



The exoskeleton market is still in its infancy — but evolving quickly and ripe with opportunity. It's a double-edged sword for OEMs who must identify the most impactful applications and crack the code on full-scale production.

This isn't easy in an industry that, to date, has been built on smaller volumes and custom production. As the industry shifts — and exoskeletons become more common and viable for everything from medical rehabilitation and mobility to heavy load lifting — OEMs should be smart about the transition to efficient, high-volume production.

The requirements facing exoskeleton designers, including minimizing excessive heat during operation, ensuring safety, etc., are hard enough. Moving to full-rate production presents a new set of challenges and considerations.

Projects that seemed feasible during R&D and even low-rate initial production (LRIP) can quickly become impossible at scale for a variety of reasons:

- Elements of the original design are cost-prohibitive at scale
- Chosen components aren't reliably available at scale
- The chosen supplier cannot maintain the quality and performance of the prototype components at scale
- Versioning of exoskeleton designs (different sizes and applications) results in an excessively complex supply chain

How can OEMs foresee (and avoid) issues that may arise as they ramp up production?

Here, we'll cover key tips and insights.

Designing with variations in mind

Successful exoskeleton companies of the future will produce models for a range of applications; and exoskeletons, like their users, will vary significantly in size and shape. As such, the biggest challenge for engineers may be the design variations that will need to occur to make them viable at scale.

To accommodate for different sizes, weights, postures and use cases, exoskeleton designers need to think beyond the prototype. If OEMs hope to cater to diverse body types and applications, they'll need to consider all possibilities.

For example, an exoskeleton for a 250-lb. warehouse worker that supports heavier-load lifting will look very different from one designed for rehabilitation purposes in an elderly, 130-lb. person. The torque and power needed in the first example will be much higher than that of the second use case.

Even for those sticking to a single application, the size of the user comes into play. Typically, designers will start with the most common sizes first, and create variations up and down from there, within a given range. For example, a 70% male form might be a good starting point to cover a sizable portion of the female and male population. However, if a chosen supplier doesn't offer a wide enough range of motor sizes, designers will face re-work and manufacturability challenges when they attempt to scale to meet a wider range of human sizes.



Designing for sustainability

Find a partner with a breadth of options

One way to streamline future exoskeleton versioning is to begin with motors and actuators that share a common architecture (or a common supplier) but have the flexibility to be scaled up or down in size and torque to meet a range of application or user size needs. Fewer design variations — and fewer supply chain contacts — make for easier and more cost-efficient full-scale production. Look for a partner that has a large variety of sizes in the motor series/category you're considering.

Choose an industry expert

We're only just scratching the surface of the possibilities of exoskeletons. That means that a lot is still unknown. To stay ahead of the curve as the industry evolves, you'll want an engineering partner who has the expertise to help you navigate:

- Emerging requirements and certifications, particularly in the medical space
- Current and forthcoming guidance from OSHA (and other regulatory bodies) around exoskeleton use in the workplace
- Sizing and selection for motors and other components to help enable easier scalability and manufacturability

Vett partners by assessing their longevity and experience. How long have they been in business? How long have they been in the robotic and exoskeleton space? What is the nature of their relevant experience? How have they helped clients in similar applications?

This expertise should extend to engineering and application support. You'll want to choose a partner and components that don't bring added complexities or concerns around machining tolerances—which could necessitate re-engineering as you scale beyond the prototype. Kollmorgen application experts can help OEMs with engineering support during the motor integration process and beyond.

Check fulfillment and support capabilities

In any application, strong support and fast lead times are key to scaling quickly and successfully. This is even more crucial when it comes to exoskeleton suppliers; the relatively small and emerging nature of this industry means that few partners can support full production, even at modest volumes.

Motor deliveries for production quantities as low as 10 units can take months to arrive in hand. Imagine scaling that into the hundreds! In the fast-paced world of emerging, investor-backed exoskeleton tech, OEMs simply can't afford those delays. Kollmorgen, on the other hand, has a proven track record for fast, high-volume fulfillment — with large-volume deliveries in weeks versus months.



Frameless motors designed for exoskeletons

Very few frameless servo motors on the market today were designed with humanoid robots and exoskeletons in mind. This can make motor selection feel like jamming a square peg into a round hole. Kollmorgen's TBM2G motors are different — designed specifically to meet the unique demands of exoskeleton design.

While most motor manufacturers offer only two or three frame sizes, the TBM2G motor comes in seven diameters ranging from 50 mm to 115 mm and three stack lengths ranging from 8 mm to 26 mm — for a total of 21 possible combinations.

TBM2G motors were made to integrate easily into the harmonic gearing most commonly used in exoskeleton and robotic joints.

In terms of performance, TBM2G motors deliver consistent torque across the full speed range — to meet the especially demanding motion requirements of exoskeletons. In fact, few motors in this class can deliver the same level of performance at the low temperatures necessary for viable exoskeleton use.



Kollmorgen Frameless TBM2G Motors

- Developed from years of rigorous R&D, testing and customer feedback
- Designed for operation at 48 VDC and below
- Optional integrated Hall sensors that don't increase motor length
- Multiple standard thermal sensor options to match the most popular drive options in the market
- Optimized to perform better than any other motor on the market at the low winding temperatures required by typical exoskeleton applications

Ready to help you scale

There's no use in designing for exoskeleton manufacturability if your motor partner can't keep up. As the market picks up speed, Kollmorgen is already ahead of the curve — ready to meet increasing demand as quickly as you can scale production.

Kollmorgen is a global leader in frameless, brushless motor design and manufacturing, and is committed to achieving the highest levels of manufacturing and operational excellence. Our highly automated motor manufacturing processes enable the delivery of large quantities quickly — even with standard modifications to meet specific needs.

Every production line includes stringent quality control systems with documented processes, revision control, extensive training, visual management, thorough quality checks and more. Beyond our manufacturing capabilities, our experts are always on hand to offer engineering guidance, support and service to help you get more from every design.



Ready to move forward?

[Contact us](#) to discuss your needs and goals with a Kollmorgen exoskeleton expert.

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About Kollmorgen

Kollmorgen, a Regal Rexnord Brand, has more than 100 years of motion experience, proven in the industry's highest-performing, most reliable motors, drives, AGV control solutions and automation platforms. We deliver breakthrough solutions that are unmatched in performance, reliability and ease of use, giving machine builders an irrefutable marketplace advantage.