MAD CITY LABS INC.

# Custom Vs. Off-the-Shelf Solutions:

# Are You Dreaming Big Enough?

**CUSTOM POSITIONING SOLUTIONS PROVIDE MORE LEEWAY FOR INNOVATION, AND AT FAR LESS COST, THAN MANY CUSTOMERS REALIZE.**

**By Jenice Con Foo,** Mad City Labs, Inc.

When looking for a positioning solution, customers often skip directly to an off-the-shelf option, believing it will always be the most cost-effective and expedient approach. However, the reality of this decision is more complex and nuanced.

Budget, timelines, and performance specifications always form the basis for this choice, but are you just trying to solve the problem immediately in front of you, or are you thinking about what might be required of this instrument in the future — what it could be capable of?

Regardless of whether the goal is a one-off solution or multiple units as part of a wider instrumentation, it is good practice to evaluate the question of standard-versus-custom in the context of your specific application. This article provides readers a clear path to determining whether an off-the-shelf solution or a custom solution is the optimal answer to their needs.

## Defining Specifications

The process of weighing a standard positioning solution against a custom-built solution begins by clearly defining your desired instrument's performance specifications — the highlights of what you expect the instrument to do.

Any outline of a positioning system's performance specifications includes precision, speed, dimensions, and materials. Further, this outline takes two distinct forms: a "must-have" list, comprising the instrument's bare minimum requirements, and a "wish list" detailing features or characteristics that may not be absolutely necessary, but would be a boon to instrument users if they fit within budget and time constraints.

The must-have list should be simple for most customers to assemble. It addresses, for example, how big (or, more likely, how small) the unit must be, how much mass it must be able to move, and how far it should travel.

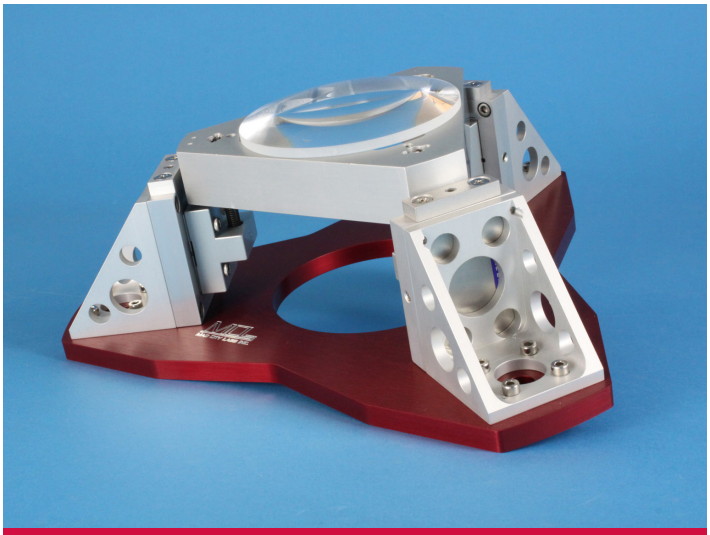
The wish list is a more ambitious endeavor. Obviously, there exists more room for innovation in a first-generation instrument, or a one-off instrument intended for a research application, versus a revision being made to an existing instrument. In the latter situation, designers generally fixate on ensuring everything fits together and not alienating existing customers.

Two general rules apply to wish list preparation. First, at risk of sounding cliché, shoot for the stars! Think about your childhood birthday or holiday lists – you might not get a video game console, a pony, or those fancy limited-edition sneakers, but it didn't hurt to ask. The same is true of an instrumentation wish list — aspiring beyond your base needs is the whole point.

Second, prioritize your wish list. Budget and time constraints may not be as limiting as you initially imagine. Prepare for this scenario by deciding ahead of time which features or characteristics would be most important, should such additions prove feasible. As we will discuss later, the line between the wish list and the must-have list is not as black-and-white as it may initially appear.

That all said, for some projects, clear-cut performance specifications on the must-have list will drive the decision of off-the-shelf vs. custom.

Indeed, in some cases, an off-the-shelf solution will be suitable for (or close enough to) the project's required perfor-



*Custom design for use in an atom interferometer for phase shift correction. The design is for a vacuum compatible, piezo-actuated kinematic mirror mount with 1 nanoradian precision. The design blends custom engineering while also incorporating an existing off-the-shelf product.*[1]

mance specifications. For example, if you're looking at a multiple unit order, a standard product may be ideal, as it may be the cheapest option overall, and you know it's been thoroughly tested from a quality control point of view — lots of units already are in use. Still, be wary of trying to fit a square peg into a round hole (i.e., don't want a standard solution to fit so badly that you miss its flaws specific to your application).

In other cases, must-have performance specifications require specialized materials or operation in challenging environments, where off-the-shelf solutions are unlikely to meet user needs. Customers in these unique scenarios often are aware that a custom solution may be the only fit for their needs.

## Defining Usage

A vital arbiter in the standard-versus-custom decision is how the instrument's usage is defined; more accurately, this step involves refining usage from broad terms to narrow, application-specific terms.

For example, if you plan to buy a bicycle and ride it, your performance specifications include two wheels, handlebars, and brakes. However, will you be riding in the mountains — requiring shock absorbers, knobby tires, and a sturdy frame — or will you be riding on street courses, requiring instead thin, treadless tires, a lightweight frame, and gearing that favors speed over torque?

Now, parallel that example to the use of a positioning solution: you need to move something, but is the overall instrument meant to scan samples fast? How fast is "fast," and what does scan movement actually look like? (For example 90 percent of the time, fast scanning will be required to build up this certain type of image; or, we plan to visit 10 sites on our sample media, and we have to be able to return to this starting point, but we are scanning very slowly.)

Once performance specifications and usage have been defined — and even if an off-the shelf solution has been identified — due diligence dictates exploring all possible solutions in the context of budget and time investment.

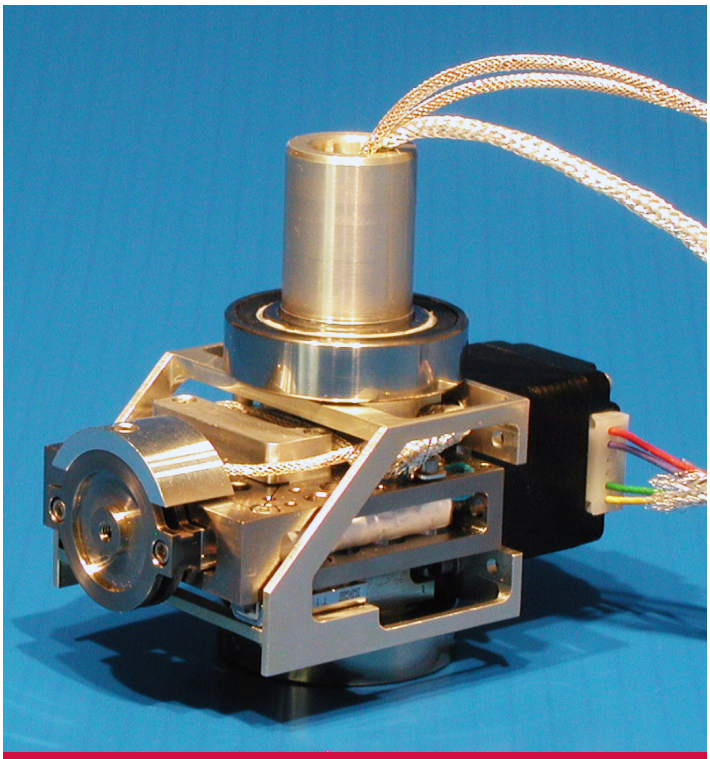
## Calculating Budget and Time Investment

Budget is a priority parameter and often the most important element in any purchasing decision, be it off-the-shelf or custom. Further, it can be acknowledged that there always exists a trade-off between performance specifications and budget.

It's also worth noting that budget awareness can differ between a corporate customer — who is more likely to have a firm understanding of their budget, to the penny — and a research customer, whose budget mandate may not be as rigid as their performance specification needs.

Accordingly, customers must weigh the long-term effects of any design decisions against the short-term budgetary concerns.

Again, for the sake of example, consider an off-the shelf solution that meets most of the performance specifications for a given project. However, implementation of this off-the-shelf component will require the manufacture of a new mounting system and new sample media holders. Consequently, the project is subject to additional costs and design time.



*A custom-designed piezo-actuated load cell for space-based studies of bone density. The design incorporated specific material requirements as well as challenging performance criteria.*

From machining and manufacturing points of view (for the industrial partner), such adaptations are easy. However, the customer's business may have 1,000 customers of its own who now have two different types of sample holders that, superficially, look the same. Will those users erroneously try to use the old holders in the new version of the stage, only to have them get stuck and break as they're being removed? The point is, even a minor adjustment can have major implications, particularly for a volume customer.

Thus, for the customer, prudence dictates a follow-up conversation with the off-the-shelf part's manufacturer to determine whether a custom component would be more appropriate, given time and budget concerns. A determination must be made regarding the timeliness of each design option, as well as whether the costs can be apportioned over many iterations (i.e., a one-off research solution will result in a single up-front cost but, for a product that will be used many times, the time investment and financial cost can be apportioned over the volume of the product).

Similarly, customers should be aware of a common pair of budget-related mistakes. The first is the temptation to nix a

feature because of the up-front cost. Might you want to add that feature — due to competitor-offered options or customer demand — in the future? Such a scenario raises the complications of backward compatibility and internal product change approvals.

Another common impediment to custom component success is budget and design rigidity. Customers must be willing to reopen/re-examine criteria and product features in the face of new information or context.

Finally, customers must acknowledge and seek to understand the relationship between timelines and budget. Evaluating a solution's time cost, and its effect on budget, involves several factors:

- As detailed above, design time considerations are applicable to both off-the-shelf and custom solutions, albeit in different contexts.
- Lead time and delivery time apply to both off-the-shelf and custom solutions.
- Implementation time can seem deceivingly simple to calculate, but one must consider that an off-the-shelf solution may not be a perfect fit, leading to increased installation times, or it may require the addition of new software capabilities.

## Conclusion

There is no right or wrong answer to custom vs. off-the-shelf. Rather, careful balancing of project priorities and a clear definition of desired outcomes determine the appropriateness of either solution.

Off-the-shelf solutions can include hidden costs that may not be apparent initially, while custom solutions are subject to a variety of factors that can affect cost and timelines — many of which are dependent upon the customer's initial preparation and specification requests. Ultimately, custom solutions provide more leeway for innovation — at far less cost than many customers realize.

It is vital to choose an industrial partner with the requisite technical expertise and creativity to assist your project – one who can make useful suggestions and knows how to turn "feasible" into "fantastic." Perhaps even more important, your industrial partner must be committed to helping you find *your optimal* solution, and not just their *most profitable* one.

[1] *S. Dickerson et al., Phys Rev. Lett 111 08001. Aug. 19, 2013.*

## About The Author

Jenice Con Foo is a member of the technical sales and marketing team at Mad City Labs. She obtained a Ph.D. in physics from La Trobe University (Australia), followed by positions at the Synchrotron Radiation Center and the University of Wisconsin-Madison. Her research background is in experimental condensed matter physics and ultra-high vacuum instrumentation.

## About Mad City Labs

Mad City Labs designs and manufactures a complete product line of high precision piezo nanopositioners, micropositioners, atomic force microscopes, and single molecule microscopes. We provide innovative instrument solutions from the micro- to pico-scale for leading industrial partners and academic researchers. Visit www.madcitylabs.com or email mclgen@madcitylabs.com for more information.

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