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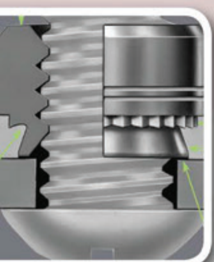

**FASTENING & JOINING:** How to test self-clinching fasteners for reliability

**FLUID POWER:** Do's and Don'ts of seal validation

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## Five keys to "mechatronics made easy"

BY: **Mark Huebner** Market Development Manager PBC Linear & 3D Platform

# 5 keys to "mechatronics made easy"

*Bringing together mechanical, electrical, programming, and control engineering is not effortless. But integrating technology advances, and focusing on these five areas, can simplify the process and ensure that mechatronics is made easy.*

**Today's fast paced** product development cycles and rapid advances in technology have pushed the need for greater cross-disciplined engineering. Where once the mechanical engineer could solely concentrate on the hardware, the electrical engineer on the wiring and circuit boards, and the control engineer on the software and algorithmic programming, the field of Mechatronics brings these areas together creating a focus for a complete motion solution. Advances in, and the integration of all three fields together, streamline mechatronics design.

It is this simplification that is driving advances in robotics and multi-axis Cartesian systems for industrial uses and manufacturing, automation for consumer markets in kiosks and delivery systems, along with the rapid acceptance of 3D printers into mainstream culture.

**Here are five key factors that, when put together, result in easier mechatronics design.**

## 1 Integrated linear guides and structure

In machine design, bearing and linear guide assemblies have been around so long, that often the mechanics of a motion system is treated as an afterthought. Advances in materials, design, features, and manufacturing methods, however, make it worthwhile to consider new options.

For example, pre-engineered alignment built into parallel rails during the manufacturing process means less cost because of fewer components, greater precision, and fewer variables in play over the length of a rail. Such parallel rails also improve installation because multiple fasteners and manual alignment are eliminated.

**Newer parallel rails** feature pre-engineered alignment, which reduces the overall cost and improves movement precision. Newer linear guide systems integrate support structures into the linear rail itself. The shift from individual component design to engineered one-piece designs or integrated sub-assemblies reduces the number of components, which also cuts cost and labor.

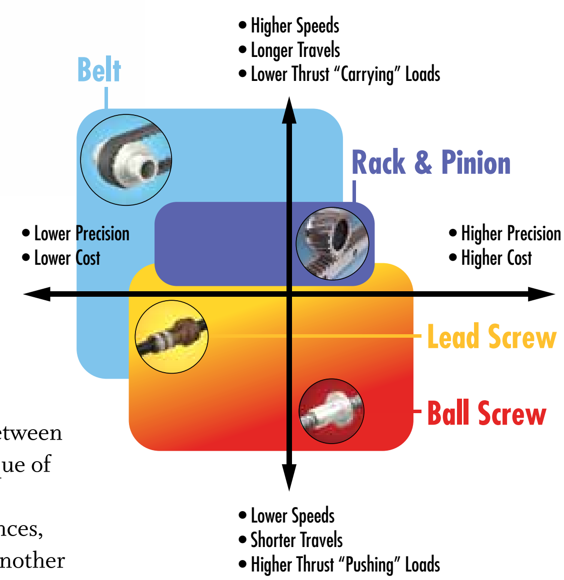
In the past it was almost a guarantee that whatever linear guide system an engineer selected, they would also have to consider mounting plates, support rails, or other structures for the needed rigidity. Newer components integrate support structures into the linear rail itself. This shift from individual component design to engineered one-piece designs or integrated sub-assemblies reduces the number of components, while also cutting cost and labor.

## 2 Power Transmission Components

Selecting the right drive mechanism or power transmission components is also a factor. The selection process, which involves balancing the right speed, torque, and precision performance with the motor and electronics, begins with understanding what results each type of drive can produce.

Much like the transmission in a car operating in fourth gear, belt drives suit applications where top speeds over extended length strokes are required. On the opposite end of the performance spectrum are ball and lead screws that are more like a car with a powerful responsive first and second gear. They offer good torque while excelling at quick starts, stops, and change of direction. The chart shows the differences between the speed of belts and the torque of screws.

Similar to linear rail advances, pre-engineered alignment is another area where lead screw design has advanced to deliver greater repeatability in dynamic applications. When using a coupler, pay attention to the motor and screw alignment to eliminate "wobbling" that reduces precision and life. In some cases, the coupler can be eliminated completely and the screw affixed directly to the motor, merging directly the mechanical and electrical, eliminating components, increasing rigidity and precision, while cutting cost.




**Selecting** drive mechanisms or power transmission components involves balancing the right speed, torque, and precision performance with the motor and electronics. This chart gives a rough idea of the capabilities of various motion control components.

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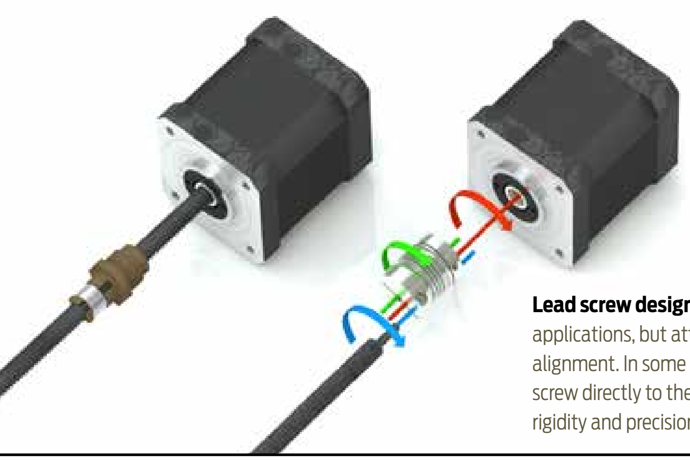
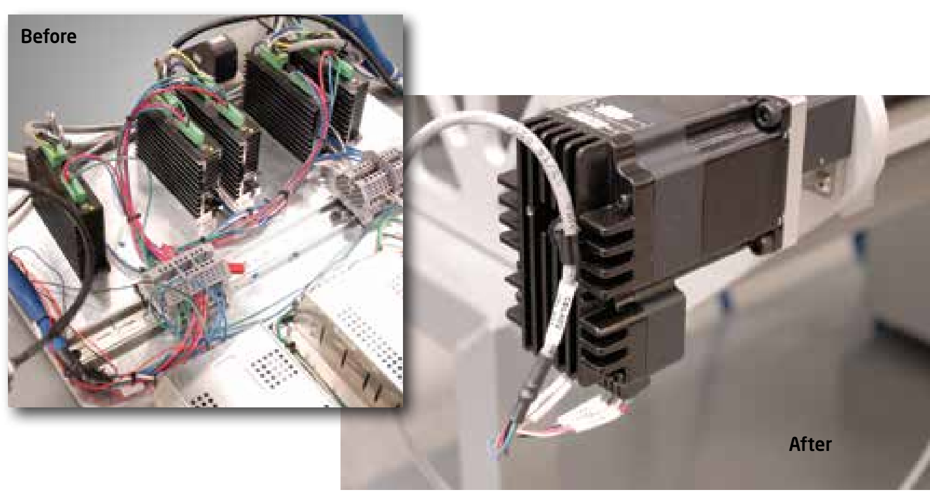
**The chart shows** the differences between the speed of belts and the torque of screws

| | Screw (1 mm lead) | Belt |
|---|---|---|
| **Repeatibility** | 5-10 micron | 50 micron |
| **Typical Max. Velocity** | <1 m/sec | 3-10 m/sec |
| *Example Application* | | |
| **Max Speed** | 0.98 in./sec | 78.5 in./sec |
| **Thrust*** | 68 Lbf | 3 Lbf |
| *NEMA23 motor at 24V … using 1 mm lead on screw … motor torque is 24 ozf-in. at 1500 rpm | | |
| Other considerations | Limited by **Critical speed**, screw whip and end fixity | May require gearbox for dynamic performance or inertia matching |



**Lead screw design** can deliver high repeatability in dynamic applications, but attention should be paid to the motor and screw alignment. In some cases, you can eliminate a coupler and affix the screw directly to the motor, eliminating components, increasing rigidity and precision, while cutting cost.

3

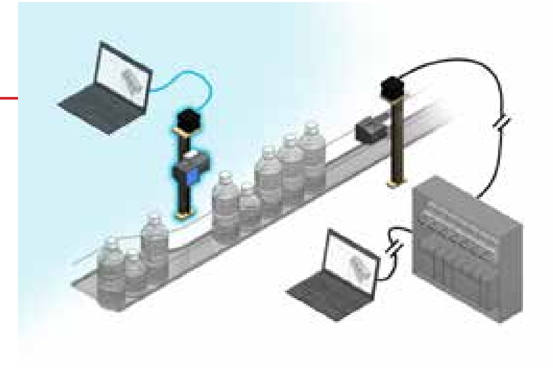



**Smart motors** simplify and eliminate a lot of wiring.

## Electronics and Wiring

Conventional configurations for the electronics in motion control applications include complicated wiring arrangements, along with the cabinets and mounting hardware to assemble and house all of the components. The result is often a system that is not optimized along with being difficult to adjust and maintain.

Emerging technologies offer system advantages by placing the driver, controller, and amplifier directly onto a “smart” motor. Not only is the space needed to house the additional components eliminated, but overall component count is trimmed and the number of connectors and wiring are simplified, reducing potential for error while saving cost and labor.



**Moving** the controller and the drive onboard the motor simplifies any trouble-shooting that may be needed. Access to the motor and electronics is uncluttered and straight forward.

# 4

## Designed for Manufacturing (DFM)

### • Bracketization

Along with easier rail assembly of integrated designs, experience and emerging technologies such as 3D printing increase your ability to create prototype mechatronic and robotic assemblies to DFM standards. For example, custom connector brackets for motion systems have often been costly and time consuming to process through a tool room or fabrication shop. Today, 3D printing lets you create a CAD model, send it to the 3D printer, and have a useable model part in a fraction of the time and at a fraction of the cost.

**3D printers** can help deliver custom connector brackets for motion systems at a fraction of the time and cost of sending designs out for tooling.

### • Connectorization

Another area of DFM that has already been covered is the use of smart motors that put the electronics directly on the motor, making assembly easier. In addition to this, newer technologies that integrate connectors, cabling, and cable management into one package, simplify assembly and eliminate the need for traditional, heavy, plastic chain type cable carriers.

**Newer technologies** integrate connectors, cabling, and cable management into one package, which eliminates the need for traditional, heavy, plastic chain type cable carriers. *Photo courtesy of Cicoil*

# 5

## Long Term Maintainability

Newer technologies and advances in design not only affect the up-front manufacturability, but can also influence the ongoing maintainability of a system. For example, moving the controller and the drive onboard the motor simplifies any troubleshooting that may be needed. Access to the motor and electronics is uncluttered and straightforward. Additionally, many systems can now be networked allowing for access from virtually any location to perform remote diagnostics. DW

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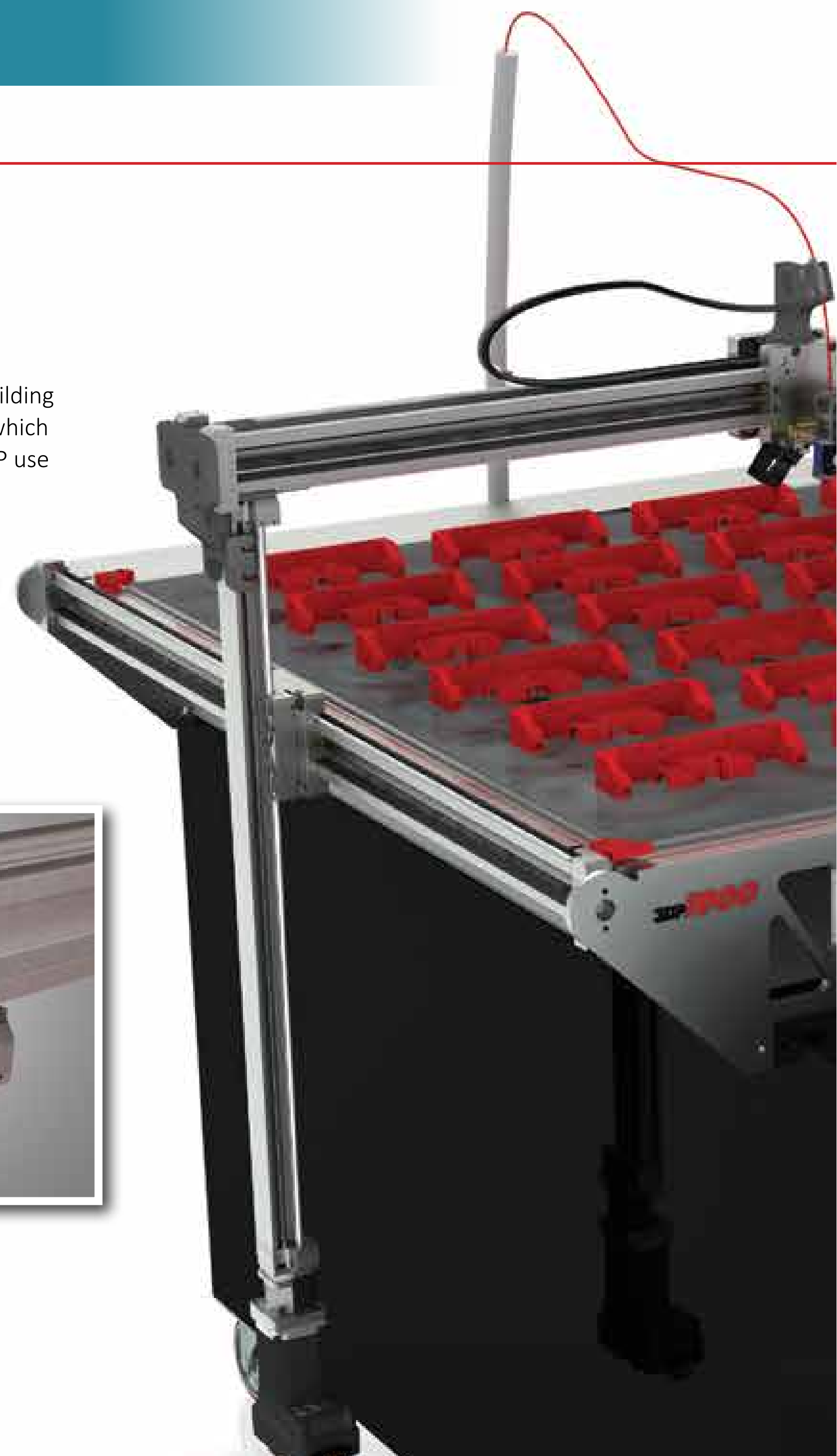
# USING MECHATRONICS TO MAKE A 3D PRINTER

**3D Platform** is a company that has put mechatronic advances to work in building its robust large format 3D printers. With a build area of 1 m x 1 m x 0.5 m, which is 74 times greater than the average desktop 3D printer, it is critical that 3DP use mechatronic advantages to maintain high performance.

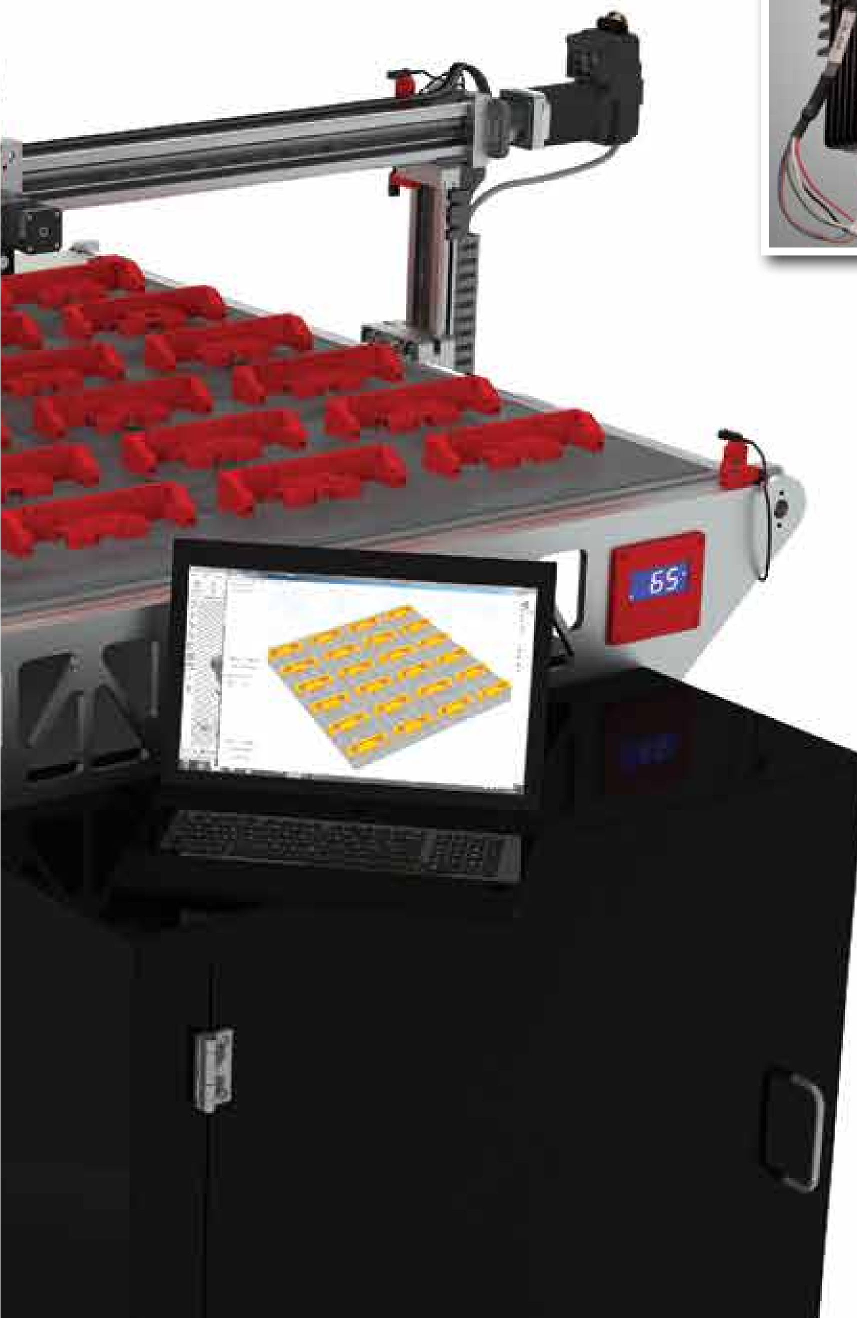
3D PLATFORM



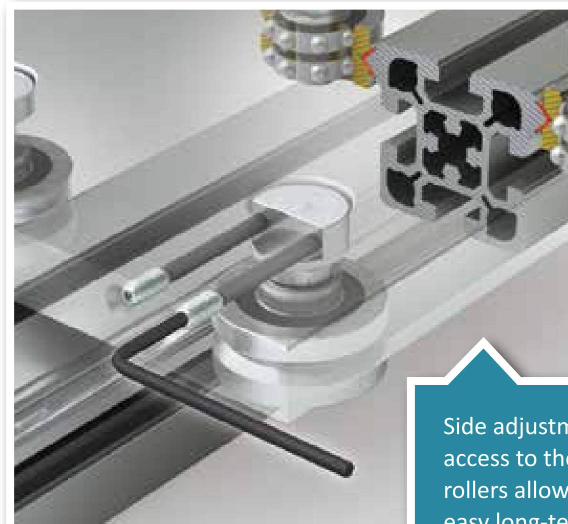
3D printing technology enables the use of custom optimized bracketry designed for ease of assembly and long term maintenance.

The pre-engineered alignment and structural rigidity built into the SIMO® Series linear actuators provide 3DP with a solid backbone for the core XYZ gantry of the printer.

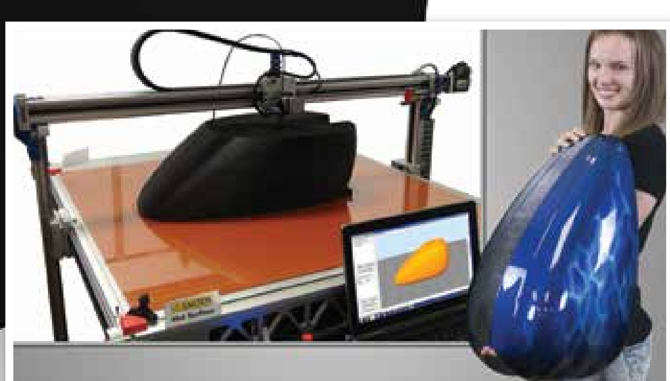
The torque and agility of the Constant Force anti-backlash lead screw and nut, allow for the quick start, stop, and change of direction required for 3D printing that can reach down to precise layer resolutions of 70 micron.



Stepper motors with integrated amplifiers from Applied Motion Products allow heat to be dissipated out from under an enclosure while simplifying wiring and eliminating multiple connection points.



Side adjustment access to the rollers allows for easy long-term maintenance of the bearings.



The 3DP printers suit a wide range of applications in industrial design, rapid prototyping, product development, automotive design, building and naval architecture, custom props, sculptures, stage sets, artistic development, and much, much more. It can be used not only for creating one-of-a-kind large prints, but also as a production platform printing multiple parts at the same time on the oversized print bed.

**3D Platform**
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