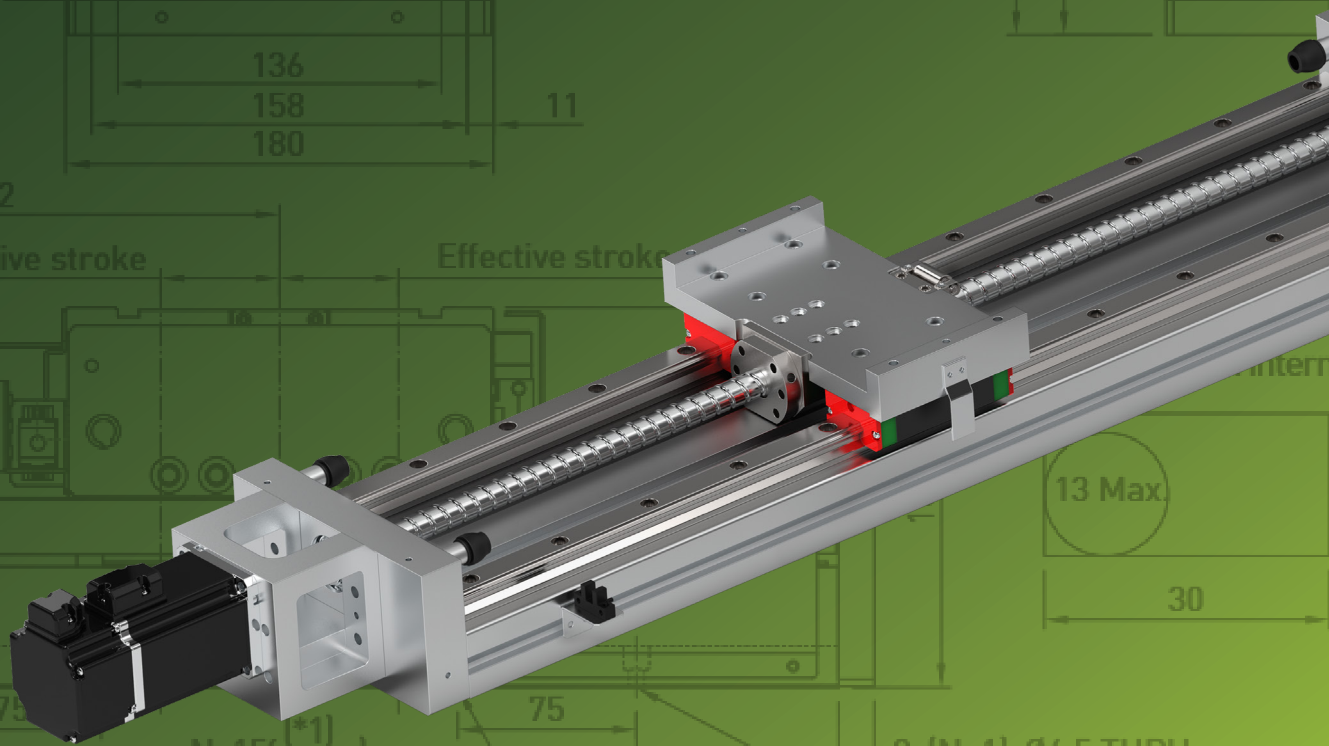
HIWIN®
Motion Control and System Technology

Faster to market:
Factors in multi-axis stage manufacturing



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ABSTRACT

HIWIN'S engineering team addresses the importance of partnering with suppliers that have the quality components and expertise in the various aspects of single- and multi-axis stage development. For more than 20 years, the company has offered on-site manufacturing, in addition to co-design, development and testing from its Chicago-area factory.

BACKGROUND

Leveraging components and know-how from decades of experience in the North American Market, and supported by its parent company located in Taiwan, HIWIN Technologies and sister company, HIWIN Mikrosystem, HIWIN is known throughout the region for high quality mechanical, mechatronic, electrical, and robotic components, and solutions. Combined with the market-specific expertise of an American company, HIWIN Corporation in Huntley Illinois, near Chicago, is ideally suited to produce single and multi-axis stages. As a result, OEM and Automation Integration customers benefit from shorter lead times and tighter supplier partnerships for the best outcomes, especially during the prototyping stages of their design.

THE INITIAL DESIGN

There are many factors to consider when selecting stage technology (See Table 1 on next page). Rely on your stage supplier to understand how each of these requirements impacts the selection of components, and even accessories, to the design of the motion system.

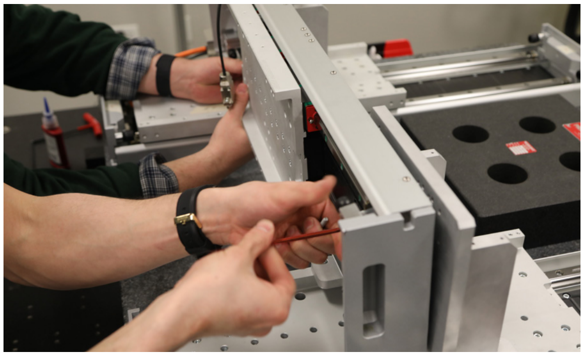

Fig. 1 Installing the bridge axis on a gantry system

Single- and multi-axis stages are used in a wide variety of applications. These include automatic soldering systems, screw feed machines, adhesive laminating machines, CCD lens shifting, automatic spray machines, semiconductor manufacturing equipment, assembly lines, pressing machines, spot welders, surface processing automation, labeling machines, packaging/converting machines, marking presses and conveyor lines for myriad materials handling and much more.

Fig. 2 Ensuring parallelism of the master rail and subsidiary rail

HIWIN engineers evaluate the customer requirements of each mechatronic application. Mechatronics Engineering Project Leader Michael Carroll explains, "Virtually every case we have been presented includes a number of variables that drives us to recommend a standard or custom solution. For example, if it is a very high-speed application, then the linear motor solution is usually optimum. Likewise, if it is an optical scanning process, the customer will likely need an ironless linear motion unit. And, of course, cost is always a factor." To efficiently evaluate applications, HIWIN has engineers versed in various industries and motion technologies to field inquiries.

Table 1

	Requirement	Description
Project Requirements	Budget	A ball-park cost can help ensure the customer and vendor are on the same page from the beginning.
	Scope	What level of integration is the customer comfortable with? Would they prefer components, single-axis stage(s), or a multi-axis system? Are they looking for integrated or third-party drives and motion control?
	Actuation	How is the stage driven? Common types include linear motor, belt, and ballscrew.
	Stroke/Work envelope	The maximum travel distance along a given axis.
Loading Conditions	Stage Orientation	The orientation in which each stage is installed; options include horizontal, vertical, side-mount, and upside down.
	Payload Mass	The mass of all parts that will be moved by the stage or system (typically excludes the carriage mass).
	Payload Mounting Location	Location of the center of mass of the payload in relation to the center of the carriage.
Precision requirements	Accuracy	The positional accuracy tolerance is needed for a specified point.
	Repeatability	The tolerance for hitting a specified position consistently.
	Straightness and Orthogonality requirements	Specified only if needed, straightness relates to the flatness of travel in the vertical and horizontal direction along a given axis. Orthogonality relates to perpendicular stages in a given system.
	Angular Requirements	Specified only if needed, it includes the roll pitch and yaw tolerances.
Motion Profile	Max Velocity	The maximum speed the stage will achieve.
	Acceleration	The maximum acceleration/deceleration needed.
	Dwell Time	Time in-between moves.
	Duty cycle	The proportion of time the motion system is active.
Motion Characteristics	Movement type	Does the application require point-to-point movement or scanning moves? Is accurate position or velocity required during travel? How important is the smoothness of motion?
	Servo Jitter	The stability of the carriage while holding a single position.
	Settling time	The time for the carriage to come to a complete stop.
Control requirements	Communication protocol	How will the system need to interact with the control architecture or software?
	I/O and cabling	How do the motors/drives/feedback/sensors connect physically with the control system? What are the electrical connections, cable chain requirements, etc.?
	Position Feedback	Encoder feedback can be incremental or absolute; either digital or analog. It can be direct (i.e., linear encoder on stage axis) or indirect (i.e. rotary encoder on a motor coupled to ballscrew).
Environment and design constraints	Contamination Protection	What potential contaminants(dust, debris, liquids, etc.) need to be accounted for in the design? Is it a clean room or a machine shop? Protection options may include cover, bellows, semi-sealed, or fully sealed.
	Ambient temperature	What is the temp of the environment? Does it vary through the cycle or the year?
	Size constraints/ envelope	How much space is there for mounting?
	Available power supply	The input voltage/current is supplied on-site to the drive. Typically, 220V single or three-phase, but may be 110V as required. Some drives are DC-powered.

Following the initial analysis of the application, he co-design process begins. Engineering Manager Art Holzknecht notes that HIWIN has added digital tools that enable faster, more cost-effective solutions for customers, including simulation studies of the impact of various performance options. However, digital tools do not replace experienced engineers.

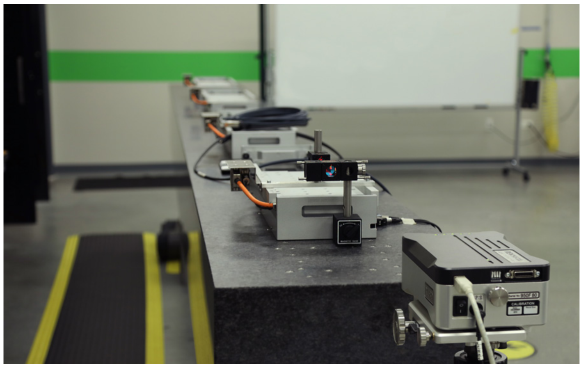

Fig. 3 Laser interferometer testing of the stage for accuracy and repeatability

Mike Carroll further noted there are often other challenges of a different sort. "We are often presented with situations where the customer knows a lot about their industry, such as the biomedical industry. However, they are less experienced in the science of motion control. That is where our onsite engineering capability offers substantial benefit. We can take the given conditions of load, perpendicularity, parallelism and even cabling on the linear motor to affect the best solution for their application, whether it be in a test lab environment or caustic chemical condition of a semiconductor operation.

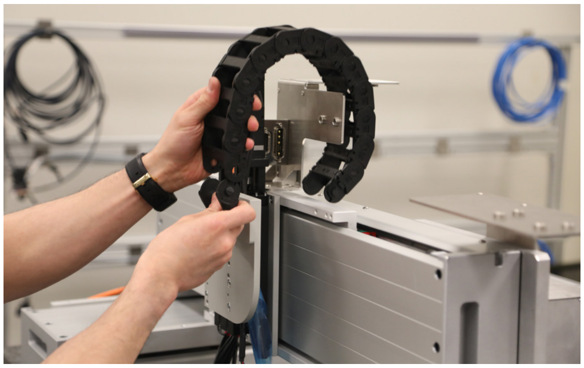

Fig. 4 Attaching the cable chain

Further, designing a custom solution from standard inventoried parts reduces cycle time even more quickly. According to Carroll, "This gives us the ability to reduce that traditional 16-to-20-week delivery window way down."

MANUFACTURING

A state-of-the-art manufacturing environment ensures the quality of the stages. Utilizing granite tables (due to its structural and thermal stability, granite is used as the flatness reference), the room is temperature-controlled and separate from the machining department.

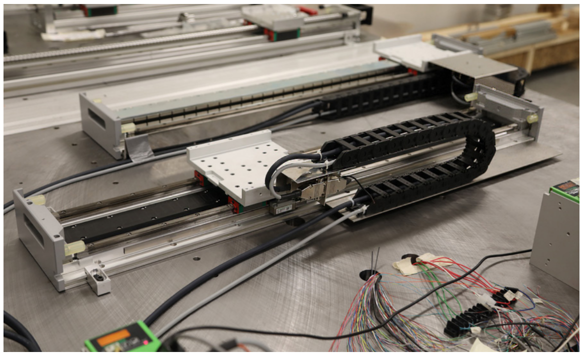

Fig. 5 Prototype testing of a linear motor stage

Holzknecht adds, "The most important instrument used to verify the performance and specifications of our mechatronic motion systems is a laser interferometer. The interferometer is a length measuring standard based on the precisely known wavelength of laser light from a HeNe laser source. The wavelength accuracy is fully traceable to NIST (National Institutes of Standards and Technology). By using specialized optics, the interferometer can measure the linear accuracy and repeatability, as well as geometric errors of motion including pitch, yaw, and horizontal and vertical straightness of travel. The interferometer measurement data is used to provide an error map that is stored in the servo drive to improve the accuracy of the motion."

Industrial Engineer Erin Norwood adds more ways that HIWIN saves time for our customers. “We can include plates, brackets, covers and other accessories to suit the optimum design of the system we have created for the customer, or simply to supply them configured parts for their own designs“.

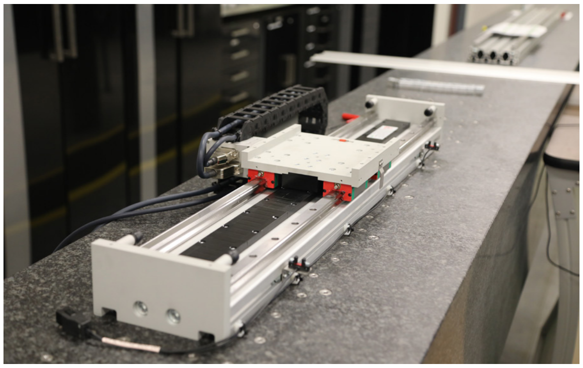

Fig. 6 Connectting the drives to the multi-axis stage

LOCAL PARTNERSHIP

Art comments on HIWIN’s ability to co-design, “We are closer to our customers with all aspects of design, manufacturing, test and delivery of the systems for our customers,” adding that the customer has real-time interaction with his engineering team and may visit the Huntley facility for acceptance testing.

Carroll offers, “Customer support is critical to our success and they’ve backed up that belief with a major expansion of our engineering talent.” Holzknecht adds, “We can have all engineering disciplines design, mechatronic and production…altogether in the room to interact with customers. That is key because the same people in that deep engineering discussion are also the ones who will do the manufacturing and production.”

As for the future, Art expands, “We can already take the motion control systems we produce and pair them with our robotics capability. More customers are using our systems in fully automated production or testing operations and this end-to-end system capability makes us a more attractive supplier. We have robotic engineers on staff and engineers specializing in software integration. We now have a Software Development Kit that is distinct between us and the competition.”

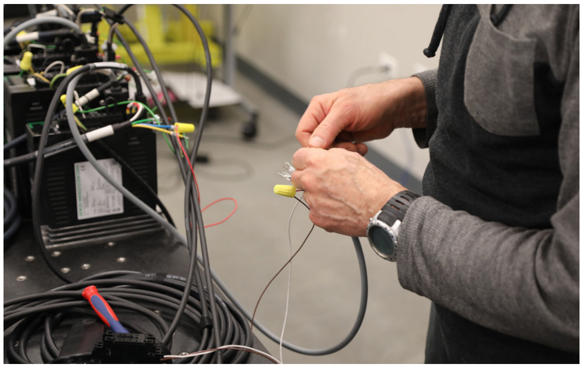

Fig. 7 Validation Testing of completed systems

Michael Carroll cites a final capability. “A customer presented us with a stability spec question and we were able to go to our in-house mechatronic work cell and prove it out for them.” Erin Norwood adds, “We can talk directly to the lead technician in our work cell, who has produced many of our systems and validated the specification. We also gain valuable insights into the designs of products by being able to interact with that work cell team. The back-and-forth benefits both sides and often starts new thinking for the engineering team, especially when an alternative design idea results in easier manufacturability.”

Editor Note: This article was prepared from input supplied by HIWIN personnel, including Engineering Manager Art Holzknecht, Industrial Engineer Erin Norwood, and Mechatronics Engineering Project Leader Michael Carroll. All are based at the company’s facility in Huntley, Illinois, near Chicago

HIWIN USA
12455 Jim Dhamer Drive
Huntley, IL 60142 USA
Phone: (847) 827 2270
Fax: (847) 827 2291
info@hiwin.com
www.linearstages.hiwin.us