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# More. Better. Integrated.

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# More. Better. Integrated.

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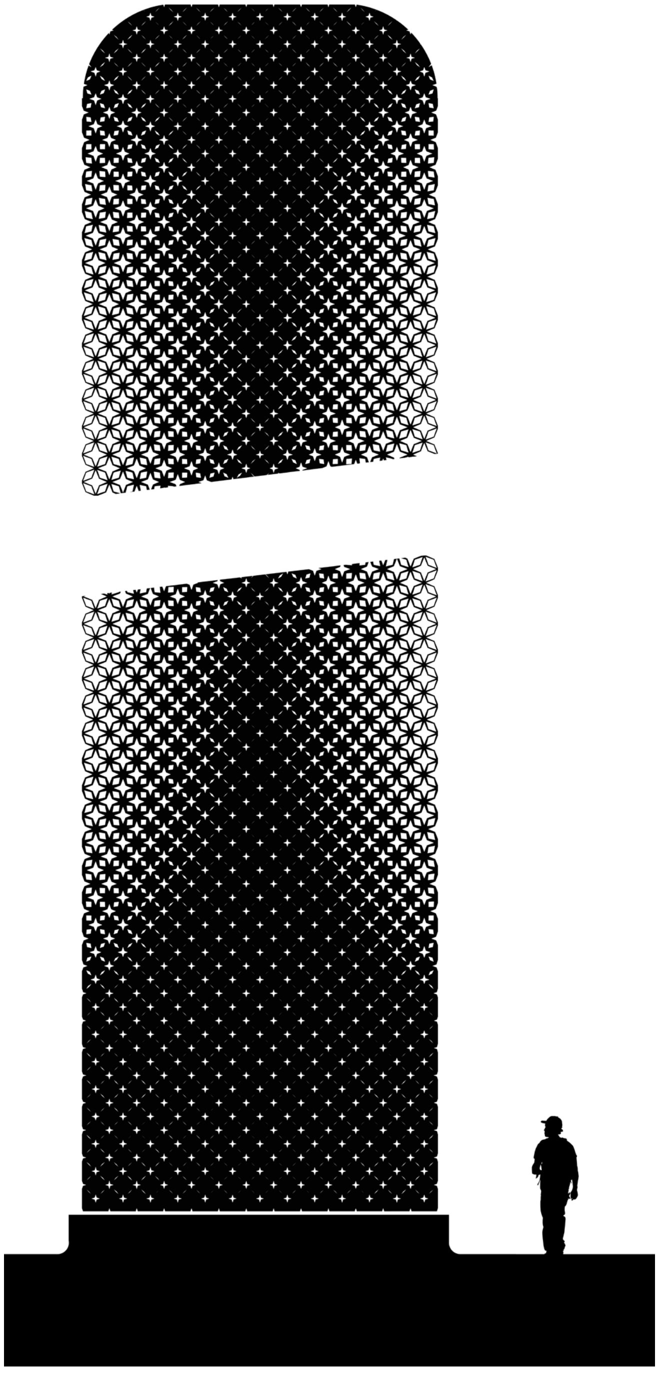


I would like to take a moment to appreciate the simplicity of discussions about technology that happened only a short time ago. What brand of parallel bar or type of pencil one used largely led the debate. Lead, ink, wood and other materials that made up this analog world were relatively easy to learn and use. One seldom had to break focus from a design to figure out how to use them, and they never crashed. Notably, the small set of industry-wide tools and techniques forced time for reflection. Today, the time available to gain conviction in a concept has become increasingly difficult to find as schedules compress and software capabilities continue to feed rising expectations of speed in a competitive market. One can do nothing but accept the bitter irony of technology both facilitating and causing these expectations.

Even the most technologically adept find it a continual challenge to develop techniques that keep focus on the design and not on the tool itself. The rate of software development compounds these challenges, making best practices a moving target. Despite these battles, the ability to facilitate speed, harness complexity, and conduct thorough analysis keep us coming back for more as the growing pains of software evolution become an accepted hazard in the wake of higher profits and new ways of designing.

Our most critical challenge is how we embrace this constant change and the resultant demand for our design process to change along with it. This is no easy task when technology can have such a profound effect on virtually every facet of a business model and requires understanding at all levels and experiences within an organization. Because of technology's pace, we must embrace a more constant evolution in our process while at the same time respecting the value of routine. Ultimately, we must strive to be at the leading edge of technology as a way of not only maximizing quality and profits but also pushing boundaries of design. Speed is good for business, but we must not forget about how these new processes can more effectively and creatively solve the problems of our built environment.

### This is not your father's learning curve.

With many audiences, describing concepts of scripting, parameterization, or algorithmic thinking can be daunting. However, in many ways, they can be compared to something as simple as a jig built for a woodworking project. Like a piece of wood fashioned to help push planks through a table saw, a software script or complex parametric model is a tool made to support other tools. Much of their function is to facilitate ease, repetition, precision, speed and other strategies for efficiency. AutoCAD is a jig for drafting. BIM is a jig for doing lots of AutoCAD simultaneously. Scripting and other custom programming are yet other layers to this family of jigs—all built in an effort to streamline and improve quality.

With the growing and changing array of tools, it is no surprise that firms continue to struggle through the technological adolescence of what it means to be able to introduce mountains of data to a problem at the click of a button. Now more than ever, projects can easily become bloated and overdrawn as intensely detailed "smart objects" and other memory-hogging parametric components can be dropped into a drawing without proper scrutiny. Adding to the struggle, software training is eternally catching up with software development.

This constant state of transition forces more of a "tool collective," versus a singular platform, solution, as various tools come in and out of favor. Because of this, buzzwords like "interoperability" are increasingly used as architects and others invent more effective ways of streaming data from one tool to the next. This rate of change can be unsettling to many, particularly those with a bit tighter grip on tradition. However, as stubborn as this hesitancy may be, it's worth listening to in some ways. If the arsenal of tools gets too bloated, the streamlining these tools were supposed to deliver can actually have the opposite effect. If one is changing and adapting too frequently, one can never develop a technique to its full potential. This balancing act and inevitable struggle with redundancy and interoperability will always be present, but the more an organization can embrace this constant flux, versus resisting it, the easier it will be to evolve.

**Complicated data driving simple solutions**

This complicated "tool collective" is accompanied by an even more complicated set of data for one to access and manage. As the basis for our design decisions, robust simulations and other information are only valuable if evaluated by the right people at the right time in a project timeline. As real-time analysis becomes more and more of a reality throughout the design process, disciplined management of information flow becomes increasingly critical.

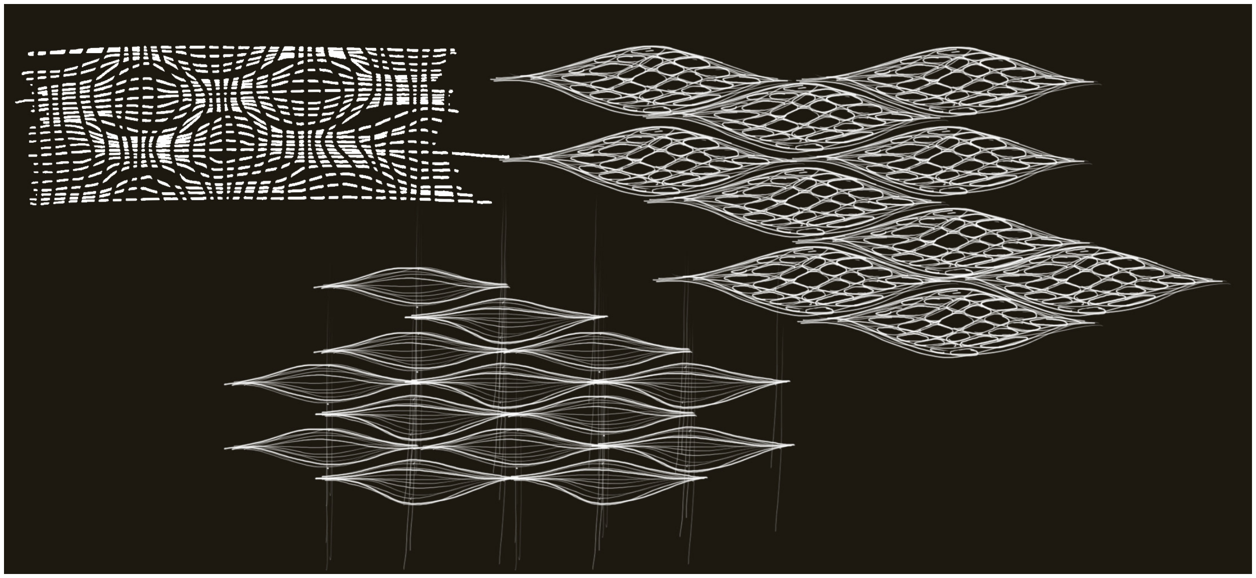
Structural engineers, architects, code consultants and other project players all interpret data differently. As architects, it is critical that we shepherd this data through the design process in a thoughtful and deliberate way so that the entire team can support consensus-built goals devoid of data saturation, with its power to divert focus from core issues.

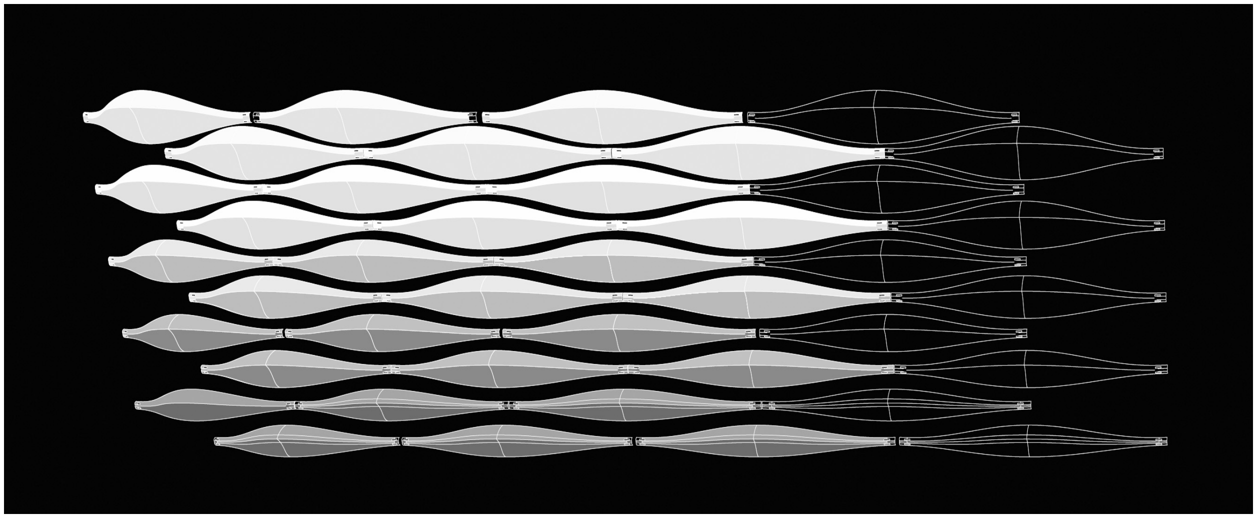
These issues can be tough to keep sight of when we're in a period of fast and constant transition within the design process. Many of our fundamental challenges are a symptom of forcing longstanding systems of delivery over a set of tools that are desperate to offer us so much more. Firms must creatively identify strategies for resolving disconnects between the fundamental changes in our tools and the resultant shifts in our project communication, delivery and thinking.

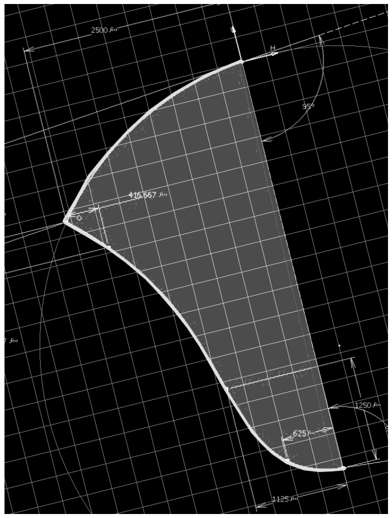
As if this was not enough of a challenge, much of the education is coming from the bottom up as new graduates and other young professionals have some of the best perspectives on technology's potential. Conversely, they lack broad perspective of a given profession or firm vision. Therefore, it is essential that communication around technology occurs across all levels of experience.

**Software: No longer "wow" but "what if?"**

Software's ability to handle staggering complexity has enabled previously unattainable architecture to be realized. Many would argue that scripting, parametrics and algorithmic thinking have been the catalyst for what might be the next great architectural movement alongside Neoclassicism or Postmodernism. While that may be a debate for another time, the parametric or algorithmic mindset has







undoubtedly invaded the culture of architecture in a way that has turned our process on its head, and it is naïve to think that it hasn't long been doing the same to our built environment.

Designers are now developing concepts based on performance-driven criteria instead of the more traditional diagrammatic thinking that gets progressively more detailed in its study. This generative, bottom-up approach has revealed new opportunities and ideas that other tools or processes haven't. One particular technique doesn't have to be employed exclusively, however. In many cases, employing both in parallel can bring more thorough insight and discovery to a problem. Every tool and associated process brings unique value when used wisely. Parametric software, in particular, has reinvigorated our appreciation for how digital and analog tools affect the ways we solve problems and the solutions we find.

Yet, for all the amazing tools and capabilities at everyone's disposal, designers seem to be getting past the "wow" of software. There is a collective questioning of "what is this really doing for us," which is inspiring a more creative and diverse use of these tools. Many are focusing on how parameterization and other advanced methods of design can effectively attack the important social and environmental issues of architecture. Bioclimatic design can be more effectively proven and executed through robust simulation and material usage can be more effectively managed. The list of potentials is long but often minimized by the press and academia. The ability to harness great data and geometric complexity is now quite accessible. As architects, it is our responsibility to critically examine and promote how we use this ability for things other than magazine-friendly architectural sculpture.

Many are already harnessing data from the collectives of social media and other Internet sources to reveal new perspectives on culture around the world. These same kinds of pools can be used to drive a more collectively-informed architecture. What if a building design started from creatively compiling sets of data from Facebook, which in turn drove a parametric model of physical space? What would it look like? What would it do? Using technology and the expertise of other professions to better connect physical space with our exploding virtual space has only just begun, opening another great frontier for architecture. It can only be done with a strong grasp of our tools and how we might evolve them to better lead the evolution of our built environment.

The movement to take control of the tools software developers feed us is an exciting and encouraging development in our profession. Instead of being slaves to the limitations of "out-of-the-box" capabilities, architects are developing the skills needed to create their own tools. Computer science and architecture have begun to mix, as big and small firms alike are writing and adapting applications to better tailor software to their project needs. As a result, these digital jigs are finally in the hands of the craftsmen, where they should be. Suddenly, software development is driven by a massive collective of users versus a small pool of test groups. This phenomenon has been accelerated by a growing open-source culture where adaptation of software is not only easier but also encouraged. As a result, the explosion of creativity that might have typically been reserved for architectural design has also been applied to the design of the tools themselves, creating a completely new and exciting dynamic between conception, exploration, fabrication and beyond.

**Multi-source**

The evolution of technique and the tools that support it have also informed our broader role as architects. It has facilitated an unprecedented level of collaboration, blurring roles and, in many ways, moving us towards the interdisciplinary "real-time" collaboration that we are beginning to see between architects, engineers, builders and many other specialized consultant groups.

Only 15 years ago, engineers, builders and other consultants had little input in "design." They were given designs to respond to. Today, the highly technical process of designing buildings, combined with advances in digital technology, begs, if not necessitates, collaboration between all players from the very beginning.

In this way, ownership of a solution is now defined by a multidisciplinary team, not an individual. Architects will continue to guide dominant aspects of design, but the solution is no longer coming from a singular source. These multidisciplinary overlaps offer an exciting change in the profession. Redundancy is eliminated and a more holistic and shared vision is achieved. As architects, we must continue to lead from a broad perspective, protect what is most important to a design, and embrace the potential of our new shared roles and responsibilities.

**Case Study: Basrah Sport City**

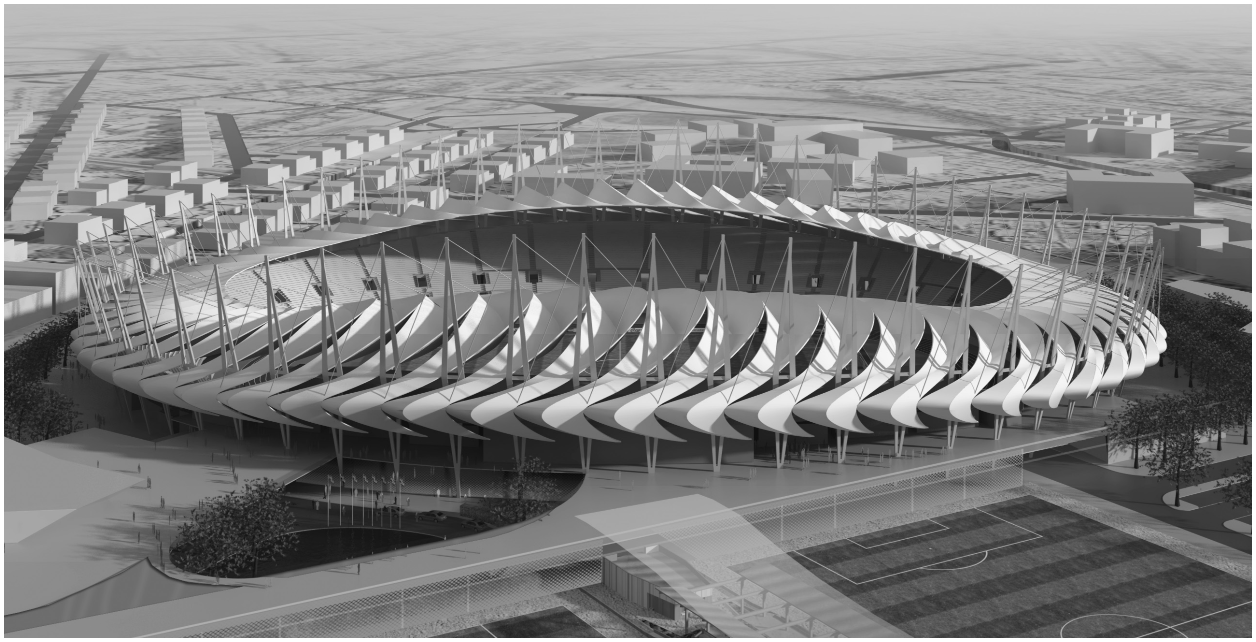
Basra Sport City is a multi-phase, multi-venue, mixed-use complex initiated by the selection of Iraq to host the 2013 Gulf Cup of Nations, or Khaleeji, a biennial soccer tournament for Arab countries. The centerpiece of the initial, $500 million phase of the project is a 65,000-seat stadium designed to international-competition standards for soccer and track and field. Also included in phase one of the project is a 10,000-seat secondary stadium, four training soccer fields, team housing, and a fire station, among other facilities and infrastructure.

Logistics have been a core challenge of the project. In addition to the number and diversity of venues being designed, we have coordinated the work of a global design team including firms from Jordan, Egypt, Bahrain, China, England, the United States and others. Adding to the challenge is the project's fast-track schedule, language barriers, and the fact that it is being constructed in an area that has been a war zone for much of the past twenty years. For these reasons, technology has never been more important. Its ability to facilitate quick response to continual unknowns and last minute surprises has been particularly valuable for this project.

In the case of the main stadium's skin, initial concepts were explored using a number of tools, both analog and digital. Once these early concepts started to solidify in terms of material and shape, they were shared with several potential fabricators to be used as the basis for schematic proposals. With the architect and structural engineer as reviewer, these proposals were submitted and negotiated with the contractor. Ultimately, a fiberglass fabricator was selected and scope was defined. It was determined that critical connection elements would not be in the scope of the fabricator and, therefore, the structural engineer was hired to design connections and manage tolerance with other skin elements yet to be fully designed.

Because of these unknowns and several design complexities sur-

rounding the fiberglass panels and connections, a more robust parametric model was quickly determined to be the best avenue forward. Using Digital Project, parametric control of everything from compound panel surfaces to connection details could be made adjustable and interconnected. In the beginning stages of modeling, we sat shoulder-to-shoulder with the engineer to develop a plan for attributes that would require adjustability. Expected changes due to cost and the unknowns of future design development played directly into our strategy, as simplicity remained at the forefront. Two profile spline curves and three edge curves elegantly defined all fiberglass surfaces, along with a host of other controls. Cost, quality, and design intent continued to be studied and refined by all parties without risk of substantial redesign, due to the parametric control of the model.



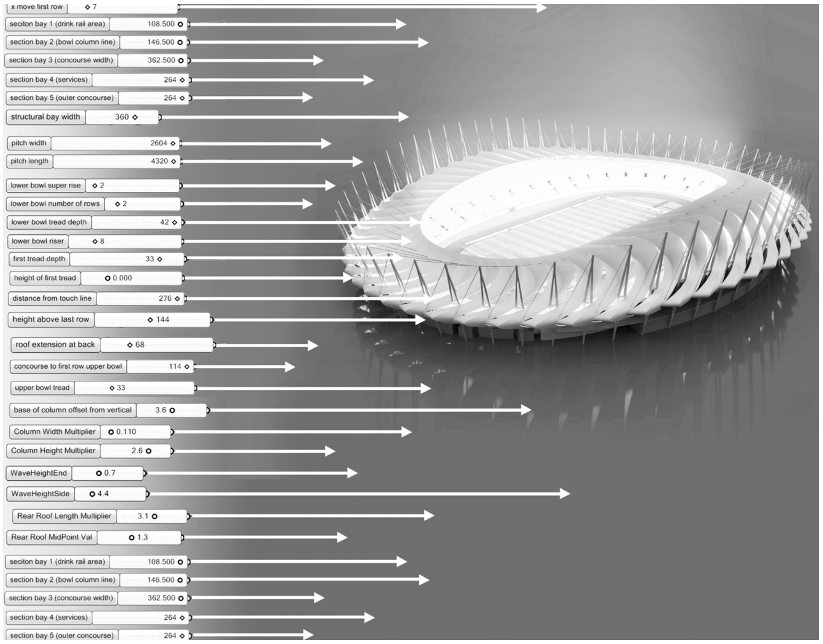
Specific advantages of this control included evaluating how molds would work with the tapered stadium mass. Two arcs made up the plan shape and with the skin leaning out at fourteen degrees, geometrically this necessitated a minimum of thirty fiberglass molds (ten sideline, ten endzone, and ten transition bay). However, this was beyond cost tolerances. Because of adjustable parameters identified early in the modeling process, it was easily determined that geometrical differences between these thirty molds could be made up in the adjustability of connections and "mold damming" to vary the length of the same mold. Thus, the ability to use one mold for the entire stadium became plausible and would be a huge cost savings. The ability to quickly and confidently prove this solution meant the difference between moving forward with the original design and a complete re-thinking of the concept due to fears of high cost.

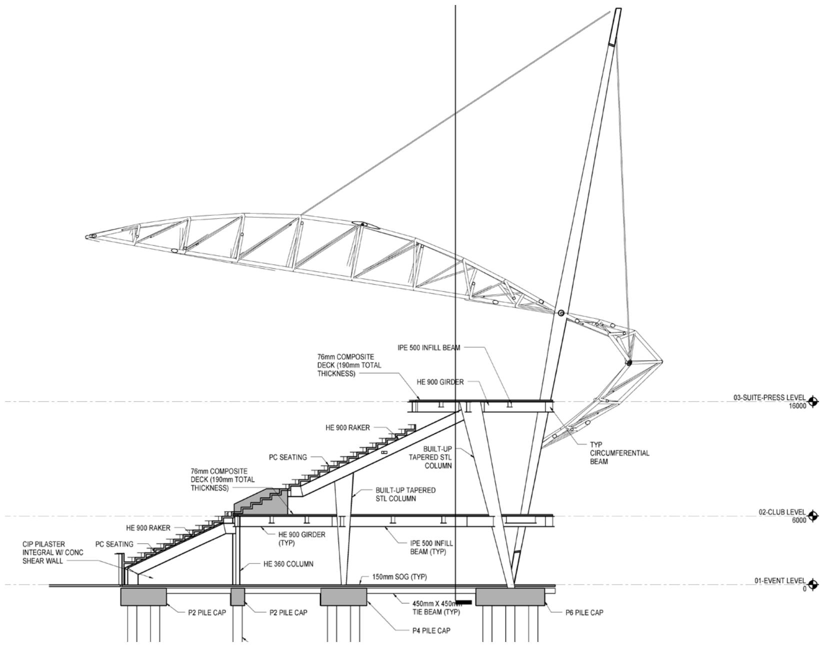
Later in the process however, because it was estimated that parts would be completed at a rate of one per day, the fabricator determined that a minimum of five molds would be needed to shrink fabrication schedule regardless of shape. Still within cost bounds, suddenly, the design was not bound by one shape. Again, through the parametric model, another scalar variable was quickly introduced into the skin model to provide the vertical gradation of panel height seen in the final design. This helped to increase shading higher on the skin while improving views lower down from the concourses. Traditionally, the opportunity to evolve the design further would have been impossible at this late stage, but due to parametrics, it was a simple exercise.

The counterparts to these massive fiberglass panels are the more delicate steel "column shrouds." They visually blur the large columns they cover by using a varying porosity of traditional Islamic patterning. This gradation was overlaid onto a traditionally-developed Islamic grid as a way of further expressing the broader project goal of respecting past traditions, while at the same time embracing the new and progressive future of the city and country.

Because of the pattern complexity and expected evolution of these shrouds, parametric control became an immediate need. The shrouds were acting not only as visual screens but also as mechanical exhaust vents in various locations. The ability to quickly examine and change the free area ratio was extremely valuable, as this requirement evolved throughout the design process. Additionally, changes in column size or pattern shifts resulting from structural analysis could instantly be addressed once the basic parametric definition was in place. This global control of complexity was extremely comforting as engineering analysis continued until it was time to place orders for steel. It allowed for substantial design study late into the process, as patterns could be quickly evaluated for aesthetics, performance and cost.

Furthermore, this pattern was intended to exist throughout the project site as a unique and recognized part of the Basra Sport City identity. Once design of the pattern was finished for the centerpiece elements of the main stadium, the parametric definition could quickly be adapted to a multitude of conditions. Athlete housing, VIP guest quarters, fire station and other venues all had several areas where this pattern was integrated. Screen walls, reliefs, swimming pool patterns and many other elements were quickly examined and executed within hours. Additionally, some evolved into slightly different versions of the initial definition. In the case pictured here, the change in porosity was achieved through




conditional statements, dictating additional lines be introduced based on distance from a given point or line.

One of the more compelling aspects of the design process for the main stadium skin and other elements around the site was the elimination of traditional construction documents. Instead, shared 3D environments were used to create a streamlined interdisciplinary workflow from concept to fabrication, with the risk of translation errors between parties virtually eliminated. This allowed for the strengths of everyone to be more effectively used throughout the design process and encouraged creativity to flourish in a collaborative, cross-disciplinary way.

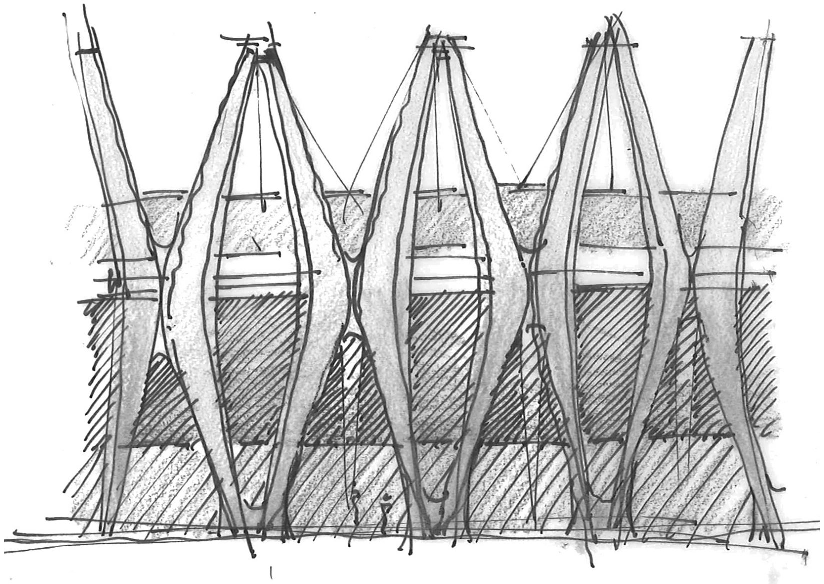
**Case Study: Al Menaa Stadium**

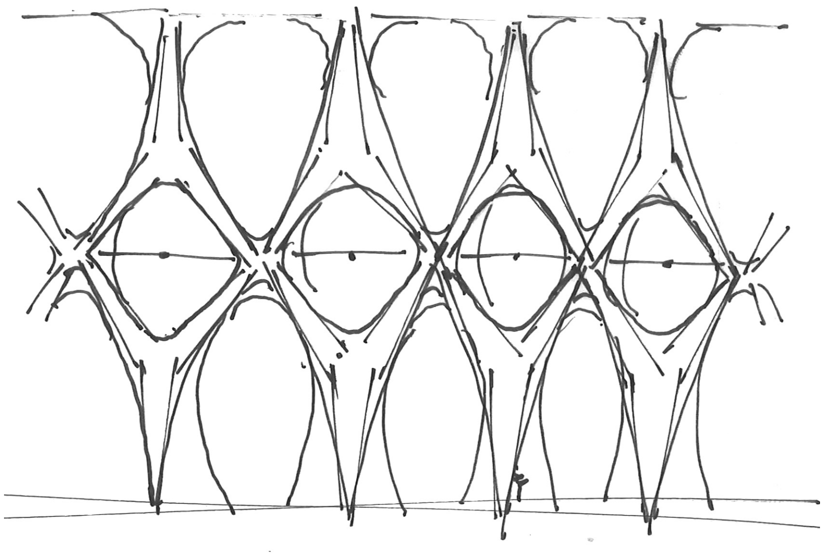
The next goal in exploring parametric systems was to define an entire 30,000-seat stadium, also in Basrah, Iraq. As in the previous example, after initial concepts were roughly established via a multitude of design tools, a list of adjustable parameters was developed for a parametric script that would serve expected architectural and engineering needs later in the process.

With the client goal of gathering more seats in sideline areas versus end zones, the solution developed for the stadium would inevitably lack repetition due to constant change in height and plan depths. The resultant complexity of this issue, in combination with complex curvatures of the roof design intent, suggested the need for parametric control of the entire system. Mathematical ratios for varying column heights, roof structural depths, seating clearances, number of seating rows, and a host of other interconnected variables were identified and integrated into the adjustability of the model. These customized functions maximized ease of exploration and adjustability once the system was in place. Expected internal design evolution, as well as potential client driven changes, were introduced ahead of time making the model increasingly nimble for future project evolution.

Additionally, the same file used to explore architectural goals was used by the engineer to evaluate stresses and resultant structural solutions. The shared platform eliminated the chance of misinterpretation, as well as the need to recreate information between architect and engineer. Another added benefit to information flow was the extremely small file size of models. This also added speed and clarity of communication to the overall process. To streamline even further, the parametric definition was linked directly into structural analysis software. Thus, there was no need to recreate separate SAP or even BIM models. Ultimately, everything was driven from the single lightweight parametric study model. Finally, the definition could be linked directly with environmental analysis software for near-real-time feedback concerning daylighting, acoustics, and other environmental impacts relating the stadium, site and surrounding context.

Besides the interrelated variables of the stadium itself, we were also linking the roof geometry to other elements on site, such as a time capsule monument requested by the client. In the model, the roof ridges and valleys are projected to a flat plane, and then assigned associated depths to create a relief pattern for a precast monument wall. Fabrication variables, such as relief depth and overall panel depth, are integrated for mold creation. As a result of this linking to the actual roof geometry, we can continue to evolve the stadium design and the monument relief will update automatically. It was a less expected use of parametrics in our process and is a good example of creatively identifying connections between seemingly unrelated elements.

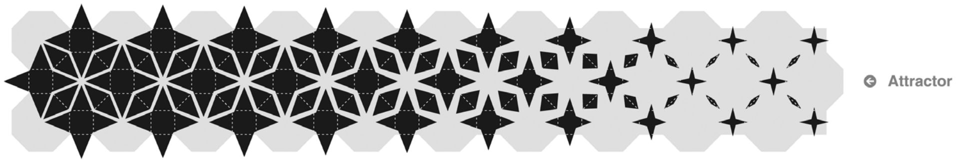




In terms of design exploration, one of the more interesting observations was that, while accidental opportunities surfaced, they were less frequent as compared to other software platforms. Therefore, it was still quite beneficial to use other digital and analog techniques when exploring concepts. These studies ultimately helped to more effectively determine the parametric variables desired within the definition. For me, it further reinforced the need to embrace a diverse toolset when designing. From the pencil to parametrics, the tools used in this process were all bringing different kinds of value to the exploration, making for a better and more informed design.

As for speed, it was yet another compelling case where the ability to move quickly was never more critical, as the entire effort spanned only three weeks, including animations and other presentation efforts. Particularly in design competition situations, strong conceptual foundations have been essential, even before a project is awarded. After contracts are signed, even though parametric foundations can keep further evolution nimble, the ability to start over is at that point difficult due to the level of work already embraced by the team and client. Thus, design conviction becomes essential very early. This would not be possible without the power of technology.

The latest advances in technology remind us, in a big way, how much tools can affect the end product. As always, they're all about the design process getting faster, as well as better. Getting faster is readily understood. It's the getting better part that goes to the heart of the matter. Generative and parametric tools are giving architects, engineers and builders the ability to build, test and optimize models in real time, with the key drivers of a project directly informing the lines, shapes and geometry of the design. By their very nature and how they interface, these tools are forcing new thinking and opening new ways to navigate design problems.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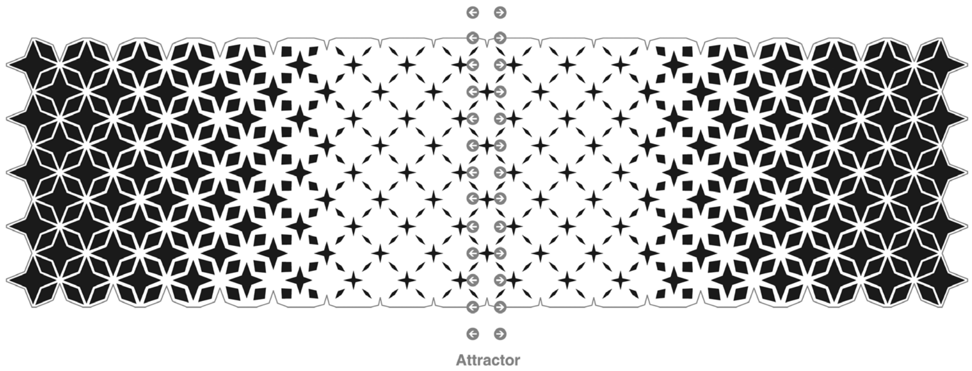
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