CUSTOM SERVO DRIVES

BENEFITS AND TRADE-OFFS

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Executive Summary

Custom servo drives were historically used only to address constraints of form, fit and function. Today, however, limiting costs by removing unwanted or unnecessary functions plays a bigger role in determining the choice of drive. Integrating peripheral electronics and algorithms into the servo drive further justifies the preference for Custom over Standard servo drives.

Introduction

Servo drives are available from numerous vendors and are available in a bewildering variety of forms and capabilities. Each company seems to have its own idea of what functionality is best, or what form of packaging the customer needs most. The variety of options presents a challenge to the machine builder who has to identify the product best suited to the application at hand.

Custom Servo Drives are designed to meet specific customer and machine requirements. So the obvious questions are these:

- Under what conditions should one consider a custom solution?
- What benefits would such a solution provide?
- How would one judge whether a custom solution is justifiable, or even desirable?

Typically, an OEM would use custom drives to address specific concerns of form, fit and function. Increasingly, however, the prime motive for seeking a custom solution has become cost; in other words, acquiring a custom servo drive in order to benefit from the savings that a product designed to meet specific, and not general requirements, will bring. As with most engineering design choices, the challenge lies in identifying the relative benefits of a custom solution for a specific application and balancing these against any disadvantages this may have.

This article addresses the question of customization, providing information on:

- When a custom solution should be considered
- Trade-offs to consider in order to make an informed decision
- The path that a custom drive development program would take in practice

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Form: Refers to the packaging and dimensions

Fit: Refers to how the product fits into the overall machine system. A prime example is communications: Does the product have communications capabilities that enable it to merge easily into the system?

Function: Refers to the specific functions that the product performs. Some examples are the control structures employed in the product, or the protection and diagnostic functions that are offered.

Considering a Custom Motion Solution

Two seemingly conflicting trends have been seen of late in the servo drive market. On the one hand, more and more products are becoming available from a multitude of vendors with OEMs increasingly viewing these as commodity devices as opposed to specialized electronic equipment. On the other hand, and in conjunction with the commodity-centric viewpoint, has come the expectation of commodity-like prices - indeed prices are decreasing as competition increases, and customers often place prime focus on the product's cost, and only secondary focus on features and performance. This is very different from the situation a few years ago, where the feature set was the subject of customer focus. The expectation now is that all products on the market will have the same or very similar features; the product with the lowest cost will have the greatest chance of being designed into a new application, and especially into retrofit applications.

Lowering the System Cost

For many OEMs who are seeking ways to increase, or at least retain, their market share in an increasingly competitive and global economy, price of system components is the focal point of new machine designs. Indeed, much effort is being invested in re-evaluating existing designs in order to reduce their cost, and such retrofit design efforts are often embarked upon instead of designing completely new machines. Even in the world of commodity Servo Drives, machine designers are now looking at innovative options in order to minimize machine cost. It is exactly for this reason that custom designs can be attractive and in some cases even necessary.

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Let's consider our first example, which is a semiconductor wafer-handling robot. Typically, these machines have 3 or 4 servo axes, and often the robot itself is mounted on a rail along which it is moved back and forth between wafer loading pods or wafer processing stations. A major machine design consideration in these applications is cabling between the machine controller and the robot. Traditional designs have the servo drives residing in the same area as the machine controller, and long cables running from the drives to the motors, located at the robot.

What are the problems associated with this type of set-up? Well, the cables between the drives and the motors are often heavy-duty and expensive, and may need to be reinforced in order to withstand the continuous bending that they are subjected to. In this case the solution is simple - mount the drives at the robot itself. And we can go one step further by designing a multi-axis servo drive in which most or all of the drives exist in one package. The benefits are immediately clear:

- Lower wiring costs
- Enhanced reliability due to shorter cables and less stress on those cables
- Cost savings resulting from the shared functionality that this brings. For example, a multi-axis drive may need only one point of communication between it and the machine controller, as compared with one point per drive in the traditional case.
- Integration of machine-specific functionality, such as pressure sensors and machine I/O. These I/O points may be at the robot, and so integrating their interface at the drive will reduce wiring costs and computing costs.

Adding Value

The last point mentioned in the example above brings us to another, even somewhat revolutionary, aspect of servo drive customization. The intent is, after all, to add value for the customer - so if we are already designing a product to meet custom requirements then we can go a few steps further and integrate other machine functions into the drive. Very often it is the drive itself that operates on these functions; and even if it does not, the drive can provide a conduit for measurement, digitization and communication of the sensory information back to the machine controller.

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An example may be a pressure sensor. Considering the wafer handling robot once again, it is often necessary to measure pressure, or, in the case of a vacuum, the absence of pressure. Why not integrate the pressure sensing mechanism on the custom drive instead of building or buying a dedicated sensor? We are combining unrelated functions in one functional element, and are saving unit costs and installation costs in so doing.

What about the Packaging?

The great advantage of a custom servo drive solution is that one is not constrained by a particular packaging philosophy. Rather, packaging is designed according to what is needed. Traditional servo drive packaging includes such niceties as an attractive cover, a mounting flange, and connectors designed to meet any number of standards that may or may not be relevant for our customer.

Being free of the traditional packaging constraints allows one to literally think outside the box. Does the customer really need that Mil-Spec connector? What if drive could be mounted on the actual machine? This second question may be of particular interest because mounting the drive at the machine, where it is needed, will reduce other obvious elements of the system cost - primarily wiring, and other non-obvious costs such as the reliability of that wiring. And finally, the product outline can be such that the product will fit into the available or allocated machine space.

Filling a Need

We have spoken about the benefits of a custom servo drive in terms of the reduced cost and added value that the customer gains. One can make the argument even more straightforward by simply considering what the customer needs. Many products fail simply because their design is driven by their manufacturer's perception of what the customer needs, rather than actual customer needs. Of course, there are many fine examples of servo drives that do an excellent job of managing the trade off inherent in making a product that meets the requirements of numerous and differing customer application requirements. However, one can take this paradigm up a level and avoid design trade-offs by providing exactly what the customer wants. When this approach is taken one can actually reduce the cost of the servo drive as a unit, since what is provided is exactly what the customer needs; no more and no less. In this way, the true technical and commercial needs of the customer are satisfied.

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Summary of the benefits of a custom servo drive solution:

- Meets the exact customer need, without the overhead that is required in non-customer-specific products
- Multi-axis solutions reduce cost due to sharing of system components, such as computing power, power supplies and communication interfaces.
- Multi-axis solutions for space, cost, and wiring savings
- Tight integration within the mechanical constraints of a machine
- Integration of customer firmware with the drive firmware, thus leveraging existing computation resources, and enabling the customer to retain control over core process.

Factors and Trade-Offs to Consider

When considering a custom drive development program, one needs to review the cost benefits against the risks that a development program entails, and the associated development costs.

Actual Need

The most obvious factor to consider is that of *need*. The need can be evaluated in terms of Form, Fit, Function, and Cost. A machine designer should ask him or herself whether an existing, off-the-shelf product can fulfill these needs, or not. If they can, then there is no need to pursue a custom solution since it may not add the level of value that one is looking to achieve.

Volume is Key

The effort involved in developing a custom product would only be worthwhile, for the vendor and the machine builder, if there is sufficient volume. The word "sufficient" is purposely vague in this context, since it depends greatly on the product itself and on the quantities that are forecast to be used. Some vendors may require a certain minimum quantity of units to be forecast, whereas other may look at the subject from the point of view of potential revenue. Both are relevant.

Development Costs

Cost is the most sensitive aspect of custom development programs, and in most cases, there will be costs associated with the development of a customer product that the vendor will ask the machine builder to bear. By examining the issue from both points of view, it is possible and beneficial to get the two sides to first understand one another's needs and perspective.

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From the vendor's point of view, their risk is associated with developing a product for a particular customer, and they will seek mechanisms to cover that risk. Commonly, the vendor will determine a NRE fee as part of the process. The burden then falls on the machine builder, who will argue that paying for something that does not yet exist puts that money at risk. How do the parties come to an agreement such that both sides truly win? One way is to tie payment of development costs tightly to development progress. The machine builder will want to specify program milestones at which progress can be measured and verified. This mechanism should even be seen as favorable by the vendor, since it adds another dimension of control to the program, and will help the vendor meet the program goals.

Development Schedule and Risks

Any custom development program will have a time-line associated with it. If the machine builder has concluded that a custom design is right in terms of form, fit, function and cost, then the last key in the decision process is whether the product can be developed in time for the machine to reach its intended market. The machine builder must demand, and the vendor must provide, a detailed development schedule, in order for the machine builder to make an informed decision.

A mistake often made at this point in the process is that the schedule cannot be expected to be completely accurate. After all, the schedule is being laid out for a product that will be developed, and there is always some measure of risk associated with this process. The risk to the schedule will be lessened if the custom product is being designed around existing building blocks. The risk will be greater if new technologies or capabilities are being developed. To achieve the win-win situation that both the vendor and the machine builder desire, a healthy and honest evaluation of scheduling risks is required.

The other risk is that the product functionality may turn out to be different to what the customer expected. As we shall see, partnering with a strong servo drive vendor such as Servotronix Motion Control is key to mitigating risks on all sides, and breaking through to achieve the win-win situation that is needed.

Custom Drive Development Path

Managing the development risk is the key to success, and as we will see in the last section of this article, this risk is mitigated by making the right choices when it comes to a servo drive vendor.

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The path to success in a customer servo drive development program is guided by the following principles:

- **Partnership**: the vendor and the machine builder are partners. A spirit of cooperation is key at all levels, be it management, engineering or operations.
- **Program Management**: the vendor must be able to field skilled and experienced program managers, who will be dedicated to the development of this product, and sensitive to the needs of the machine builder.
- **Product Specification**: the product requirements should never reside permanently in the imagination of some person or other. The requirements need to be written in a detailed specification. Ideally, this specification would be written by the vendor, based on input received from the machine builder. In this way, the vendor gains a deep understanding of what it is that the machine builder is looking for, and the machine builder is able to see whether the vendor actually understands the needs. The specification can be iterated as understanding between the parties gets closer, and then finally agreed upon at a formal design review.
- **Avoid changes to the specification**: Of course, some change to the specification may be required as the program progresses. However, continuing or significant changes will adversely impact the schedule, and perhaps even the final product. The later in the program changes are made, the more difficult it becomes to integrate them into the original design. We end up adding patches in software and hardware, and this can severely impact the functionality and reliability of the end result.
- **Be an active partner**: The most successful programs are those where the customer takes an active role in the program development. This role may not involve any actual development work, but certainly involves keeping up to date, even on a weekly basis, with development progress.

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Top 6 things to consider when deciding to go custom:

- **WHY**: Is the product I really need available off the shelf? Need is considered in both technical and financial terms.
- **HOW MUCH**: Does the volume justify the development of a custom product? Advise with your vendor!
- **WHEN**: How long is my design cycle? When is the drive really needed for machine integration?
- **HOW**: How is the customization program going to be managed?
- **WHAT**: Take the time and expend the effort to define the product properly and completely. Get the vendor to write the specifications, to ensure that they understand and internalize what you need.
- **WHO**: Which companies are out there that have the technical capabilities and the business model to make a custom product?

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