Design and construction projects are notorious for cost overruns, schedule delays and unhappy customers. According to the Better Business Bureau construction complaints top the list of grievances of any industry. Add the complexity of working with internationally renowned architects, one-of-a-kind museum designs and building committees and this complexity skyrockets. The need for cost certainty and guaranteed implementation is sorely needed but most times an unrealized goal for museum projects around the country.

Trends in museum design and construction
As much a work of art as the works it houses; such is the trend in the design of museums for the past two decades. When Frank Gehry’s Guggenheim Museum Bilbao exploded onto the scene bringing international attention and tourism dollars to the declining metro area, other cities took note and the plan for museums designed and built the world continued its shift. Although probably not tied directly to the success of that institution, the completion of the Bilbao certainly solidified a trend. Since the 1970s, the role of museums has changed from that of “‘quiet lonely places serving mostly the upper levels of society,’ says Arthur Rosenblatt who spent 20 years at the Met in New York.”

Analysis by the organization About Museums estimates there are at least 17,500 museums in the United States alone. It’s likely that figure is low as their measurements only recognize public facilities. Those owned by private organizations, foundations or families, like the Nasher Sculpture Center in Dallas, are not among those counted. Another organization, the Institute of Museum and Library Services compiled a database of museums that participated in their programs which included 18,410 museums. This figure grew by up more than 2,500 in just eight years.

One driver behind that explosive growth seems to be the universal appeal of museums. Yearly, over 800 million visits to museums take place. Each day 2.3 million people take in the arts in various forms. With these kinds of figures, the desire to include a museum in the cache of cultural offerings a municipality has to offer is easy to understand. Each year, more people visit museums than attend all professional baseball, basketball and football games combined. As the draw becomes more and more apparent, museums have evolved to provide a greater breadth of services and functions to their patrons.
Since the Bilbao, the building itself must serve as part of the attraction. Attaching the name of a ‘starchitect’ to a new museum serves as a way to generate greater excitement around the completion of a building and solidify visits from those curious about the building as well as the wonders it houses. Such has certainly been the case in Beck’s markets as we are underway on a Renzo Piano addition to the famed Kimbell Art Museum in Fort Worth and have completed another Renzo design on the award–winning Nasher Sculpture Center in Dallas.

**Balance between form and function…and implementation**

The right balance is akin to striking gold for museum administrators. Such seems to have been the case for the Museum of Glass in Tacoma, Washington, whose iconic 90–foot stainless steel, tilted cone draws upwards of 300,000 visitors per year. The museum was designed by Arthur Erickson and the cone holds 200 spectators. Its design is a reflection of the region’s history; evoking saw mill wood burners once characteristic of the area.

Once patrons are attracted to the museum, the challenge becomes keeping them there. Among the top trends these days are food service and even signature restaurants within the museum. Gift shops now occupy prime museum real estate, and those with a street entrance generate greater spending than those only accessed through the collection.

In addition, museum spaces serve greater functions than those occurring during normal business hours. Weddings, corporate events, lectures, political functions, and myriad others now take place within museum walls. The cultural aspect of the buildings makes them naturally attractive for ceremonial events. As a result, great halls are common in the design of newer museums.

Additional trends impacting the design of the museums of today include flexible gallery space, outdoor art and landscaping, technological capability and parking. Exhibits travel from one museum to the next and their arrival tends to draw increased visitors to the spaces. In the Dallas area, this was certainly the case when the King Tut exhibit arrived, as lines of people waiting to see the exhibit stretched nearly around the block of the Dallas Museum of Art.

Few better examples for the need for outdoor spaces exist than the Beck built Nasher Sculpture Center. The building houses some of the pieces, but the real gem of this wildly successful center is its serene garden. Visitors scarcely realize they are within a stone’s throw of the bustling Woodall Rogers freeway. The design and construction of the garden is done in such a manner that the city–scape all but disappears.

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**Annual museum visits by type***

*Data courtesy of the 2006 Museum Financial Information Survey*
Aligning form and function is one challenge on these types of projects, implementation of the built space while maintaining the budget and schedule is sometimes even more so. Accurately budgeting and building one-of-a-kind designs is a real challenge and change orders quickly test the patience (and profitability) of any organization. Design consultants from across the globe working through language and cultural barriers, museums trying to differentiate themselves from their competition, materials sourced from all over the world and egos that could only rival rock stars are just a few of the reasons these projects require a unique solution.

Building a glass roof guaranteed not to leak
Nasher Sculpture Center

The ability to work with these marquee names is certainly facilitated by hiring a contractor who brings an enhanced understanding of the elements that go into an architectural design. Designs evolve and change and when a contractor can understand the process, the beneficiary is the end product. For example, when building the Nasher Sculpture Center the vision behind Renzo Piano’s design was for the museum’s travertine walls to represent ancient ruins connected by a modern, curved glass ceiling and clear glass walls. The design of the roof in particular required intense collaboration and ingenuity among all team members. As illustrated in the images on this page, the curved glass roof is intersected by the stone walls.

Because of its curve, rain water runs and collects by the walls, where it must be funneled into a gutter system. Any leaks within the walls would require dismantling stone walls; in and of itself represents a situation to be avoided. Given that priceless pieces of art are housed within the walls, the thought of the cost implications of water damage to art work mandated the decision to devise a custom drainage solution.

Traditional waterproofing includes flashing and sealants with gutter systems. Because of the specifics of this project, the team did not want to use any sealant materials as they have a tendency to dry out and/or rot after 20 to 25 years. The end goal with all waterproofing and drainage solutions was to eliminate any need to dismantle the building’s stone walls.

The Solution

The museum building includes five wall sections connected by curved pieces of glass. Within each wall is a custom gutter system that drains water without any chance for internal leaks. Re-examining the idea of traditional waterproofing measures, the Beck team, performing both as the architect of record and contractor, called in a manufacturer of commercial kitchen components and applied their talents to the task. The solution included eight-foot stainless steel welded sinks within the walls.

As the water drains off the glass, it flows into the sinks, which are tucked in beneath the glass roof. From there it flows down an internal gutter system to outlets. The gutters and all sinks are welded together, leaving no opportunity for sealant related leaks. The entire system was designed to a capacity exceeding 100 year storm levels for North Texas. Since completion, the building’s drainage system has handled a 100 year storm and performed exactly according to intention. As the system was designed, manufactured and installed, Renzo Piano himself stated to the client, Ray Nasher, that Beck was delivering a system that rated a 1,000 year warranty.
Guaranteeing costs | Salvador Dali Museum

The Beck Group provided preconstruction and construction services for the new 66,400 SF Salvador Dali Museum facility that is as flamboyant as the Spanish artist himself. Designed by Yann Weymouth, AIA, LEED AP with HOK, the Category 5 hurricane resistant building protects and exhibits the museum’s priceless collection, which is the largest outside of Spain. The new facility doubles the museum’s exhibition space as well as provides ample storage space which was sorely needed. The glass free-form installation has become the building’s trademark.

As Construction Manager at Risk, Beck worked with consultants and vendors worldwide to obtain the precise materials needed for the museum. Lighting consultants were located in Washington, DC, security consultant in New York, and acoustical consultant in Florida. Many products were custom made and fabricated in other countries, including tile from Italy, structural framing for the glazing system from India, and glass fabricated in China. By working proactively and challenging these suppliers, we were able to establish realistic budgets and schedules. We were able to complete the project within budget and completed the project without any change orders.

One example was the signature design features of the Dali Museum; the architectural concrete helical stair. The design was originally to be a steel structure; however, Beck’s preconstruction team analyzed several different options and recommended it be built as a cast–in–place structure. The end result delivered the same architectural intent, and resulted in a $600,000 savings by switching to concrete from steel.

In our concrete subcontractor meetings, we coordinated with numerous concrete formwork suppliers to determine the best system for installation. The formwork system had to allow for placement sequencing and each section of stair had to be placed and stripped before forming the next section to allow for not only the settlement, but for any uncoiling of the stair due to the tension in the curved sections. Beck’s preconstruction team was able to bring the cost down through value engineering and constructability methods which brought the project into budget.
Cultural alignment of team members | Kimbell Art Museum

When Beck was selected for the construction of the Renzo Piano addition to the renowned Kimbell Art Museum in Fort Worth, we quickly assembled a team familiar with Renzo’s workshop from their work on the Renzo designed Nasher Sculpture Center. Even with a team experienced in working with the Italian architect, the need for cultural understanding existed among all team members. In addition, the inspiration behind the design and selection of materials was a driving concern to both the Renzo Piano Building Workshop team and the Beck team.

From the earliest days of their work on the design, members of Beck’s team were invited to Genoa to view progress and facilitate team building. As the design progressed and the design team began finalizing plans, the teams again came together to discuss the availability of materials in Texas. Beck’s project manager and superintendent made several journeys to visit and were taken across the Italian countryside to see construction underway. These trips provided our management team with first-hand knowledge of the quality, look, feel and functionality of the materials the design team envisioned for use on the Kimbell addition.

Use of architectural concrete features in the plans for the Kimbell addition; this is a material the design team feels passionately about, and the end result must not only provide the desired shape, but the color, finish and functionality are all key components of the design. On one visit, the construction team visited several museums in Italy that featured the concrete work of one particular contractor. Renzo’s team works with this contractor for all the architectural concrete elements on their projects in Europe.

Sourcing the same concrete work in Texas was a driving concern for both the design and construction teams. The Renzo team visited the Dali museum project referenced earlier to see the architectural concrete used on the helical stair. Although of the highest quality and certainly impressive, the Florida–based concrete contractor’s product did not exactly match what Renzo was after. Our team recommended Renzo bring on the Italian concrete contractor he works with in Italy and we are currently working with this group under our contract to source the materials needed to produce the exact color, weight, strength and finish that the designer is after.
Ensuring quality | Nasher Sculpture Center

The signature element of a Renzo design is typically the roof system. At the Nasher Sculpture Center in Dallas, the system is glass with a custom cast aluminum roof grill that diffuses the light for proper viewing of the art. Constructing that vision presented several challenges for the Beck team. Specifically the design of the curved ceiling presented a need for a counter weighted installation.

The structure of the Nasher Sculpture Center ceiling includes steel beams for support with an intricate cable system supporting those beams. Both the beams and the cables are in place to support the weight of 16 glass panels, each weighing in at 1,100 pounds. The weight of the panels, if installed without counter balancing measures, would have introduced great stress to localized area of the walls and steel beams, and stood to pull the impacted walls toward one another.

The inflexible nature of glass made any such movement unacceptable. The design of the Italian glass manufacturer left three millimeters of space on either side of the glass panel. While this is more than what is typical of US glass manufacturers, it was either too much or too little spacing if the walls and beams were displaced during installation.

To overcome this challenge, a two–pronged installation solution was devised. Using mock ups to test the process, first, the team applied load to all beams and cables weighing the same amount as the glass panels. By applying the weights, localized stress was spread throughout the structure and any movements were eliminated by the counterbalancing. In the mock up, this process was successful, and so the Beck team applied it to the project.

Second, the glass was installed in a checkerboard pattern. Calculations made during the mock up phase indicated removal of the weights in a step by step method would allow glass installation to proceed free of wall movement. Starting at the center panel, the weights were removed and the curved glass panel was installed. Each subsequent panel was installed moving diagonally down, then up and finally across.
Beck has been a leader in developing and utilizing Building Information Modeling (BIM) technology since before the acronym was even termed. We utilize Revit, Innovaya and NavisWorks on all of our projects. Through the use of BIM, we can create models that generate documentation, study clashes, produce quantities, estimates, and schedules for construction with varying levels of automation.

On the Kimbell project in Fort Worth, Beck has applied BIM to the process to aid us in facilitating communication and collaboration among the design team and Beck. Through the use of BIM models, we have identified and resolved a number of issues that had previously gone undetected through a 2D process. Specifically, our team has used laser scanning on the site prior to pouring slabs in order to identify stub-ups, preventing costly re-work. Additionally, BIM has been used to model parts of the building that could not be constructed as drawn and have the function as desired. The model is used to illustrate the challenges to the design team and then is used to track the resolution process.

For example, as drawn exterior concrete walls were not intersecting, meaning that the building would not be weather tight. Calling upon our internal architectural expertise, Beck placed a Revit expert on the jobsite to recreate the 2D CAD drawings in Revit and use the model to communicate not only with the design team to resolve potential issues, but also to work with the subcontractors whose shop drawings are also in 3D format.

By converting the drawings into a 3D model, our team has been able to improve communication among all project stakeholders. Further because the design continues to evolve and grow even as it is rising out of the ground, the 3D models created by Beck have been exceptional tools for illustrating exactly what potential project changes will cost and what drives those cost changes.

Recently, the decision was made to increase the underground garage height of the Kimbell addition. In addition to that height increase, the first floor (ground level) height has been reduced. The 3D model was utilized heavily in exploring how these changes would impact the amount of architectural concrete used both in underground elements as well as on the first floor.

Architectural concrete is a high cost item in that the process of pouring the walls mandates the use of expensive form work, which can only be used for two pours to maintain the desired finished wall aesthetic. All team members hoped that cost of the increase in height underground would be cancelled out by the decrease on the first level, whose exterior is entirely architectural concrete. Unfortunately, the changes ultimately cost more than the original plans. Although architectural concrete decreased on level one, it was increased in the underground garage. As such, the costs of that expensive material was a wash in terms of the change. The increased structural concrete in the garage associated with rising the level impacted the cost.

It was through the 3D model that the Beck team and the concrete contractor were able to illustrate these exact price changes to the rest of the team.
On the LEED Platinum certified BRIT project, our team’s use of NavisWorks for clash detection benefitted the project in multiple ways. First, our team imported the Revit drawings into NavisWorks for help in coordinating overhead piping and HVAC ducts. Because the facility relies on geothermal for climate control, the piping and duct work deviates from the norm for buildings in the Fort Worth, Texas area.

Because of the systems associated with geothermal climate control, the plenums in the project were difficult to coordinate because we had to suspend 58 heat pump units from the structure in those plenums. A majority of the plenum spaces were very tight. On the second level of the building, ceilings were sloped with about 5 feet of plenum space to accommodate all duct, piping, and heat pump units, which average in size at about 3’H x 5’L x 4’D, and must be suspended level. There were also very tight and crowded plenum spaces for pathways through open areas.

Solution
Rather than lowering the ceiling, which would have deviated from the architectural drawings, our team was actually able to raise a ceiling in one room after the Owner saw the space and voiced a concern that the design ceiling height felt too low.

Using NavisWorks to identify the exact location for all piping and heat pump units well ahead of installation, all the piping/duct was installed per the approved shop drawings. The process went smoothly and avoided manpower and material cost that would have resulted in field coordination/modifications.
In order for a museum project to achieve its desired outcome, those putting the pieces of the building into place must have a dedication to achieving vision within budget bordering on the obsessive. Because the building serves as the first attraction to the facility, design intent cannot be compromised. In the face of seemingly impossible, contractors who are dedicated
enough to work side by side with the artists who created the project’s vision to identify the method to take the building from drawn design to concrete, steel, and glass are the hidden catalysts behind prompting museum patrons to visit a new facility. The very best firms are able to achieve this while providing the cost and schedule certainty that museums require.