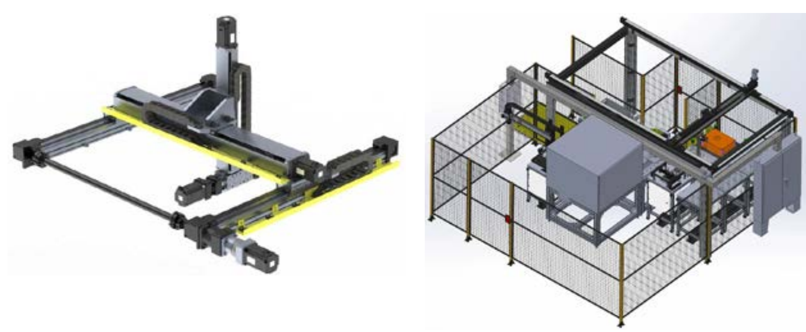
How to design and specify a multi-axis automation solution for your application

By Matthew Gulleen, Applications Engineering Manager
Tolomatic, Inc.

Introduction

Multi-axis systems describe a large cross-section of controlled movement technologies used in various processes, often in automated industrial and manufacturing applications to lift, position, and move loads. Typically, these systems are described by how they achieve multi-axial movement – such as linear or rotational – or articulated systems that feature more complex movements.

In this paper, we will focus attention on linear multi-axis systems, examine the various types and configurations, and review basic design considerations. These considerations will help guide the exploration of pre-engineered systems, modified systems, and custom-designed systems to meet your specific application requirements.



Linear multi-axis systems are used in a variety of processes, from desktop-sized pick-and-place solutions to room-sized manufacturing and assembly systems

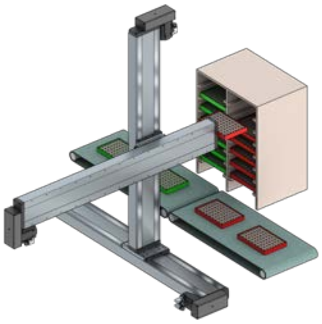
Linear multi-axis basics

Widely employed for their precision, repeatability, power, and versatility, linear systems can be configured as a one dimensional (single axis), two-dimensional (X-Y axis), or three-dimensional (X-Y-Z axes). While linear motion systems are controlled to efficiently travel in point-to-point straight-line motions, many applications require more complex and circuitous movements. Multi-axis systems synchronize linear motion in two or more axes to execute complex trajectories and highly dynamic movements.

Unlike complex robotic arms that move with rotational joints or articulated systems, linear systems facilitate coordinated point-to-point movements along the three orthogonal X, Y and Z axes. These movements create up to three sliding axes that correspond to moving vertically, horizontally, and laterally. Linear robots and multi-axis systems of this nature are also known as Cartesian systems, after the namesake Cartesian coordinate system that is used to plot positions in three-

About Tolomatic

Tolomatic has been designing and manufacturing innovative electric linear actuators, pneumatic actuators, and power transmission products for factory automation for over 65 years. These solutions are designed to simplify motion control for industrial applications. Available in in-line or reverse-parallel motor/drive configurations, Tolomatic products can be used as a direct replacement for pneumatic and hydraulic cylinders in a wide variety of packaging, material handling, machine tooling and general industrial automation applications. For more information on Tolomatic products: Please visit www.tolomatic.com or call Tolomatic toll free at 800-328-2174 or 763-478-8000.



Cartesian systems will often outperform rotational or articulated robotic arms in terms of positioning accuracy, speed and repeatability

dimensional space. Rotational components (Rx, Ry, and Rz) can also be added to each axis. This can achieve up to six-axis configurations that have a much wider capability range than traditional six-axis robots.

Cartesian Systems

The basic design of a Cartesian system is comprised of three linear actuators, each dedicated to move along a prescribed X-Y-Z axis (or X-Y in the case of a two-axis system), and coordinated simultaneously by a motion controller. Pre-assembled, pre-configured systems are available, or a multi-axis system can be designed and custom-built to meet application requirements, using many types of linear actuators and drive mechanisms. These multi-axis systems will often outperform rotational or articulated robotic arms in terms of positioning accuracy, speed, reach, and repeatability. Improved performance factors and lower costs make these systems a more practical choice for many applications.

To deliver movement efficiently, Cartesian systems are often built in an overhead configuration. While the base axis (X) of a system is usually fixed along its entire length, the two remaining axes (Y, Z) are cantilevered, and as such, limited in range and payload because of the torque generated to the base axis by the individual actuators moving along orthogonal axes. Typically, these types of very accurate and repeatable Cartesian systems are used for automated processes in a limited work area with a travel of one meter or less. This design is well-suited to lighter-weight applications, such as pick and place, light assembly, and dispensing applications, but there are enhanced designs possible for more robust and heavy-duty industrial applications.

Gantry Systems

To overcome the cantilever limitations of a multi-axis robot, a Gantry system greatly expands the range and in many cases, payloads. Generally speaking, a primary design characteristic of a gantry is the addition of a second, parallel base axis (XX), with the second axis (Y) spanning the base. Even greater stiffness and load capacity can be created with the further addition of a parallel Y axis (XX-YY).

Two Axis XX'-Y(D) Gantry

Two Axis XX'-YY'(D) Gantry

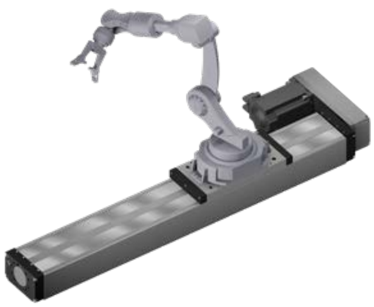
Three Axis XX'-Y(D)-Z Gantry

Three Axis XX'-YY'(D)-Z Gantry

By eliminating the unsupported cantilever configuration with a parallel axis supported at both ends of travel, a gantry system is the design of choice in many industrial and manufacturing process applications. This improved support allows for heavier payloads, longer strokes, and greater stability. With axes located above the work envelope, space-efficient gantry systems use nearly their entire work envelope and are ideal for applications with aggressive load and stroke length requirements. Gantry systems can support thousands of pounds and upwards of 60 inches of stroke. However, efficient two- and three-axis gantry systems are also common in smaller applications, with stroke lengths and cubic work envelopes smaller than 24 inches.

When exploring requirements for your gantry design, a pre-engineered solution is often a good place to start for many applications. Qualified providers of such systems may also offer downloadable CAD models that facilitate system design.

Pre-configured gantry systems have their place for smaller footprint applications. However, you will typically need a customized gantry solution for larger weights, longer distances, or higher force range applications. A customized solution creates infinite combinations to maximize flexibility, speed, efficiency, and throughput.



This "Cobot" articulated arm with Twin profile Rail Stage actuators creates a 7th degree of freedom for a higher level of movement flexibility

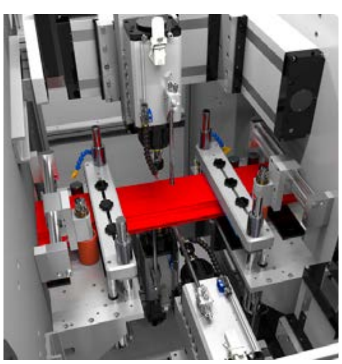
Industrial Robots and Cobots

An additional configuration for Cartesian systems and gantry systems combines the system with an articulated collaborative robot (cobot) arm, end-of-arm tooling (EoAT), or an effector mounted onto its outermost axis, to form a more sophisticated system (often referred to as a Cartesian Robot or a Gantry Robot). This creates a 7th degree of freedom to make rotational and/or custom movements, or reach in and around to create a higher level of movement flexibility for application-specific factory automation requirements. The flexibility of mounting any third-party motor on the linear actuators, similar to Tolomatic's Your Motor Here program, can also facilitate ease of integration with complete industrial robot solutions.

Multi-axis applications

Depending on their configuration and design, multi-axis systems can carry loads ranging from a few ounces to thousands of pounds, operate at a controllable slow or fast pace with high positioning accuracy, and provide functional reliability over long cycle periods. Because of this repeatability, versatility, and simplicity, the applications for linear multi-axis systems are widespread and growing. These include, but are not limited to:

- Welding automation
- Printing and 3D printing
- Assembly automation, including pick-and-place applications
- Fastening, cutting, sorting, and scribing
- Material handling, transfer, loading, and unloading
- Storage and retrieval
- Indexing, sorting, and physical positioning
- Palletizing, unitizing, and packaging automation
- Dispensing and filling
- Machine Tool and CNC
- Dynamic laser and sensor positioning
- Medical and test instrumentation
- Material application and spraying
- Entertainment and video production



A wide range of multi-axis applications are facilitated by linear actuators, such as material handling solutions for manufacturing to high-precision machine tool and CNC applications

Applications with larger footprints, heavier payloads, longer strokes and more robust duty cycle requirements will require the supporting infrastructure of a gantry system

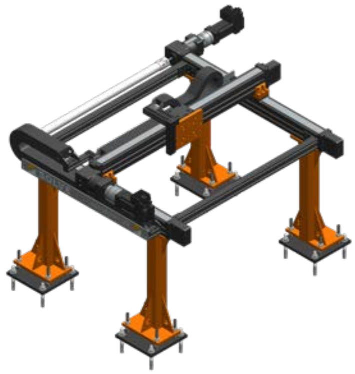
Not surprisingly, this wide range of applications creates very different requirements, including factors such as load, force, speed, travel, stroke length, accuracy, and duty cycle – design considerations which we will examine in greater detail later in this document.

Smaller, lighter-duty applications can be successfully engineered using reliable linear actuator combinations, while applications with larger footprints, heavier payloads, longer strokes, and more robust duty cycle requirements will require the supporting infrastructure of a gantry system. A capable provider will:

- Present pre-configured, modified standard, or purpose-built solutions depending on the demands of your application
- Have collaborative engineering to properly design the system to the application needs
- Support integration efforts during installation.

Pre-engineered, custom, or somewhere between?

Pre-engineered solutions



Pre-engineered solutions can provide significant advantages to companies seeking a proven multi-axis system. You may wish to first evaluate pre-configured systems to save development time and costs (or if you are in need of a fast-track solution). Many standard platforms are available in two- and three-axis solutions with commonly-specified stroke and work envelopes, load capacities, and speeds designed to accommodate a wide range of applications. Tolomatic offers stroke-specific, pre-engineered system and gantry designs with robust B3W belt-driven actuators that provide significant load capabilities. Using any Tolomatic actuator or gantry system, you can specify the motor of your choice (with the Your Motor Here program) as well as the mounting brackets, grippers, and accessories you need to complete your system.

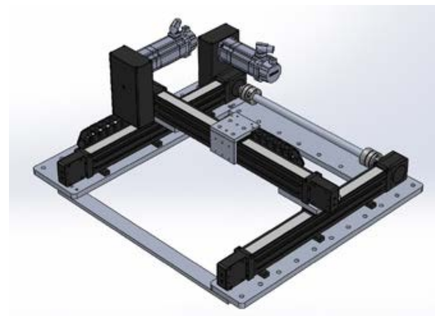
Turnkey actuator solutions

Tolomatic's TRS Twin profile Rail Stage actuators provide a stroke-configurable, turnkey solution

Among actuator choices, Tolomatic's TRS Twin profile Rail Stage actuators provide a stroke-configurable, turnkey solution as an ideal, rugged base for a Cartesian system. TRS actuators can be mounted orthogonal and carrier-to-carrier with no additional plates and feature "Your Motor Here®" (Tolomatic's flexible mounting tool for popular motors). The machined, enclosed, and rigid design handles high moment loading while providing reliable positioning along the length of travel with minimized deflection. Designed from the ground up with a choice of ball or roller screw models, the TRS will perform in a wide array of applications. TRS actuators are available in two standard sizes and are capable of handling loads up to 1,356 lb (615 kg).

Modifying a pre-engineered system

If your requirements fall just outside of pre-engineered designs, Tolomatic offers the ability to quickly and affordably *modify a solution* to your needs, including stroke, speed, force, or weight requirements for various axes. Start with our proven, pre-engineered design platform, and we can evolve the design to your unique specifications and requirements.



We often partner with distributors and integrators including Solve Industrial Design NYC to help provide a custom, purpose-built multi-axis solution for your most challenging application

Custom solutions partners

Some challenges push the envelope and can't be solved by existing standards. That's when you should consider a custom-designed system. Linear motion systems experts such as Tolomatic can offer decades of experience and innovative products to help get you to a solution quickly. However, not all providers care enough to collaborate on your multi-axis challenges or are willing to make modifications to their products. Unlike many that offer only catalog solutions, Tolomatic embraces technical challenges and partners with local distributors and integrators, such as Solve Industrial Design NYC – multi-axis solutions specialists. Along with your Tolomatic distributor, we collectively bring a wealth of design knowledge, experience, and engineering creativity to your multi-axis challenge.

Multi-axis design considerations

Specifying, building, and integrating the right multi-axis system can seem daunting. Putting a system together takes planning and engineering. There are many variables and design considerations, but if you gather the information you need and choose the right partner to assist you, it's easier than you think.

Advice: Find a strong partner, even if you build it yourself

Because the foundation of linear multi-axis systems are linear actuators, there are likely thousands of options. However, not every actuator provider is equipped, or willing, to provide the answers and assistance you need. A good partner offers many ways to explore and achieve your automation goals, including:

- A wide selection of proven, pre-engineered multi-axis solutions in the most requested sizes and specifications, with platform flexibility to tailor advanced configurations from standard products
- Willingness and ability to modify pre-engineered systems with no minimum

order quantities, creating a unique solution for your requirements without the costs and timeframe of custom development

- Industry leadership in motion control, a reputation for problem-solving, and the experience to know how to help
- Powerful resources, tools, and sizing software to help engineer your system, and the assistance to walk you through the process.
- Collaboration on design, including no-cost virtual design consultation with an engineer
- A demonstrated wealth of design and problem-solving knowledge from designing numerous solutions and supporting other applications
- Capable internal resources and powerful partnerships in multi-axis system design and integration, with a network of local representation

#1 Concept **#2 Refine** **#3 Finalize**

Easy three-step process to a custom solution – work with experts at Tolomatic and Solve

A three-step process to building and integrating a multi-axis system

No matter how complex, every process needs a place to start.

1. **Concept:** What does your multi-axis system need to do? Start with a simple drawing on a napkin, a PowerPoint sketch, a rough CAD layout, or download Tolomatic's pre-configured gantry system CAD model. Next, start building your design parameters: How fast does it need to be, what weight does it carry, and how often does it move? What is your budget? Does it fit within the specifications of a Pre-Engineered Solution or can it be built with modifications? Once you understand some basic parameters and performance goals, it's a great time to request a virtual design consultation with one of our engineers.
2. **Design:** From what we learned in the concept phrase, we'll design a more sophisticated layout that includes the required components to meet the specified parameters. We look at size and configuration (Cartesian system or gantry system), movement (speeds, cycle time, accuracy, repeatability, dwells); space (working envelope, stroke length, environmental concerns); and load (weights, load dimensions, forces, center of gravity).

   With this information, we recommend the type of system and assemble the components in 3D drawings. In addition to actuators, the detailed design can include cable track and tray, transition plates, base plates, jack-shaft and couplers, framing, and end-of-arm tooling.

3. **Finalize.** The design is presented to the customer engineers and then we coordinate discussions of any required changes. Based on these discussions and marked-up drawings, the final design is modified based on your input.

In-depth design stage considerations and process

Having a process to follow when defining axes of motion, along with engineering tools like sizing calculations or sizing software programs can be beneficial. The following steps are recommended to ensure potential risks and consequences are being considered in sizing an actuator:

1. Gather motion/load and environmental requirements for the application, such as:
   - Stroke (distance), load (mass), force, speed (time), duty cycle (dwell times, cycles/minute)
   - Load and force variables with estimated center of gravities (tooling load mounted to carrier, tooling forces, or payload/reaction forces)
   - Ambient temperatures, contamination (i.e., dust, debris, chemicals, weld slag/spatter, etc.)
   - Desired Ingress protection (i.e., protection levels against splashing, spraying, raining)
2. Validate the "best and worst case" application scenarios when sizing, for example:
   - Travel scenarios for different motions (end of range, loading/unloading, clear tooling, engage part, press into place)
   - Separate process time in the context of the total cycle time requirement.
   - Unique loads or forces referred to as "peak" (maximum loading condition) and "continuous" (the average of all the moves)
3. Calculate loading conditions or use a capable sizing software application:
   - Load variables (multiple points of mechanical advantage, external dynamics, etc.)
   - A powerful sizing software solution, such as Tolomatic's *SizeIt* can manage all of the calculations including back-checking for speed torque curves with multiple speeds and loads/forces.
4. Compare the results based on performance, size, and cost
5. Select the appropriate features and options
6. Verify solutions with an applications engineer

Engineering tools like sizing calculations or sizing software applications can help properly size linear actuators for your application

Evaluating components for your multi-axis system

By their nature, multi-axis systems and gantries are multi-component systems. A variety of component choices can be combined to, in many cases, create a system that provides excellent performance to fit your specific application. As described earlier, many providers have created pre-engineered multi-axis systems and gantries to accommodate common applications or provide a place to start modifications.

Even the most experienced integrators and engineers will collaborate with engineering teams at multi-technology actuator manufacturers to select and tune their multi-axis designs

When unique requirements demand something beyond pre-configured systems, the engineers at Tolomatic can often modify components to provide high-performance solutions. Alternatively, Tolomatic and our integration partners collaborate with you when the requirements suggest a fully custom solution. Whether you are investigating pre-engineered solutions, seeking modifications, looking for custom development, or engineering your own multi-axis solution, Tolomatic is a flexible partner to work with and a great place to start.

The heart of the system: Linear actuators

Linear actuators drive the motion of the gantry along each axis. The X and Y axis actuators are usually *rodless actuators* (belt-driven or screw-driven), which move and carry loads throughout the footprint of the system. *Rod-style actuators* are often used for the Z axis, or the vertical motion. It's essential to work with a provider that not only fully understands the movement and performance dynamics of the actuators being specified, but can provide a choice of technologies for evaluation. The advice of an integrator is useful, but the engineering teams at multi-technology actuator manufacturers are most astute at understanding the performance characteristics and tolerances of the different actuator types and drive methodologies.

General criteria for Linear Actuator Drive Types

When it comes to evaluating linear actuators for a reliable, high-performance multi-axis system, some additional considerations should include:

- Rigidity: Critical to minimize deflection and guarantee high positioning accuracy.
- Repeatability: achieved through low backlash mechanics, proper homing sequence, adequate motor sizing and feedback loop.
- Duty Cycle: actuators should be sized to 100% duty cycle. Robust designs include actuator designs that have been tested to 100% duty cycle performance. The actuators should be sized appropriately to each individual application to ensure best fit for both duty cycle and life expectancy.

and...

- Load: the right actuator is essential, whether it's the high precision and repeatability required for lightweight 3D printing heads, or gantry system rodless actuators that predictably and reliably move up to 4,000 lbs
- Environmental: Application considerations may dictate actuator manufacturing specifications to include negative or positive pressure inside actuator body. An option for purge ports may be added to meet certain environmental requirements.
- Straightness and flatness are tolerances that must be applied in two planes: the ZX plane (flatness) where the straightness tolerance is quantifying the 'up and down' deviation of the carrier; and YX plane (straightness) where the straightness tolerance is quantifying the 'side to side' deviation of the carrier. Applications requirements dictate how important straightness and flatness are to actuator selection.

A number of criteria should be evaluated when considering the type of drive used in your application

PARAMETER	POWER SCREW DRIVE	TIMING BELT DRIVE
Length of stroke	**Short to medium** (up to 120 in) Limited by physical length of screw stock, actuator body and bearing system	**Long** (up to 204 in in standard configuration, longer lengths possible) Limited only by ability to tension the timing belt
Linear velocity	**Low to medium** (up to 50–60 in/sec) Limited by critical speed of the screw and DN of nut	**High** (Up to 200 in/sec)
Axial force (thrust)	**High** (up to 2,700 lbf)	**Medium** (up to 325 lbf)
Lead accuracy	**Good** (.003–.004 in/ft for standard rolled ball nuts; .005–.006 in/ft for composite nuts)	**Medium** (.010–.015 in/ft*)
Unidirectional repeatability	**Good** (±.0005 in)	**Good to medium** (±.002 in)
Backdriving	**Will occur with some of the nut leads**	**Will always occur**
Resistance to shock loads	**Good**	**Medium**
Operation at high duty cycle	**Medium to good**	**Excellent**
Expected service life	**More predictable, based on Dynamic Load Rating calculation**	**Based on testing**
Maintenance	**Low to medium**	**Low**
Drive efficiency	**Medium to high depending on the nut type** (60% for composite nuts, 90% for ball nuts)	**High** (90%)

** With properly tensioned belt*

- Support Structure: Machined, welded, and extruded framing are all suitable options depending on the application requirements. Work with your partner to determine the best solution for your application.

Actuator Drive Trains

Identifying the proper drive train relies on application requirements, such as how reliable the positioning must be along the length of the travel, speed, stroke length, etc. Many applications make the choice of a linear drive easy. For example, belt-driven actuators are ideal for long-stroke applications requiring high linear velocity and low to moderate thrust. The length of stroke of a belt-driven actuator is limited only by the ability to efficiently tension long strands of timing belt and the extrusion length of the actuator body. Spliced extrusion actuators may be used for extremely long stroke lengths. If the application stroke length and speed are moderate, but the axial thrust is high, and (or) if a high positional accuracy is required, then screw-driven actuators are an ideal fit. When the choice isn't as obvious, consider all available application parameters to make a good selection. Here are some basic considerations for different drive choices:

Screw-Driven Actuators

Screw-driven actuators are known for high axial thrust capacity as well as accuracy and repeatability in applications of moderate stroke length and speed. Relatively low system inertia and predictable service life (ball and roller screw drives) are additional benefits. These parameters make screw–driven actuators ideal for a variety of applications such as machine tools, assembly and packaging equipment, robots etc.

Three primary types of screws are used in linear actuators: lead (or Acme), ball screws and roller screws. The differences are in the design of the thread shape along with the design and operation of a matching nut.

The limitations of screw–driven actuators include shorter stroke length than belt drives and running speeds limited by critical speed values (rotational speeds approaching the system's natural vibration frequency, leading to resonance).

Belt-Driven Actuators

Belt-driven actuators are efficient (90 percent to 93 percent) and easy to operate and maintain. They have a long service life because there are few moving parts and low component wear. They can be operated at 100 percent of duty cycle, at much higher speed limitations than their screw-driven counterparts, and are available in much longer lengths than screw drives. Belt drives are available in various materials, sizes, widths and tooth geometries that mesh with corresponding grooves on the pulleys to prevent any relative motion between the belt and pulleys. This ensures synchronous linear motion with a permanent speed ratio.

These benefits make belt drives ideal for long stroke applications requiring high linear velocity. The length of stroke of a belt-driven actuator is limited only by the extrusion length of the actuator body and the ability to efficiently tension long strands of the timing belt.

On the downside, belt drives have reduced load-carrying (thrust) capacity compared to screw drives. They also have lower accuracy and repeatability and there are no good theoretical methods for estimating service life Belt-driven actuators are more sensitive to impact loads, and some timing belt materials are prone to gradual elongation during operation, which requires periodic tensioning. Improperly tensioned long belt drives could slip (jump teeth) at high accelerations. Belt drives often require speed reduction to overcome high inertia associated with loads and pulleys. Vertically positioned belt drives require emergency brakes to prevent backdriving under the weight of load at power loss and should be sized appropriately to alleviate elongation during operation.

Motors and Servos

Early on in the design phase of automation projects, it is not uncommon to have the initial motion and loading factors only partially defined. The definition of these factors often comes into more focus as components are selected. It's important to recognize that some providers will require you to use their motors as part of the multi-axis system, while others allow motor mounting flexibility. This additional level of specification freedom can not only expand the choices of motors and functional possibilities for your system, but also reduce system costs, custom mounts, simplify parts inventories and consolidate technologies.

Interfaces and accessory components

Transition plates create the link between actuators in a common plane of motion or in the transition from one plane to another. In a multi-axis system, multiple actuators are connected to each other and there are many ways to do that, depending on the needs and complexity of the system. Some actuators, such as the Tolomatic TRS Twin-profile Rail System are engineered for the carriers to attach seamlessly without a transition plate.

Auxiliary rails provide extra support to ensure the system can manage the load and guide the load. These rails are the hallmark of gantry systems, but can also be applied in smaller cantilevered systems to provide additional rigidity and handling capacity.

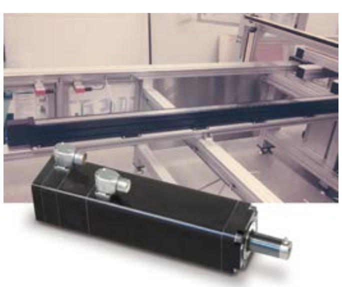
Energy chains, cables and cable management, all of which are configured to match the electric or pneumatic power source and the motion profile. It's important to use energy chains and cabling of a grade and construction rated for the duty cycle and environment, as well as properly design routing to reduce friction and eliminate premature failures. Components in energy chains include cables, plugs, connectors, hoses, interior separation elements, strain relief devices and guide channels.

Jack shafts allow you to drive the multiple actuators with a single motor and drive while keeping the actuators synchronized with each other. When the load is large or needs to move across a wide distance, a single actuator and rail won't be sufficient. A single motor will drive a master actuator, which is connected to a similar actuator through a jack shaft. The jack shaft helps prevent wobble, binding, and vibration.

Assembly and kitting capabilities offered by some providers delivers pre-assembled components or kitting for easier on-site builds and integration

Multi-Axis in action

Tolomatic actuators are the choice in myriad multi-axis applications across dozens of industries, in multiple products and powering hundreds of processes. With our deep body of experience and vast portfolio of linear actuators and supporting technologies, chances are we have designed, engineered and assisted the development of an application like yours. Here are just a few examples:



An electric-driven gantry with linear servo actuators and absolute encoders replaced a pneumatic gantry to produce greater accuracy in this ultrasonic welding application

Medical Industry Ultrasonic Welding

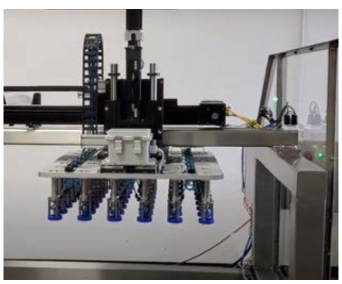
A medical company was looking for an alternative to their existing pneumatic gantry system, which required manual adjustment in setup. Lack of positioning control resulted in welding and dimensional inaccuracies, delays that slowed production time and high scrap rates. Customer demands prompted an immediate change to an efficient electric motion control solution that would provide consistent performance carrying the heavy ultrasonic tooling heads, in and out over long distances, on the feed tables.

A standard stroke configurable B3W linear belt-drive actuator was selected for the X- and Y-axis for its long stroke lengths and high load carrying capabilities for both the in-feed and out-feed table. Since accuracy and repeatability were customer concerns, servo motors with absolute encoders were selected for all 5 axes. An IMA33 linear servo actuator was selected for the z-axis for its integrated servo motor design providing force feedback functionality from the motor/drive system to ensure speed and positioning consistency throughout the welding process.

The electric-driven gantry provides quick, accurate, repeatable ultrasonic welds and eliminates inaccuracies from manual adjustment as well as higher costs related to compressed air. The gantry also reduced product scrap and increased machine cycle time and product throughout.

Food Industry Pick-and-Place Gantry

A food plant manufacturing cinnamon rolls ran into issues with an existing two axis pick and place machine. A need for a fast, direct replacement lent itself to a modified gantry solution. The gantry was used to pick up cinnamon rolls from one conveyor belt and move them to a parallel conveyor belt. The customer required the new gantry system to fit into the existing machine to get back up and running.



Accurately moving trays weighing 250 lbs from one conveyor to another in just 2 seconds is facilitated by this belt-driven multi-axis solution that was retrofit into an existing machine

A B3W linear belt-drive actuator runs across the span of the two conveyors and a GSA linear slide actuator moves the load up and down. End-of- tooling grabs the cinnamon roll trays, weighing 250 lbs, and moves them from one conveyor to the other in less than two seconds. This high duty cycle system was built in less than four weeks.

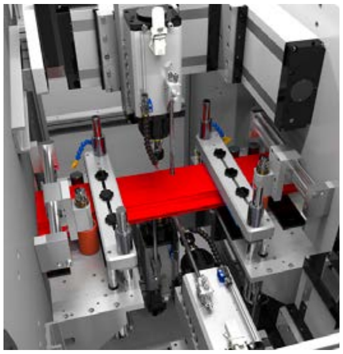
Plating Dip Tanks, Ultrasonic Cleaning

A manufacturer was experiencing difficulties with traditional rack and pinion systems in a plating application. The rack-and-pinion system had been the design standard for many years to move parts into and out of dip tanks. However, the installation of the rack-and-pinion system required extra time, labor and carefully machined parts for final assembly in this plating system. The hurdle for the customer was the top rails, which had to be perfectly flat and smooth for mounting the rack and pinion system.

A multi-axis gantry is often the ideal solution for manufacturing processes that requires a combination of material handling and precision through a multi-step process, such as this dip tank application for plating

An electric gantry system helped alleviate these issues by providing precise movement, but avoiding the installation headaches of alignment of a rack and pinion. Stroke-configurable B3W belt-drive actuators provide the 22-foot X movement along the top, left to right. Another B3W belt-drive actuator provides the 8-foot up-and-down Y axis in and out of each dip tank. The electric motion program controls acceleration, deceleration and velocity through the every move.

This solution eliminated the labor and machining time required for assembling and aligning the rack and pinion system. It also allowed the customer to greatly increase throughput, with greater control over the entire process.



Deflection during machining and the challenges of metal shavings affecting motion control were solved by Tolomatic's rigid, self contained Twin profile Rail Stage (TRS) rodless actuators

Machining with High-Speed Drills and Routers

A manufacturer of window and door framing extrusion was looking for an accurate, rigid 3 axis system to precisely machine their product. Traditionally, the manufacturer had issues with control and stability in the automation process. Off the shelf actuators had too much deflection to accurately machine the components and were not able to achieve an adequate life-cycle with the metal shavings in the environment. Tolomatic developed a custom actuator solution with the Twin profile Rail Stage (TRS) rodless actuator. The high rigidity of the aluminum single-body actuator prevented deflection to ensure perfect, repeatable machining operations. Additionally, the actuator's flat carriage design and sealed components prevented metal shavings from getting inside the actuator.

The new TRS solution in an XYZ Cartesian configuration gave much faster throughput and eliminated the numerous issues with off the shelf solutions. This increased throughput and machining accuracy allowed the company to optimize their process and gain access to new markets.

Conclusions

The versatility and contrasting array of product and process applications that rely on multi-axis systems and gantries is as vast as it is impressive. As more industries march toward greater automation, the impact of these, and more advanced systems in the future, is virtually unlimited. Every solution begins life as a challenge, and an idea. Tolomatic has a broad portfolio of proven, industry-leading linear actuator solutions and the experience and ability to help develop and apply them to your application.

While the design and engineering of a multi-axis system can be simple or sophisticated, the path to a solution follows the same process that engineers have used for generations, with the recent advantages of advanced products, technologies and integration experience. Whether you're an engineer who is looking to bring multi-axis efficiency and value to your process or product, or a non-engineer with simply an idea, Tolomatic and our partners can help you bring your multi-axis vision to life.

SOLVE

Solve Industrial Design NYC is Tolomatic's proven partner for development of advanced multi-axis systems. Solve consists of a team of engineers, designers and creatives based in New York City. "We're problem solvers and solution specialists committed to creating change through design. We treat each project with purpose and stand behind everything that leaves our doors. Our mission is simple – empower innovation without limitation."