Custom fixture designers need to plan meticulously before presenting their concepts to the manufacturer

GOING CUSTOM? DON'T CRASH + BURN

BY DAVID D. RODSTEIN

Custom fixtures occupy an important niche in the marketplace. The motivations for specifying a custom fixture are varied. Aesthetics is one reason to go custom. For example, a new or renovated building or creatively designed outdoor space often needs unique lighting fixtures that complement the design theme.

Historic preservation is another application for custom fixtures. This may involve taking existing visible luminaires and rewiring or updating the lamps and optics, and/or reproducing damaged or missing units.

The sheer size of a fixture may also dictate the need for customization–for instance, when adapting American fixtures for a European application. Special photometric needs may likewise require a custom solution, particularly concerning the visually impaired and partially sighted. Much has been written about light levels, glare recovery, contrast and color. There are few standard fixtures that address these needs.

In addition, custom fixtures can address scenarios where energy efficiency, high glare control and high illumination levels are at odds with each other. Finally, maintenance issues (such as a very high ceiling or

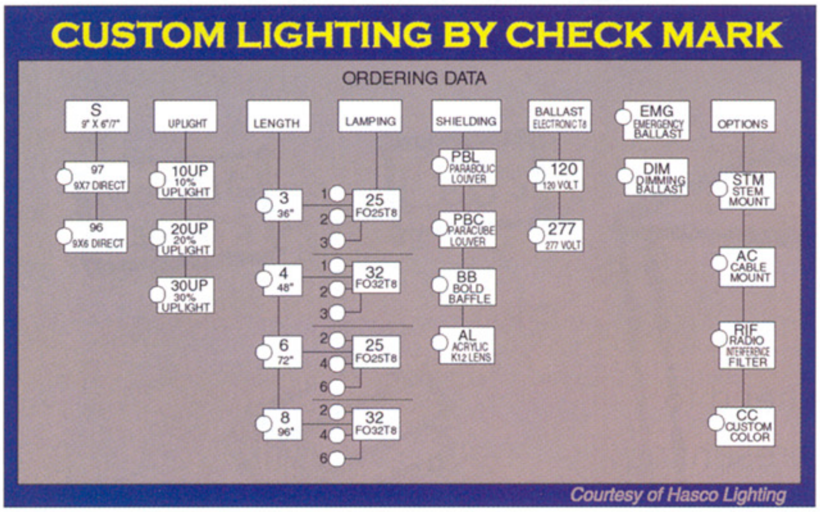

Figure 1.

other obstacles to easy access), not to mention hostile environments related to weather or vandalism may dictate the need for custom fixtures.

But for all their potential, custom fixtures can be troublesome. Many fall apart or burn up in the prototype stage, while some fixtures come in over budget, late and below quality standards. But designers can avoid this nightmare if they plan carefully before approaching a manufacturer.

"Custom" is a relative term and most commonly refers to the modification of a fixture already in production. One can "customize" by checking different options on the order sheet; the customization can be a special color, finish or use of a ballast in the case of discharge lamps **(Figure 1)**.

The problem areas lie in a completely new design. This is because architects, interior and lighting designers are not usually trained to think in terms of mass production. Although they understand space, form and structure, they can get into trouble with products that have to be replicated more than once. On the other hand, industrial designers and mechanical engineers–who can be expert at creating excellent lighting fixtures and who know manufacturing and mass production–can lack the sense of scale and big-picture perspective of how a new fixture idea will fit into the entire building and lighting scheme. What follows is a look at some of the nuts and bolts of designing and manufacturing custom fixtures.

TIPS FOR GOING CUSTOM

1. Start from the inside out. Start with the internal components, draw around them and give them twice the space needed. If possible, build rough physical models. Start with a bare lamp, lampholder and ballast/transformer. Build around it, then draw what you built. Expert drawing skills can give one a false sense of security. What looks so good on paper is often far from the reality.

2. Understand materials performance. Many materials behave like cats when we want them to be like dogs. Materials do not bend and shape to please us. They basically do what they want when they want, with or without provocation. As is the case with cats, you have to work with them on their terms.

Understanding materials and designing for their inherent properties results in a far better design than sketching a vacuous form that can barely be manufactured. This situation rears its ugly head when clothing fashion designers sign their name to residential decorative fixtures. These celebrity designers often sketch an idea and leave it to the craftsperson and engineer to clean up the mess.

Here are some of the most commonly used materials in custom fixture design along with their pros and cons.

Sheet metal–formed: This is the basic unit of fixture design. Inexpensive to work with, it bends, curves, is easy to drill through and can be cut into oddball shapes **(Figure 2)**. Anything attached to the inside of a sheet metal part is visible to the outside including weld marks. Ninety-six inches is the longest practical length. Common use is for strips, wraparounds and fluorescent reflectors.

Sheet metal–spun: This is used for round symmetrical forms **(Figure 3)**; undercuts can also be implemented. Like bent sheet metal, all attachments from the inside are visible to the outside. A high-gloss mirror finish can be laborious. Common uses are in highbay reflectors, urns, woks and metal globes. Tooling costs and lead time are reasonable for custom runs.

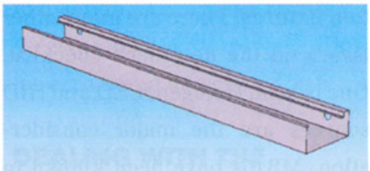

Figure 2.

Figure 3.

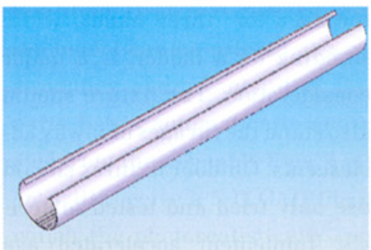

Figure 4.

Figure 5.

Hydroform: A flexible mold in combination with oil gives a smooth specular finish. Sharp corners or protrusions cannot work since they tear the mold. Hydroform is standard for anodized reflector cones, or TYPE IV snow-shovel optic reflectors. Tooling costs and lead time are reasonable.

Aluminum extrusion: This material can be used when the part needs to be long, lightweight and designed to hold lots of internal hardware invisible on the outside surface **(Figure 4)**. Extrusions are easily cut to length. Fancy cross-sections are easy to make. The tooling is inexpensive. A minimum weight must be purchased, however, since the machinery needs to run for 100 hours at a time. Common uses are linear suspended fluorescent fixtures, shoebox outdoor fixtures and the track for track lighting.

Die cast aluminum: This material is most commonly used for complex single parts. One anchor station can replace lots of little brackets invisible to the outside. Typical uses are in track heads, outdoor floodlights and recessed downlight frames. Undercuts are not allowed. Beware of high tooling costs and long lead time. Which leads to...

Sand casting: This can perform the same function as die casting, however there is little tooling cost. A high gloss finish requires extra labor, which results in a high price per piece. Sand casting is ideal for small quantities; common uses are aluminum, iron and bronze outdoor light poles. The part is formed from a solid material, impression is left in an oil/sand compound, molten metal is poured in, and when cooled, the part is reproduced.

Permanent molding: This technique is also called low gravity die casting. It is similar to sand casting, but instead of a sand mold, machined steel is used. There is less costly post finishing, parts can be made faster but at a higher tooling cost. This method is still less costly and offers a shorter lead time than die casting.

Plastics: Plastics are nearly universal to any manufactured good. Plastic is at its worst when it is used to imitate wood, stone and marble finishes. Plastics will look good if the product is designed around the material's inherent properties. Plastics are best used for diffraction and diffusion of light where glass is impractical. Molded plastic housings that are opaque can be quite elegant if properly designed with the appropriate plastic compound. Excellent finishes and vibrant colors are an advantage here. Plastics come in various levels of flammability and hardness. Compounds should be approved by Underwriters Laboratories and the National Electrical Code.

To create a vacuum-formed plastic, a heated sheet is forced into a female mold using air pressure. Domes and lenses are formed through moderately priced tooling. Sharp corners and fasteners cannot be integral. Molds can have textures. UV grade acrylic and polycarbonate for lighting is widely available **(Figure 5)**.

Injection molding is a first cousin to die casting. High tooling costs and long lead time practically eliminate it for custom lighting.

Reaction injection molding is a variant used for low-quantity production runs and refrigerator-sized components. Air is injected into the molten plastic resulting in foam of desired hardness. It is not used for diffusion and diffraction of light, but can be ideal for fixture components with a low heat lamp. A crinkle or semi-gloss finish of any color will have a fine appearance.

Plastic extrusion is most common for linear lenses. Diamond or other patterns can be rolled on. Common applications are for wraparounds. Substituting plastic extrusion for aluminum in a body is not practical since it will sag without metal support.

Glass: Soda-lime–used for beverage bottles–should be avoided. Tempered, lead crystal and borosilicate are the proper types for lighting applications. Glass does not degrade, rust or yellow; however, its fragility and weight requires special handling and shipping.

Tempered glass will take heat and impact. Glass cannot have holes drilled into it, near the edges. Glass is best used in historical or architecturally significant installations where fixtures are to be viewed by generations to come. Avoid using glass in a chain hotel or retail establishment that gets remodeled every few years.

If the luminaire requires a halogen or HID source, glass is necessary because of the heat. Quality plastics will work well in most installations, are far less fragile and more forgiving to rough service.

3. Understand the manufacturing processes. Fixtures are often assembled on moving belts–usually the most cost effective and expedient manufacturing method **(Figure 6)**.

One belt can turn out 50 to 300 fixtures per hour with five to 20 people providing the labor. This technique lends itself to simple fixtures. Any changes to the routine completely upset the process, so moving belts are impractical for special small production runs.

Complex fixtures–complicated wiring, many individual parts, or hard to fit in components–need to be assembled by an individual craftsperson on a stationary workbench. Design omissions and errors are corrected on the spot. This often is an expensive way to build

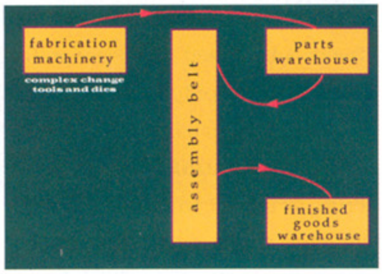

Figure 6.

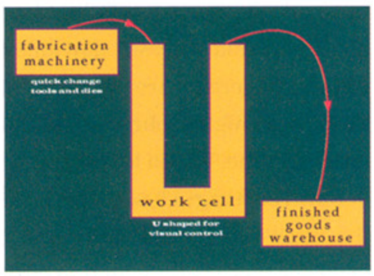

Figure 7.

a product. Custom chandeliers and fixtures that contain crystal are an example of luminaires that are usually built on tables/benches.

A "kanban" is a hybrid system of belt and table **(Figure 7)**. Machines with quick change dies deliver parts to a U-shaped work cell. Workers build the fixtures as they and the foreman see fit and can adapt to changes, yet have rapid production of standard items. Manufacturers who employ this system often combine quick delivery with high quality.

CHECKLIST ITEMS

Materials and manufacturing are only part of the story regarding custom fixtures. There are many other issues on the designer's checklist. One is heat. Halogen, LED and HID sources are the major consideration. MR16s have been known to melt their pins in the socket. Electronics hate heat the way cats hate water. Metal halide lamps turn funny colors, just like your body does at the wrong temperature when you run a fever and feel sick. Plastics, even in a fluorescent fixture, can cause overheating. Underwriters Labs and Electric Testing Labs have specific guidelines for testing and thermal limits.

Durability is another key issue. Ease of relamping without tools or the need for three hands, while standing on a ladder, is a major consideration. The fixture should also stand the ravages of rowdy adolescents. Outdoor fixtures should use only tried and tested materials. Implement accelerated age and water testing if a new material is being considered; if there's new sealing design; or if the fixture is to be placed in a hostile climate.

The parts list should also be easy to decipher. When a fixture has many sheet metal brackets, screws and fasteners, a single cast piece can replace all of those. The parts list should not take up more than two 8.5 x 11 landscape pages on a spreadsheet.

Finally, convenience of mounting is critical to avoid back charges from contractors. Many do not read instruction sheets. (How many times have you seen downlight wallwashers installed improperly?) Wiring compartments of installed fixtures need easy inspection. An excess number of screws and other hardware allows for errors and defects.

DEALING WITH THE MANUFACTURER

Communication with manufacturers is critical to ensure a successful custom fixture design. If a picture is worth a thousand words, a 3-D model is worth a thousand pictures. In the past few years, most industrial designers and engineers have switched from drawing boards and 2-D computer aided design to 3-D solid modeling where a product is designed three dimensionally in a virtual fabrication shop. Drawings derived from the model can be printed as a redundancy and/or submittal. The parts list is automatically generated from the assembly files. A client will receive a 3-D CAD file in which the photorealistically rendered model can be turned around in space, have parts hidden or transparent, and have sections cut by at the click of a mouse. In the old days it would take months to render all the views by hand; now it's done by rolling a track ball. The old-fashioned line drawings method is gradually being phased out. It can take a little time to learn the software packages, but once mastered, they offer a far better way of communicating the design.

Cost is another issue. Most manufacturers will require 50 percent of the cost up front, especially if tooling or testing outlays are required. Credit histories and repeat business will dictate when the balance is due.

Engineering and design time is critical; more time allowed for the design stage will cut production costs and field problems by an exponential factor. Do not skimp on this fee. Set-up and tooling for small runs can be longer than the production cycle. Per unit price and tooling charge are an inverse relationship.

Next is the question of delivery. A good rule of thumb: Expect it to be late. Coordination of delivery from various suppliers is needed. Pilot experimental production runs should be implemented to work out any kinks that did not show up in the prototype phase.

Finally, there is the question of regulatory approval. If a sample fixture needs regulatory testing, the timing can be at the agency's mercy. NEC, UL, ETL, and regional issues can slow down and restrict many design features. Chicago , New York City and the west coast states have special rules regarding fire resistance and seismic durability. Washington State, California and New York have strict energy guidelines. These rules cover everything from accessibility of wiring compartments when fixture is installed, to the weight supported by the outlet box.

IT'S JUST BUSINESS

Many fixture manufacturers have a very conservative product line and adopt a market follower outlook. Many will not completely fund new products on speculation. Marketing a new idea can be as costly as the development process. The development cost and time of a custom fixture is amortized on the first run.

The big advantage of a custom fixture is that it can advance the state-of-the-art with the initial market risk nearly eliminated. A ground-breaking new custom design that is successful will often go into mass production. The designer can collect a royalty, and the lighting industry has a product that will be bought on its merits, instead of its cheaper price. Conversely, a fixture that has a little market potential can be discontinued but still yield a profit in its first run.

Original custom fixtures should be given a long lead time; implemented when there are more than a few are to be replicated; and designed from the inside out. Remember: If there is a standard fixture or modified standard solution available, try it first. There is no need to reinvent the wheel–customization is difficult enough as it is.

REFERENCES:

Manufacturing and engineering consultation from Thomas C. Roberts, PE.

About the Designer: David D. Rodstein, IDSA, LC, Member IESNA (1987), is principal of Rodstein Design. He has a Bachelor of Industrial Design from Pratt Institute; a Graduate Certification in Management from the Wharton School, University of Pennsylvania; and has studied design in Denmark and England. He has held full-time design positions with Lightolier, The Pace Collection and Simkar Lighting. Rodstein Design concentrates on fixture design, lighting design and product strategy in the lighting field. Clients include Lightolier, Litelab, Hubbell, Hasco Lighting, RLR Industries, Rambusch and WAC Lighting.