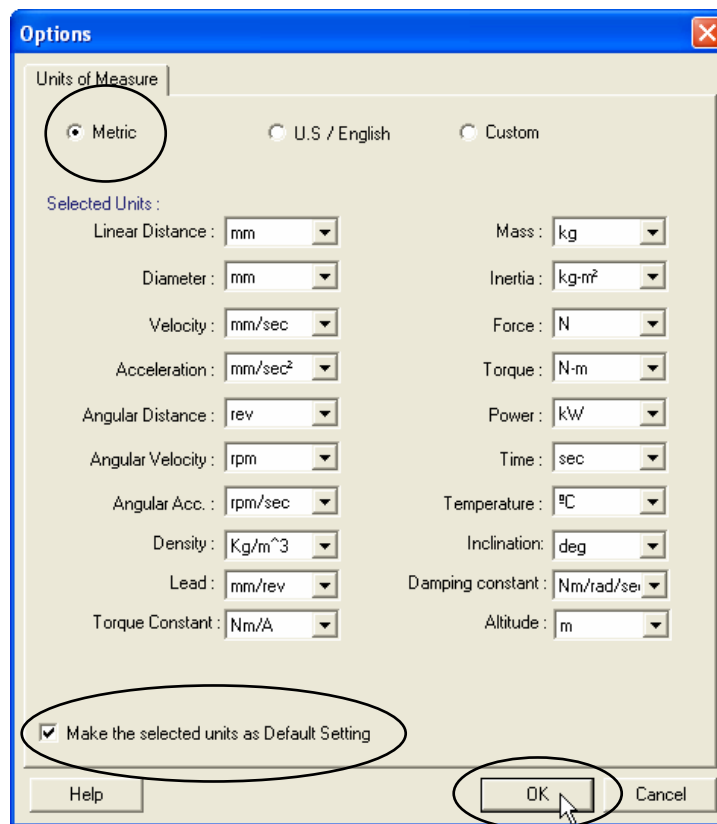
This is the System View page that summarizes the system. If multiple axes exist, they will all be shown here. Let's get started.

Setting Up User Defaults

- From the top menu, select **Options > Units of Measure**.

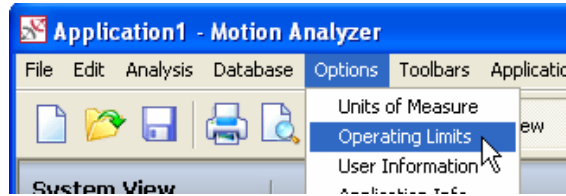


- Change the selection to **Metric** and check the box to **Make the selected units the Default Setting**, if desired. Press **OK** to save and exit.

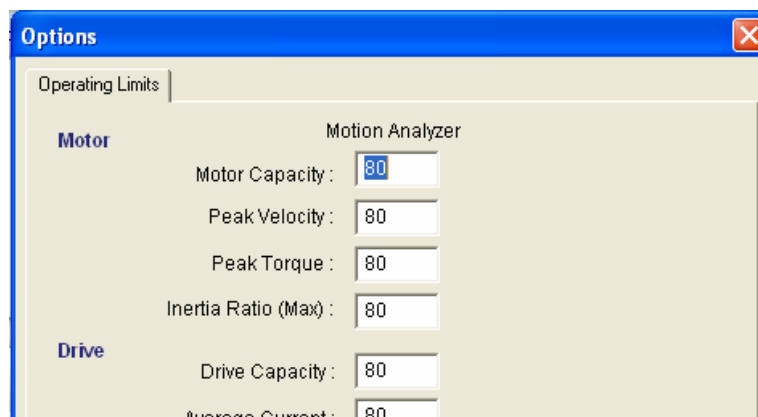


Most mechanical actuator vendors conduct business in metric units.

5. From the top menu again, select **Options > Operating Limits**. Press **OK** to save and exit.



The automatic selection process is affected by the limits entered in this table. Each of the motor/amplifier/gearbox variables listed in the table is a *percentage of the rated values* listed. The idea here is to choose operating limits based on the reliability of the data that is entered. Think of this page or table as a *safety factor* when selecting a combination. Keep the numbers as shown.

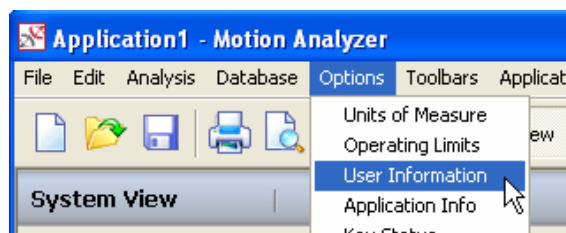


6. Press **Cancel** to exit without changes.

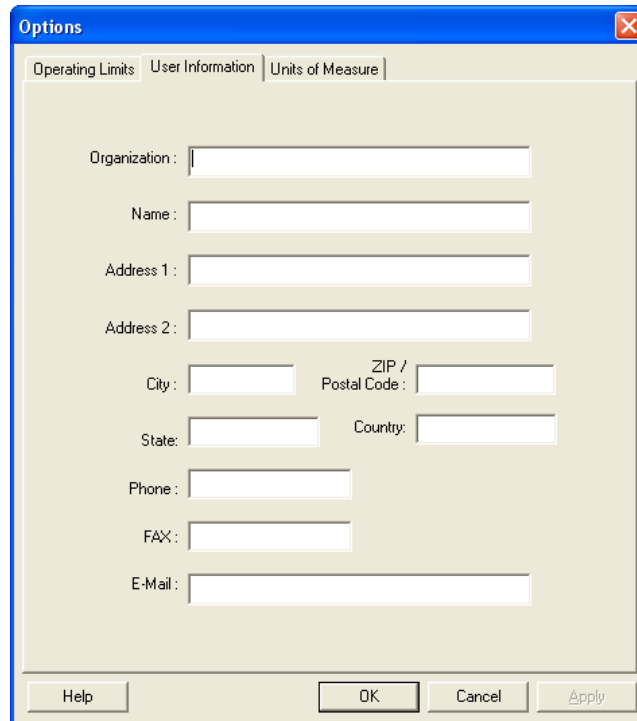
If entered data (load, transmission, profile and environment information) is absolutely reliable, these limits *could* all be set to 100% utilization but we all know that some information may not be totally accurate or we may encounter some unknowns during the implementation of the application.

- “Peak Velocity” and “Bus Volts” are the most easily defined so keep these numbers at 90% or higher.
- “Peak Torque”, “Peak Current” and “Average Current” are less reliable so keep these numbers at 80%.
- “Winding Temperature” is the most sensitive to errors so 80 % would be normal.

7. From the top menu again, select **Options > User Information**.



Your information may be entered here so that your name, address, email, phone number and company name will automatically appear on any reports. If you are preparing this system for another user (your customer, for instance), another screen will prompt you for their information when a system report is generated.



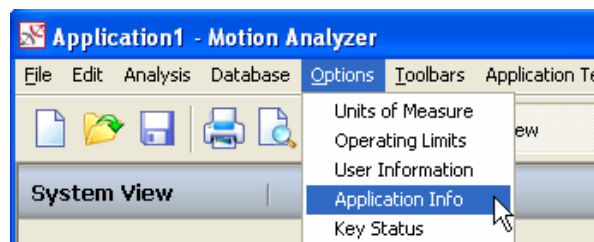
The 'Options' dialog box is shown with the 'User Information' tab selected. It contains the following fields:

- Organization :
- Name :
- Address 1 :
- Address 2 :
- City : ZIP / Postal Code :
- State: Country:
- Phone :
- FAX :
- E-Mail :

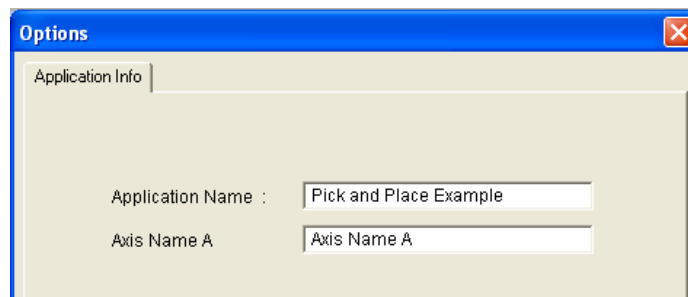
Buttons at the bottom: Help, OK, Cancel, Apply.

8. Press **OK** to exit.

9. Finally, from the top menu again, select **Options > Application Info**.



10. Enter '**Pick and Place Example**' for the **Application Name** and Select **OK** to close the window.

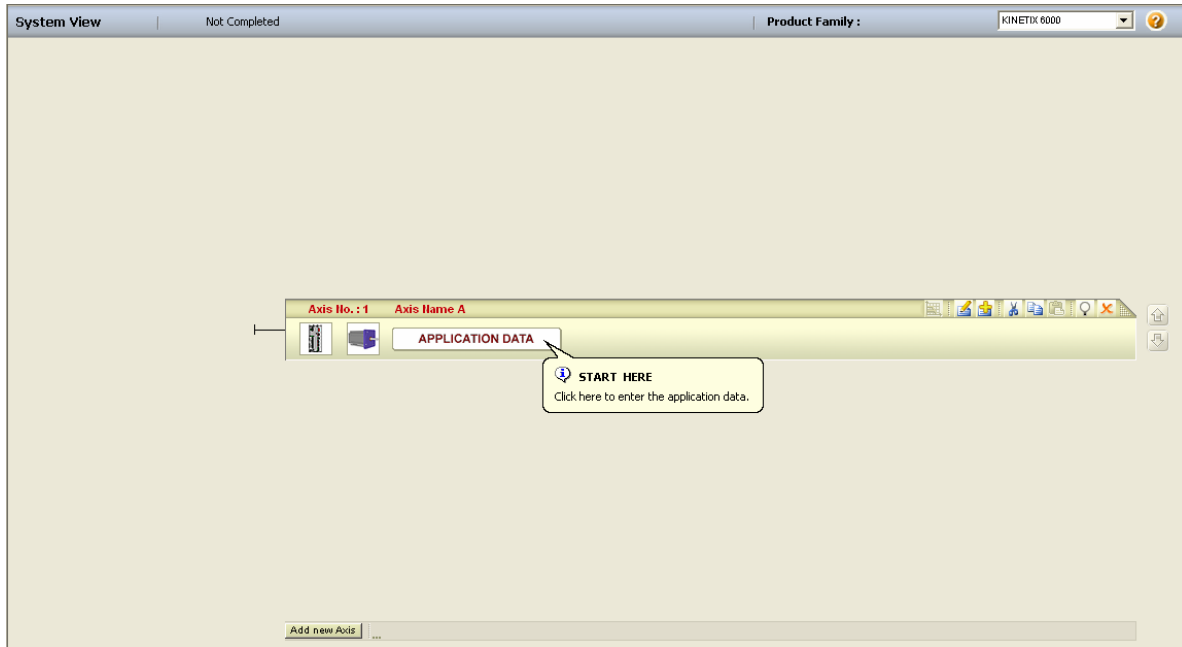


The 'Options' dialog box is shown with the 'Application Info' tab selected. It contains the following fields:

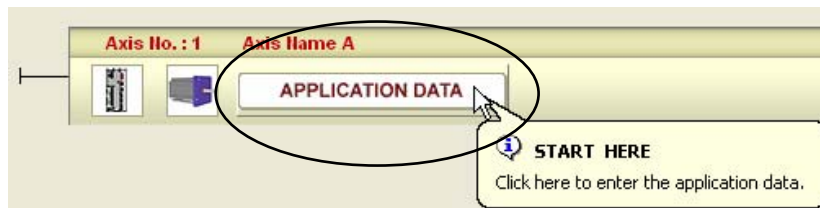
- Application Name :
- Axis Name A :

Entering Application Data

The System View screen displays one axis by default. At this point, minimal information is shown. As we proceed with our sizing exercise, additional information will populate this screen. At the end of the sizing exercise, information such as motor and drive part numbers, actuator types, etc. will be viewable from this screen.



11. To begin entering data for an axis, click on **Application Data**.



The Axis Data page displays basic setup options for the axis.

Axis Data - Axis Name A Product Family : KINETIX 6000

Axis Setup | Cycle Profile | Mechanism | Transmission Stages | Selection

Load type : Linear Rotary Application Templates
Press Roll Feed (Const Tin)

Actuator type : User Defined Actuator Allen Bradley Integrated Linear Actuator Allen Bradley Integrated Linear Stage

Voltage Selection

Supply Type : AC 1 phase AC 3 phase DC

Voltage Type : Single Range

*Nominal Voltage: Select Voltage Tolerances % - 0 + 0

Motor / Drive Parameters : Max Ambient : 40 °C Altitude: 0 m

Axis Name : Axis Name A

System Notes :

* Indicates mandatory field(s) Help

On this page, you choose whether your axis is *linear* or *rotary*, and whether the axis is built from user-provided components or one of Rockwell Automation's MP-Series Integrated Linear Stages. The voltage (or range of voltages) that will be provided to the drives is defined here, and you can enter a typical ambient temperature or altitude for the motor's operating environment. If your axis requires a (factory only) holding brake, you can make this selection here. Finally, this is where you can give the axis a meaningful name.

12. At the bottom of the screen, click on the area marked **System Notes**.

System Notes :

Keep good notes here!

This is where you can enter important information about the system, or keep track of assumptions that were made in the sizing process. This data will be printed on the system report and it will remind you that these assumptions need verified.

It is quite common for data to be missing or unavailable during this process.

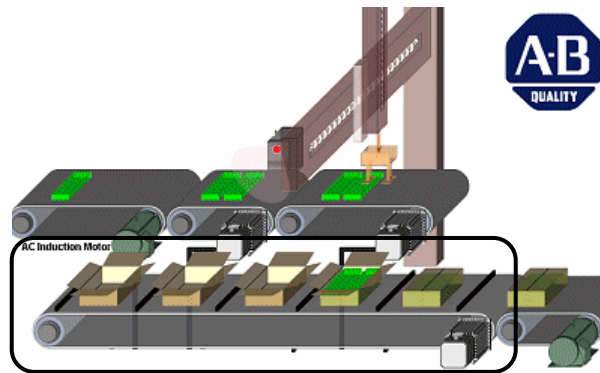
Let's get started entering information about the belt indexer axis.

There are (7) steps to sizing a motion application in Motion Analyzer. They are:

- (1) Specify **load type** (linear or rotary)
- (2) Determine application **preferences**
- (3) Specify the machine's **cycle profile**, or worst case move
- (4) Specify **actuator type**
- (5) Specify **transmission stage(s)**
- (6) Search for a suitable **motor/drive combination** for the application
- (7) Select **shunt** (if required) and system module (for Kinetix 2000/6000 drives)

Let's follow the (7) steps outlined above to enter our application data.

Here is the data that was provided for the **belt indexer** axis:



- Package weight (i.e. total weight on belt at any one time) = 3 kg
- Belt Actuator:
 - Belt Weight = 2 kg
- Drive Rolls, Quantity (2):
 - 100mm diameter (about 4")
 - 600mm long (about 24")
 - Rolled Steel
- Motor Coupling Moment of Inertia = $2.6g\text{-cm}^2$
- Move 250mm (about 10") in 1 sec. and dwell for 1 sec.
- Plant operates at 460Vac with an ambient temp of 30 degrees (C)

13. Some additional system information provided by the customer is that the plant has **460Vac** and the system operates in a '**30**' (degree C) environment. On the **Axis Setup** tab, fill in the data for the '**Belt Indexer**' axis as shown below.

Axis Data - Belt Indexer Product Family : KINETIX 6000

Axis Setup Cycle Profile Mechanism Transmission Stages Selection

Load type : Linear Rotary Application Templates
Press Roll Feed (Const Tin)

Actuator type : User Defined Actuator Allen Bradley Integrated Linear Actuator Allen Bradley Integrated Linear Stage

Voltage Selection

Supply Type : AC 1 phase AC 3 phase DC

Voltage Type : Single Range

*Nominal Voltage: 460 Tolerances % - 10 + 10 Voltage Help

Motor / Drive Parameters : Max. Ambient: 30 °C Altitude: 0 m

Axis Name : Belt Indexer

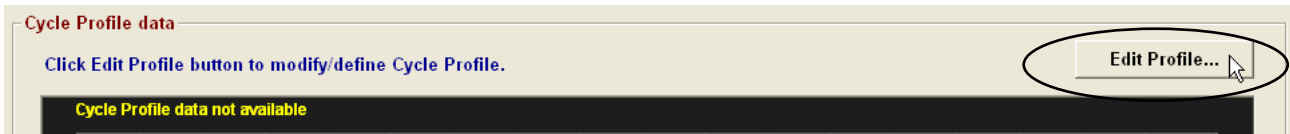
The tabs across the top lead you through entering the required data. The *green check mark* means that you have completed a tab and the *red "x"* indicates that more data is needed.

Entering the Axis Cycle Profile

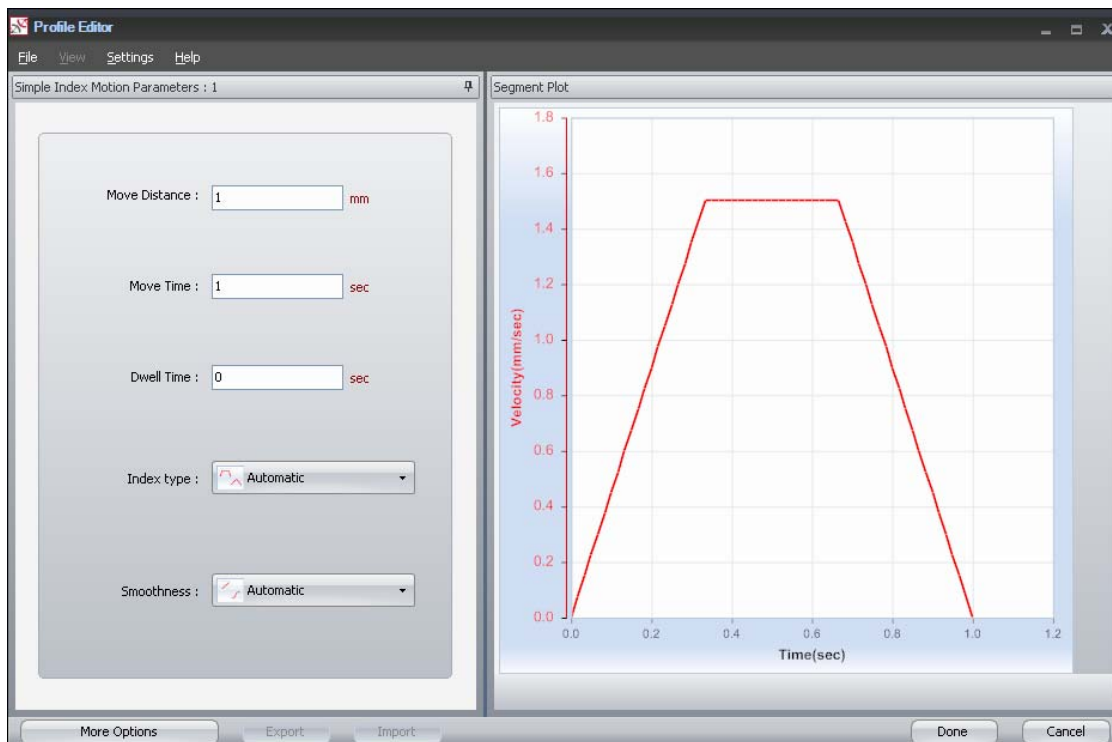
14. Move on to the **Cycle Profile** tab.



15. Click on the **Edit Profile** button.

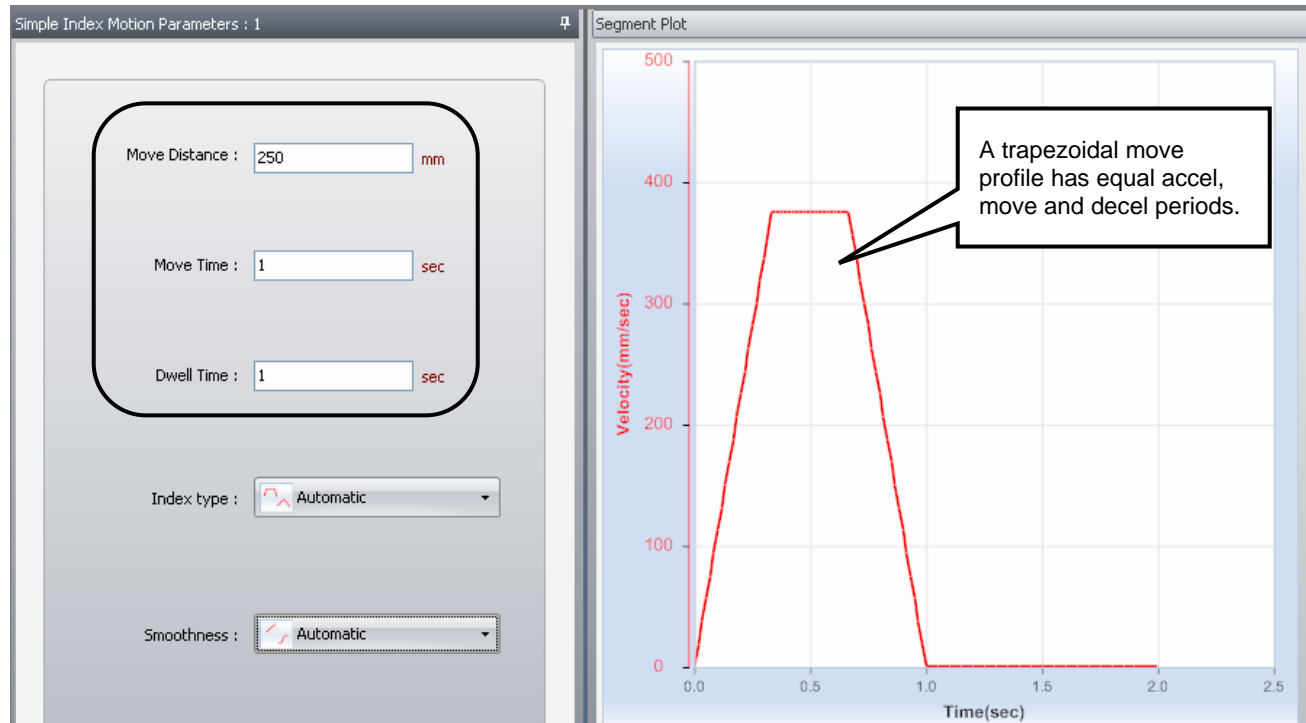


The following window opens.



Our required cycle profile is a simple point to point move (move 250mm in 1 sec. and dwell for 1 sec), so we are going to stay on the Simple Indexing Motion screen. If the profile had more moves, changes in speeds or changes in loads/forces, we would need to use the more advanced profile entry screens found under More Options.

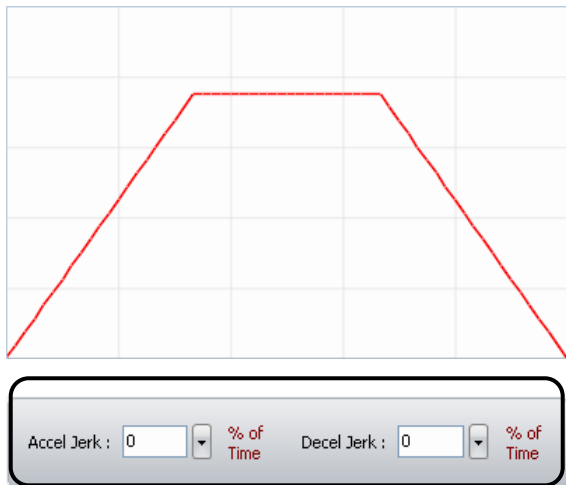
16. Simply enter the required **Move Distance**, **Move Time** and **Dwell Time** as shown.



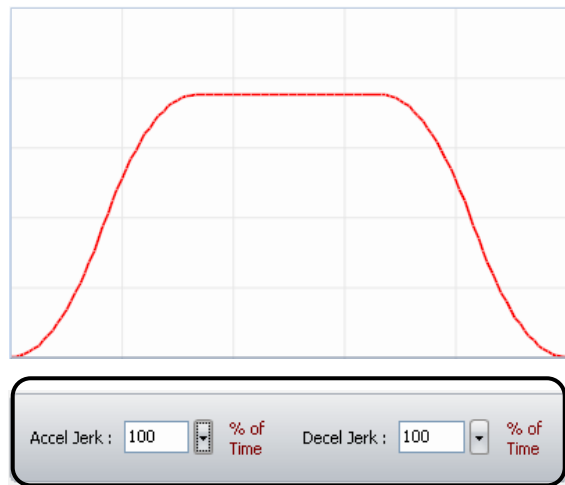
It is important to include your *dwell* time in the cycle profile, because the software assumes that the move is performed over and over with no stopping. The dwell tells the software to factor in resting periods for the thermal modeling of the motor and drive. You may end up with a motor and drive much larger than you need if you omit this dwell period.

Typically, a *trapezoidal* move profile with equal acceleration, move and deceleration times (the 1/3 rule) is used, but this profile can be harmful to the mechanical components of the system or even lead to premature failure. If your motion controller is capable of smoother profiles or *jerk limiting*, be sure to enter those values here if you plan to use them.

Pure S-Curve profiles limit acceleration for 100% of the time and a Trapezoidal profile for 0% of the time. Studies have shown that the best *compromise* between move speed and smoothness is simply 50% jerk limitation (50% of overall accel or decel time).



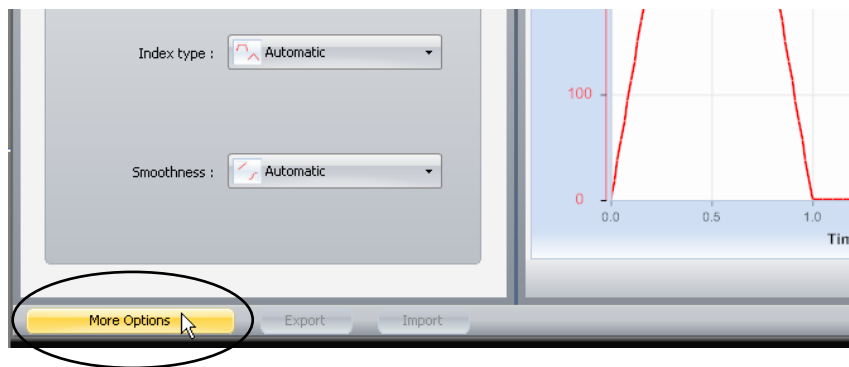
Trapezoidal Profile



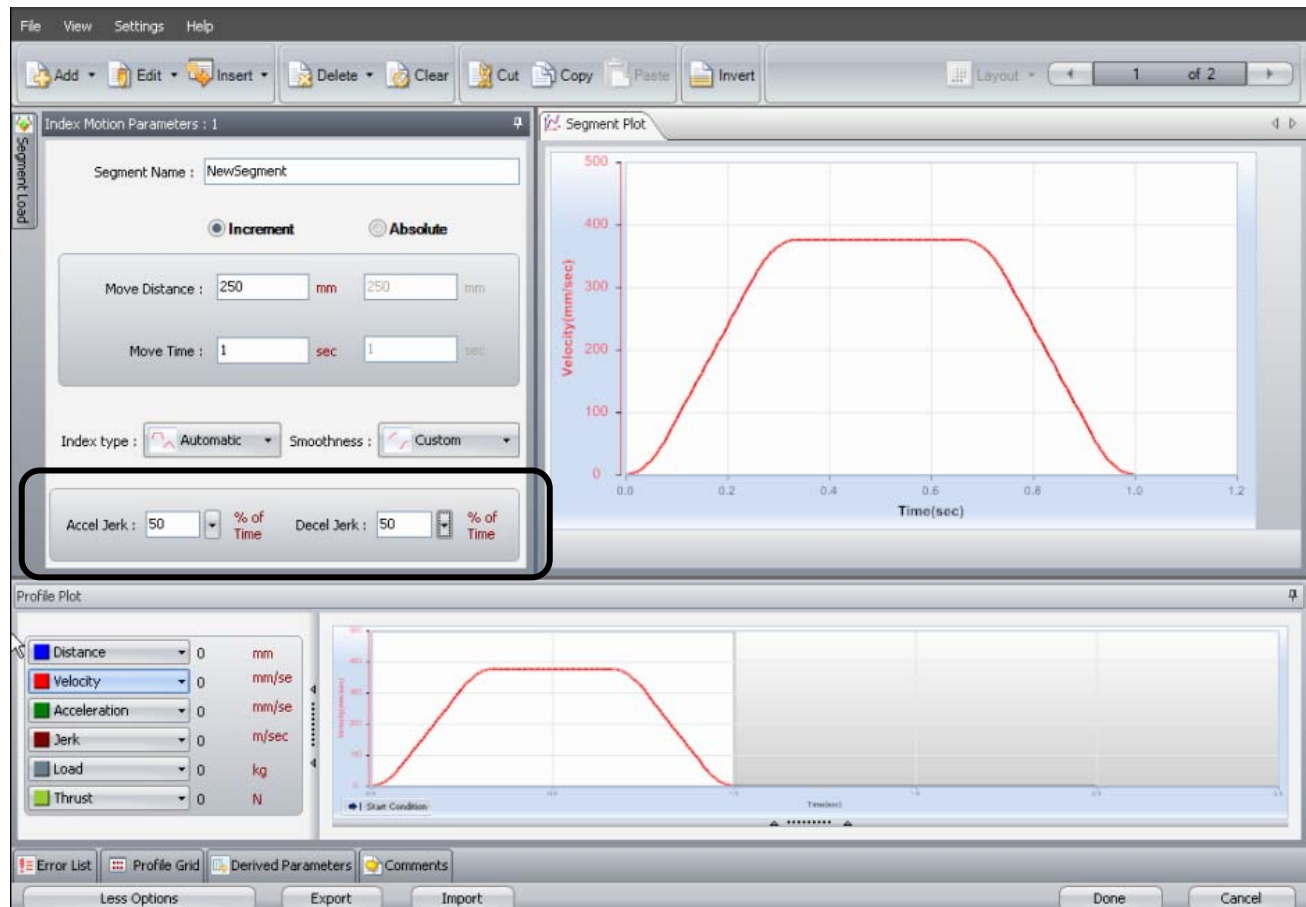
S-Curve Profile

Smother move profiles require **higher motor speeds** and **higher motor torques** in order to complete in the same amount of time. Failure to enter this profile here could lead to a motor being chosen that is not capable of the required speed or torque.

17. Click on **More Options** to specify our move profile parameters.



18. Enter '50' for **Accel Jerk** and for **Decel Jerk**.



The simple move profile has now been split into (2) parts; the move and the dwell portions.

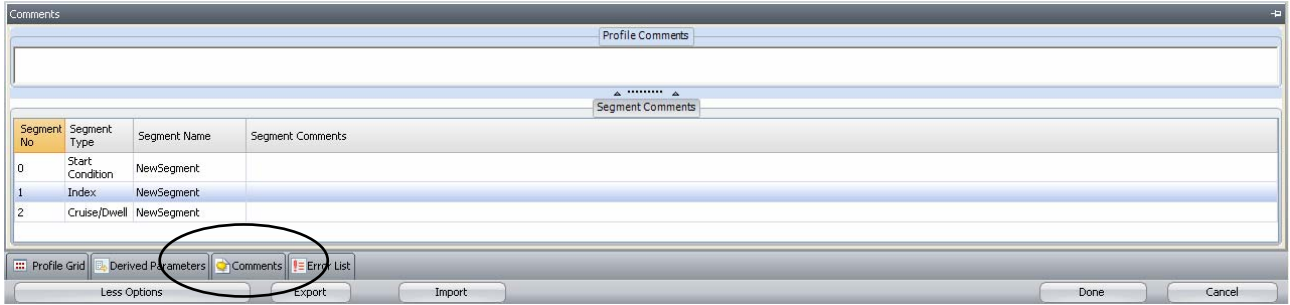


19. Click on **Derived Parameters** at the bottom of the screen.

TIME		POSITION		SPEED		ACCEL		JERK	
Start Time:	0 sec	Start Position:	0 mm	Start Speed:	0 mm/sec	Avg Accel:	1125 mm/sec ²	Accel Jerk:	18 m/sec ³
Accel Time:	0.33333 sec	Seg Distance:	250 mm	Avg Speed:	250 mm/sec	Peak Accel:	1500 mm/sec ²	Decel Jerk:	18 m/sec ³
Decel Time:	0.33333 sec	End Position:	250 mm	Peak Speed:	375 mm/sec	Avg Decel:	-1125 mm/sec ²		
End Time:	1 sec			End Speed:	0 mm/sec	Peak Decel:	-1500 mm/sec ²		

The required acceleration, deceleration and maximum velocity required to complete the move are all calculated automatically. These values can be used in the controller programming.

20. Click on **Comments** at the bottom of the screen.

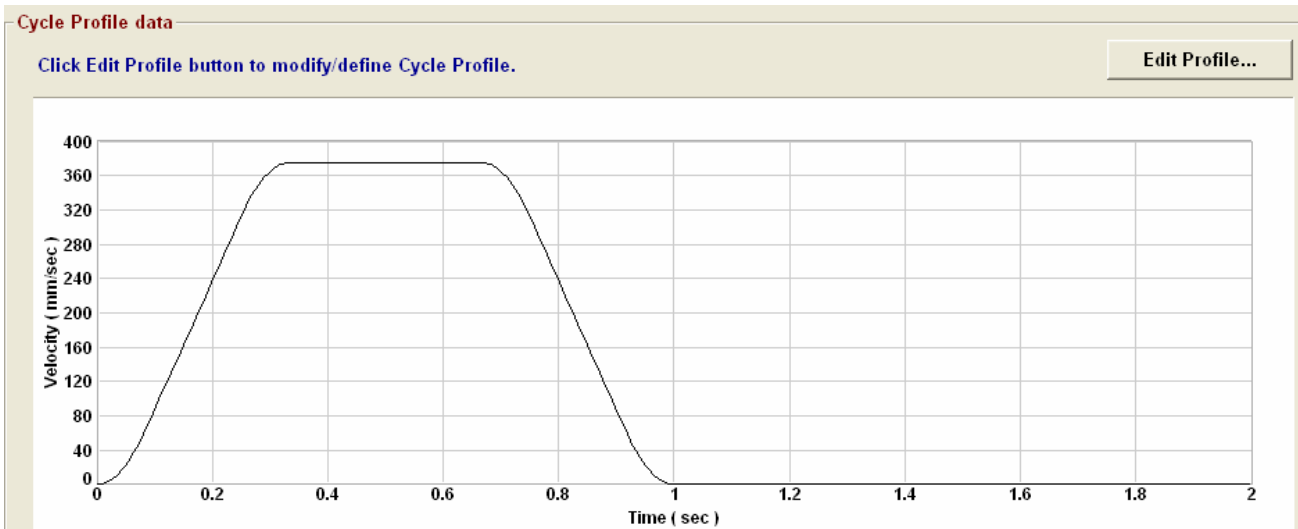


There are places to make notes on the overall cycle profile or even every individual segment.

There are many more advanced features and functions provided by the enhanced profile editor. We will explore more of these throughout the remaining chapters of this lab.

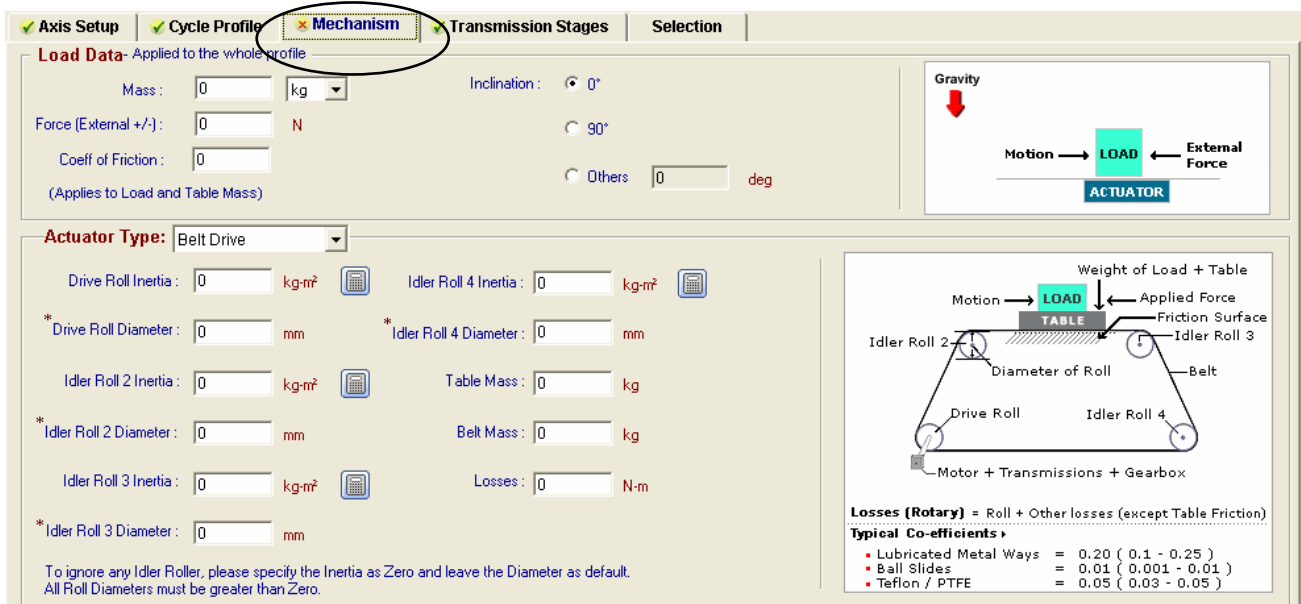
21. Press **Done** when complete.

The Cycle Profile should appear as shown.

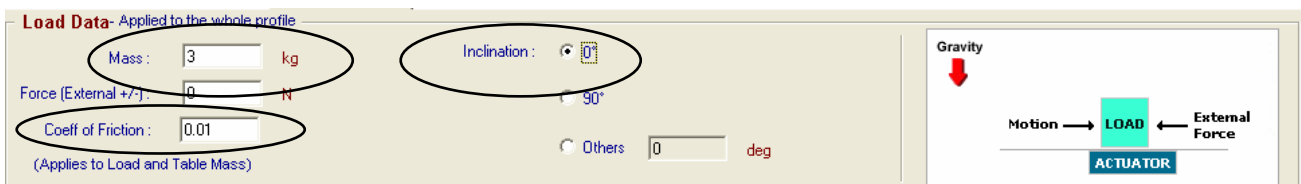


Enter the Mechanical Information

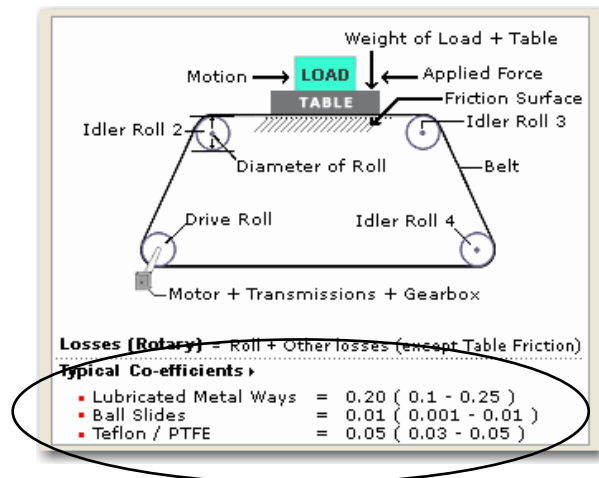
22. Click on the **Mechanism** tab to continue.



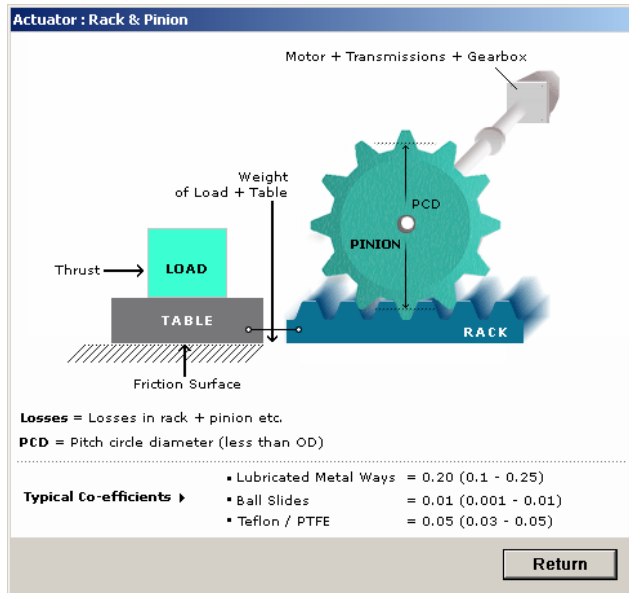
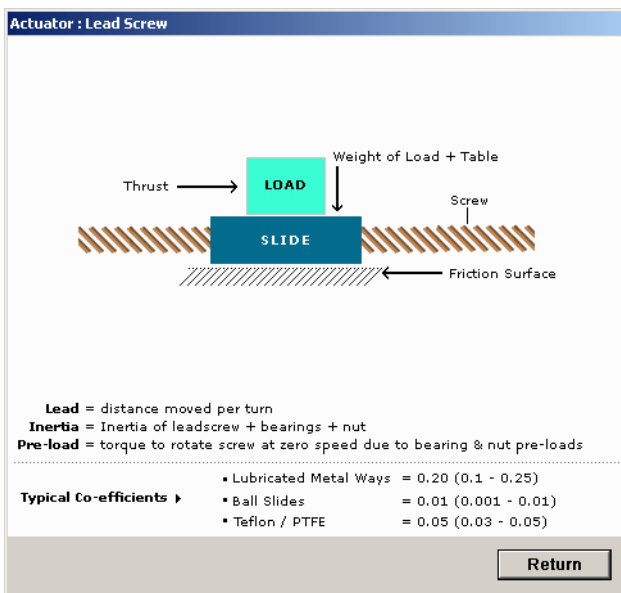
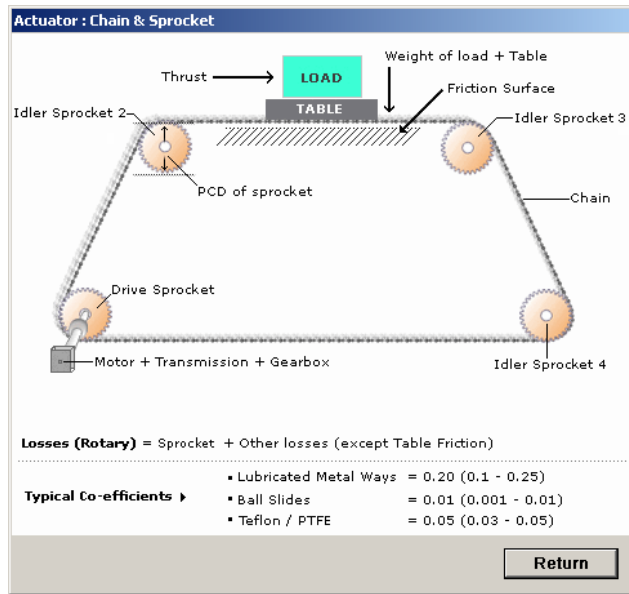
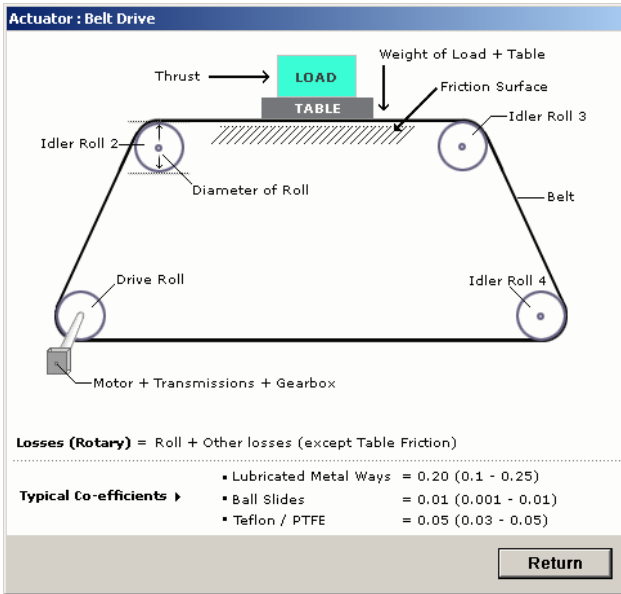
23. Locate the **Load Data** section. Using our axis data, enter a **Mass** of **3 kg** to account for the weight of the packages on the belt. Since our drive rolls are typically made with roller bearings, we can use the **Coefficient of Friction** for a Ball Slide, which is listed as **'0.01.'** You should add this to your list of items to be verified in the System Notes if you are not sure. Leave the Inclination angle at **(0) degrees** since we're working with a horizontal axis.



This tab also includes extremely helpful diagrams of the different types of actuators supported by Motion Analyzer. The actuators are selected from the pull down menu for **Actuator Type**. Notice how the input parameters and the diagram change for each type of actuator. Helpful values for terms like *coefficient of friction* are included as well.



We have **(4) Actuator Types**; Belt Drive, Lead Screw, Chain & Sprocket, and Rack & Pinion. The four actuator diagrams are as follows:



24. Select **Belt Drive** for the **Actuator Type** used in our application.

Actuator Type:

25. In the **Actuator Type** section, enter a **Belt Mass** of '2' kg and our **Drive Roll Diameter** of '100' mm. The software automatically enters this same diameter for Idler Roll 2, 3 and 4. Here is a reminder of how the rolls are arranged:



Actuator Type: Belt Drive

Drive Roll Inertia : 0 kg-m² Idler Roll 4 Inertia : 0 kg-m²

*** Drive Roll Diameter : 100 mm** * Idler Roll 4 Diameter : 100 mm

Idler Roll 2 Inertia : 0 kg-m² Table Mass : 0 kg

* Idler Roll 2 Diameter : 100 mm **Belt Mass : 2 kg**

Idler Roll 3 Inertia : 0 kg-m² Losses : 0 N-m

* Idler Roll 3 Diameter : 100 mm

To ignore any Idler Roller, please specify the Inertia as Zero and leave the Diameter as default.
All Roll Diameters must be greater than Zero.

Weight of Load + Table

Losses (Rotary) = Roll + Other losses (except Table Friction)

Typical Co-efficients

- Lubricated Metal Ways = 0.20 (0.1 - 0.25)
- Ball Slides = 0.01 (0.001 - 0.01)
- Teflon / PTFE = 0.05 (0.03 - 0.05)

Motion Analyzer includes an inertia calculation tool that aids in the process of finding the total inertia of simple or complex rotating objects.

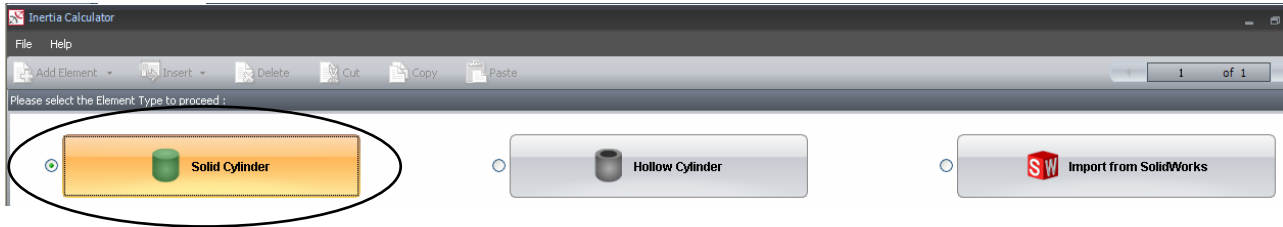
26. Click on the **Inertia Calculator** button next to the **Drive Roll Inertia** box and wait as the tool loads.



The inertia calculator tool lets us model the rotating object as solid or hollow, based on the weight or the size of the material and can even model a composite load made of many types of material layers, or *elements*.

The Import from SolidWorks option allows users that have already modeled their system in SolidWorks to eliminate unnecessary time recreating the load model in yet another tool. This option, however, requires a *licensed copy* of SolidWorks (viewers are not supported).

27. Our Drive Roll is a solid piece of steel, so select the **Solid Cylinder** radio button.



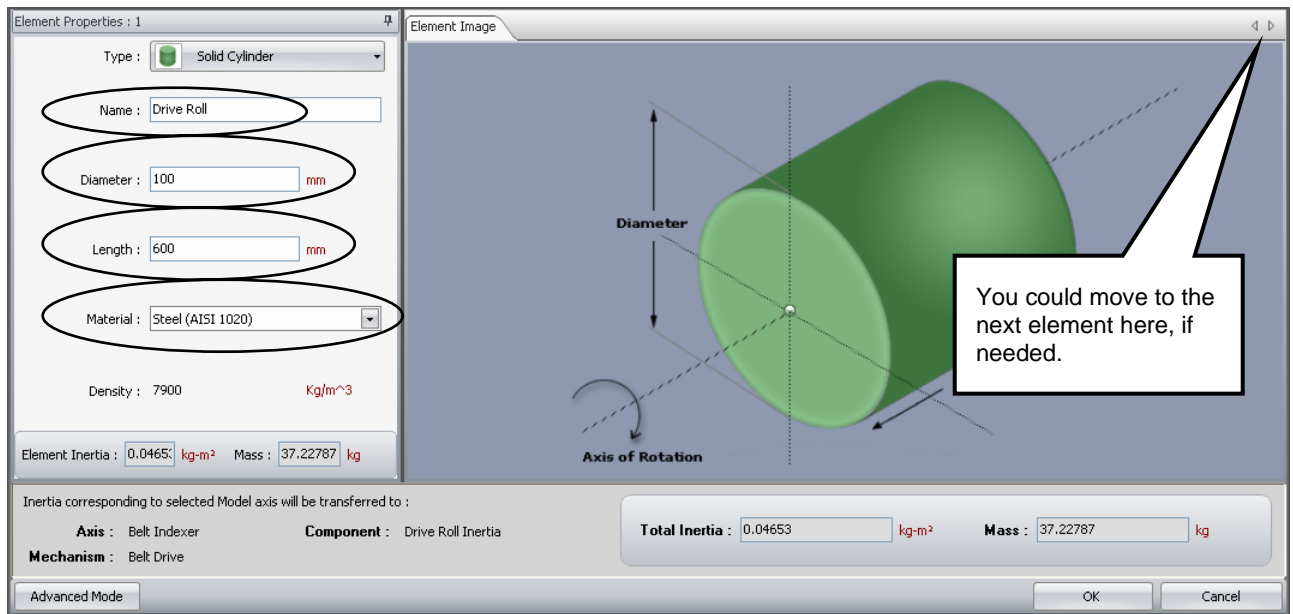
The tool can model our object based on many different pieces of information, including the dimensions and the material that it is made of.

28. Enter the **Name** 'Drive Roll' for this component.

29. Enter '100' mm for the **Diameter**, from our machine data.

30. Enter '600' mm for the **Length**.

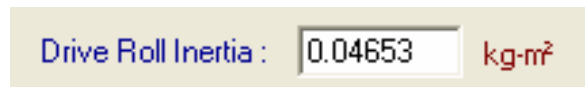
31. Use the drop-down menu to select **Steel (AISI 1020)** for your **Material**.



The software calculates the Total Inertia (J) and Mass for this component. If we had additional components, we could move to the next sub-component.

32. Click **OK** to exit.

Your Drive Roll Inertia should be as follows:

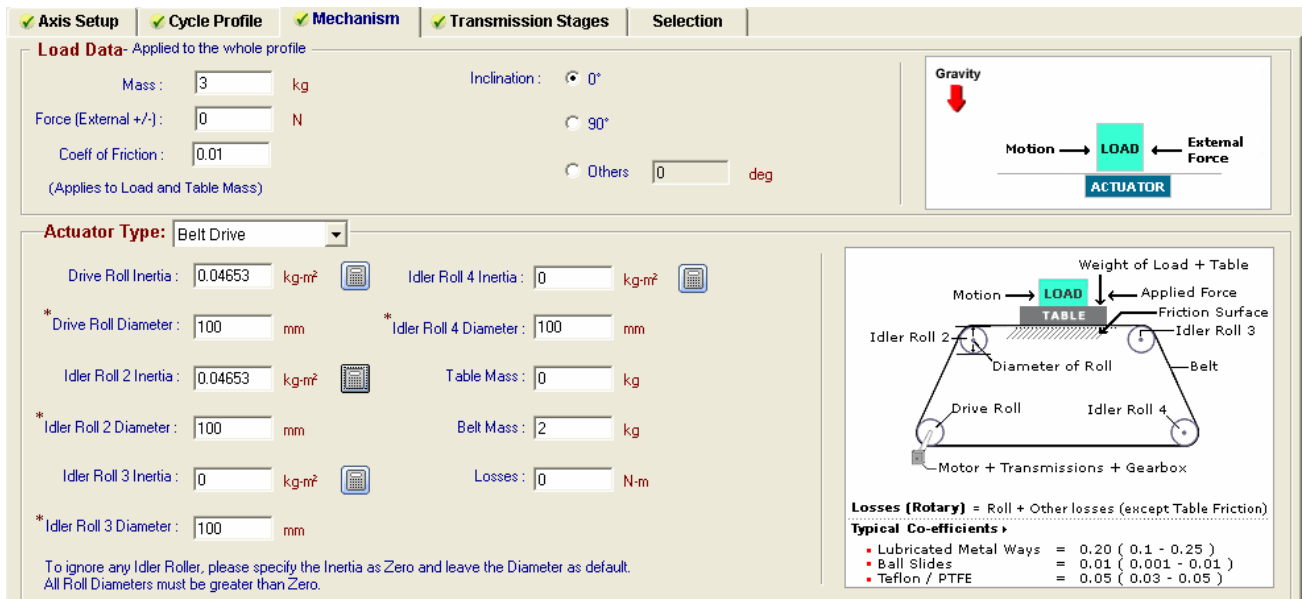


33. Since the Drive Roll and Idler Roll are the same geometry and material, simply **Copy and Paste** the **Drive Roll Inertia** value into the **Idler Roll 2 Inertia** field.

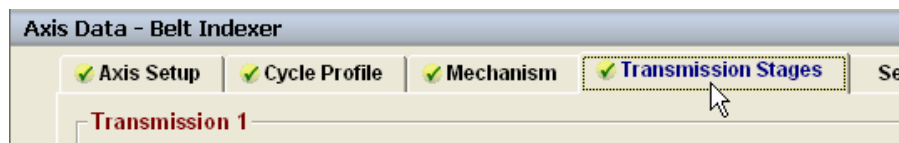


You don't need to fill in anything for the remaining idlers, since this axis only has (2) rolls. If you have more idlers than the (4) provided, note that you can simply add the inertia values together and enter the total in one of the spaces provided.

34. Your **Mechanism** tab should look as follows:



35. Move to the **Transmission Stages** tab.



This tab allows you to enter the mechanical information for any rotating devices connected between the motor shaft and actuator. Use the drop-down menu to view the **(4) available models** and their associated **diagram**. A helpful **Compute Model** is also provided for each to aid in entering the required data.

Transmission 1

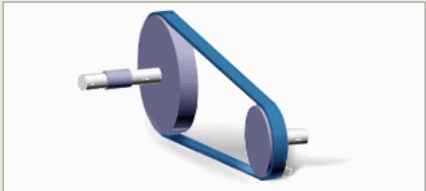
Transmission : Belt Drive Compute Model

Ratio :

Inertia : kg-m²

Efficiency : %

Friction Torque : N-m



Transmission 1


Transmission : Chain & Sprocket Compute Model

Ratio :

Inertia : kg-m²

Efficiency : %

Friction Torque : N-m



Transmission 1


Transmission : Spur Gear Compute Model

Ratio :

Inertia : kg-m²

Efficiency : %

Friction Torque : N-m



36. Select a **Coupling** for our system, as mentioned in the machine data section.

Transmission 1


Transmission : Coupling Compute Model

Ratio :

Inertia : kg-m²

Efficiency : %

Friction Torque : N-m

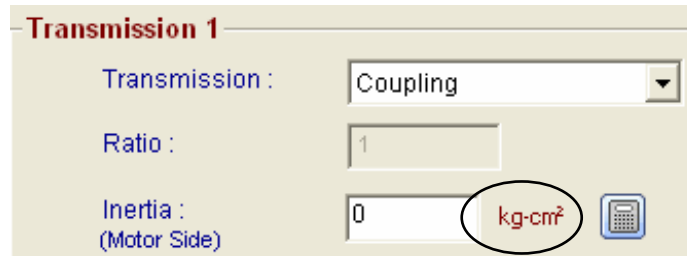


Coupling must be chosen carefully to avoid backlash and provide a high degree of stiffness.

This is published data available from the coupling manufacturer. It can be used in the **Simulation** feature of Motion Analyzer to model system performance.

We see from above that the motor coupling has a moment of inertia = 2.6g-cm^2 . This info would come from the coupling vendor's data sheets.

37. Carefully change the **units** first, using the drop-down menu, and then enter the value. Doing this in the wrong order converts the value. The closest unit to the one we need is **kg-cm²**, so we will have to convert.



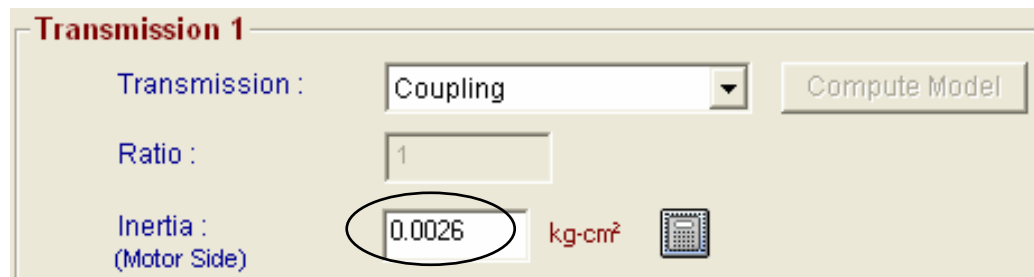
Transmission 1

Transmission : Coupling

Ratio : 1

Inertia : 0 kg-cm²
(Motor Side)

38. Enter '**0.0026**' for the converted **Inertia** value.



Transmission 1

Transmission : Coupling Compute Model

Ratio : 1

Inertia : 0.0026 kg-cm²
(Motor Side)

Finding a Valid Solution

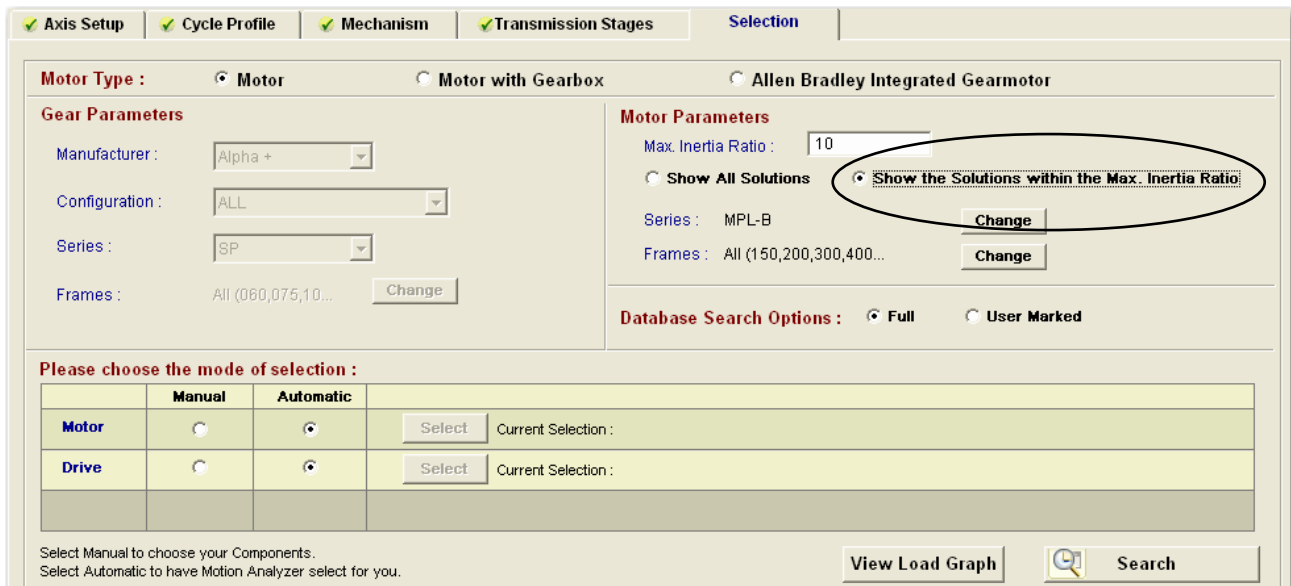
39. We have finished entering the application data and now we can select a motor and drive. Move to the **Selection** tab.



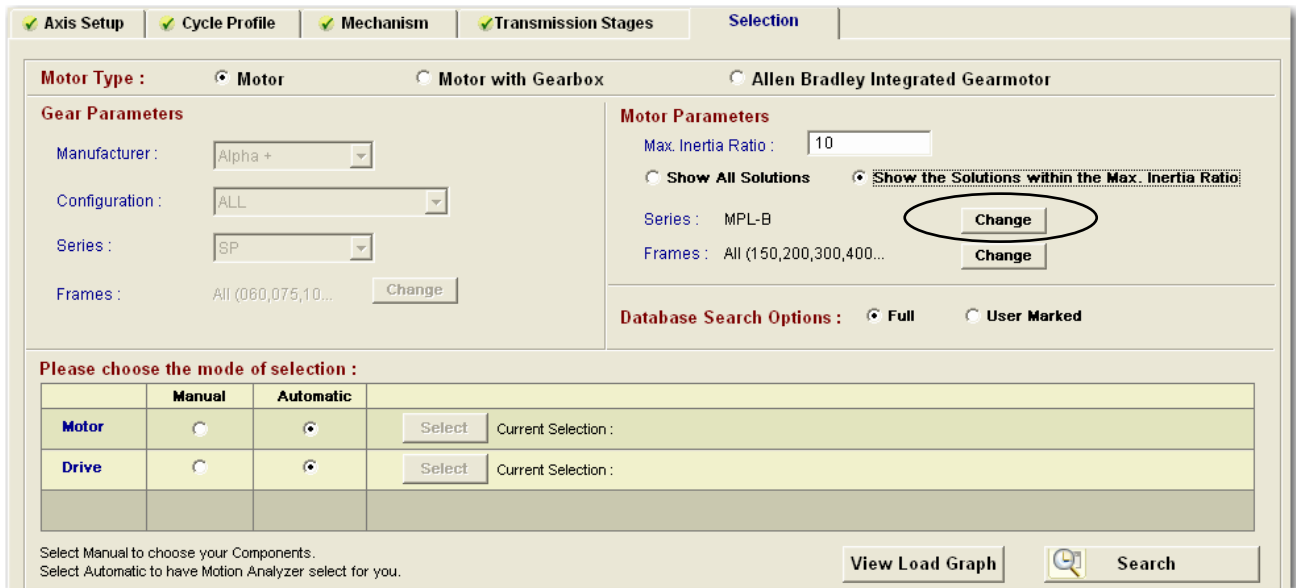
This tab allows us to set our *selection preferences*.

- We can specify whether to include or exclude a gearbox.
- We can specify which motor families to include, even down to the frame size of the motor. By default, the MPL Series motors are chosen. These motors are fine for most applications.

40. Press the radio button to **Show the Solutions within the Max Inertia Ratio** (load to motor mismatch). We will exclude solutions above 10:1 in order to insure system stability. This is a concern when trying to position accurately.

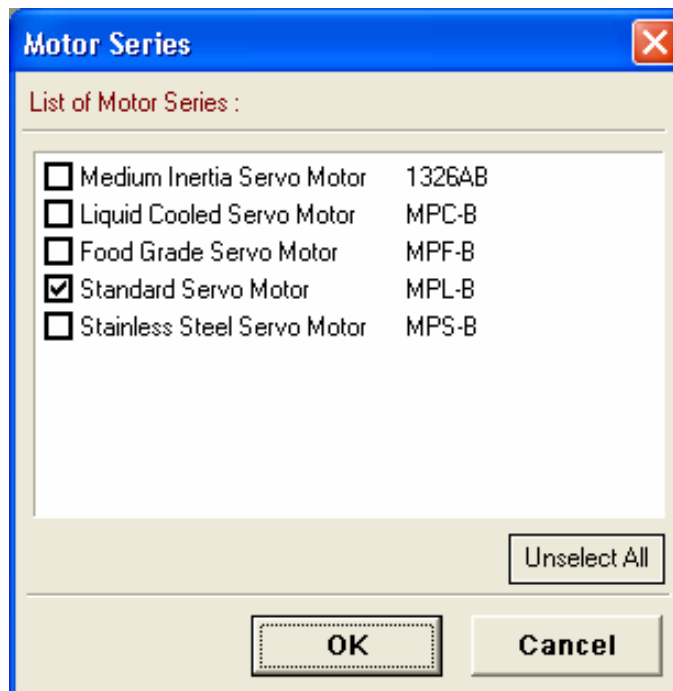


41. If you had special requirements for your motor (food grade or wash down environment or if you just had a size and space restriction), you could direct Motion Analyzer to choose from a different set of motors. Click on the **Change** button next to the motor **Series**.

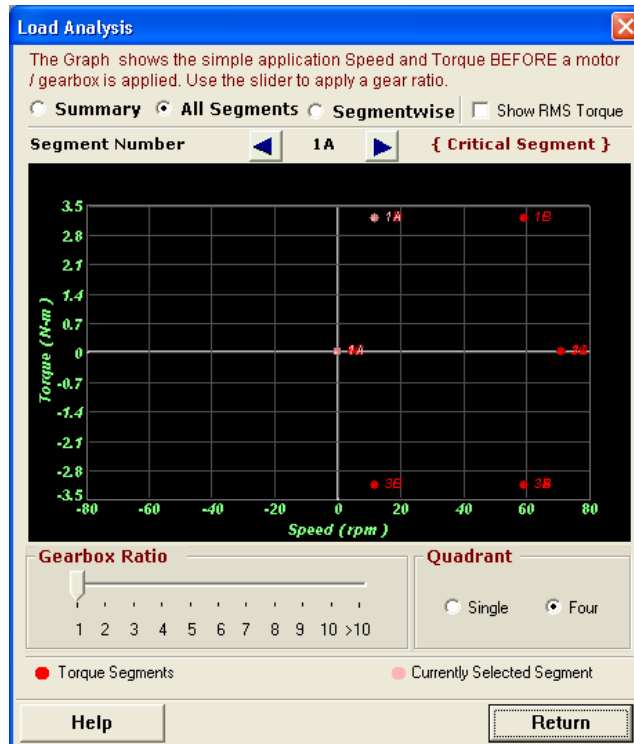


42. Here you can see the other choices that are compatible with our 460Vac Kinetix 6000 drive family. We will not be changing our selection. Press **OK** to continue.

- **1326AB** motors are chosen for medium inertia applications.
- **MPC** motors are the liquid cooled version of the MPL motor.
- **MPF** motors are the food grade version of the MPL motor.
- **MPL** motor(s) are the *most commonly used* motor. They are great for low inertia applications.
- **MPS** motors are the Stainless Steel wash down rated version of the MPL motor.



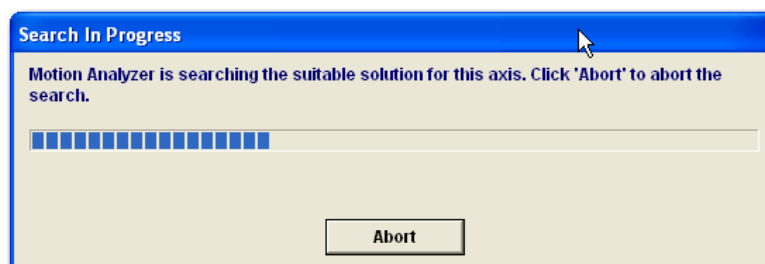
43. Another helpful tool provided in Motion Analyzer is the **View Load Graph** feature. If you are having trouble finding a valid motor and drive combination with the automatic search tool, it may be that your solution requires too much torque or speed than the selected motors can produce. Click on this button to see our requirements.



44. It seems that our required speed (RPM) is very low, considering that these motors can go up to 5000-6000 RPM. The torque does not seem high, so we will try to proceed. Press **Return** to close the tool.

45. With the selection mode set to **Automatic** for the motor and the drive, press the **Search** button.

46. **Wait** while the software searches for all valid solutions (based on your preferences).



Motion Analyzer displays the list of *viable* motor and drive combinations. The list can be sorted in a variety of ways, based on your needs, and the color codes indicate whether a parameter exceeds your “safety margin” setting or exceeds the capacity of the product (usually when manually chosen). The motors displayed are actually quite large, due to our high inertia.

Solution List

Depending on the preferences selected for the ‘max. Inertia ratio’, or ‘Show all Inertia’ or ‘Show the solutions within the max. inertia ratio’, it is possible to be presented with solutions which seem unreasonable. However if the user is just doing a first pass analysis it is reasonable to use the ‘Show the solutions within the max. inertia ratio’ and expect a large quantity of failing results.

This screen summarises the results of an automatic search with colour codes to indicate status:-

Colour	State	Status	Meaning
1	1	Pass	All parameters passed
2	2	Caution	One or more parameters exceeded the recommended limit but the solution is viable provided all customer data is accurate
3	3	Near Fail	One or more parameters exceeded 100%. The solution is not viable as entered but may respond to optimisation (e.g. changing gear ratio, reducing load requirement etc.)
4	4	Far Fail	One or more parameters exceeded 500%. Optimisation is unlikely to bring the solution into viability but should be considered a 'last resort'.

47. Let’s sort our solutions *by cost* in ascending order. Click on the **M+D Cost** (motor and drive) column as shown below. 100% is defined as the highest priced solution. All of the solutions are listed as solution state value of 1 or passing (green). Slide the lower **scroll bar** to view the other operating parameters (or any *offending* values in the case of a solution state other than 1).

First, you will only want to look at solutions with a Solution State of “1” because that indicates no criteria failed, or is within the safety margin. Then you will most likely want to pick a solution that has the best cost or inertia ratio. When you consider the inertia ratio, you ideally would like to minimize it but that is always based on how much bandwidth you really need in the application. If it is a point to point move where some overshoot can happen, you could possibly go 10:1 or less and probably be ok. If it is a high bandwidth requirement such as something that does contouring, etc., you try to match it lower, say 3:1 or less. Ideally, you try to match the motor rotor inertia to the load so that they act in unison.

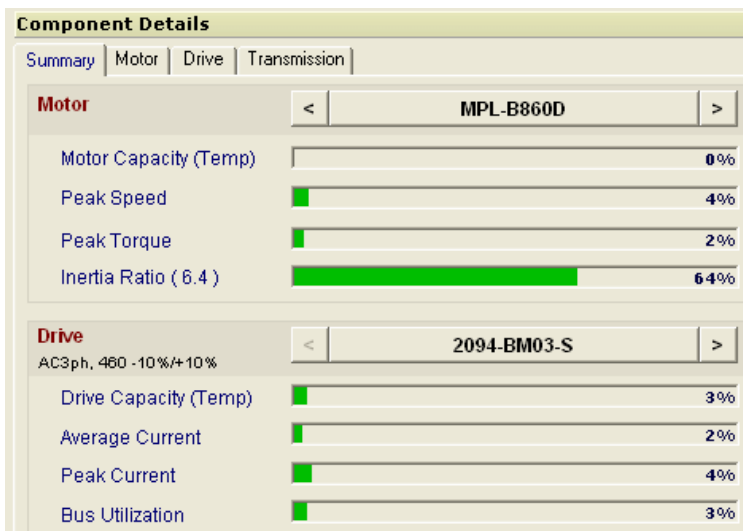
If you look at the drive, you will want to make sure the peak currents/torques are below 80% since any type of loss or friction that is not accounted for may mean the difference from doing an acceleration and deceleration. Motion Analyzer is only as good as what you enter into it. If you look at the motor, you will want to make sure Motor Winding Temperature less than 60% to make up for losses or friction that was not accounted for.

Bus utilization of the drive is next important because if it is exceeded, then there isn't enough DC Bus to spin the motor at the required V/1000rpm that the application needs. Peak Velocity in the motor section tells you what the motor can and can't do based on the input voltage. If the bus utilization is too high, then the motor can not make that move. Many times you need to increase the input voltage, if you can or change to a different motor winding or in the long run, change the cycle profile and/or work with the mechanics.

You can also tell a lot from the speed torque curve. If you are seeing a lot of torque required but only at very low speeds, some kind of reduction may help to improve that situation. Generally, it moves the points down and to the right because the motor generates less torque but requires much higher speed.

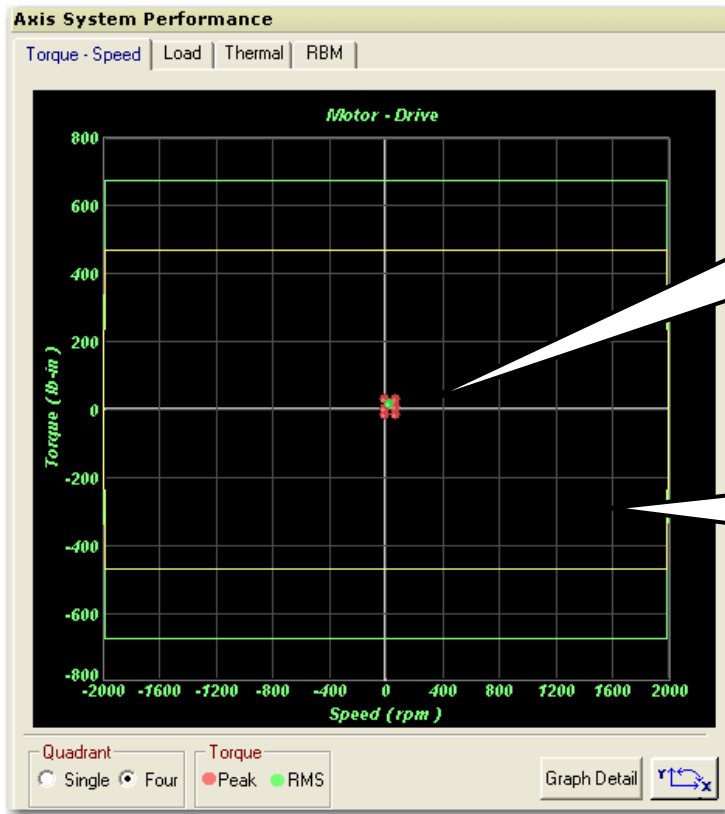
For motors that have a low rpm and high RMS torque, you will want to consider a gearbox.

48. Highlight the **first all green solution** in the list and click on **View Solution** to see its performance.



The **bar graphs** for this motor and drive combination are all green, which is good. Since most of the values are extremely low, it looks like this motor was chosen strictly based on the **high inertia value** of the drive rolls. The “62%” is from our 10:1 limit (6.2:1 is 62% of 10:1).

Next, look at the **Torque-Speed** curve. Here we see that both the Peak and RMS Torque values are within the *continuous* portion (the yellow lines) of the Torque-Speed curve. The continuous portion means that the motor and drive can safely operate there indefinitely and will not overheat. Occasionally, the torque values can spike into the Peak region, typically for accelerating the load, but this adds to overheating the motor or drive. The software models the amount of time the motor and drive are in the peak zone when calculating the “Capacity” values.

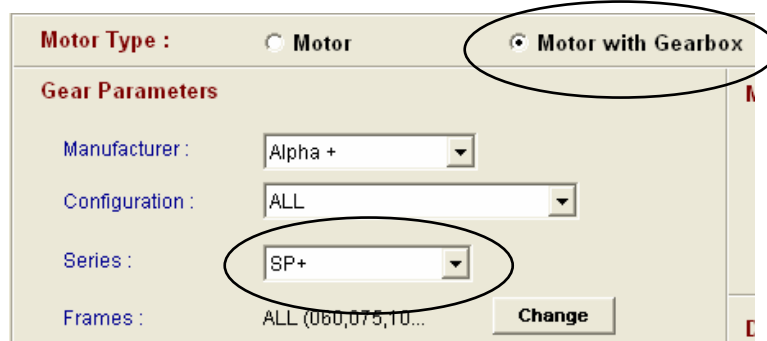


It is usually good to maximize the speed capabilities of the motor. This curve shows a motor with “wasted” speed and torque capacity.

The 4-quadrant Torque-Speed curve shows positive and negative motor speeds as well as positive and negative (regenerative) torques.

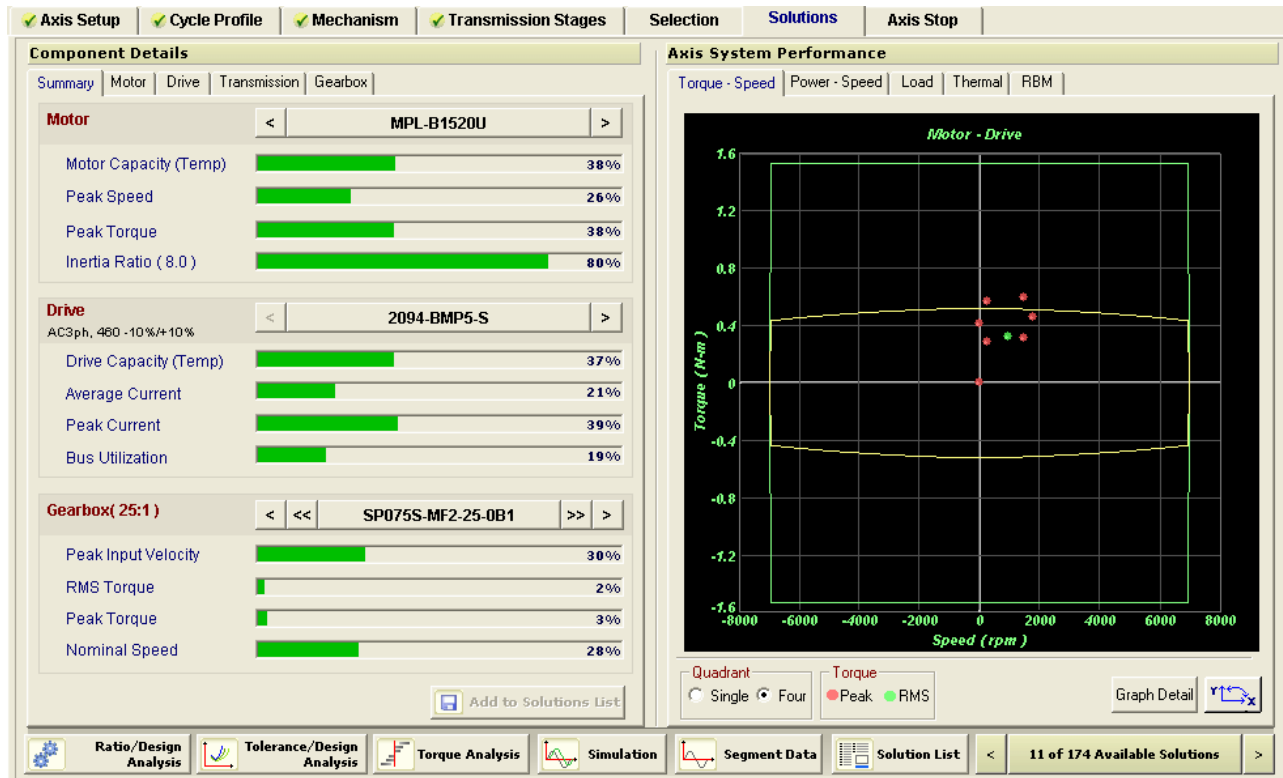
Although this is a valid solution, the data indicates that a **gearbox** would probably have been in order so that a smaller motor and drive could have been chosen. The cost of the additional gearbox versus the savings of a smaller motor and drive is often a wash, so this is not necessarily a *bad* solution. *It is actually quite common, however, to use a gearbox with a belt type actuator.*

49. To actually make this change, return to the **Selection** tab, select the **Motor with Gearbox** option and select an **Alpha +** (the **SP+ Series**) gearbox, as follows:



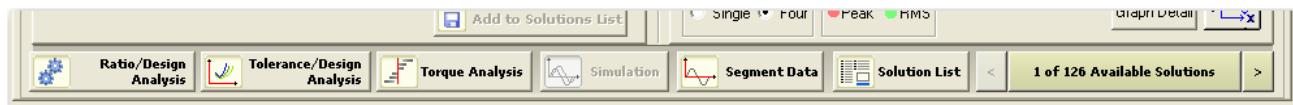
50. Press **Search** and use your skills to select the best, low-cost solution in the list.

Your new lost-cost solution results might look similar to this (*many possibilities are available*):



A simple gearbox now allows us to use one of the smallest motors and drives available. Why? Because the high inertia of the idler rolls is reduced by the *square* of the gear ratio ($35^2 = 1225$), while the motor speed requirement only increases 1:1 with the gear ratio. Ah, physics!

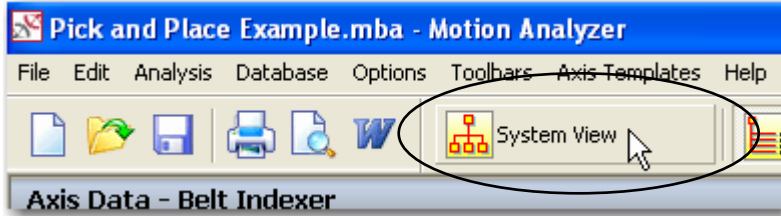
There are many additional analysis tools included with Motion Analyzer, shown at the bottom of the screen. Each one helps optimize the motor and drive selection and possibly remove costs from the system.



- **Ratio/Design Analysis** gives great insight on what the best gear ratio (or belt reduction ratio) may be, based on the motor and drive parameters.
- **Tolerance/Design Analysis** offers the ability to examine the crucial system parameters as one system variable changes, such as line speed or product weight.
- **Torque Analysis** and **Segment Data** help to investigate what aspect of the system require the most torque during a duty cycle. It is often surprising where the losses or requirements are originating.

Look for additional (advanced) labs available on these topics.

51. Return to the **System View**.

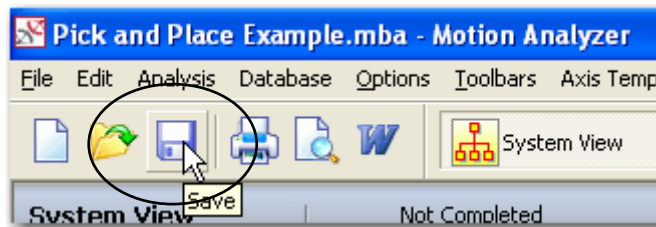


Observe all of the icons that represent our selected components. Our motor, drive (and gearbox, if chosen) selection are even specified.



Drive, motor, gearbox, coupling, belt actuator and cycle profile (shown above). The yellow triangle above simply points out that the gearbox selected comes from our 3-party provider, Wittenstein, and not Rockwell Automation.

52. Be sure to **Save** your work. Confirm any prompts and choose a location to save your file.



Lab 2: Sizing a Horizontal Lead Screw (15 Minutes)

About This Lab

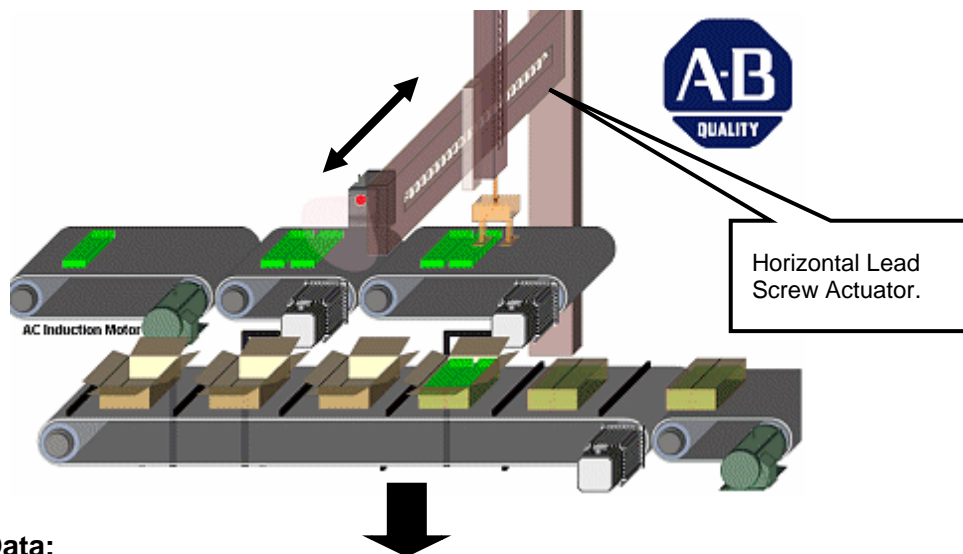
In the first lab, we gained experience with a belt driven system. Now we will work with a horizontal lead screw axis; the Traverse axis on our Pick and Place machine. In this lab, you will:

- Use the Cycle Profile Editor tool to enter a complex move profile
- Select a motor and drive for your lead screw axis
- Analyze your system choices with the Ratio/Design Analysis tool.

Follow the steps below to complete Lab Section 2.

Using the Cycle Profile Editor Tool

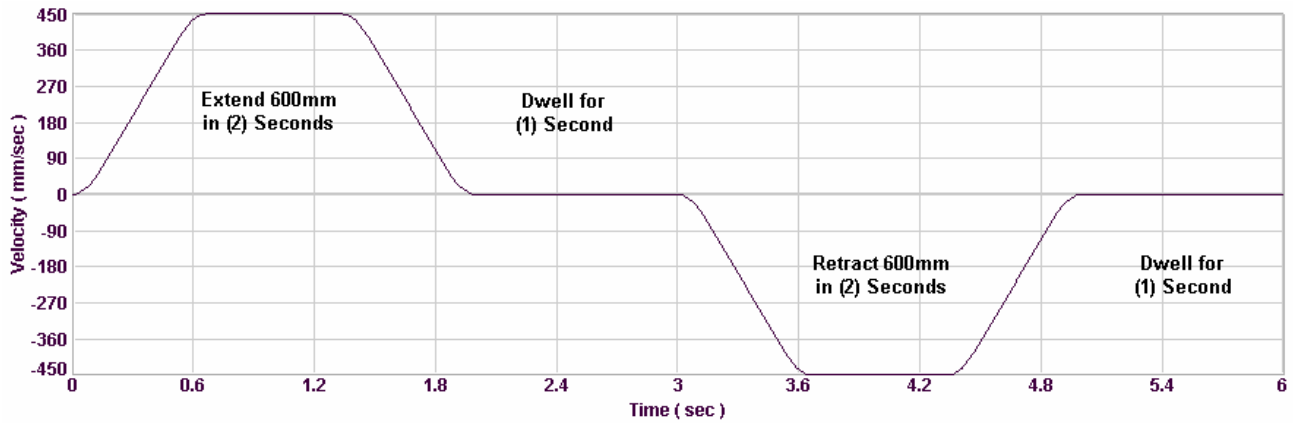
Let's continue where Lab #1 left off. This next axis employs a *linear screw actuator* to convert the motor's rotary motion into linear motion. The application specifications are listed below:



Horizontal Axis Data:

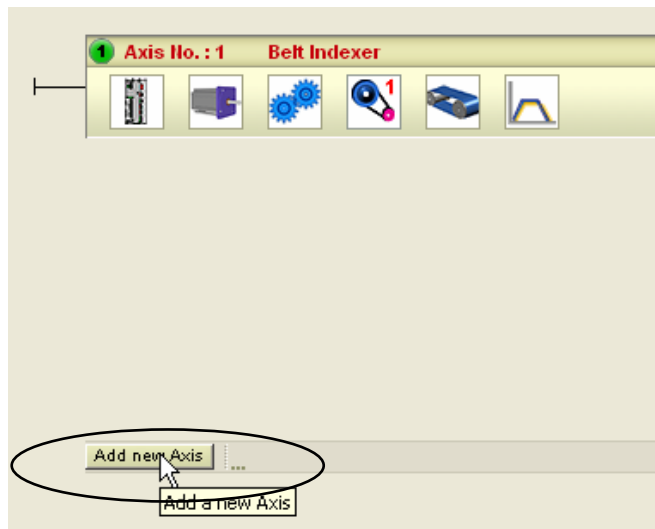
- Package weight to be moved = 3 kg
- Total Slide Mass (Includes Mass of Vertical Axis) = 45 kg
- Coefficient of Friction = 0.01 (= 1%)
- Lead Screw Specification:
 - Lead = 25 mm/rev
 - Length = 1200 mm
 - Diameter = 25 mm
 - Material = Steel
 - Efficiency = 90%
- Motor Coupling Moment of Inertia = 2.6g-cm²
- Bi-directional move of 600 mm in 6 seconds overall. See profile drawing.

The required velocity profile is shown below. This profile incorporates smooth trapezoidal velocity moves that limit acceleration and reduce the harmful effects on the machine. This is similar to the profile used in the previous axis.

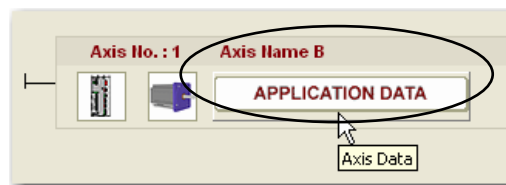


The move profile is described as “moving the product to the **placing point**, pausing for 1 second to drop it off, moving back to the **picking point** and pausing for 1 second to pick up the next product.”

1. Just below the first axis, click on **Add new Axis**.



2. Click on the **Application Data** button for the second axis.



The Axis Data screen is shown. The Axis Setup tab has the typical default values, but the voltage is set to 460Vac from the previous axis' settings. Since input power is only provided to the first Kinetix 6000 drive, all drives will have the same 460Vac rating.

Axis Data - Axis Name B Product Family : KINETIX 6000

Axis Setup
 Cycle Profile
 Mechanism
 Transmission Stages
 Selection

Load type :
 Linear
 Rotary

Actuator type :
 User Defined Actuator
 Allen Bradley Integrated Linear Actuator
 Allen Bradley Integrated Linear Stage

Voltage Selection
 Supply Type :
 AC 1 phase
 AC 3 phase
 DC
 Voltage Type :
 Single
 Range
 *Nominal Voltage:
 460
 Tolerances %
 - 10
 + 10

[Voltage Help](#)

We certainly could have chosen to use an “Allen Bradley Integrated Linear Stage” rather than a “User Defined Actuator” because the Allen Bradley Integrated Linear Stage product (MPAS) has a position range of up to 76 inches.

3. Change the **Max Ambient** temperature setting to our ‘30’ degrees (C) from before and change the **Axis Name** to ‘Horizontal Lead Screw.’

Axis Setup
 Cycle Profile
 Mechanism
 Transmission Stages
 Selection

Load type :
 Linear
 Rotary
 Application Templates
 Press Roll Feed (Const Tin)

Actuator type :
 User Defined Actuator
 Allen Bradley Integrated Linear Actuator
 Allen Bradley Integrated Linear Stage

Voltage Selection
 Supply Type :
 AC 1 phase
 AC 3 phase
 DC
 Voltage Type :
 Single
 Range
 *Nominal Voltage:
 460
 Tolerances %
 - 10
 + 10

Motor / Drive Parameters :
 Max. Ambient :
 30 °C
 Altitude :
 0 m

Axis Name :
 Horizontal Lead Screw

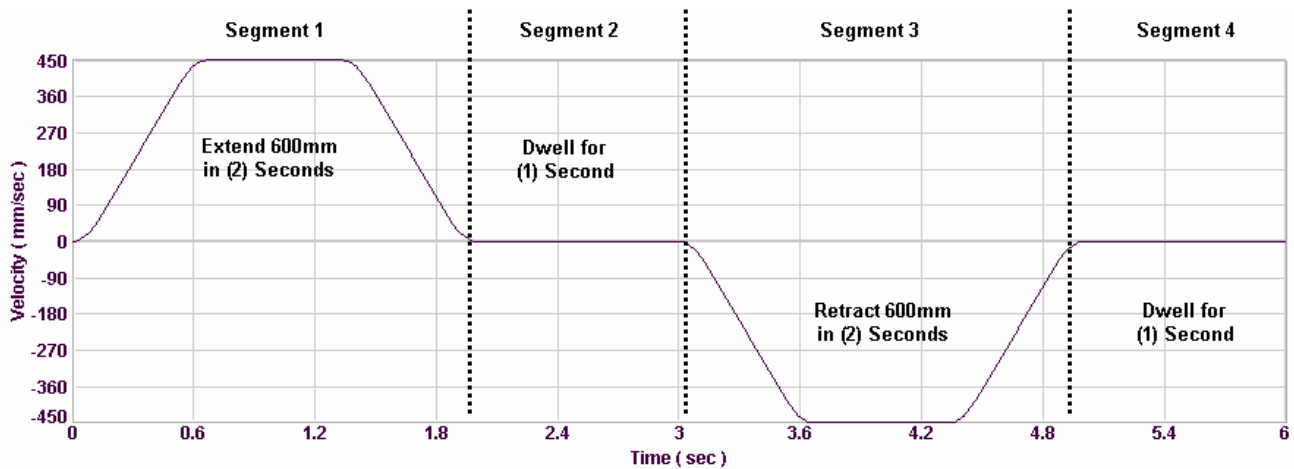
[Voltage Help](#)

Enter the Cycle Profile

4. Move to the **Cycle Profile** tab.
5. Click on the **Edit Profile** button.



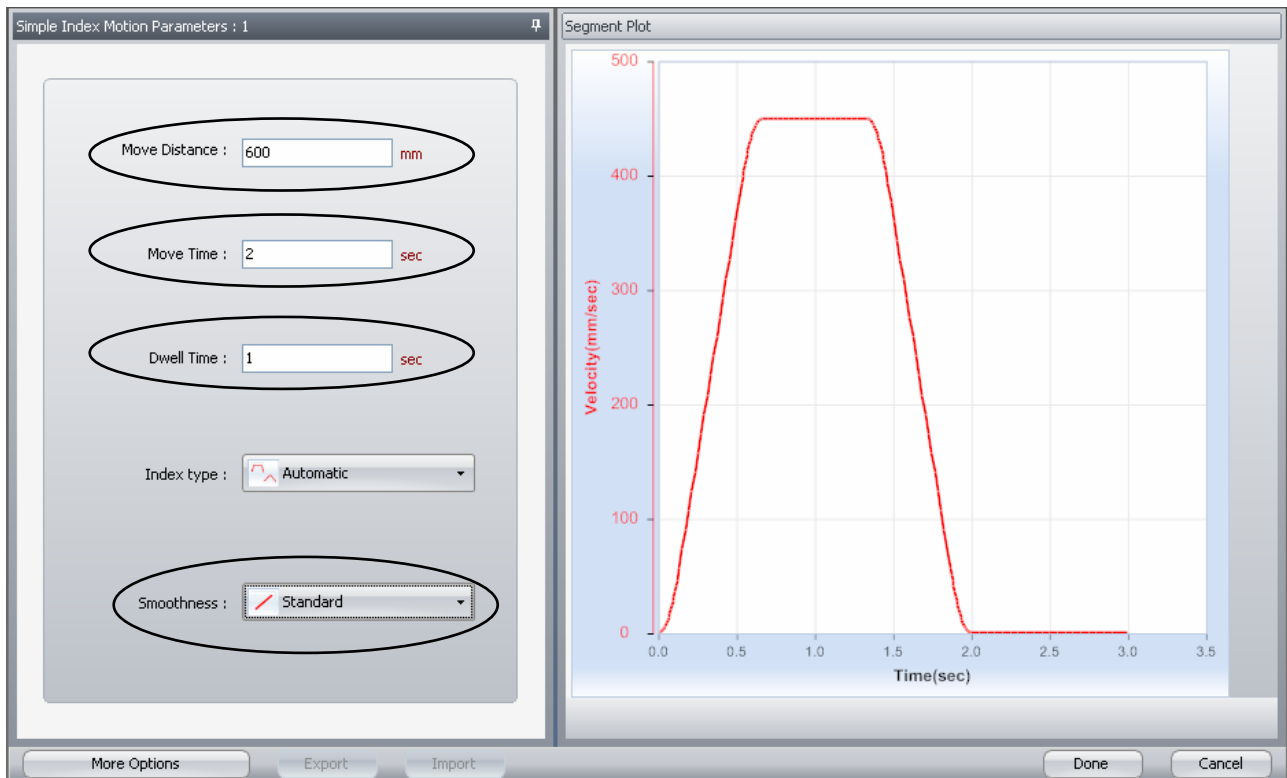
Since this move profile consists of more than one simple point to point move, we will need to use a more advanced profile editor. Here is the required move profile, segment by segment:



Let's enter the first (2) segments using the Simple Index editor.

6. As we did before, enter a **Move Distance** of '600' mm.
7. Enter a **Move Time** of '2' seconds.
8. Enter a **Dwell Time** of '1' second.

9. Use the drop-down menu to change the **Smoothness** to **Standard**, which uses a jerk limit of 40% of time. Now our profile is beginning to take shape. *Be sure to notice that this also implies that the motor will use 25% more peak torque to make up for taking time to accelerate smoothly.*



Since the horizontal axis is making a “round trip” move, let’s consider this the extension move and dwell. We’ll need to create a retraction move and dwell that is equal, but opposite in direction of this move.

10. Click on **More Options** at the bottom of the editor.

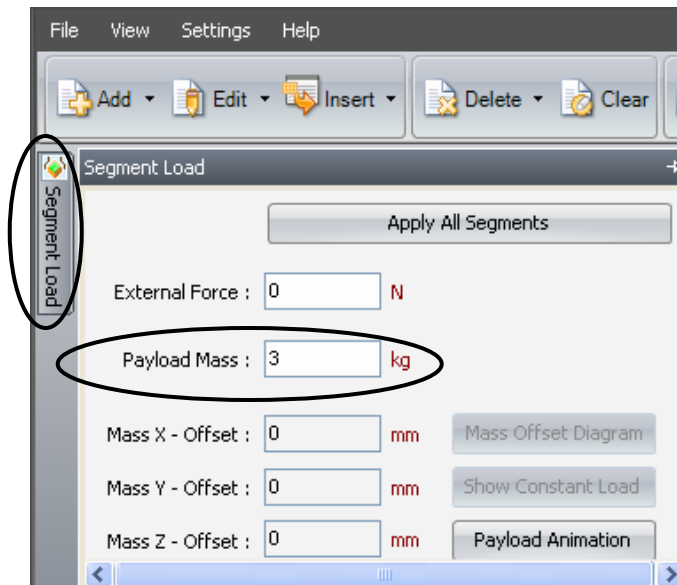
When the expanded editor opens, move segment 1 should be highlighted.

11. Click **Copy** to put a copy of the move into the clipboard.



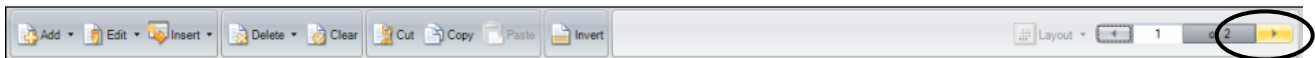
Before we move on, we’ll need to tell the software that the axis is carrying the load during this portion of the move.

12. Click on the **Segment Load** tab on the side of the editor and add our '3' kg **Payload Mass** to the profile.



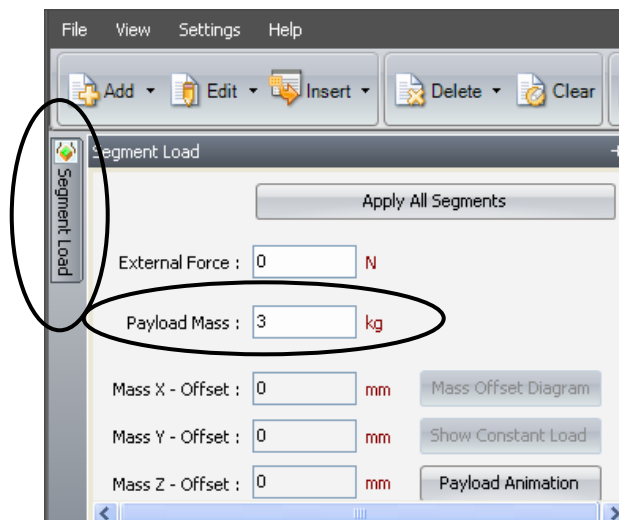
We could also apply any external forces here as well.

13. Click the > **right navigation arrow** to move to the next move segment.

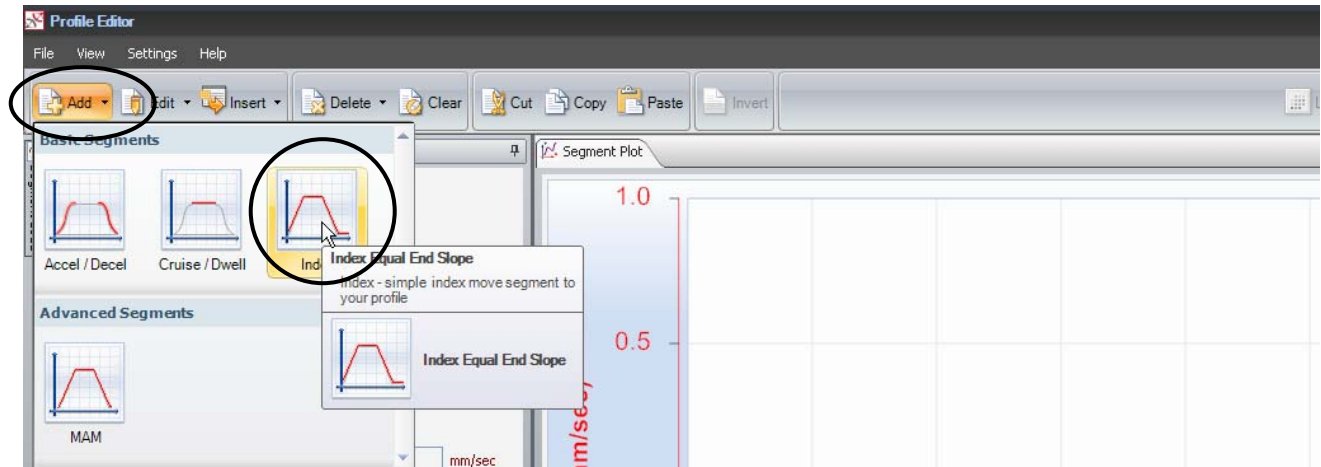


Technically, the payload is still in place for this portion of the move, so we'll add it. This is much more important to consider when sizing a vertical axis which is always overcoming gravity.

14. Click on the **Segment Load** tab again and add our '3' kg **Payload Mass** to the profile.

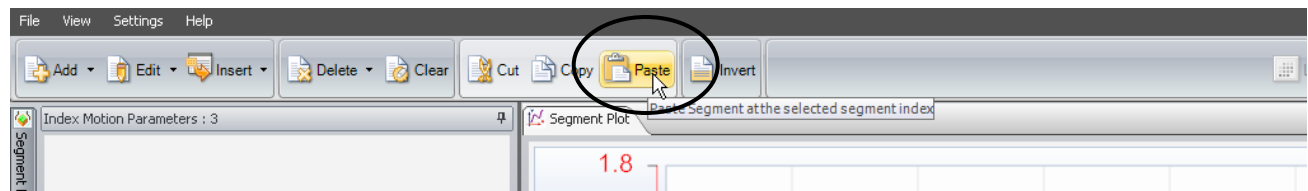


15. With the dwell segment (#2) highlighted, click on **Add** and then **Index**.



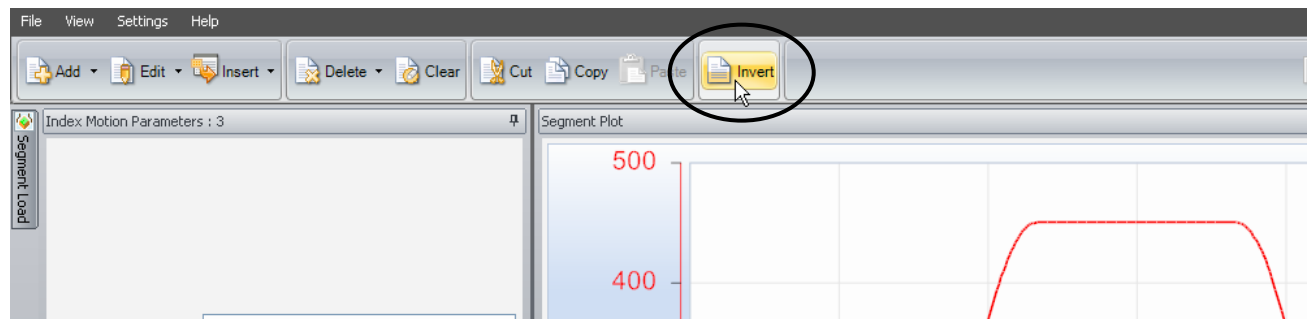
A new segment is added, but we'll need to provide the speed and distance.

16. With the new segment (#3) highlighted, click on **Paste**.



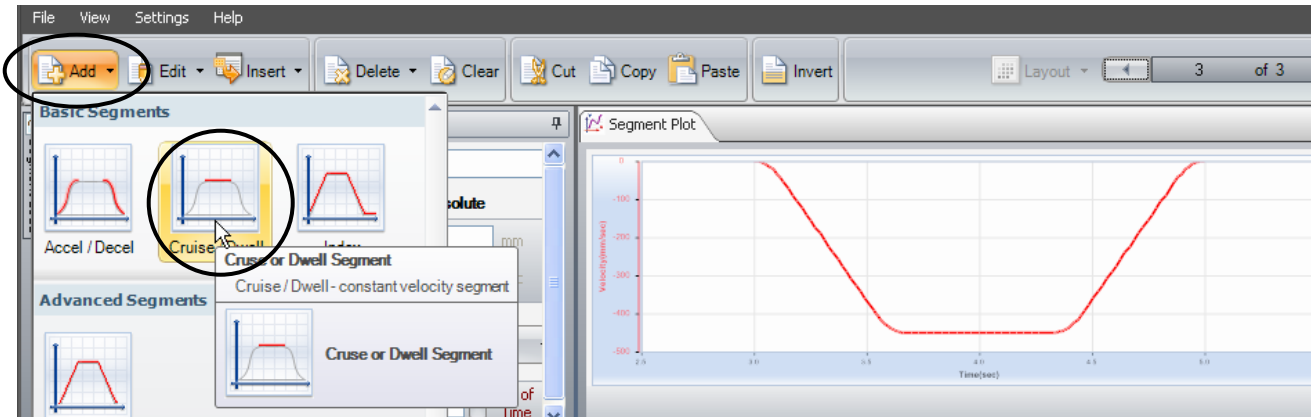
The new segment now looks just like the initial extension segment. We'll need to change its direction in order to simulate the *retraction* move. Again, this is extremely important for vertical axes, as we'll see later in the lab.

17. Click on **Invert** to easily create the retraction move.

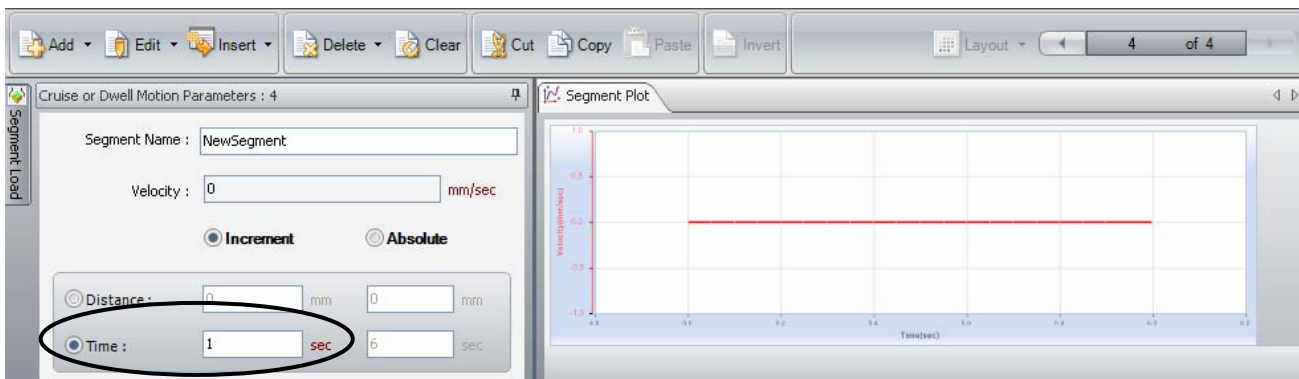


That was easy. Let's add the final dwell segment.

18. With segment (#3) highlighted, click **Add** and then **Dwell**.



19. Change the dwell **Time** to '1' sec.

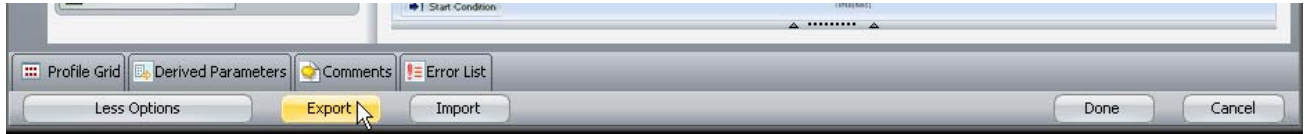


20. You can confirm your payload by clicking on **Load** in the lower left area of the editor. The line indicates that the load is indeed present for segments 1 and 2, but then removed for segments 3 and 4.



Experienced Motion Analyzer users may notice a lot of new enhancements to the profile editor, beginning in V4.6.

21. Next, click **Export** at the bottom of the editor.



Motion Analyzer saves you time and money on your development by allowing you to easily **export** your cycle profile where it is actually needed; in the motion controller's application program.

22. Click **Next** to see more options for exporting.



New for version 4.6, users can eliminate the task of having to recreate the motion profile in the motion controller by simply pasting it into their Logix motion application code or into SolidWorks for program simulation.



Advanced User Challenge:

- Use the export wizard above to copy your move profile into your paste buffer
- Open RSLogix 5000 and create a new project
- Open the MainRoutine and drop a Time Cam (MATC instruction) on a rung
- Create a Cam Profile array with at least (20) elements, open the editor and paste the profile into the Cam Editor

This is what the finished Export Wizard and the Cam Editor should look like:

Profile Export Wizard

Export Options - Logix CAM

Profile Data has been copied to the clipboard in the format shown in the table below. This data can be directly pasted to the Logix CAM table.

Master	Slave	Type
0	0	Cubic
0.133333333333333	0.0025	Cubic
0.533333333333333	0.0925	Cubic
0.666666666666667	0.15	Linear
1.33333333333333	0.45	Cubic
1.46666666666667	0.5075	Cubic

< Back Next > Cancel Help

Cam Editor - Table

[]	Master	Slave	Type
0	0.0	0.0	Cubic
1	0.1333...	0.0025	Cubic
2	0.5333...	0.0925	Cubic
3	0.6666...	0.15	Linear
4	1.3333...	0.45	Cubic
5	1.4666...	0.5075	Cubic
6	1.8666...	0.5975	Cubic
7	2.0	0.6	Linear
8	3.0	0.6	Cubic
9	3.1333...	0.5975	Cubic
10	3.5333...	0.5075	Cubic
11	3.6666...	0.45	Linear
12	4.3333...	0.15	Cubic
13	4.4666...	0.0925	Cubic
14	4.8666...	0.0025	Cubic
15	5.0	3.4694...	Linear
16	6.0	0.0	Linear
*			

Start Slope: 0.0
End Slope: 0.0

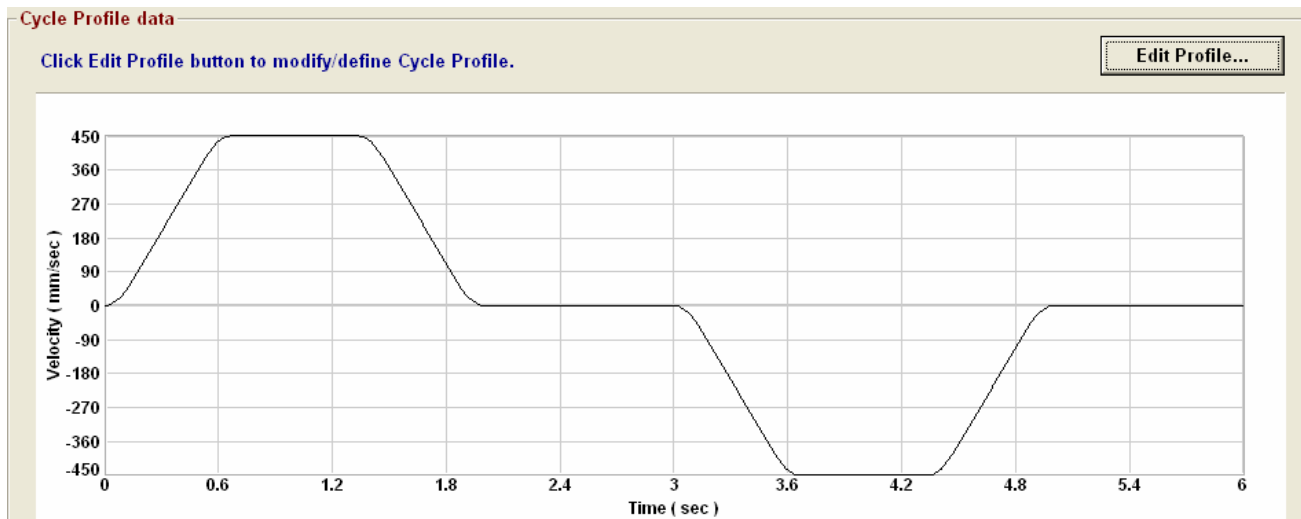
Master: 2.23333 Position: 0.596667 Velocity: 0.0 Acceleration: 0.0 Jerk: 0.0

OK Cancel
Apply Help

Our (6) second move profile.

23. Click **Done** to close the profile editor.

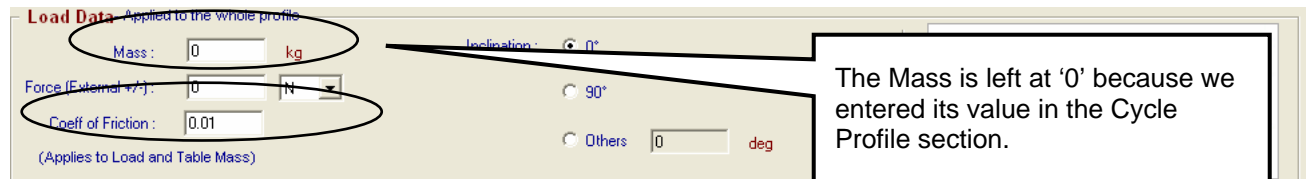
Your profile should now look like this:



Enter the Mechanical Information

24. Move to the **Mechanism** tab.

25. Enter the **Load Date** for the horizontal axis from our application information.



Load Data: Applied to the whole profile

Mass : 0 kg

Force (External): 0 N

Coeff of Friction : 0.01
(Applies to Load and Table Mass)

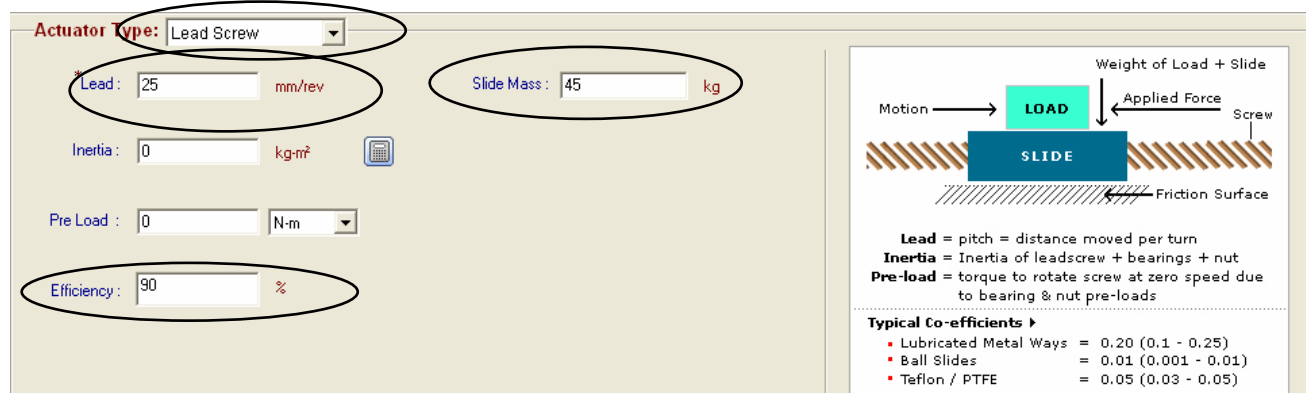
Indication : 0°

90°

Others : 0 deg

The Mass is left at '0' because we entered its value in the Cycle Profile section.

26. Use the drop-down selector to choose a **Lead Screw** for the **Actuator Type** and enter the known data as shown below.



Actuator Type: Lead Screw

*Lead : 25 mm/rev

Slide Mass : 45 kg

Inertia : 0 kg-m²

Pre Load : 0 N-m

Efficiency : 90 %

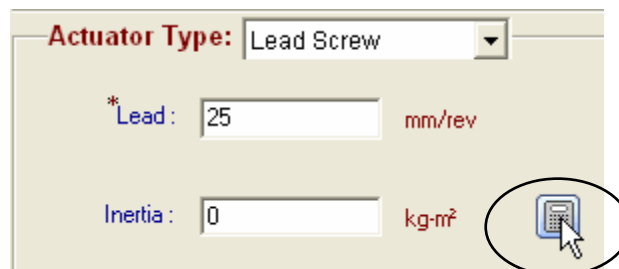
Motion → **LOAD** ↓ Weight of Load + Slide
← Applied Force ← Screw
SLIDE
← Friction Surface

Lead = pitch = distance moved per turn
Inertia = Inertia of leadscrew + bearings + nut
Pre-load = torque to rotate screw at zero speed due to bearing & nut pre-loads

Typical Co-efficients

- Lubricated Metal Ways = 0.20 (0.1 - 0.25)
- Ball Slides = 0.01 (0.001 - 0.01)
- Teflon / PTFE = 0.05 (0.03 - 0.05)

27. Click on the **Inertia Calculator** button.



Actuator Type: Lead Screw

*Lead : 25 mm/rev

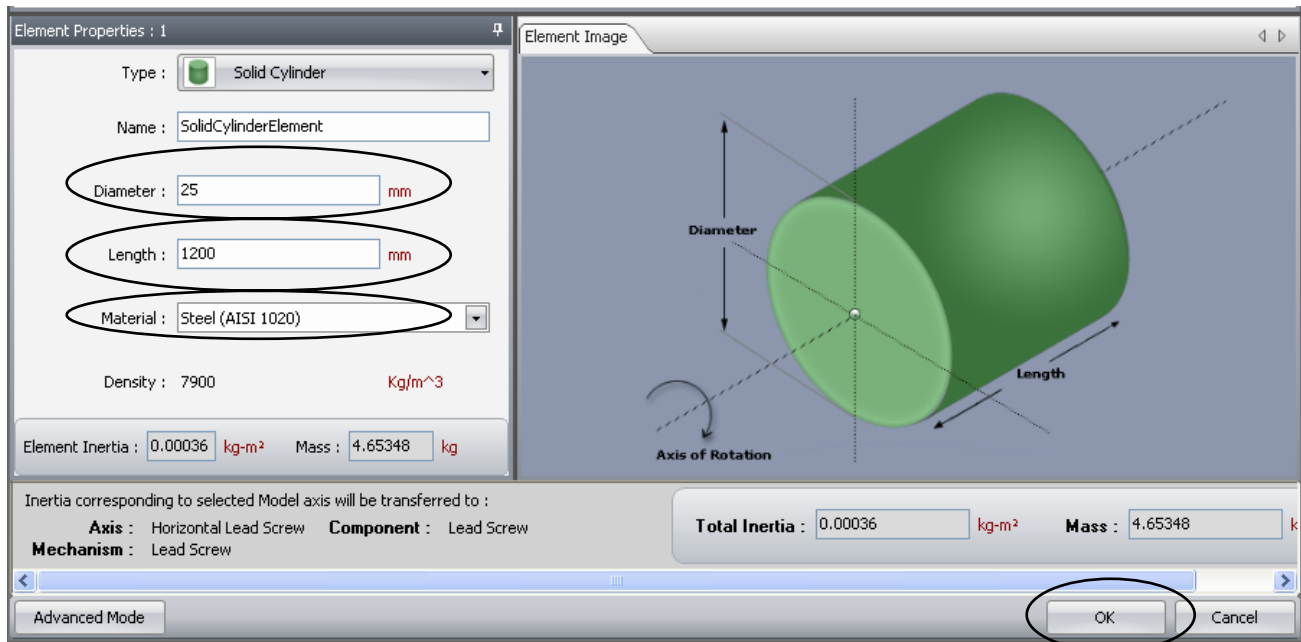
Inertia : 0 kg-m²

Inertia Calculator button

Here we will be modeling any objects being rotated by the motor, in this case, the ball screw.

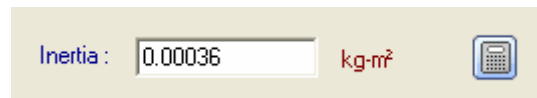
28. Use a **Solid Cylinder** for the element **Type**.

29. Enter the **Diameter**, **Length** and **Material** for our steel screw as shown.



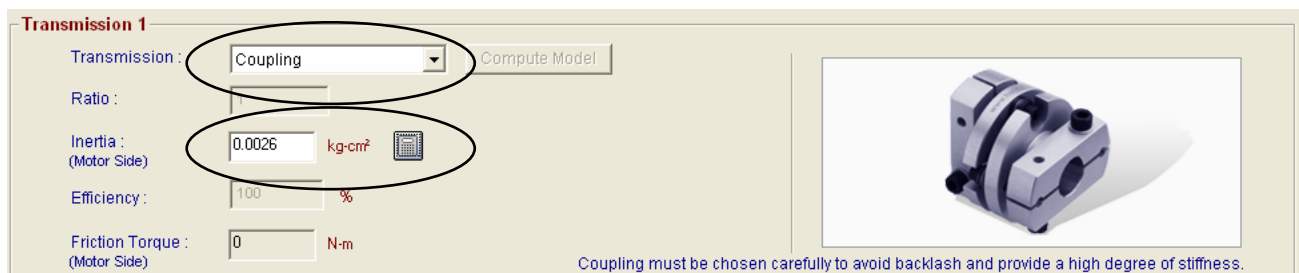
30. Press **OK** when complete.

The inertia is shown below.



31. Move to the **Transmission Stages** tab.

32. Enter the data for the **Coupling** between the motor and lead screw, just like we did for the belt actuator in the last lab. Be sure to set your **units** to **kg-cm2** for the Inertia field first and then enter the **converted value**.



Select a Motor and Drive

We have entered all of the known information and it is time to select the motor and drive. *When using lead screw actuators, you are not typically required to use a gearbox.*

33. Move to the **Selection** tab.

34. We will once again choose to **Show the solutions within the Max Inertia Ratio** and allow the software to automatically search for our motor and drive combination. Press **Search** when ready.

Axis Data - Horizontal Lead Screw Product Family : KINETIX 6000

Axis Setup
 Cycle Profile
 Mechanism
 Transmission Stages
 Selection

Motor Type :
 Motor
 Motor with Gearbox
 Allen Bradley Integrated Gearmotor

Gear Parameters
 Manufacturer : Alpha+
 Configuration : ALL
 Series : SP
 Frames : All (060,075,10...

Motor Parameters
 Max. Inertia Ratio : 10
 Show All Solutions
 Show the Solutions within the Max. Inertia Ratio
 Series : MPL-B
 Frames : All (150,200,300,400...

Database Search Options :
 Full
 User Marked

Please choose the mode of selection :

	Manual	Automatic	
Motor	<input type="radio"/>	<input checked="" type="radio"/>	<input type="button" value="Select"/> Current Selection :
Drive	<input type="radio"/>	<input checked="" type="radio"/>	<input type="button" value="Select"/> Current Selection :

Select Manual to choose your Components.
Select Automatic to have Motion Analyzer select for you.

35. Sort the list by **M+D Cost** again.

List Categories by : M+D Cost View Utilizations as : Text Graphical

Sol State	Motor	Drive	M+D Cost	General Rating	Performance Rating	Peak Speed	Winding Temp	Peak Torq
2	MPL-B230P	2094-BMP5-S	19%			22%	2%	
2	MPL-B320P	2094-BMP5-S	20%			22%	1%	
1	MPL-B420P	2094-BMP5-S-2...	21%			22%	2%	
1	MPL-B430P	2094-BM01-S	23%			22%	3%	
1	MPL-B4530F	2094-BMP5-S-2...	23%			36%	2%	
1	MPL-B4530K	2094-BM01-S	24%			27%	2%	
1	MPL-B4540F	2094-BM01-S	24%			36%	2%	
1	MPL-B520K	2094-BM01-S-250	27%			27%	1%	
1	MPL-B4560F	2094-BM01-S-250	29%			36%	7%	
1	MPL-B540D	2094-BM01-S	32%			54%	5%	
1	MPL-B540K	2094-BM02-S-250	34%			27%	4%	
1	MPL-B560F	2094-BM02-S-250	39%			36%	7%	

 Pass 1
 Caution 2
 Near Fail 3
 Far Fail 4

You can see that the first two solutions are flagged as a Solution State 2, meaning “Caution.”

36. Use the **scroll bars** to move over far enough to see that **Inertia Ratio** is causing this rating. It has exceeded our 80% safety margin.

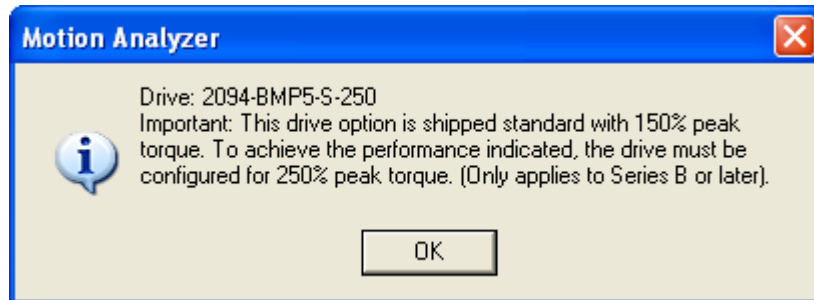
M+D Cost	General Rating	Performance Rating	Peak Speed	Winding Temp	Peak Torque	Inertia Ratio	Bus Utilization	Avera
19%			22%	2%	4%	178%	19%	
20%			22%	1%	4%	144%	17%	
21%			22%	2%	3%	43%	19%	
23%			22%	3%	3%	30%	18%	
23%			36%	2%	2%	28%	31%	
24%			27%	2%	2%	28%	21%	
24%			36%	2%	2%	22%	28%	
27%			27%	1%	2%	14%	24%	
29%			36%	7%	3%	14%	32%	
32%			54%	5%	2%	8%	47%	
34%			27%	4%	2%	8%	24%	
39%			36%	7%	2%	5%	33%	

37. Double-click on the *third* solution in the list, the **MPL-B420P** motor with the **2094-BMP5-S-250** drive.

List Categories by : M+D Cost View Utilizations as : Text Graphical

Sol State	Motor	Drive	M+D Cost	General Rating	Performance Rating	Peak Speed	Winding Temp	Pea
2	MPL-B230P	2094-BMP5-S	19%			22%	2%	
2	MPL-B320P	2094-BMP5-S	20%			22%	1%	
1	MPL-B420P	2094-BMP5-S-250	21%			22%	2%	
1	MPL-B4530P	2094-BMP5-S-250	22%			26%	2%	

The following note appears:



Important: The smaller 2094-BMP5-S drive will do the job, but not without some modification.

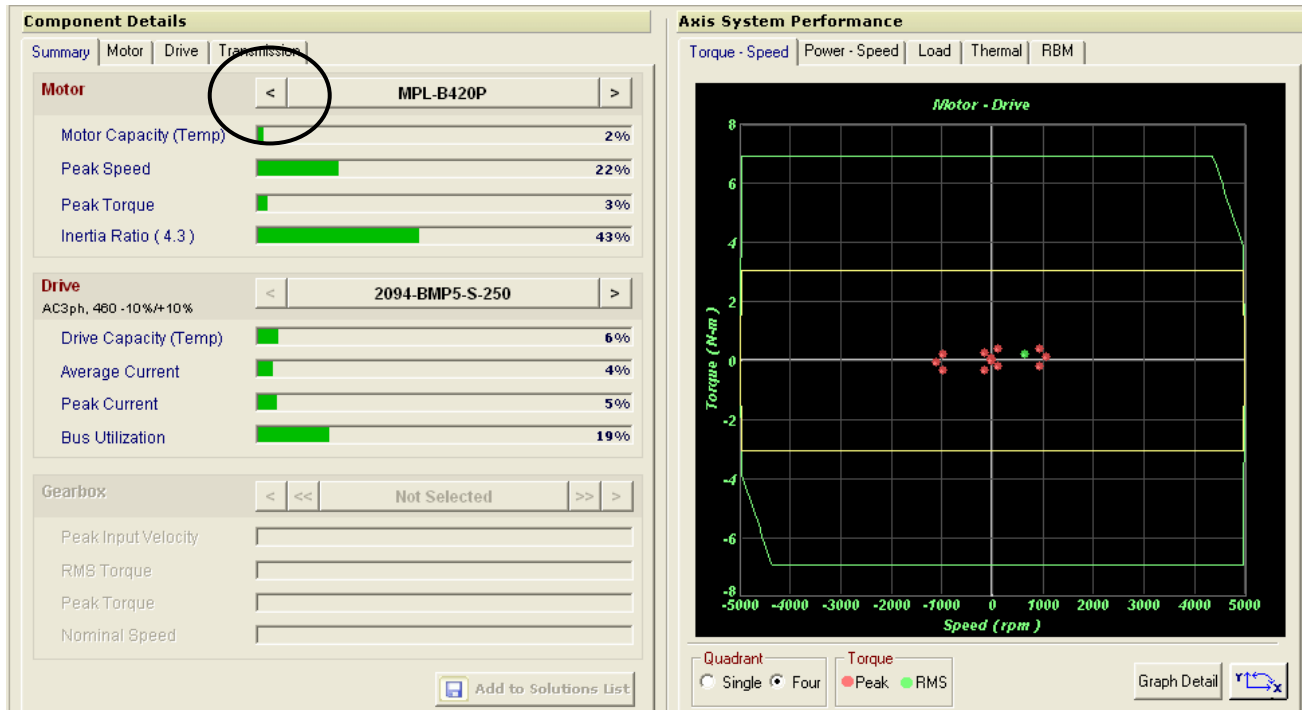
Please refer to **Appendix A** of this lab for the steps required to easily configure this drive for our enhanced usage.

38. Click **OK** to continue.

The bar graphs are all green and the Torque-Speed curve shows continuous and peak data points within the correct regions.

The required speed and torque are actually quite low for this motor. Why didn't the software choose a smaller motor? You can easily review the results of other motors (or drives) using the handy Previous/Next buttons in the bar graph area.

39. Use the **Previous (<)** button 2 times to view the performance of smaller motors.



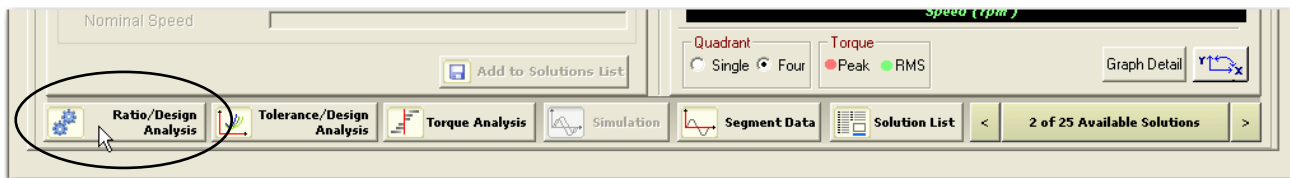
It looks like Inertia is the reason the larger motor was chosen.

40. Use the **Next (>)** button to return to the **MPL-B420P** motor selection.

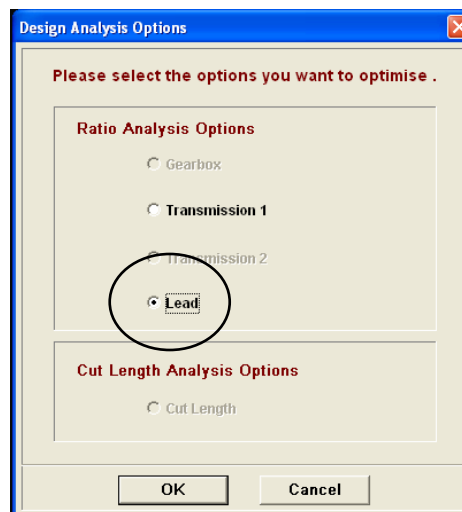
Using the Ratio/Design Analysis Tool

This is a great solution for our existing data with plenty of safety margin. But what if there something that we could change now (in the design phase) that would allow us to use an even smaller motor? We mentioned that gearbox reduction is *not* typically required when using lead screws. This is because the reduction comes from the screw itself. Our screw moves 25 mm for every motor revolution. What would happen if we chose a screw that took more revolutions to move the same 25 mm? Now we are leveraging motor velocity to gain torque and inertia reduction! We can use Motion Analyzer's *Ratio/Design Analysis* tool to find the best lead screw for our needs.

41. Click on the **Ratio/Design Analysis** button at the bottom of the Solutions screen.



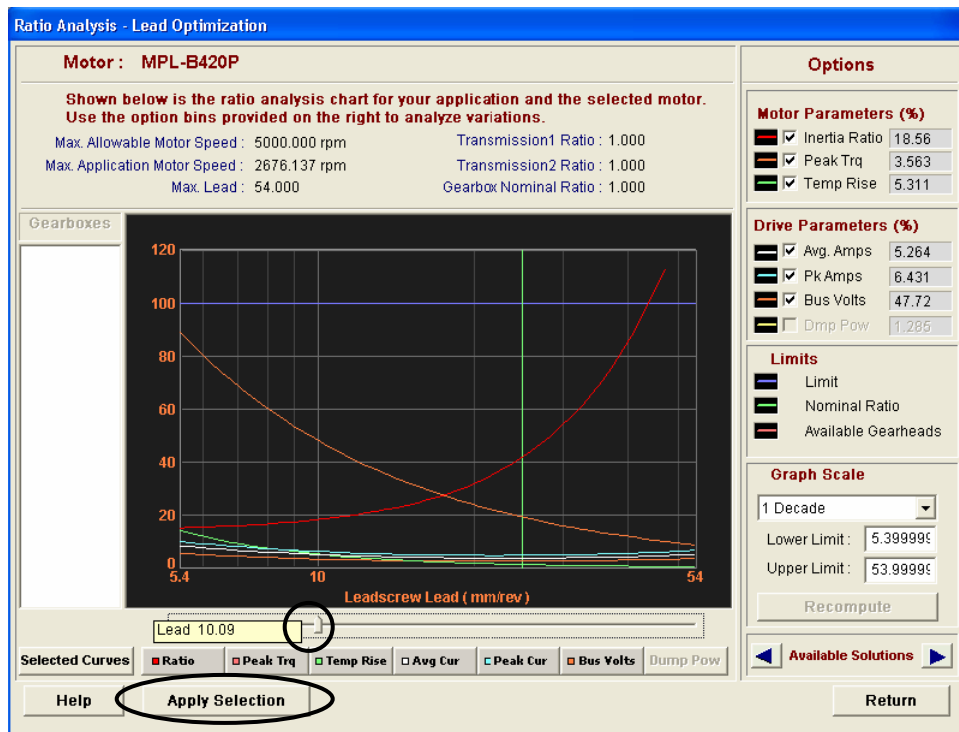
42. Choose the lead screw **Lead** option and press **OK**.



This same tool could also be used to you assist in choosing the optimum gearbox ratio and even a belt and pulley ratio.

43. The idea here is to use the **Ratio slider bar** to find a solution with the lowest torque values, without sending the other values above 100%. It looks like **Bus Volts** (orange) and **Inertia** (red) are going to be our upper limits.

44. The graph shows that a lead of about 17 mm has the lowest values for nearly everything, but that may not be a significant enough change to make a difference. Besides, screws may not be readily available in that lead. What about a 10 mm lead? Place the slider as close to '10' as possible and press the **Apply Selection** button. **Confirm** the prompt to view the results.



It looks like this change leaves us with plenty of margin for our key motor and drive values, plus the inertia ratio dropped from 4.3 to 1.9. This indicates that a *smaller motor could possibly do the job!*

45. Press **Return** when complete. A full comparison is shown below.
46. The Ratio tool indicates that going below the 5 mm lead value requires more Bus Voltage than we can provide. Press **Return** until you are back at the original Torque-Speed curve.
47. To actually make this recommended change, return to the **Mechanism** tab and change the Lead value to **10 mm/rev**.

48. **Search** for a smaller motor for this axis. It looks like an **MPL-B230P** motor with our **2094-BMP5-S** drive (with no modification) are the lowest cost solution within our tolerances.

The screenshot shows the 'Axis Data - Horizontal Lead Screw' window. The 'Component Details' section on the left lists the following specifications:

Motor	MPL-B230P
Motor Capacity (Temp)	5%
Peak Speed	54%
Peak Torque	4%
Inertia Ratio (7.7)	77%

The 'Drive' section lists the following specifications:

Drive	2094-BMP5-S
Drive Capacity (Temp)	9%
Average Current	4%
Peak Current	8%
Bus Utilization	47%

The 'Axis System Performance' section on the right shows a graph of Motor - Drive performance. Below the graph, the 'Motor' section lists the following specifications:

Motor	MPL-B420P
Motor Capacity (Temp)	2%
Peak Speed	22%
Peak Torque	3%
Inertia Ratio (4.2)	42%

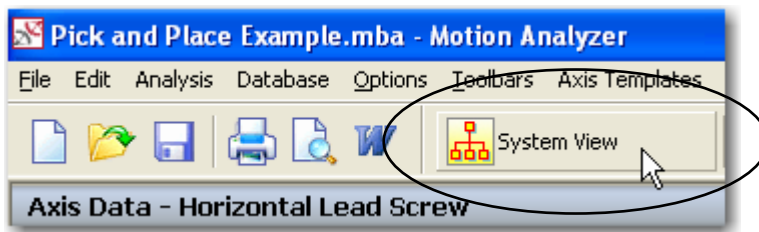
The 'Drive' section lists the following specifications:

Drive	2094-BMP5-S-250
Drive Capacity (Temp)	5%
Average Current	4%
Peak Current	5%
Bus Utilization	19%

A callout box with a speech bubble points to the 'Gearbox' section, which is currently set to 'Not Selected'. The text inside the callout box reads: 'Compare with results using the 25 mm/rev lead screw.'

We could suggest to the mechanical design team that a "10 mm" lead ball screw might be a better overall solution, but either are valid solutions.

49. Return to the **System View**.



50. Be sure to **Save** your work. Confirm any prompts and choose a location to save your file.

Lab 3: Sizing a Vertical Lead Screw (10 minutes)

About This Lab

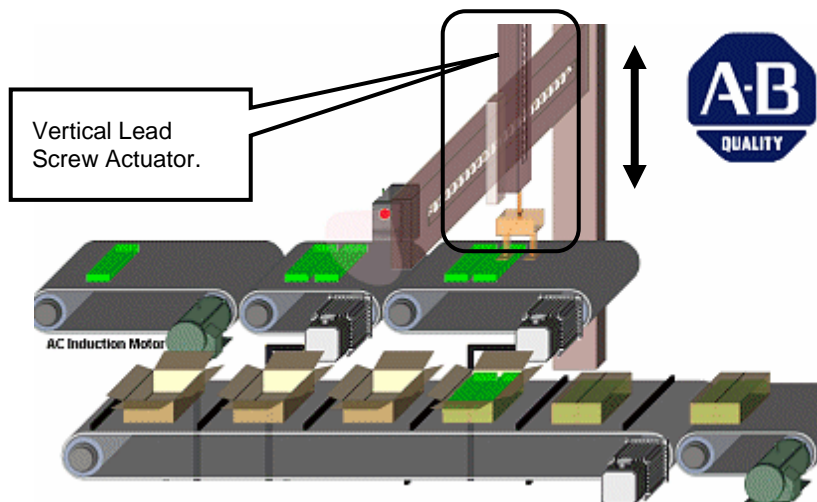
We've completed sizing a horizontal lead screw, so we understand what is involved with this type of actuator. What happens when we use a lead screw in a vertical application? What are the effects of gravity on the motor and drive? What additional considerations are we responsible for investigating? In this lab, you will:

- Reuse axis data from an existing axis
- Edit the Move Profile Data in the Advanced Profile Editor
- Select a motor and drive for your vertical lead screw axis
- Analyze the system using the Shunt Analysis tool

Follow the steps below to complete Lab Section 3.

Reusing Existing Axis Data

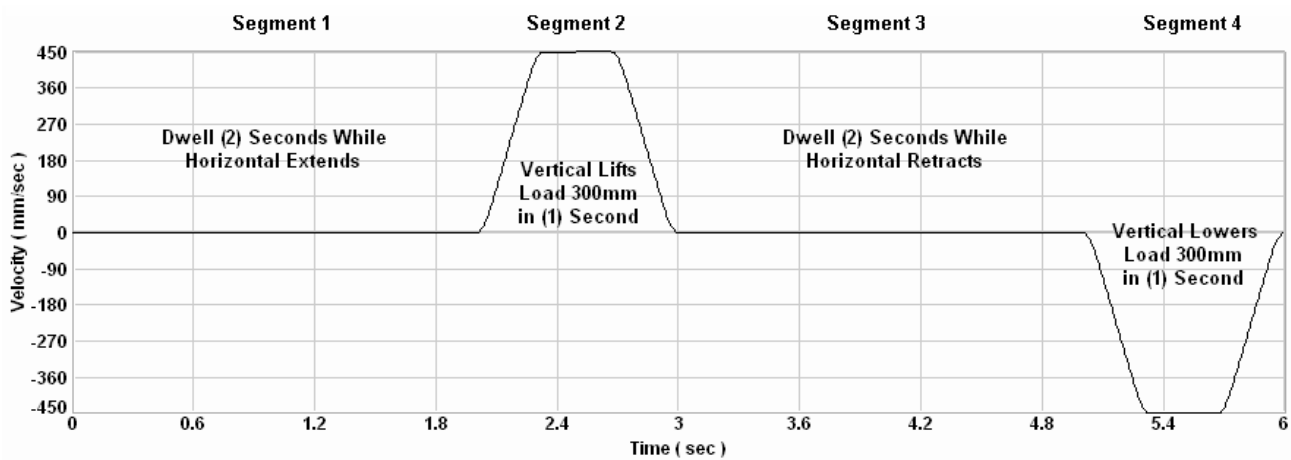
If you've already created an axis of motion similar to your current axis in Motion Analyzer, you can easily copy and paste the data as a quick starting point. In this section of the lab, you will use the axis data from the previous lab (the horizontal lead screw) as the starting point for sizing the vertical lead screw axis.



Vertical Axis Data:

- Package weight to be moved = 3 kg
- Total Slide Mass = 25 kg (including fixtures and product grippers)
- Coefficient of Friction = 0.01 (=1%)
- Lead Screw Specification:
 - Lead = 25 mm/rev
 - Length = 600 mm
 - Diameter = 25 mm
 - Material = Steel
 - Efficiency = 90%
- Motor Coupling Moment of Inertia = 2.6g-cm²
- Bi-directional move of 300 mm in 6 secs overall. See cycle drawing.

It looks like the Total Slide Mass and the Move Profile are the only differences in the axis data. The required **Velocity Profile** for the vertical axis is shown below.

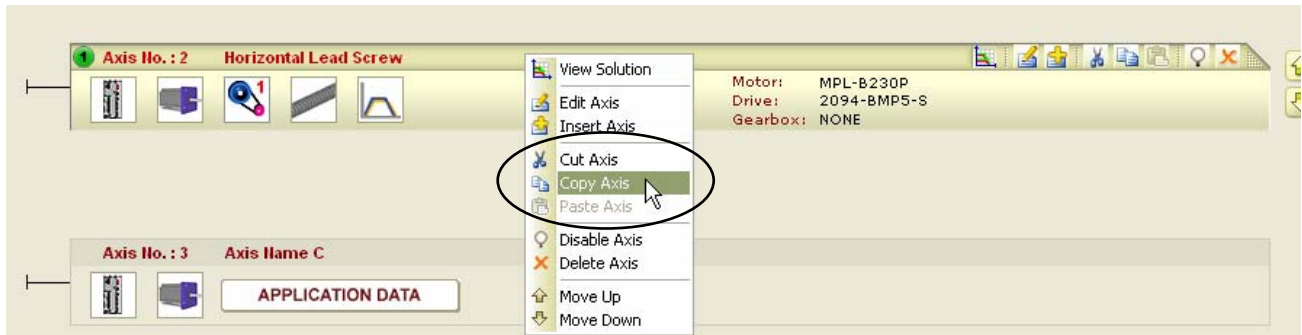


The move profile is described as “pausing for (2) seconds while the horizontal axis extends to the indexing belt, lifting the product from the **picking point**, pausing for 2 seconds while the horizontal moves over to the product carton and lowering the product back down to the **placing point**.”

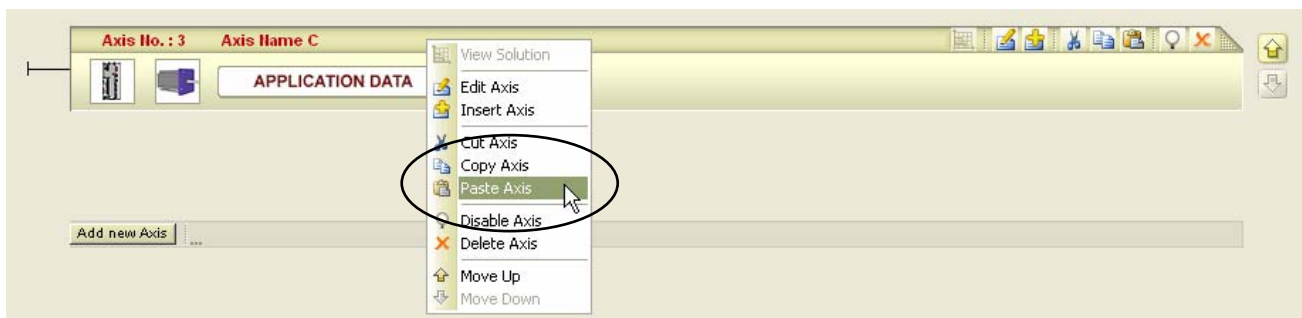
1. Just below the second axis, click on **Add new Axis** again.

We would normally begin manually entering the data at this point, but we can use the horizontal axis data to provide a faster start.

2. Right-click on the Horizontal Lead Screw axis and select **Copy Axis**.



3. Next, right-click on **Axis No.: 3** and select **Paste Axis**. Confirm by answering **Yes** to the prompt.



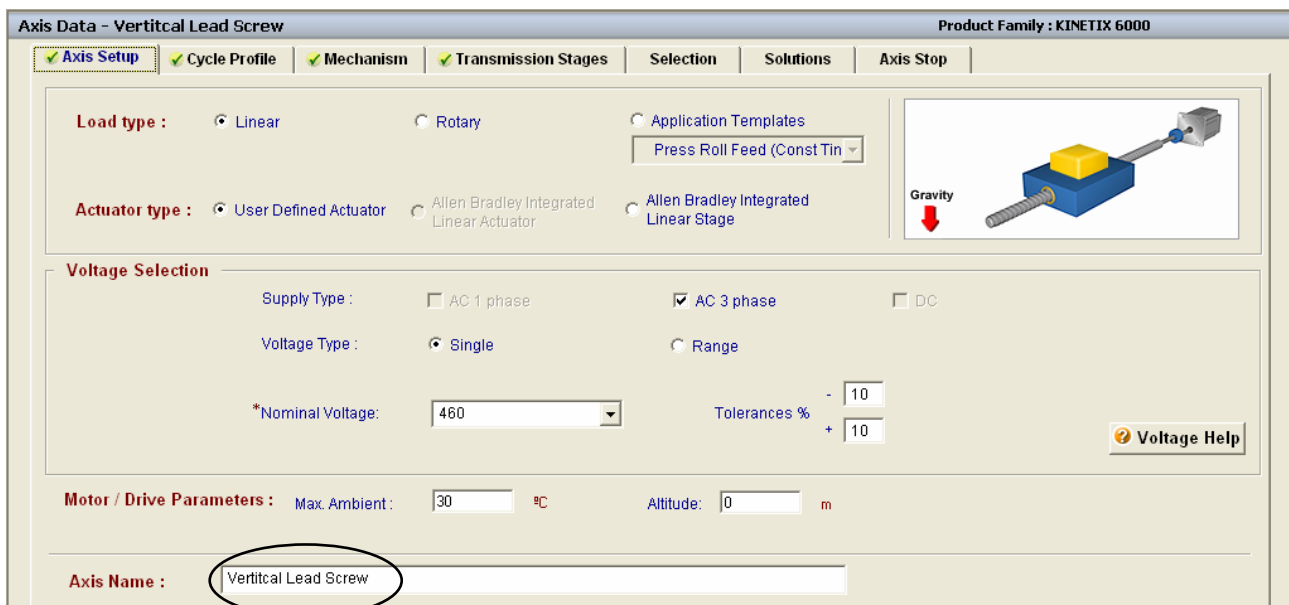
The information is brought in.

4. Double-click on **Axis No.: 3** to begin editing the data for the vertical axis.

5. Begin on the **Axis Setup** tab.

All of the data is pre-populated here, since we copied it from axis 2.

6. Change the **Axis Name** to '**Vertical Lead Screw**'.



Edit the Move Profile Data

In this section of the lab, you will need to change the 600 mm move profile from axis 2 to a shorter 300 mm move profile for axis 3. We will also account for the fact that the vertical axis moves only during the dwell portion of the horizontal axis.

7. Proceed to the **Cycle Profile** tab.

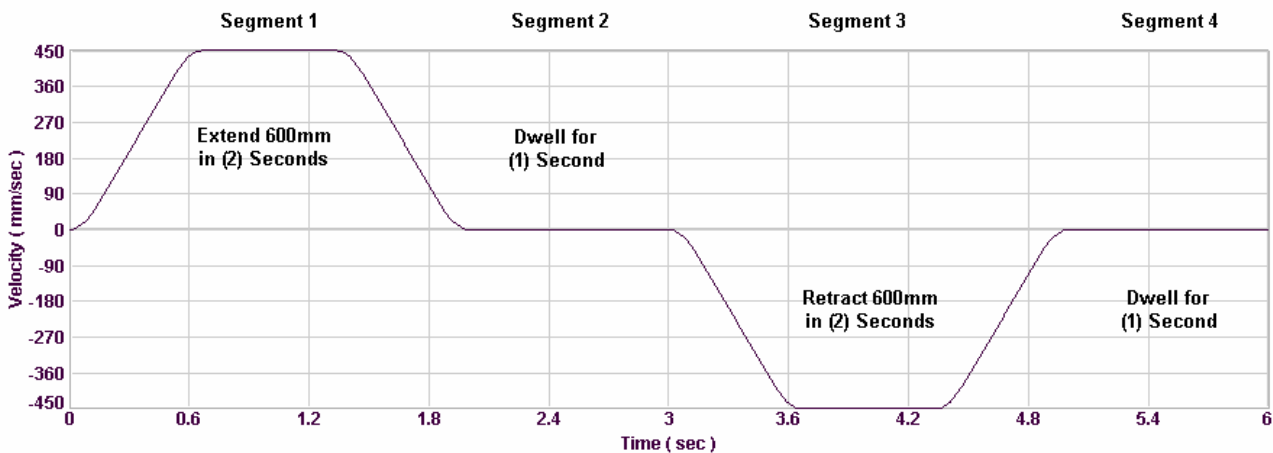
To truly model the multi-axis system, we will need to alter the move profile of the vertical axis so that the software knows it moves only during the dwell portion of the horizontal axis.

This helps us to avoid selecting power components that are oversized for our needs. If we assume that all axes are performing their worst case moves at the same time when they really aren't, we will wind up choosing larger system power modules and shunt modules than we truly need.

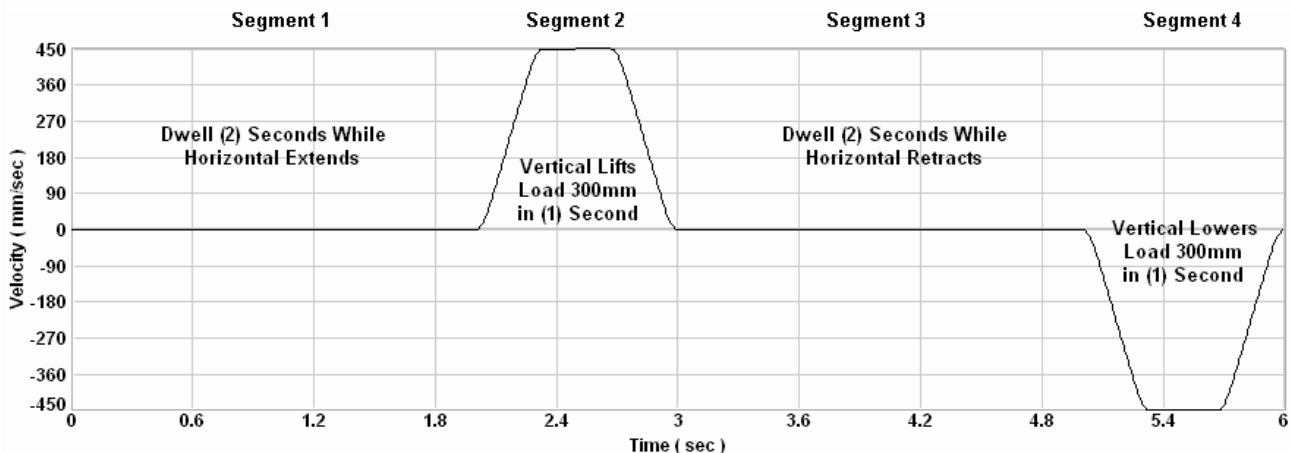
8. Select **Edit Profile**.

We want the multi-axis profile to look as follows:

Horizontal Axis Profile:

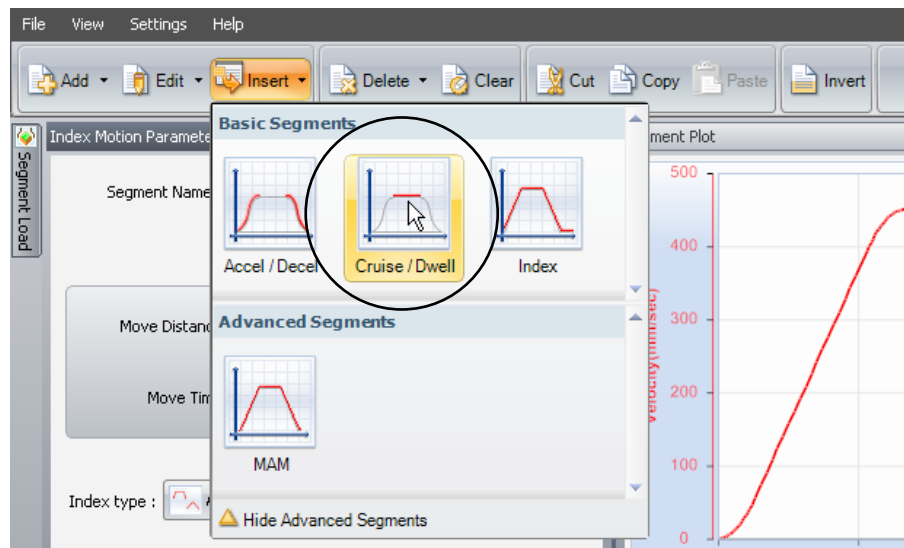


Vertical Axis Profile:

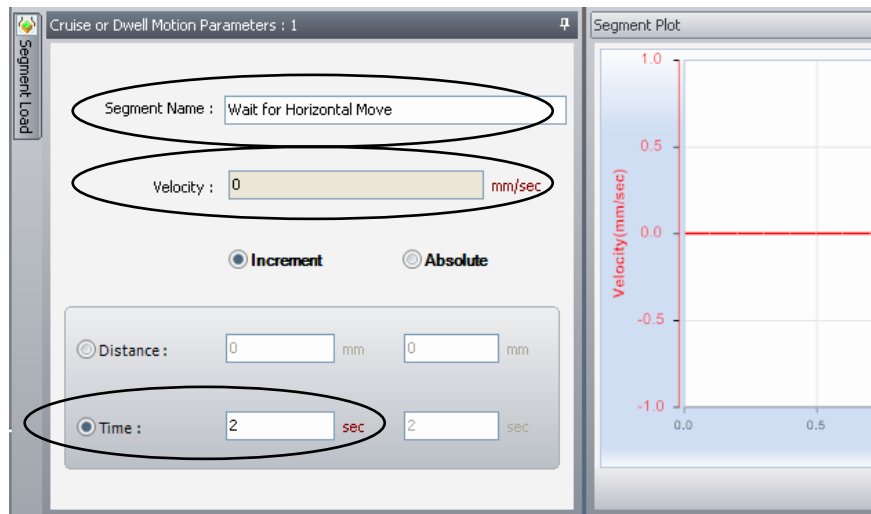


Right away, we need to insert a dwell move in front of the existing trapezoidal move segment.

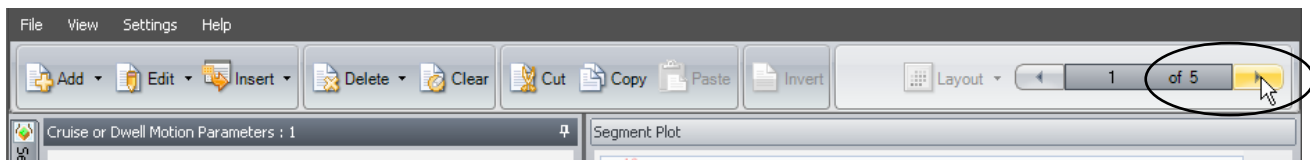
9. Click on **Insert > Cruise / Dwell** from the main menu.



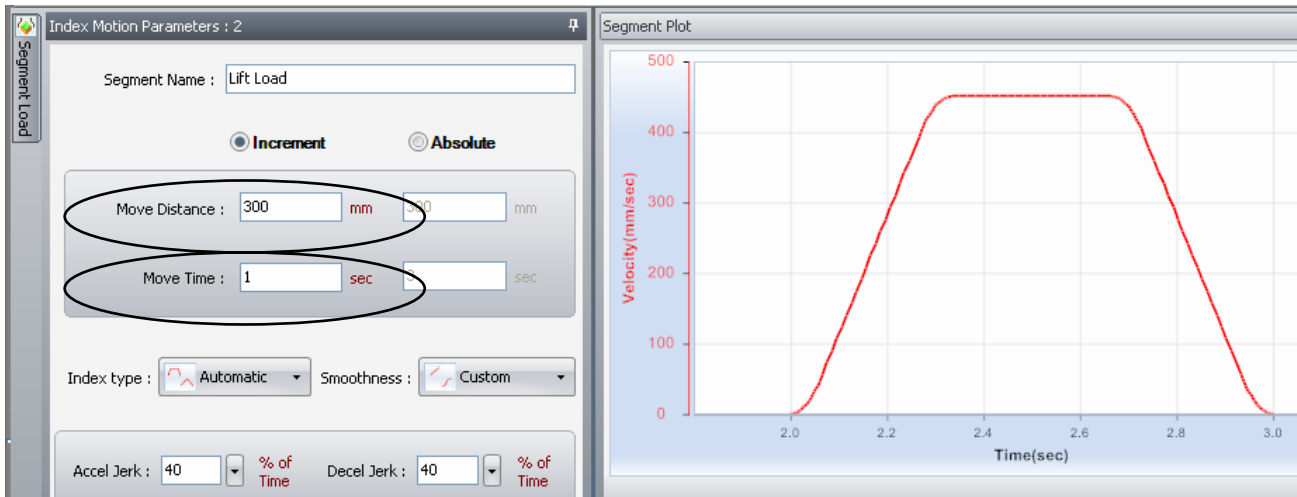
10. Fill out the **Segment Name**, **Velocity** and **Time** settings as shown below.



11. Click on the **Next Segment** navigation arrow to move **Segment 2**.



12. Enter the correct **Move Distance** and **Move Time** for our *upward* vertical profile.

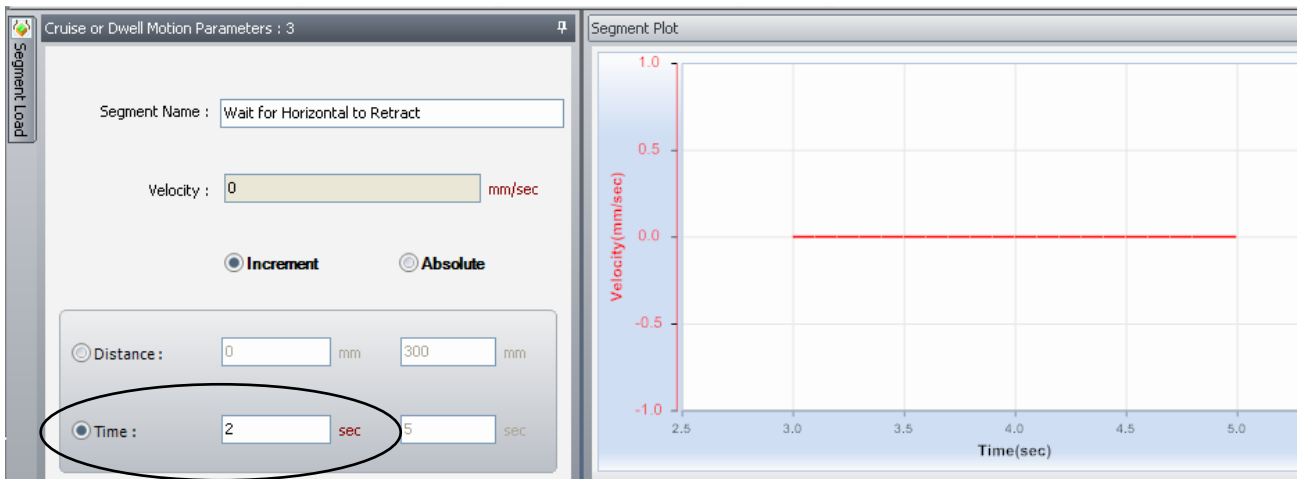


Note that the Segment Load already includes our 3 kg Payload Mass from the horizontal axis data.

Once again, the Profile Editor is greatly improved in version 4.6 of the software.

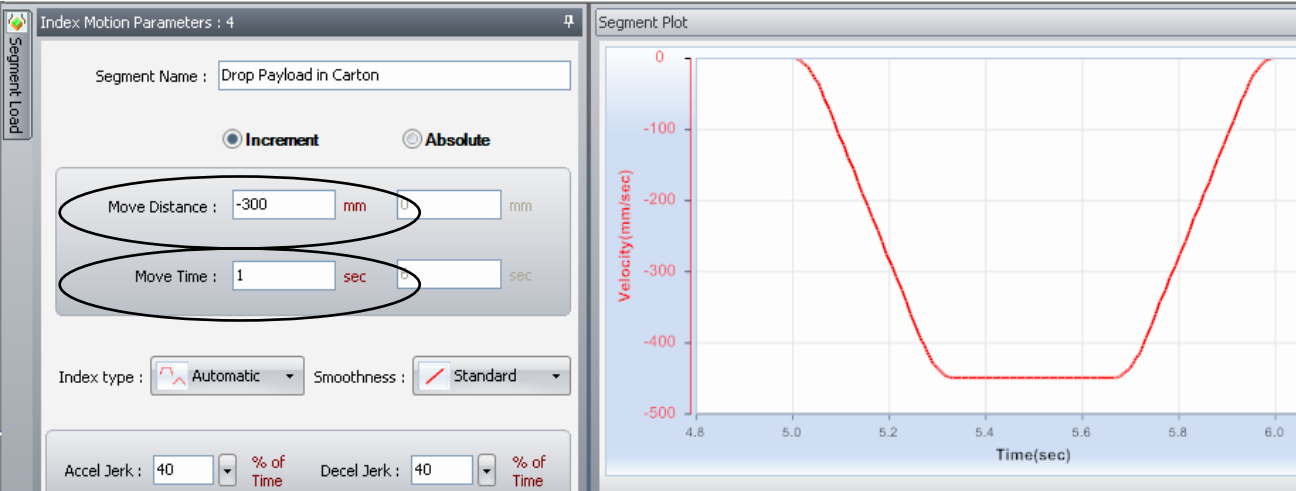
13. Click on the **Next Segment** navigation arrow to move **Segment 3**.

14. Change the **Dwell Time** to '2' seconds while the horizontal move completes the retraction move.

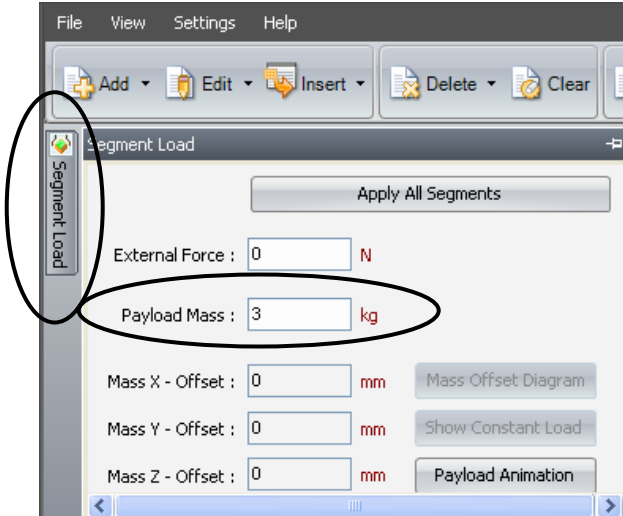


15. Click on the **Next Segment** navigation arrow to move **Segment 4**.

16. Enter the correct **Move Distance** and **Move Time** for our *downward* vertical profile.

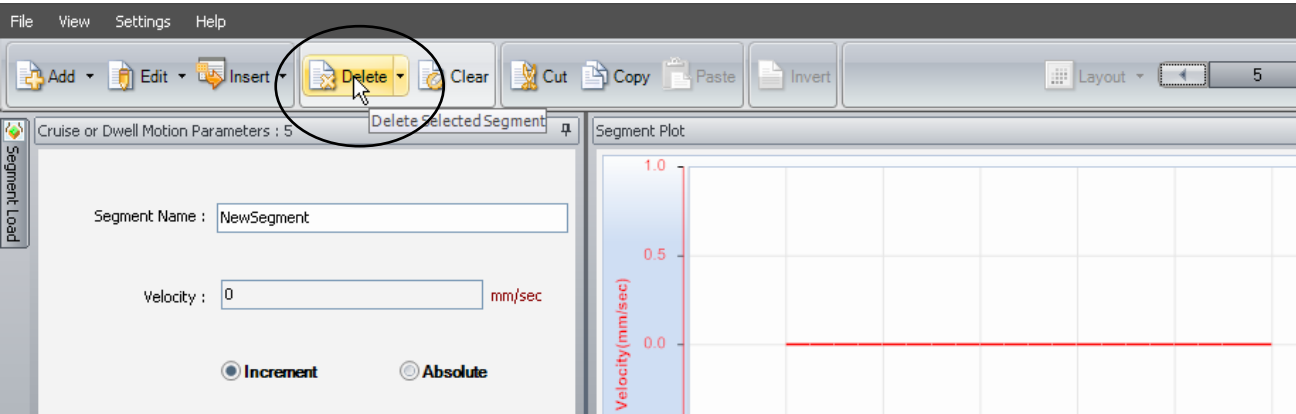


17. Click on the **Segment Load** button and add the '3' kg **Payload Mass** that is present during this move.

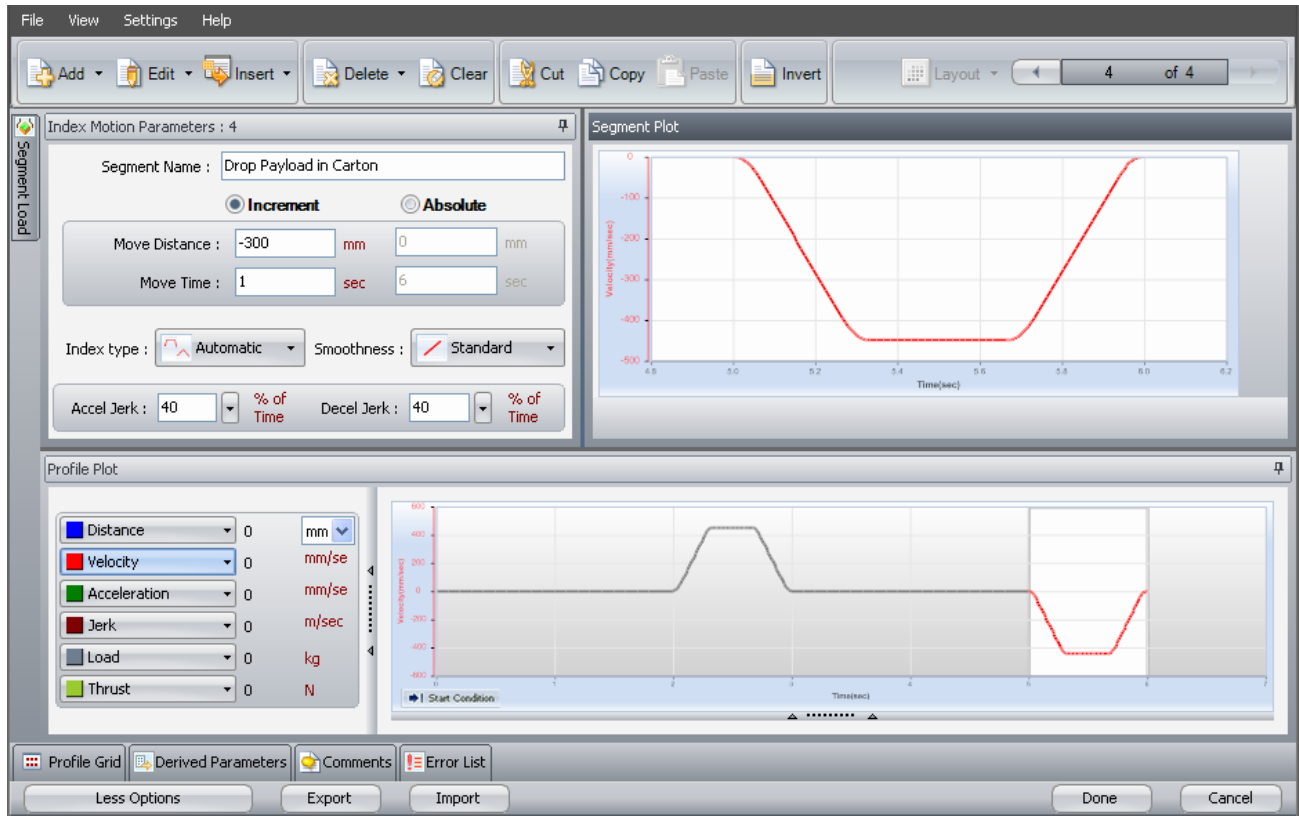


18. Finally, click on the **Next Segment** navigation arrow to move **Segment 5**.

19. We no longer need this dwell segment, so click **Delete** to remove it.

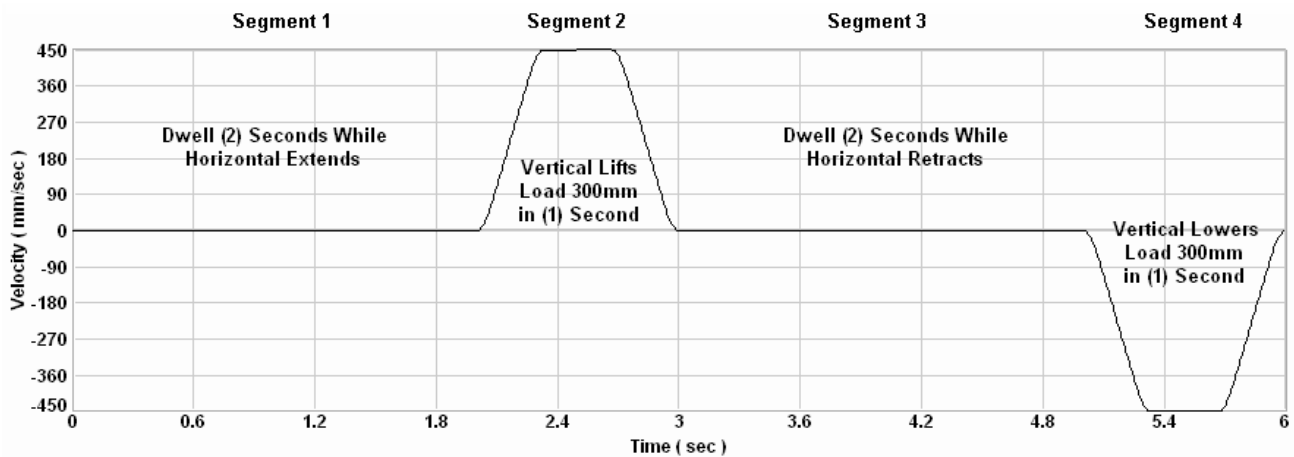


Your move profile should look as follows.



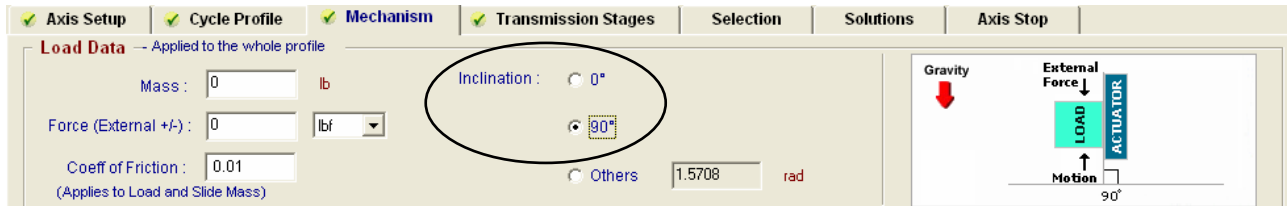
20. Click **Done** to close the **Cycle Profile Editor**.

Your Cycle Profile tab should look like this:



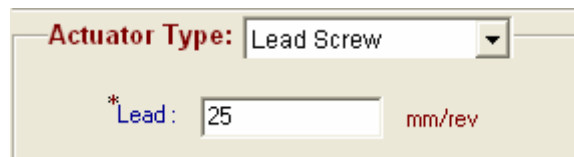
Enter the Mechanical Data

21. Move to the **Mechanism** tab.
22. Most importantly, change the **Inclination** value to **90 degrees**, to reflect our vertical axis. Press **OK** when the brake message appears.

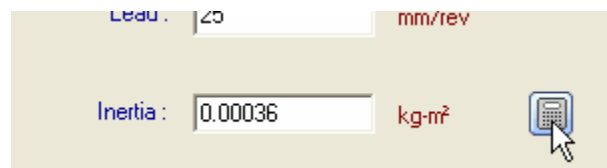


NOTE: If power is ever removed from this vertical axis, the motor would not have the ability to hold (or stop) the load from falling. Therefore, we need to select an option that will do so. Since this is a **factory only option**, so we must be careful to remember to choose this motor option *before* we place an order.

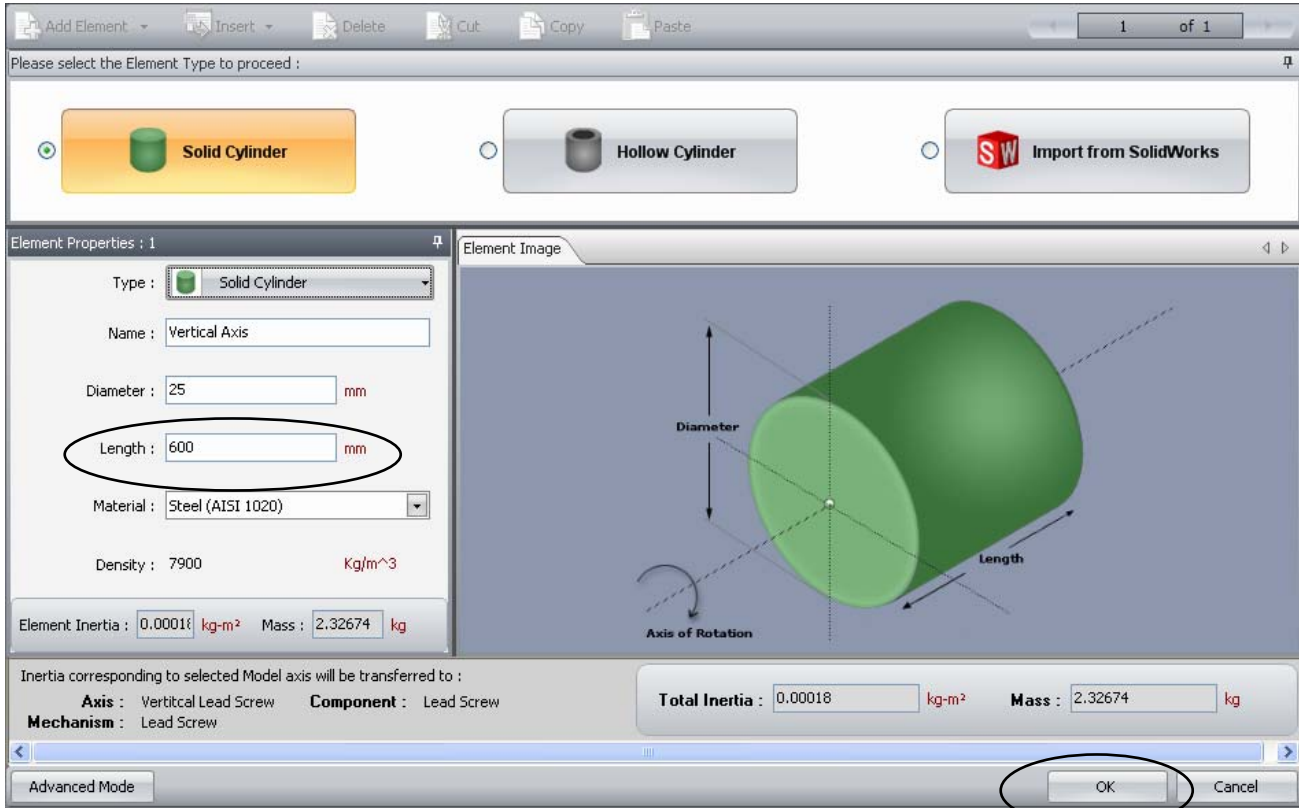
23. If it isn't already, set the **Lead** value to **'25'** mm/rev from the application data. We will be much less affected by inertia on this smaller axis.



24. Click on the **Inertia Calculator** button as before.

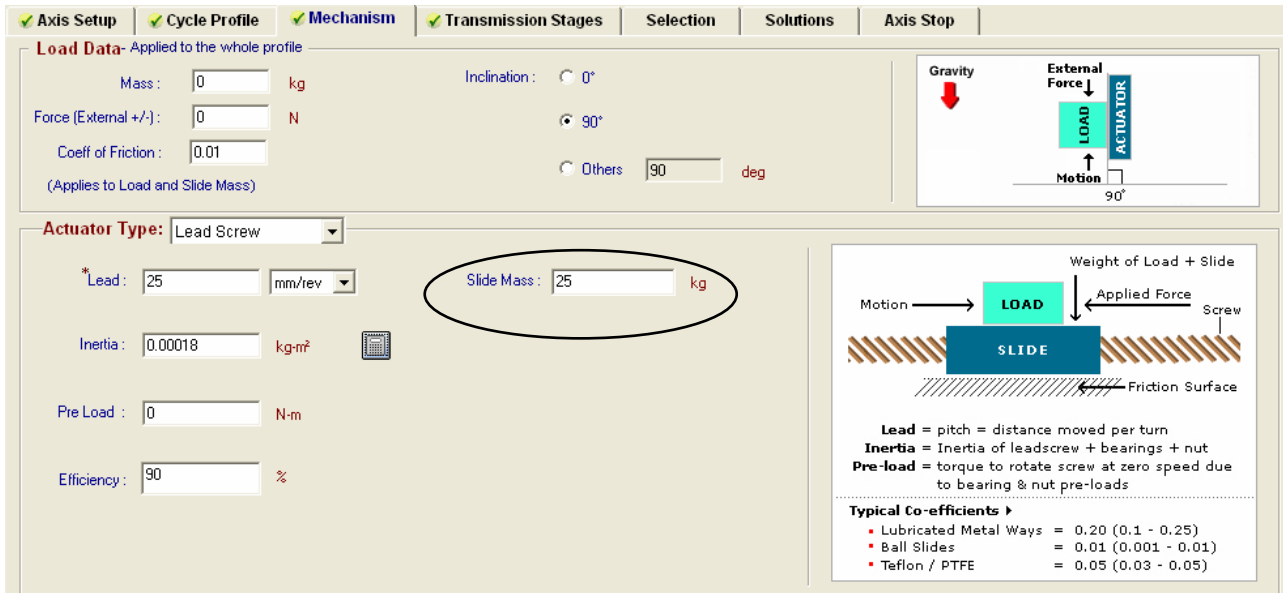


25. Change the **Length** value to the '600' mm specified for this axis. Press **OK** when complete.



26. Change the **Slide Mass** to '25' kg.

Your vertical lead screw data should look as follows:



The coupling is the same as from the horizontal axis, so we can skip the Transmission Stages tab.

Select the Motor and Drive

27. Move to the **Selection** tab.

28. All of our preferences came over from the previous axis, so press the **Search** button to begin looking for a valid solution. Answer **OK** to the prompt about the motor brake again.

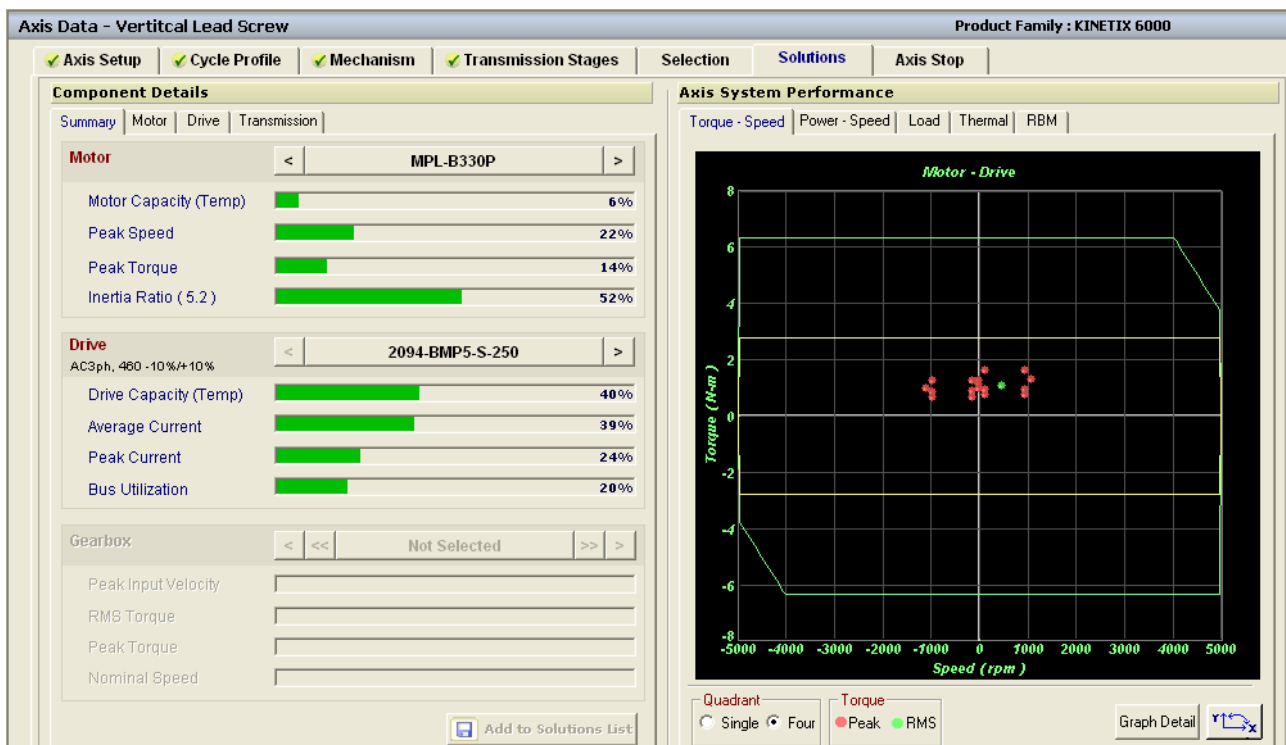
29. When the list appears, be sure that it is sorted by **M+D Cost** again and open the **first green solution** in the list.

List Categories by : M+D Cost View Utilizations as : Text Graphical

Sol State	Motor	Drive	M+D Cost	General Rating	Performance Rating	Peak Speed	Winding Temp	Peak Torq
2	MPL-B220T	2094-BMP5-S	18%			18%	32%	30
2	MPL-B310P	2094-BMP5-S	19%			23%	23%	14
1	MPL-B330P	2094-BMP5-S-250	20%			22%	4%	14
1	MPL-B420P	2094-BMP5-S-250	21%			22%	4%	11
1	MPL-B430P	2094-BM01-S	23%			22%	3%	9
1	MPL-B4530F	2094-BMP5-S-250	23%			36%	2%	9
1	MPL-B4530K	2094-BM01-S	24%			27%	2%	9
1	MPL-B4540F	2094-BM01-S	24%			36%	1%	9
1	MPL-B520K	2094-BM01-S-250	27%			27%	1%	8
1	MPL-B4560F	2094-BM01-S-250	29%			36%	4%	8
1	MPL-B540D	2094-BM01-S	32%			54%	2%	8
1	MPL-B540K	2094-BM02-S-250	34%			27%	2%	8

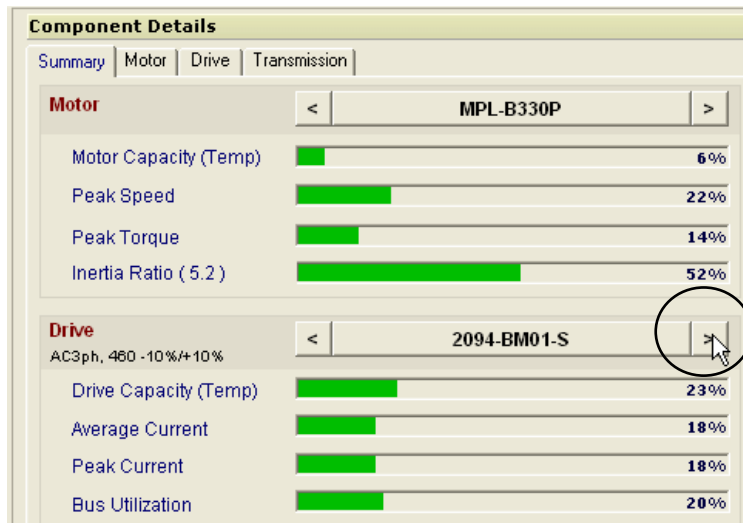
30. Press **OK** to the reminder about the 250% settings required to use this drive.

This solution looks great and the motor and drive are some of the smallest that we offer. We are satisfied.

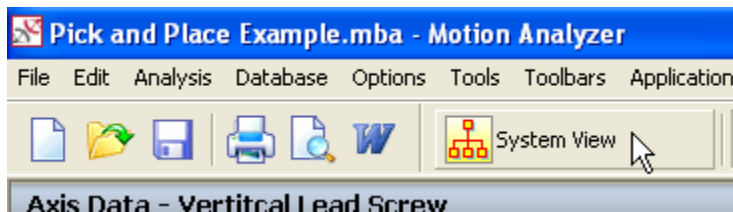


NOTE: If you are concerned about using the lower power drive and having to manually set the Peak Current limits to 250%, simply press the '>' arrow to view the axis' performance using next larger rated drive.

The 2094-BM01-S drive does not require the custom settings, doesn't take up any additional Kinetix power rail space and costs only about 15% more than the lower power drive.



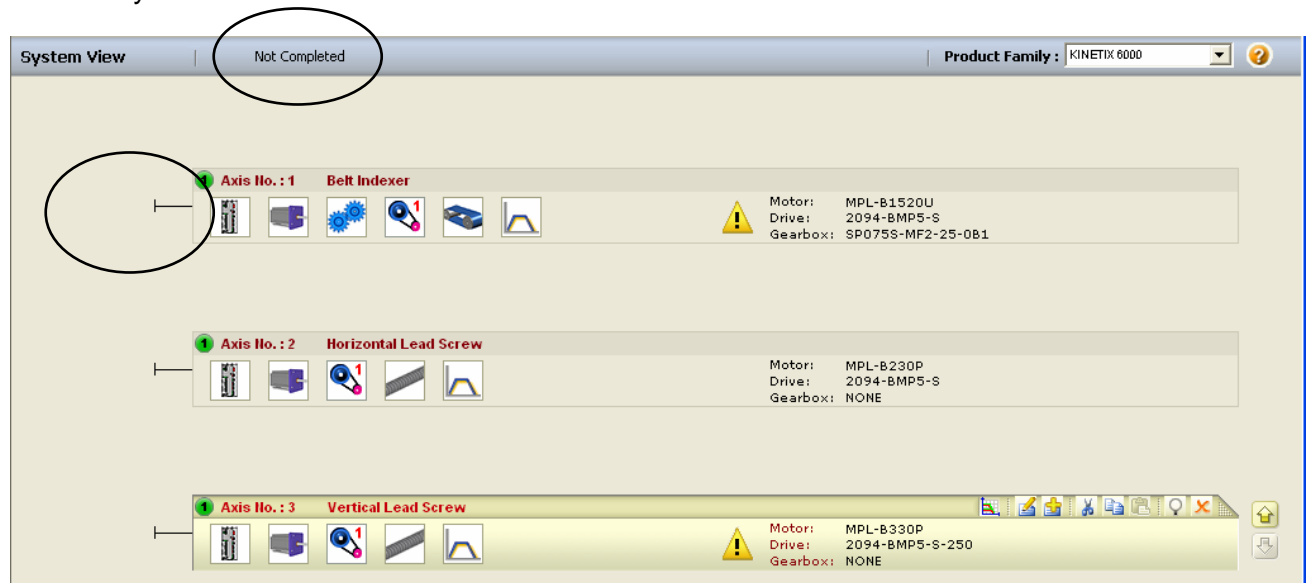
31. Return to the **System View** as before.



32. **Save** your work.

Analyze the System Shunt Requirements

You may have noticed the prompt that keeps appearing when you save your work. It mentions a system shunt. There are also some clues in the System View that alert us to the fact that we are not done yet.



Kinetix 2000 and 6000 drives are multi-axis drives and include (1) integrated axis module where the AC supply voltage is provided and up to (7) additional axis modules. The integrated axis modules contain a converter that creates an internal DC bus voltage on the backplane which powers the additional axis modules. The integrated axis module must be sized large enough to provide the required DC power to the axis modules.

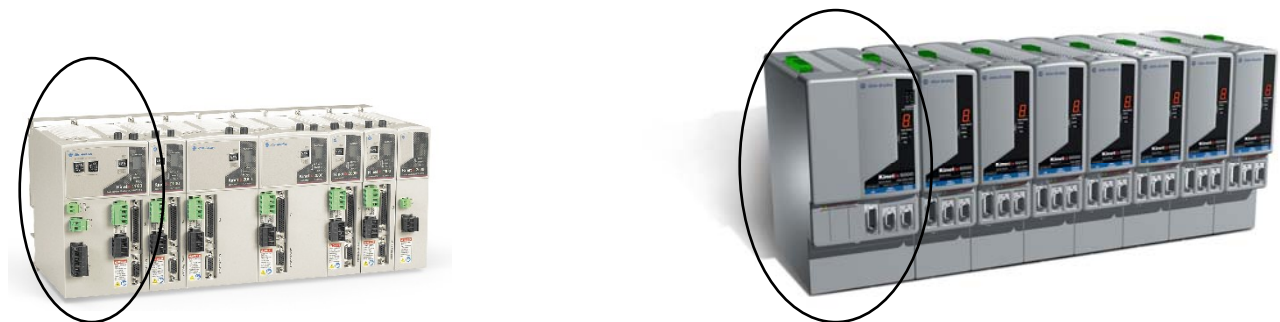
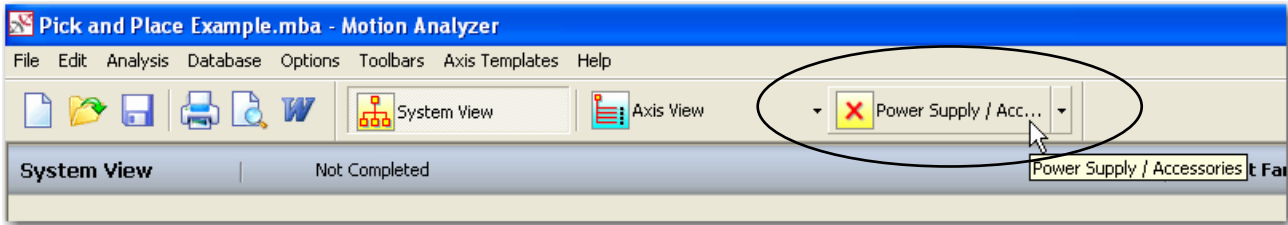


Fig. 2 The left-most drive is the Integrated Axis Module and the others are expansion Axis Modules

Additionally, most servo drives contain a shunt resistor that helps to prevent the internal power bus from an overload. This is typically a concern when stopping the axis; especially when stopping a vertical axis from falling because gravity is working against you. Kinetix 2000 and 6000 drives can share their shunt capacity across the backplane, so if one drive requires additional stopping power and another drive has extra capacity, they work together. This can save on shunt costs and space requirements.

Motion Analyzer contains tools to assist you in determining the needs of your system.

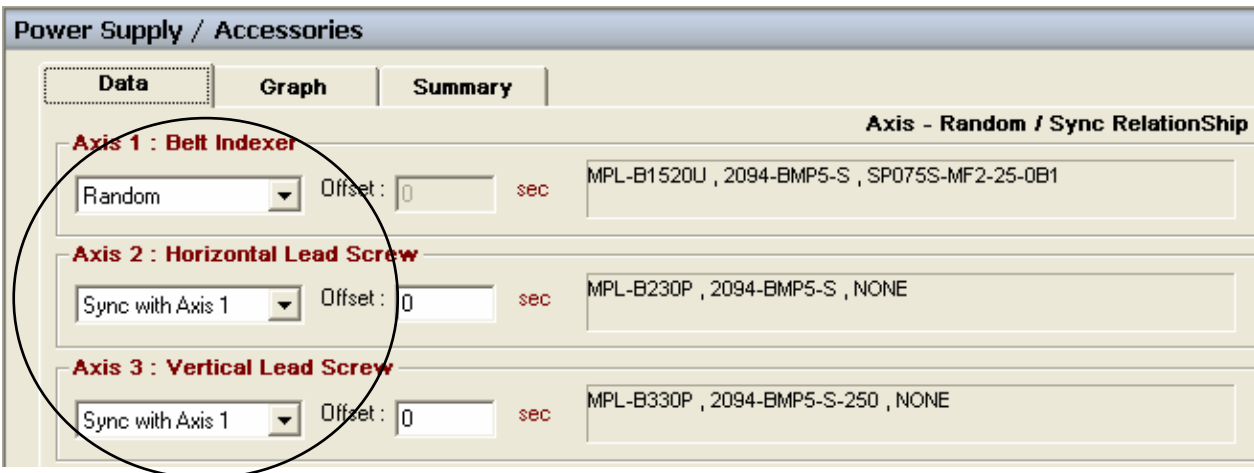
33. To select the proper integrated axis module and determine if your system requires additional shunting components, click on **Power Supply / Accessories** at the top of the screen.



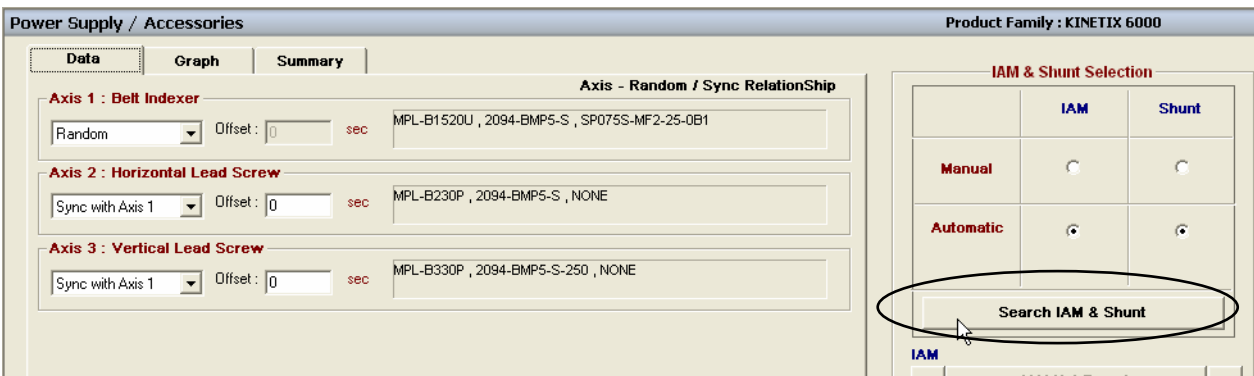
As mentioned in the lab, the phase relationship between the various axis profiles in a common DC bus system affects the peak bus current requirement. For example, if all axes accelerate simultaneously, the bus current demand will be much greater than if each accelerates in turn. Drop-down boxes allow the user to set the axes for random or synchronized operation if you know this relationship.

The “safe” setting for system sizing is all set to “Random.” In this case, the worst case current demand for each axis is automatically lined up by adjusting the phase relationship of the axis profiles.

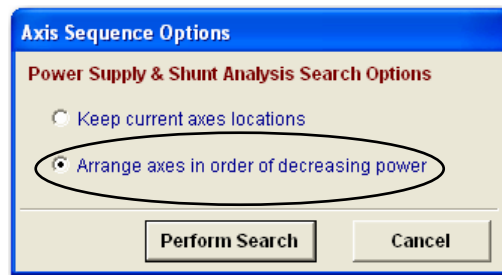
34. Since we took the time to enter our move profiles in real time, change the settings for **Axis 2** and **Axis 3** to **Sync with Axis 1** for our system.



35. Press the **Search IAM & Shunt** button to automatically size and select your required components.



36. Unless you know that Axis 1 is the largest or you are working with an existing system, select **Arrange axes in order of decreasing power** and press **Perform Search**.

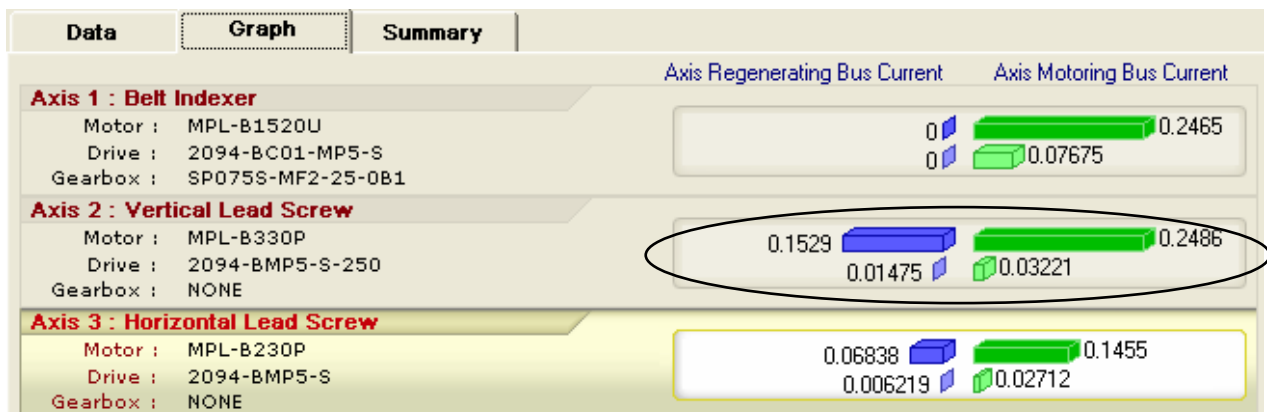


The software is not requiring any additional shunting components. The internal shunts are sufficient in this application.

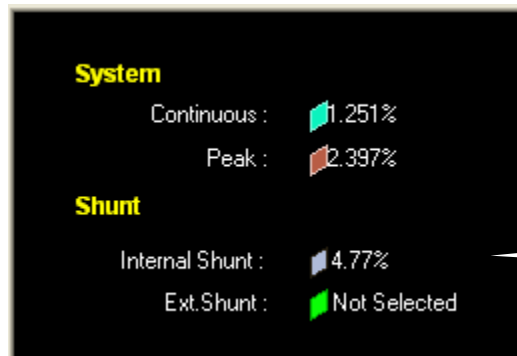
The software has changed the order of axes 2 and 3.

No additional shunting is required.

37. If you select the **Graph** tab, you can see that the Vertical axis does require the drive to absorb some *regenerative* bus current.

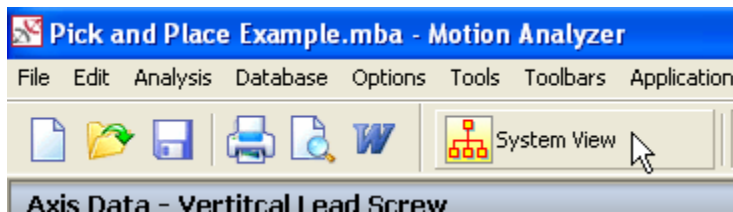


NOTE: If your system requires external shunting, be sure to keep the continuous usage percentage below 20%. These types of chopper/resistor sets are typically rated for a 20% duty cycle. If you are an inverter drive user, you already know this.



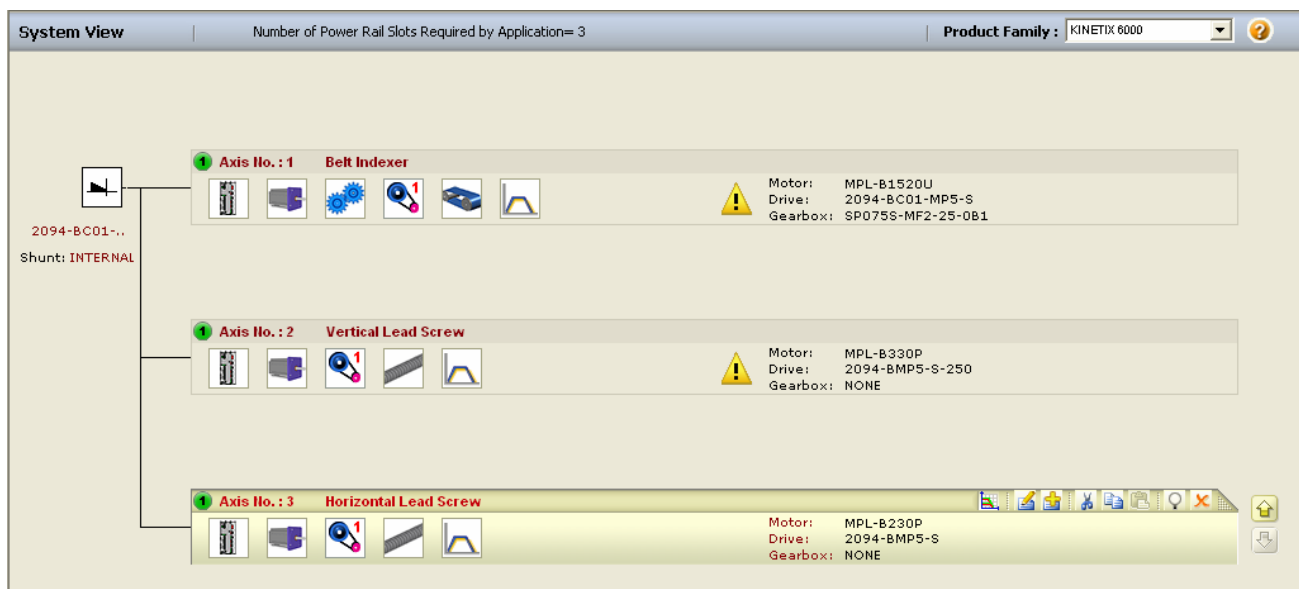
If used, keep these ratings below 20%.

38. Return to the **System View** as before.



39. **Save** your work.

Your system is now complete! You can see the new order of the axes, as well as any motor, drive and gearbox part numbers. What about cables and accessories? There must be an easy tool for finding these, right?



Continue on with the **Extra Task** if you would like to use **Motion Selector** to create a complete bill of material for your motion system.

Extra Task: Using Motion Selector (20 Minutes)

About This Lab

In the Extra Task, you can use the Motion Selector tool to create a complete bill of material for your motion system. Motion Selector does not include the controller items, such as your CompactLogix L43 controller, but it does include all motion-related components. This can include servo motors, drives and cables, as well as the motion module for your CompactLogix system and the SERCOS fiber cables to connect them all together. In this lab, you will:

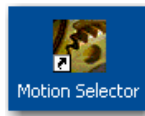
- Open Motion Selector and start with your Motion Analyzer file from labs 1-3 above
- Use Motion Selector's wizard tools to choose your axis components
- Choose the motion accessories that complete your bill of material

Follow the steps below to complete the Extra Task.

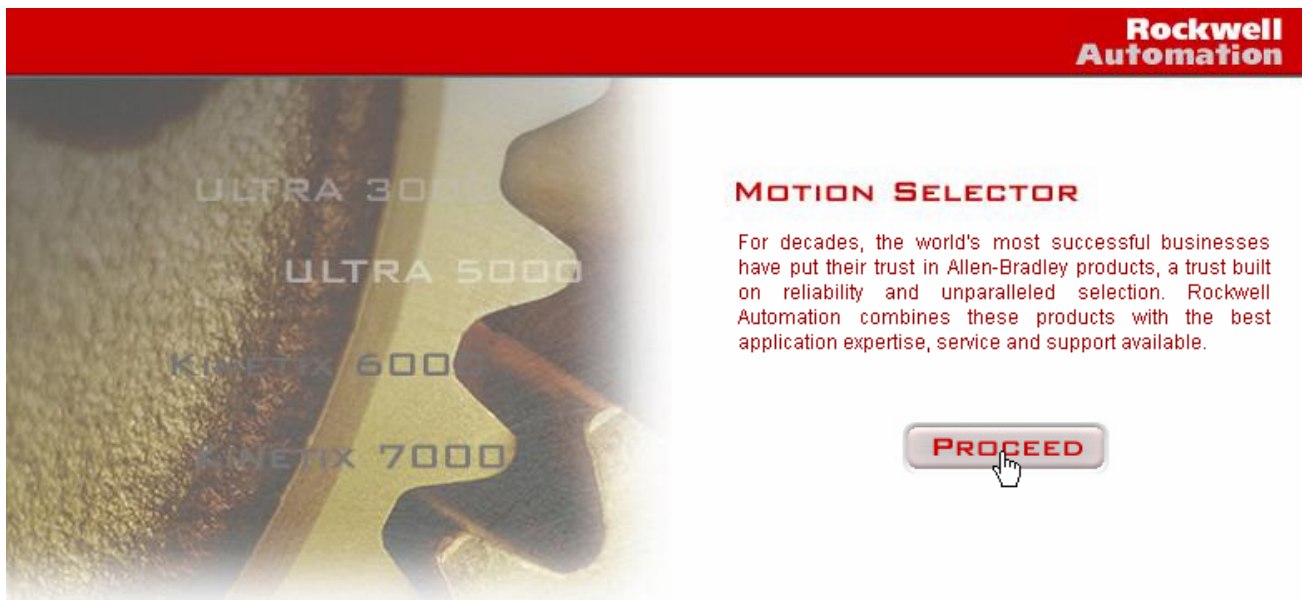
Open Motion Selector

Motion Selector is installed when you install Motion Analyzer, but runs separately. There should be desktop icons for each tool, or you can find them in the Start > Programs > Rockwell Automation tree.

1. Open **Motion Selector** by double-clicking on the desktop shortcut.



2. Click on the **Proceed** button from opening screen.



Your choices are defined as follows:

- **Create a Quick Quote** – After selecting the drive platform, you are given a list of all motors, cables and accessories for that platform. You simply enter a quantity for the items that you need and can then create a bill of material of them when you are done. *This selection requires that you know the part numbers of the items that you need.*
 - **Create a new Configuration** – This selection allows you to select a drive platform and walks you through the (10) steps necessary to select a drive, motor, cables and all required accessories for each axis in your system. Although you do have to know your drive and motor part number, you can start with the ones already selected in *Motion Analyzer* simply by pointing to the completed system file. Selecting the rest of the components using this method is much more wizard driven.
 - **Open existing Configuration** – This selection allows you to continue working with a Motion Selector project that you previously saved to a file.
3. We will start with our existing Motion Analyzer file by selecting the second option. Give it the name '**My Configuration**' and press **continue**.

The screenshot shows a configuration wizard with three main sections:

- Create a Quick Quote**: Configuration Name: [continue](#)
- Create a new Configuration**: Configuration Name: [continue](#)
- Open existing Configuration**: Select a configuration from the most recently used configuration list below or [browse](#) to open from other location.

Below the 'Open existing Configuration' section is a table with the following headers: Configurations, Last Updated, Location/Description, and Action. The table content is: No MRU Files Found.

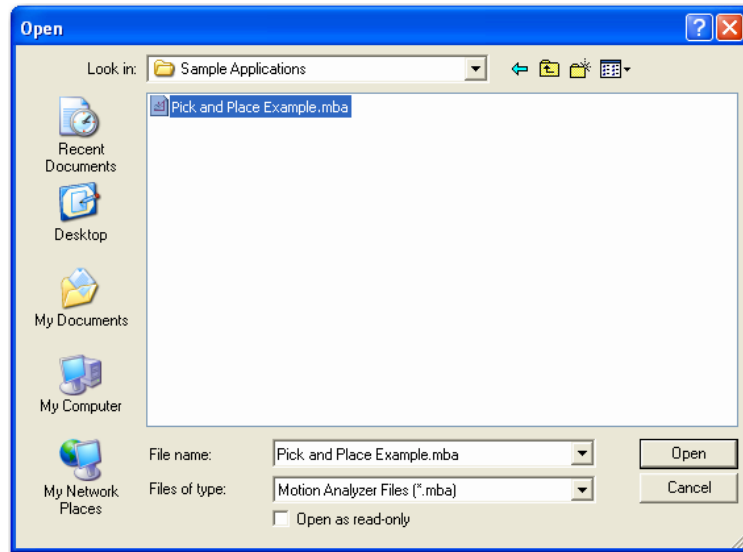
4. Select the **Start with an existing Motion Analyzer application** radio button and press **Browse** to locate your existing file.

The screenshot shows the configuration wizard with the following settings:

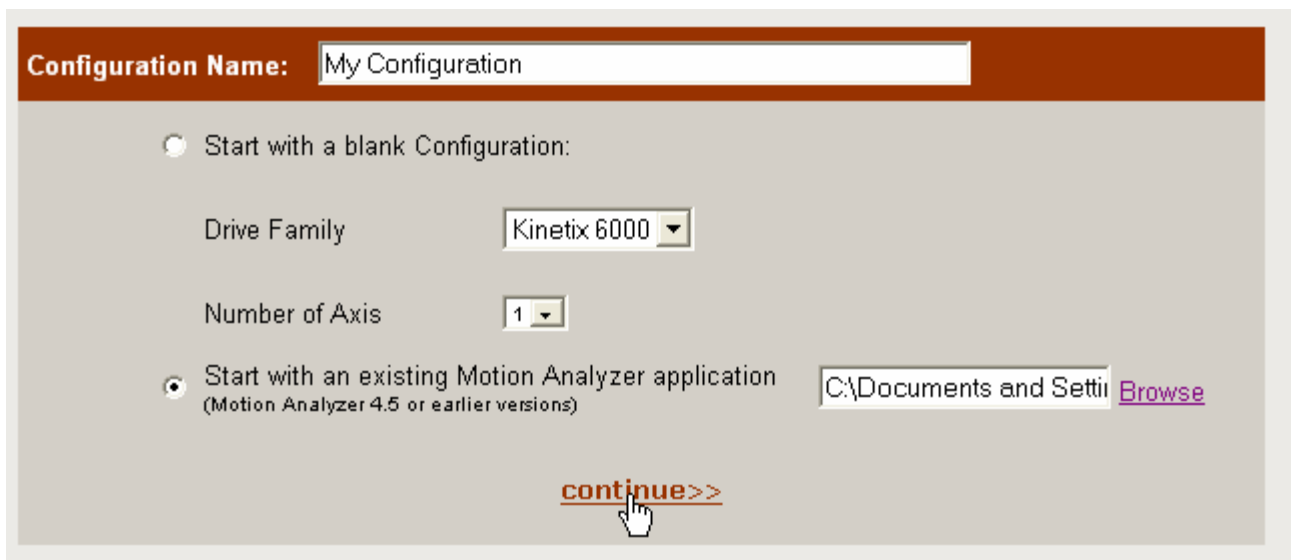
- Configuration Name:**
- Start with a blank Configuration:
- Drive Family:**
- Number of Axis:**
- Start with an existing Motion Analyzer application (Motion Analyzer 4.3 or earlier versions) [Browse](#)

At the bottom, there is a [continue>>](#) button.

5. **Browse** to the location of your Motion Analyzer file from above, select it and press **Open**.



6. On the Create New Configuration window, press continue.



Select Motion Items for the Belt Indexer Axis

The selection of the motor and drive has already been completed for you, based on your selections from the Motion Analyzer file.

Axis 1 is our belt indexing axis and we can see **Steps 1-4**, have been selected for us.

7. Scroll down under **Step 3: Motor/Actuator** to view the motor that we selected for the Belt Indexing axis.

Step 3: Motor/Actuator

Choose a Motor from the Motor List below. Use the Motor options filter to narrow your search.

Encoder Options: [.] Brake: [.] Shaft Key: [.] Factory Options: [Standard]

Total number of Motors with the selected Options: 58

	Part Number	Continuous Stall Torque (NM)	Peak Stall Torque (NM)	Rated Speed (RPM)
<input type="radio"/>	MPL-B1510V	0.26	0.77	8000
<input checked="" type="radio"/>	MPL-B1520U	0.49	1.58	7000
<input type="radio"/>	MPL-B1530U	0.9	2.8	7000
<input type="radio"/>	MPL-B210V	0.55	1.5	8000
<input type="radio"/>	MPL-B220T	1.61	4.74	6000

Selected Options: Single Turn High Resolution, Shaft Key, Standard [\(edit\)](#)

Selected Part Number: MPL-B1520U-EJ42AA [\(Product Details\)](#)

Selected Accessories: No Accessories Selected [\(Product Details\)](#)

Use these drop-downs to specify options and motor preferences.

Similarly, the drive has been selected.

Step 4: Axis Module

	Part Number	System Continuous Torque (Nm)	System Peak Torque (Nm)	Rated Speed (mm/sec)
<input type="radio"/>	2094-BC01-M01	0.49	1.58	7000
<input checked="" type="radio"/>	2094-BC01-MP5	0.49	1.53	7000
<input type="radio"/>	2094-BC02-M02	--	--	--

8. For **Step 5**, you'll need to **check the box** to include a **Motor Power Cable** and then use the drop-down menu to select a **Cable Length** of **3m (10ft)**.

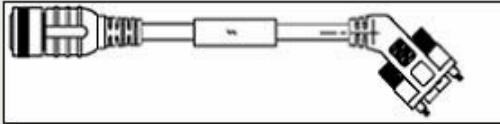
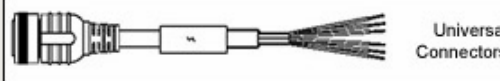
Step 5: Motor/Actuator Power Cable

Motor Power Cable Cable Length: [3m (10ft)]

Selected Power Cable: 2090-XXNPMF-16S03 [\(Product Details\)](#)

9. **Step 6** lets you choose either a pre-made cable or one with flying leads, but this also requires a connector. The note tells us that the connector is available in the Accessories section. **Check the box** for the **Universal** (flying lead) cable and select **3m (10ft)** as above.

Step 6: Motor/Actuator Feedback Cable

<input type="checkbox"/>		Feedback Cable with molded connectors	Cable Length : <input type="text" value="None"/>
<input checked="" type="checkbox"/>		Universal Feedback Cable Without Drive End Connectors (Connectors available in accessories)	Cable Length : <input type="text" value="3m(10 ft)"/>

Selected Feedback Cable: 2090-XXNFMF-S03 ([Product Details](#))

We don't need a brake cable for our belt indexing axis, so **skip Step 7**.

Resistive Brake Modules are used to dynamically stop a moving axis in the event of a drive losing power. Our safety auditor says that this system doesn't require this option, so we will **skip Steps 8 and 9**.

Skip Step 10, since Kinetix drives already include these particular connector sets as shipped. We will choose additional connectors (for our control I/O and feedback) in the Accessories section.

10. Press **continue** to move on to the next axis.

Select Motion Items for the Vertical Screw Axis

IMPORTANT: Axis 2 is our vertical lead screw axis, which requires a motor brake.

Steps 1-2 are fine for our needs.

11. For **Step 3**, use drop-down menu for the **Brake** setting to select **Yes**.

Step 3: Motor/Actuator [Reset Options](#)

Choose a Motor from the Motor List below. Use the Motor options filter to narrow your search.

Encoder Options Brake Yes Shaft Key Factory Options Standard

12. Once again, **scroll down** to view the motor that selected. The **Options** and **Part Number** shown below verify that our motor has the required factory holding brake option.

Total number of Motors with the selected Options: 35

	Part Number	Continuous Stall Torque (NM)	Peak Stall Torque (NM)	Rated Speed (RPM)
<input type="radio"/>	MPL-B320P	3.05	7.91	5000
<input checked="" type="radio"/>	MPL-B330P	4.18	11.1	5000
<input type="radio"/>	MPL-B420P	4.74	13.5	5000
<input type="radio"/>	MPL-B430P	6.55	19.8	5000
<input type="radio"/>	MPL-B4520P	5.65	13.5	5000

Selected Options: Multi Turn High Resolution, Brake, Shaft Key, Standard [\(edit\)](#)

Selected Part Number: MPL-B330P-MJ24AA [\(Product Details\)](#)

The "24" in the Part Number contains the brake option. See the *Kinetix Motion Control Selection Guide* (publication #GMC-SG001_-EN-P) for additional details and options.

Step 4 confirms our Kinetix 6000 axis module chosen for this axis (recall that the 2094-BM01-S was chosen over the 2094-BMP5-S drive at the very end of the lab).

Step 4: Axis Module

	Part Number	System Continuous Torque (Nm)	System Peak Torque (Nm)	Rated Speed (mm/sec)
<input checked="" type="radio"/>	2094-BM01	4.18	8	5000
<input type="radio"/>	2094-BM02	4.18	11.1	5000

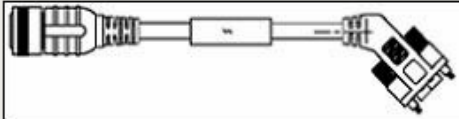
13. In **Steps 5** and **6**, select a **3m (10ft)** length for the **Motor Power Cable** and the **Universal Feedback Cable**.

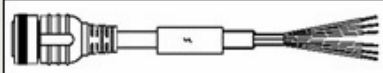
Step 5: Motor/Actuator Power Cable

Motor Power Cable Cable Length : 3m(10 ft)

Selected Power Cable: 2090-XXNPMP-16S03 ([Product Details](#))

Step 6: Motor/Actuator Feedback Cable

 Feedback Cable with molded connectors Cable Length : None

 Universal Feedback Cable Without Drive End Connectors (Connectors available in accessories) Cable Length : 3m(10 ft)

Selected Feedback Cable: 2090-XXNFMP-S03 ([Product Details](#))

14. For **Step 7**, select the **Brake Cable** option and choose a **3m (10ft)** cable.

Step 7: Motor/Actuator Brake Cable

Brake Cable Cable Length : 3m(10 ft)

Selected Brake Cable: 2090-UXNBMP-18S03 ([Product Details](#))

The brake cable for this MP-Series motor is a separate cable.

Skip Steps 8 and 9 as on the previous axis.

15. Press **continue** to start working on the final axis.

Select Motion Items for the Horizontal Screw Axis

Skip steps 1-4 since the motor and drive have already been selected through our Motion Analyzer file.

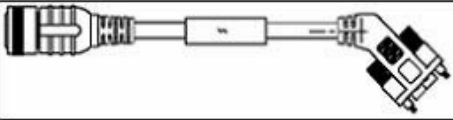
16. In **Steps 5** and **6**, select the same **3m (10ft)** cables as above.

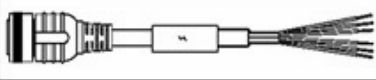
Step 5: Motor/Actuator Power Cable

Motor Power Cable Cable Length : 3m(10 ft) ▼

Selected Power Cable: 2090-XXNPMP-16S03 ([Product Details](#))

Step 6: Motor/Actuator Feedback Cable

 Feedback Cable with molded connectors Cable Length : None ▼

 Universal Feedback Cable Without Drive End Connectors (Connectors available in accessories) Cable Length : 3m(10 ft) ▼

Selected Feedback Cable: 2090-XXNFMP-S03 ([Product Details](#))

Skips Steps 7-9, as above.

17. Press **continue** to choose the system components and accessories.

Choose the System Components

A 3-axis Power Rail was chosen for our 3-axis system. If we chose to select a larger Power Rail (for future expansion), we would need to select enough Power Rail Slot Fillers to safely cover all of these open slots. Here, **no change** is required.

Power Rail

Power Rail (Slim) 1 axis Power Rail (Slim) 2 axis Power Rail (Slim) 3 axis
 Power Rail (Slim) 4 axis Power Rail (Slim) 5 axis Power Rail (Slim) 6 axis
 Power Rail (Slim) 7 axis Power Rail (Slim) 8 axis Power Rail 1 axis
 Power Rail 2 axis Power Rail 4 axis Power Rail 6 axis
 Power Rail 8 axis

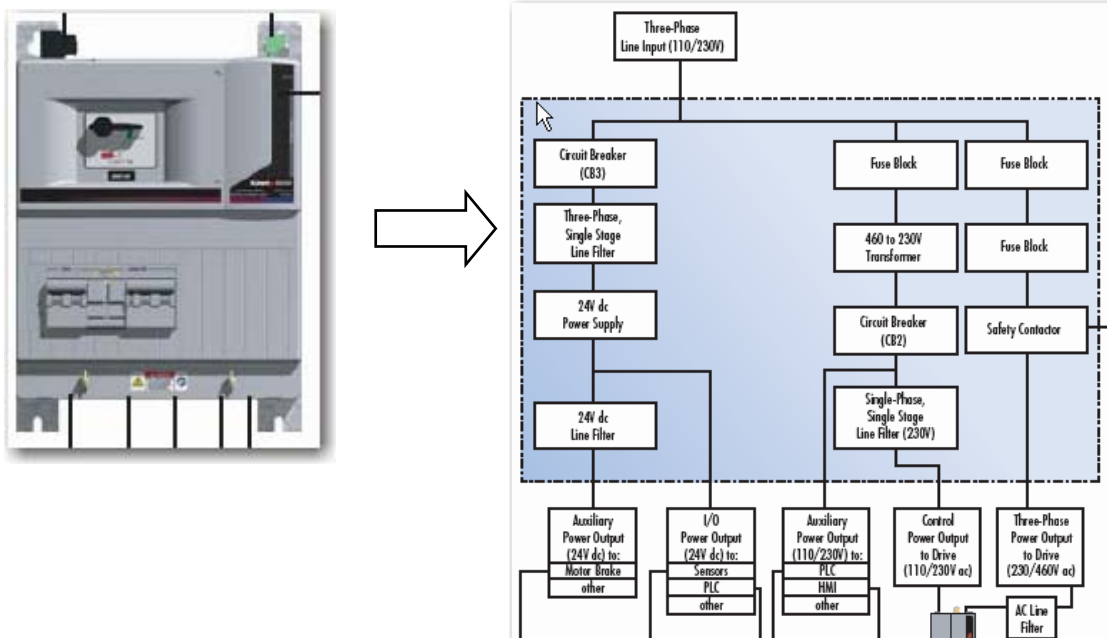
Mounting Brackets

Power Rail Slot Filler

No Yes

No shunt options are chosen, of course.

Notice, however, the option for the Line Interface Module. This product can include the line disconnect switch, the disconnect circuit breaker, power transformers, filters, 24Vdc power supplies and even the safety rated line contactor. *Who doesn't need all of these in their system?*



18. Choose the **Select Line Interface Module** option and select the **2094-BL10S** unit, since our system requires under 10A of current (based on our 2094-BC01-MP5 integrated axis module).

Line Interface Module

Select Line Interface Module

230V LIM	460V LIM
<input type="radio"/> 2094-AL09 : 230V, 20A LIM	<input type="radio"/> 2094-BL02 : 460V, 30A LIM
<input type="radio"/> 2094-AL15S : 230V, 15A LIM	<input checked="" type="radio"/> 2094-BL10S : 460V, 10A LIM
<input type="radio"/> 2094-AL75S : 230V, 75A LIM	<input type="radio"/> 2094-BL75S : 460V, 75A LIM
<input type="radio"/> 2094-AL25S : 230V, 25A LIM	<input type="radio"/> 2094-BL25S : 460V, 25A LIM
<input type="radio"/> 2094-AL50S : 230V, 50A LIM	<input type="radio"/> 2094-BL50S : 460V, 50A LIM
<input type="radio"/> 2094-XL75S-C1 : 230V or 460V, 75A LIM	<input type="radio"/> 2094-XL75S-C2 : 230V or 460V, 75A LIM

Selected Line Interface Module : 2094-BL10S ([Product Details](#))

The line interface module (LIM) option includes the circuit breaker and the contactor, and some LIMs even include an AC line filter for CE applications. This is going to save a lot of installation, mounting and wiring time.

19. Press **continue**.

Choose the Motion Accessories

In this final section of the lab, you will add any of the required motion accessories or desired options to your bill of material. We'll assume that we've used Integrated Architecture Builder to select our *control* system, so now we just need the motion components to make it complete.

20. On the **Software & Accessories** tab under **Motion Control Module**, select the **1768-M04SE SERCOS Module**. This is the 4-axis SERCOS motion module for the CompactLogix L43 controller.

Axis Module & Cable System **Software & Accessories** Summary

Motion Control Module

- None
- ControlLogix : 1756-M03SE SERCOS Module
- ControlLogix : 1756-M08SE SERCOS Module
- ControlLogix : 1756-M16SE SERCOS Module
- ControlLogix : 1756-L60M03SE SERCOS Module
- CompactLogix : 1768-M04SE SERCOS Module
- SoftLogix : 1784-PM16SE SERCOS PCI Card

Since SERCOS is a ring-style topology, we will need to select fiber-optic cables to go from the motion module *and back*, as well as the ones that “jumper” from drive to drive.

21. In the **SERCOS Cables** section, we will choose **Plastic cables only suited for use within an enclosure** for our needs.

SERCOS Cables

Cable Type

1. Plastic cables only suitable for use inside an enclosure.

22. Select the **Length** of **3m (10ft)** for the cables between the motion module and the drive. Be sure to enter a **Quantity** of '2' (since this is a ring topology) as well.

Cable Type	Length	Quantity
1. Plastic cables only suitable for use inside an enclosure.	3m (10 ft)	2


23. We will also need **(2) of the 0.1m (5in)** jumper cables between our (3) drives.

Cable Type	Length	Quantity
1. Plastic cables only suitable for use inside an enclosure.	3m (10 ft)	2
2. Plastic cables only suitable for use inside an enclosure.	0.1m (5 in)	2

24. Scroll down several sections to the **Low Profile Connector Kits** section.

This is where we will find the connector kits for the flying lead feedback cables, drive control I/O and even any auxiliary feedback devices, since each Kinetix drive supports an additional axis of auxiliary feedback right on board!

25. For our 3-axis system, choose **(3) motor feedback connectors** and **(3) control I/O connectors**, as shown below. The control I/O connector includes things like the drive enable signal, homing and over-travel limits and our brake relay for our vertical axis.

Low Profile Connector Kits		More Info 
Part Number	Description	Quantity
2090-K6CK-D15F	Low Profile Connector Kit Aux Fdbk15 pin Female	<input type="text"/>
2090-K6CK-D15M	Low Profile Connector Kit Motor Fdbk 15 pin Male	<input type="text" value="3"/>
2090-K6CK-D26M	Low Profile Connector Kit I/O 26 pin Male	<input type="text" value="3"/>

26. There are *many* other accessories that we could choose for our system, but let's take a look at the bill of material. Scroll to the bottom of this page and press **continue**.

View the Motion Bill of Material

27. The **Summary** tab shows the items we've selected for the general system and for each of the axes. You can view the axis details by **expanding** them, if you wish.

Axis Module & Cable	System	Software & Accessories	Summary
System, Software & Accessories			
Part No	Description		
2094-PRS3	3 axis power rail	General system items.	
2094-BL10S	Line Interface Module 460 V		
1768-M04SE	Control System, 1768-M04SE SERCOS Module		
2090-K6CK-D15M	Low Profile Connector Kit, Motor Feedback 15 pin Male		
2090-K6CK-D26M	Low Profile Connector Kit, I/O 26 pin Male		
2090-SCEP3-0	Cable, SERCOS fiber optic plastic cables only suitable for use inside an enclosure, 3m		
2090-SCEP0-1	Cable, SERCOS fiber optic plastic cables only suitable for use inside an enclosure, 0.1m		
Axis Modules & Cables			
Axis Modules & Cables			
+ IAM Axis	•2094-BC01-MP5-S•MPL-B1520U-VJ42AA•2090-XXNPMF-16S03•2090-XXNFMP-S03		
- Axis 2	•2094-BM01-S•MPL-B330P-MJ24AA•2090-XXNPMP-16S03•2090-XXNFMP-S03•2090-UXNBMP-18S03		
2094-BM01-S	Axis Module 460V, 12.9A	Axis 2 expanded.	
MPL-B330P-MJ24AA	Motor, 4.18 N-m (37.12 lb-in.), 5000 rpm motor		
2090-XXNPMP-16S03	CABLE, NON-FLEX, MOTOR POWER, MP, 16 GAUGE, 3M		
2090-XXNFMP-S03	CABLE, NON-FLEX, MOTOR FEEDBACK, MP, 3M	Axis 3.	
2090-UXNBMP-18S03	CABLE, NON-FLEX, MOTOR BRAKE, 3M		
+ Axis 3	•2090-XXNPMF-16S03•2090-XXNFMP-S03•2094-BMP5-S•MPL-B230P-EJ42AA		
Proceed to: ▶ Additional BOM ▶ BOM view			

28. Click on **BOM View** to continue.

+ Axis 3	•2090-XXNPMF-16S03•2090-XXNFMP-S03•2094-BMP5-S•MPL-B230P-EJ42AA		
Proceed to: ▶ Additional BOM ▶ BOM view			

Your **complete bill of material** should display (you may have to expand the sections).

Pick and Place Example					Total : .00	
Item	Part No	Quantity	Description	Price ()	Amount ()	
1	2094-PRS3	1	3 axis power rail	NA	NA	
2	2094-BL10S	1	Line Interface Module 460 V	NA	NA	
3	1768-M04SE	1	Control System, 1768-M04SE SERCOS Module	NA	NA	
4	2090-K6CK-D15M	3	Low Profile Connector Kit, Motor Feedback 15 pin Male	NA	NA	
5	2090-K6CK-D26M	3	Low Profile Connector Kit, I/O 26 pin Male	NA	NA	
6	2090-SCEP3-0	2	Cable, SERCOS fiber optic plastic cables only suitable for use inside an enclosure, 3m	NA	NA	
7	2090-SCEP0-1	2	Cable, SERCOS fiber optic plastic cables only suitable for use inside an enclosure, 0.1m	NA	NA	
8	2094-BC01-MP5-S	1	Integrated Axis Module 460V, 6kw	NA	NA	
9	MPL-B1520U-VJ42AA	1	Motor, 0.49 N-m (4.35 lb-in.), 7000 rpm motor	NA	NA	
10	2090-XXNPMF-16S03	2	CABLE, NON-FLEX, MOTOR POWER, MF, 16 GAUGE, 3M	NA	NA	
11	2090-XXNFMF-S03	2	CABLE, NON-FLEX, MOTOR FEEDBACK, MF, 3M	NA	NA	
12	2094-BM01-S	1	Axis Module 460V, 12.9A	NA	NA	
13	MPL-B330P-MJ24AA	1	Motor, 4.18 N-m (37.12 lb-in.), 5000 rpm motor	NA	NA	
14	2090-XXNPMP-16S03	1	CABLE, NON-FLEX, MOTOR POWER, MP, 16 GAUGE, 3M	NA	NA	
15	2090-XXNFMP-S03	1	CABLE, NON-FLEX, MOTOR FEEDBACK, MP, 3M	NA	NA	
16	2090-UXNBMP-18S03	1	CABLE, NON-FLEX, MOTOR BRAKE, 3M	NA	NA	
17	2094-BMP5-S	1	Axis Module 460V, 5.9A	NA	NA	
18	MPL-B230P-EJ42AA	1	Motor, 2.1 N-m (18.65 lb-in.), 5000 rpm motor	NA	NA	
Total					.00	

Motion Selector provides several convenient options for **exporting and formatting** your bill of material. You may wish to experiment with these.

MOTION SELECTOR
Pick and Place Example

BOM View

- + Pick and Place Example
- Configuration Total

- System Configuration
- Additional BOM
- BOM view
 - Export to Excel (Extract)
 - Export to PDF
 - Export to Word
- Save
- Save As
- Exit Configuration

29. **Save** your file if you wish and **Exit Configuration** when you are done.

Appendix A: Drive Peak Torque Enhancements

About This Appendix

Launched in the fall of 2008, Kinetix 6000 Safe-Off servo drives (Series B and higher) can be configured to deliver up to 250% of rated continuous torque at limited duty cycles. In applications where acceleration torque is a concern, this enhancement may provide the following benefits:

- Reduce Drive Size (up to 50% depending on application requirements)
- Reduce System Cost (up to 45% depending on application requirements)

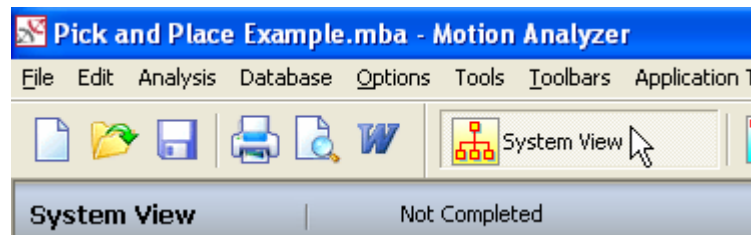
If the application has typically required a Kinetix 6000 drive that took (2) chassis slots, the peak enhancement might allow the application to use a smaller single slot drive, creating a space savings. Even if the application required a single slot drive in the past, the peak enhancement might allow the application to simply use a smaller drive. Here are the enhanced torque specifications for the single slot Kinetix 6000 drives:

Model	Cont. Arms	Peak Arms (Out-of-Box)	Overload (Out-of-Box)	Peak Arm (Configured)	Overload (Configured)
2094 -					
BMP5 - S (Series B)	2.8	4.2	150%	7	250%
BM01 - S (Series B)	6.1	9.2	150%	15.25	250%
BM02 - S (Series B)	10.3	15.5	150%	25.75	250%

Locating the Required Tools

If you have chosen a drive with a '-250' in the catalog string, the drive must be configured for using 250% peak torque or it will not perform correctly. Motion Analyzer users are guided to the tools and steps required to implement the peak enhancement feature as shown below.

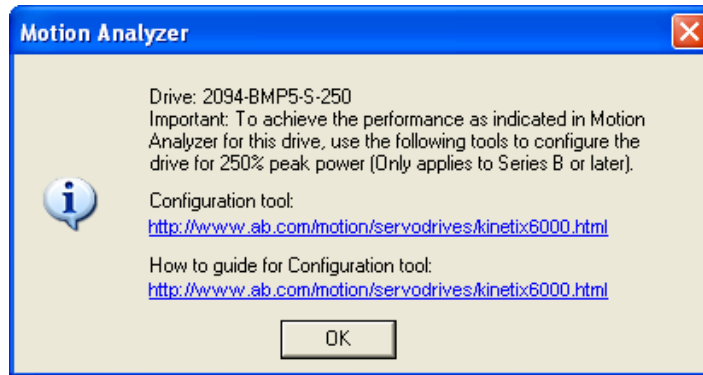
1. In *Motion Analyzer* software, click **System View**.



2. The yellow warning triangle indicates important information to the user. Click on the **triangle** for details.



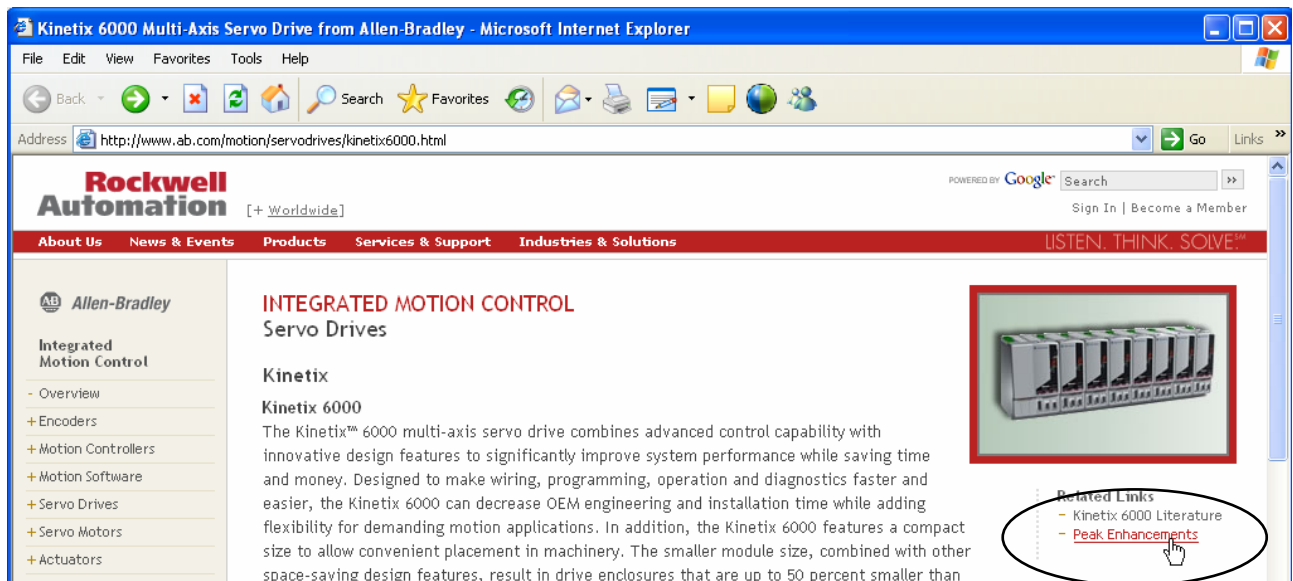
The following dialogue box appears.



The user is guided to the **Configuration tool** and a **step-by-step guide** for implementing the peak enhancement feature.

3. With an active web connection, click on the **Configuration tool link** in the dialogue box.

The following website appears:



4. Click on the **Peak Enhancement link**.

The tool and document are linked below:

Kinetix 6000 Safe-off Servo Drive for Peak Enhancement
Motion Software

Kinetix 6000 Safe-off Servo Drives with Peak Enhancement: 250% Peak Capability

Motion applications that require fast acceleration and deceleration for a limited time will benefit from the Peak Enhancement feature being added to certain 460V Kinetix 6000 Safe-off Servo Drives in December 2008. Peak Enhancement allows you to configure select Kinetix 6000-S drives to produce torque up to 250% of continuous rated current for limited duty cycles. This enhancement will provide higher peak current, potentially downsize the drive power supply and axis modules, and reduce panel space required. Additional benefits include reduced hardware cost, a smaller footprint, and easy integration into your motion applications that are already a part of the Rockwell Automation Integrated Architecture.*

* The catalog numbers that will support 250% peak include the Series B version of the following: 2094-BC01-MP5-S, 2094-BC01-M01-S, 2094-BC02-M02-S, 2094-BMP5-S, 2094-BM01-S, and 2094-BM02-S.

Configuring your Kinetix 6000 Safe-off Servo Drive for Peak Enhancement

The Peak Enhancement [Configuration Tool \[1.65MB EXE\]](#) conveniently allows you to configure your select 460V drives to achieve 250% of rated current. If you've never used the configuration tool, see the [How-To Guide \[DOC\]](#) for an example that steps you through configuration.

Downloads

- Configuration Tool [1.65MB EXE]
- How-To Guide [DOC]

Related Links

- Kinetix 6000 Servo Drives

IMPORTANT: The new Series B drive will not support any version of firmware prior to its release. Any attempt to flash the drive to an earlier version will result in a failed flash attempt, but will not affect the drive in any way. The only implication to any system that has other drives at an earlier version of firmware, is that the versions will not all be at the same level for a given power rail or application.

Lab Summary

Motion Analyzer software is an excellent tool for sizing and selecting servo motor and drive components, as well as a great way to optimize machine components. SolidWorks users can save time identifying solutions by importing their existing machine models into Motion Analyzer.

Machine designers will find additional value in Motion Analyzer's ability to identify optimum ratios for mechanical components, providing maximum system performance at the lowest possible cost.

You can download a copy of Motion Analyzer software at no charge by visiting www.ab.com/motion and clicking on **Motion Software > Motion Analyzer** from the side menus. Use the Current Updater feature to keep your software up to date.

If you require a tool that can create a complete Integrated Architecture bill of material, Motion Analyzer works with Integrated Architecture Builder software to produce system configurations that include controllers, networks and now motion components.

This concludes the Motion Analyzer lab.