Disposable or reusable: designing a motion system for medical devices

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From driving a pump to actuating an injector, medical devices that provide patient treatment rely on motion systems. Dependent on the profile of the medication, the environment of use, and the needs of the patient, these devices could be disposable, intended for one-time use, or reusable. This decision directly impacts the motion system specification, so to ensure a smooth development process and quality patient outcome, motion design should be involved at the earliest opportunity.

When developing medical devices that provide patient medication, a critical decision is whether a disposable or reusable design is most appropriate. From infusion pumps that deliver insulin, or injection systems that dose biologics, the choice of disposable or reusable provides competing advantages. The decision is also integral to the specification of the motion system, combining the motor, gearbox and feedback, that is essential for actuating the pump or injector.

Chief among the design factors is the impact to patient outcome. Devices that need to ensure precision and accuracy in medication delivery must integrate precise sensors and fine motor control. Dependent on the requirements of the medication treatment profile, the motion system might be relied on to deliver micro-unit dosing. If repeated administration is needed, these motion systems must also ensure high reliability in dosing accuracy. Considering the resource in development, motion features like this are usually required for reusable devices.

Motion system requirements

Alternatively, if the medication profile doesn't demand precision dosing, the motion system design focus from an operational performance perspective could be limited to ensuring that the torque and speed requirements can be achieved. This depends on the load, such as the viscosity of the drug, and the force with which the motion system must drive it. Even for applications when dosing precision is less demanding, careful specification is still required to balance cost, as well as size, which is important for ergonomic suitability.

For reusable devices to withstand the rigors of day-to-day use, they must also be durable, which also includes sterilizability. Reusable medical devices that come into close patient contact or provide invasive treatment must undergo an autoclave process, but this capability is dependent on the setting of use. Although hospitals with a high flow of patients will likely have autoclave facilities on-site, devices for community clinics or home use may instead need to be disposable to ensure hygiene and safety.

Reusable devices are inherently more sustainable from an environmental perspective. This means less waste, while for disposable devices, considerations over recyclability must also be made. However, design choice also needs to be based on economic sustainability. Reusable devices must be more durable, meaning they're typically more expensive, yet value can be achieved through long-term use.

Motor technology options

For disposable devices, a miniature brushed DC motor is the typical choice, although this motor type can also be applied to reusable applications. It's a cost-effective design, combined with the capability to achieve the appropriate torque density suitable for a range of applications.

Alternatively, stepper motors achieve precise positioning by moving in predefined, discrete steps. Important for drug delivery systems, stepper motors also retain their accuracy over time, and as the motor moves a defined angle with each current

pulse, they don't require a feedback device as their position is always achieved if sized properly.

Stepper motors achieve higher torque at lower speed, while if greater speed is required, brushless DC (BLDC) motors are the optimum choice. Removing the physical means of commutation, the BLDC motor instead relies on electronics, which optimizes control precision as well as efficiency. This means that BLDC motors can also achieve a smaller footprint, ideal for ergonomic considerations, while improved efficiency can optimize battery use.

Gearheads are often required for applications demanding higher torque and lower speeds. Standard gearboxes might be appropriate for disposable devices, given their typical rating that covers typical application requirements. However, for reusable designs, customization enables form factor optimization and specific material selection based on the anticipated number of operating hours and sterilization cycles.

Customization for disposable and reusable designs

Even for disposable designs, motion system customization can be preferable. Dependent on the materials and design, customized solutions can reach an improved scale of economy when a certain production volume is reached. However, when designing a medical device to reach a specific level of performance, durability, or form factor, as is often required for reusable devices, customization is typically recommended. This approach ensures a motion system with the closest specification-to-requirements match.

Design for a specific customer application can involve customizable off-the-shelf (COTS) products, through to bespoke motion system development. While the latter is more extensive, it can ultimately achieve the most cost-effective, well-performing system. Customer specific approaches demand close support from a motion specialist, and evaluating the design from the concept phase is essential to streamline development. Yet, even when less extensive customization is required,

establishing a partnership with a motion specialist at an early stage is the most effective way of developing an efficient process to optimize motion system design.

Image captions:

Image 1: Wearable injectors rely on motion system design.

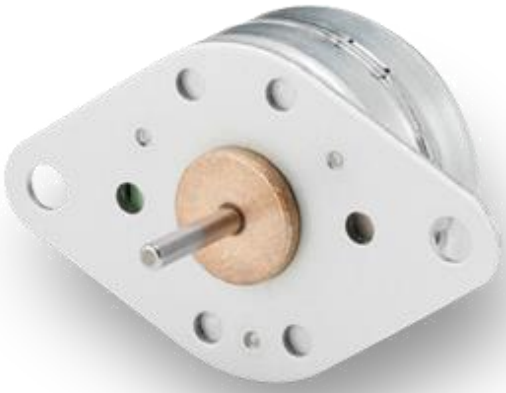

Image 2: Can stack stepper motors provide precision, high torque at low speed, and compact dimensions.

Image 3: For use in hospital theatres, sterilization with autoclave is essential.

Image 4: DC motors are economical for disposable devices, while BLDC motors increase precision and efficiency.

About Portescap

Portescap offers the broadest miniature and specialty motor products in the industry, encompassing coreless brush DC, brushless DC, stepper can stack, gearheads, digital linear actuators, and disc magnet technologies. Portescap products have been serving diverse motion control needs in wide spectrum of medical and industrial applications, lifescience, instrumentation, automation, aerospace and commercial applications, for more than 70 years.

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