

Standard and Custom Motion Solutions: 7 Factors to Consider During the Buying Process By: Brian M. Fink Product Manager, Aerotech

The ultimate success of many advanced manufacturing- and inspection-related projects and processes often hinges on a high-precision motion control solution. Composed of mechanical positioning stages, control electronics and software, the motion solution represents the fundamental platform on which the entire process is based.

Defining a motion system that meets the correct technical requirements and fits within the project's budget can prove challenging to even the most experienced motion control equipment buyers. This difficulty can be mitigated early in the buying process by considering the suitability of standard and custom solutions. Although many buyers can easily appreciate the convenience of conforming to a solution with standard products, it is often worthwhile to entertain the notion of a customized solution earlier.

However, the choice between standard and custom is far from black and white; moreover, what makes sense for one application may not be the best approach for another. There are varying degrees to which products and solutions can be defined as standard or custom, and a key element to a project's success is having a better understanding of this continuum and the trade-offs made in the selection process. The following seven factors are a starting point for buying teams tasked with procuring a precision motion solution.

1. Suitability of Standard Solutions

Standard motion solutions consist of catalog-level products like linear and rotary positioning stages, motors and controllers that are already fully designed and documented, with proven performance characteristics typically detailed in a motion control supplier's specification tables. There are two fundamental types of standard motion positioning solutions: standard off-the-shelf and standard configured-to-order.

Standard Off-the-shelf

Standard off-the-shelf solutions, such as motors, control electronics and pre-configured positioning stages, are manufactured and qualified in advance by the motion control supplier. Since these goods typically ship directly from the supplier's inventory, delivery time can be very fast – plus they are increasingly available via online ordering. Because they do not require



additional engineering work, these solutions can be more advantageous in terms of cost. Additionally, this kind of standardization lends itself to straightforward technical support.

Standard off-the-shelf solutions can also be limited in terms of product selection, availability and suitability to the application, which leads to the buyer having to make technical compromises, accept higher technical risk and devote significant time to integration.

Standard Configured-to-order

Standard configured-to-order solutions provide additional flexibility to buyers because they can be more closely tailored to the application's needs. With this approach, the buyer selects a variety of configurable parameters such as travel length, motor and feedback options, or amplifier current and bus voltage. The supplier then builds the product to the buyer's desired configuration using components that have already been specified, designed and tested. An example is illustrated in Figure 1.



Figure 1. The PlanarDL, a two-axis XY mechanical-bearing direct-drive stage, is an example of a standard configured-to-order product.

Standard configured-to-order solutions provide buyers flexible options without all of the intricacies associated with a fully custom solution. When products are engineered with a variety of fully defined configuration options, the supplier does not have to perform additional engineering work (which would elevate cost and increase delivery time), and the buyer does not have to deal with external project management. As with standard off-the-shelf solutions, straightforward technical support is a hallmark of configured-to-order solutions.

When a standard motion solution is configured to order, an added benefit is that the supplier can undertake some amount of multi-axis integration, alleviating the buyer of this task. This can involve assembling stages together in multi-axis stacks, performing precision axis alignments, optimizing controller tuning and calibrating the stages at the user's desired functional workpoint.

Limitations in standard solutions can potentially result in technical compromises on the buyer's



part, and while the supplier can help with axis-level integration, much of the system-level integration work still falls on the buyer.

2. Suitability of Custom Solutions

A motion positioning system can be customized to different degrees. A custom motion control equipment supplier uses its engineering and manufacturing resources to translate the buyer's needs into a custom-tailored, specially-documented solution designed to meet unique requirements. Custom motion positioning solutions can be categorized as follows:

Custom-Engineered Component Solutions

For buyers who desire to perform a significant portion of the machine build and integration on their own but are unable to find standard components (motors, controllers and stages) to achieve their motion and positioning requirements, custom-engineered components are a reasonable option to consider. Simpler customizations include modifying packaging and mounting patterns. An example of this is presented in Figure 2, which shows standard drive electronics that have been repackaged in a rack mount to allow for easier integration at the end-user's facility.



Figure 2. Custom drive-rack constructed of standard drive electronics and software built specifically to simplify integration and packaging for the customer.

Moderate customizations could involve modifying drive firmware or creating special travel lengths for a linear stage. Finally, some applications require a completely custom solution built with a single end application in mind. Figure 3 shows an example of such a solution built for an application that required 10 degrees of rotation, 6800 N of load capacity and sub-arcsecond positioning resolution.





Figure 3. This custom goniometer was engineered to meet a unique set of requirements including ultra-high load capacity and sub-arcsecond positioning repeatability.

Custom-Engineered Motion System Solutions

A precision assembly of standard and custom products uses the supplier's standard core building blocks to generate a unique design to fit the buyer's requirements. This typically requires special assembly considerations such as cable management, mounting brackets and precision alignments, and can even involve global workpoint or machine specifications. Custom-engineered motion systems help to minimize technical risk because the vast majority of the motion integration is performed by the supplier. Along with offering a reduced total cost of ownership compared to a do-it-yourself solution, custom engineered motion systems help users get the most out of their processes and maintain a competitive advantage. An example of a custom-engineered motion system is shown in Figure 4.





Figure 4. Dual-bridge gantry with four cross-axis carriages per bridge used for a custom laser-cutting application. The drive electronics and controls, not shown, are packaged in a separate electrical enclosure.

Integrated Automation System Solutions

Completely custom, ground-up solutions featuring higher levels of integration are sometimes necessary to meet a uniquely specific and detailed set of customer requirements. Although more resource intensive, completely custom solutions require the least amount of technical compromises and are often associated with the lowest total cost of ownership over time plus a more simplified supply chain. Additionally, choosing an integrated automation system allows a buyer to easily transition from prototype to production-ready systems, getting the end products to market as quickly as possible while achieving the throughput and quality that the buyer and their end customers require. Figure 5 depicts a completely custom integrated automation solution.





Figure 5. A process manufacturing cell with part handling integration, machine vision and integrated safety systems is an example of an integrated automation system.

3. Total Budget for Motion Solution

Prior to engaging suppliers, a buying team should draft a preliminary statement of work that provides not only a technical description of the initial requirements but also a budgetary price range for the motion solution.

Initially, from a buyer's perspective, standard motion solutions may seem to be more affordable than highly customized solutions. However, with standard solutions, it is likely that the buyer's engineering and production teams will incur additional costs associated with the design, manufacturing and integration work needed to close gaps between their requirements and the seller's scope of supply. In the case of original equipment manufacturer (OEM) projects, high volumes amplify these additional costs. For this reason, OEMs and end users may benefit from considering a custom solution. Even with the possibility of a slightly higher initial price, custom solutions can deliver greater savings in the long run.



Custom solutions may involve one-time charges to cover costs associated with engineering services, special tooling and fixturing. Although this could contribute to a higher initial cost, the process can reduce technical and financial risks for buying organizations otherwise unable or unwilling to assume these responsibilities. For high-volume motion systems in particular, one-time costs are relatively insignificant over the project's lifespan and return on investment can be quick.

4. Timeframe for Equipment Delivery

Standard off-the-shelf items can typically be received within days of order placement, while standard configured-to-order items may take slightly longer due to the need to assemble components and subsystems into a final product.

Most buyers associate customization with long lead times. However, that is not always the case. Custom systems that are assembled from standard catalog products or even slightly modified standard products may offer delivery times more closely associated with the products that comprise their core components. Yet, it is important to consider that custom solutions will always incur some engineering design period prior to the commencement of manufacturing, and that period can range from hours to months depending on the project's complexity.

From a delivery time standpoint, advance planning can help to keep a buyer's options open.

5. Application Flexibility

The decision to use standard or custom motion equipment also depends on how closely the technical application requirements can be defined to fit a standard solution in comparison to how well a custom solution can be tailored to suit the application. Moreover, a buyer must clearly differentiate needs from wants.

In many circumstances, custom solutions can more effectively meet a greater percentage of the application's demands than standard solutions. For instance, customized equipment may be necessary to achieve stringent accuracy and repeatability specifications, geometric or dynamic motion performance requirements, or operational compatibility in ultra-high vacuum or cleanroom environments.

Conversely, a buyer might consider designing the application or process around a standard motion solution's capabilities. This can be a wise approach for a variety of applications, although it might overconstrain highly complicated projects. An experienced motion control supplier is willing to assist the buyer with defining the motion solution's capabilities and statement of work and considering the tradeoffs between standard and custom offerings in relation to the application's needs.



6. Buyer vs. Supplier Scope of Work

Larger organizations with fully staffed engineering and production departments may be better positioned to perform precision integration and customization work, and therefore they may be more willing to consider purchasing standard motion solutions and then customizing and integrating them as needed to meet their application requirements. On the other hand, these organizations' engineering and production staff are likely occupied with a significant backlog of work and often focus more deeply on their value-added process than motion integration. Additionally, a buyer who independently undertakes a more sizable scope of work also assumes greater risks. For these reasons, customized solutions can offer an attractive convenience to larger organizations.

Smaller organizations with more limited resources can also benefit from purchasing customized motion solutions. Even if the buying organization is capable of performing higher levels of integration in-house, smaller organizations may find it challenging to service and provide global support for extensively customized equipment. This risk is easily mitigated by working with an experienced motion control partner who will provide the comprehensive pre- and post-sale support necessary with a custom motion solution. Further, a custom solution's total ownership cost can be quite appealing when considering soft costs associated with extended statements of work including engineering services, project management, technical support and maintenance.

7. The Solution's Expected Use Case and Life Cycle

In a one-off use case, the buying organization may be sourcing motion equipment for in-house use (such as for an R&D or production machine) or to use in a one-time build of an integrated system for an end customer. Here, standard motion solutions are a perfectly reasonable consideration, assuming technical and commercial expectations are satisfied. The convenience of quickly and efficiently procuring standard equipment sometimes outweighs concerns about one-time design, performance compromises that come with using standard products or the responsibility to perform higher levels of integration.

Custom motion solutions offer benefits when many similar or identical systems are needed over an extended period of time. In addition to the distinct advantage of being purposefully designed to achieve key technical requirements, custom motion solutions are also attractive because they provide buyers with a substantially higher degree of change control. Unlike standard motion products, which suppliers assume full responsibility for managing during the product's lifecycle, custom motion solutions create an open, collaborative process between the buyer and the supplier. In this regard, custom solutions offer the buyer a share in controlling product lifecycle and change management, and that can be particularly appealing to OEM and other higher-volume buyers.



Conclusion

These seven factors will help buying teams to focus their efforts around identifying motion positioning solutions that closely fit their needs. A successful buying team will engage motion suppliers early and communicate with them often. It is important to gravitate towards motion control suppliers that offer superior technology and expertise, exhibit a deep and thorough understanding of the buyer's application and requirements, and demonstrate a commitment to global pre- and post-sale support. A skilled motion control supplier will openly discuss the trade-offs of standard and custom solutions as well as any decisions to be made in relation to the client's project. Ultimately, success is rooted in the buyer and supplier collaborating to make rational, informed decisions in an otherwise complex environment.



About the Author

Brian Fink, a product manager with Aerotech, has 15+ years of experience in the precision motion control industry. He holds master's degrees in mechanical engineering and business administration from the University of Pittsburgh.