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May 2006

The Aquatic Centre + Precedents

Aquatic Centres are often seen in grand scales constructed for events such as the Olympics or on the scale of a community centre. The Community Aquatic Centre Competition calls for a complex that provides communal interior and exterior spaces. These spaces must house three pools, a concession, and some outdoor recreational spaces. In reality, the given lot of land is at a decent scale for a community but nothing grand like Olympic settings (Figure 1 + 2).

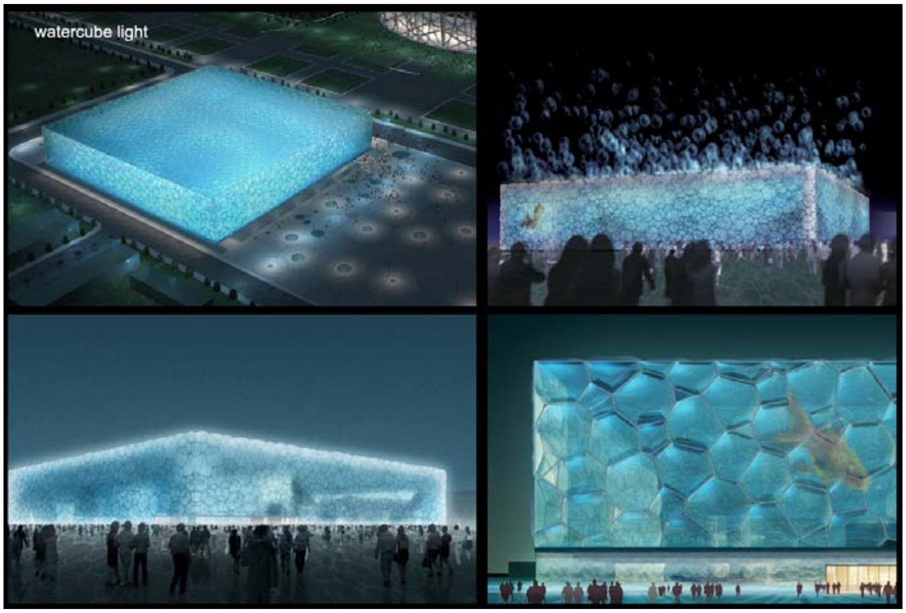

Figure 1
2008 Beijing Olympic Aquatic Centre, Vector Foiltec

In the beginning, it was easy to over reach in scale while picturing forms and shapes that can speak to the source of entertainment provided by the Aquatic Centre, water. Wavy forms and curvilinear schemes were explored and some precedents found that demonstrate unique structures and forms that relate to water. It is easy to look at larger scale construction that might seem attractive in its respective context but would become very alien or monstrous in a community setting. Early in the process, inspiration was found in architects such as Santiago Calatrava for an interesting steel structure design. In particular, examples of bridges and foot bridges that have an over-arcing spine-like structure with tension

Figure 2
2012 London Olympic Aquatic Centre, Zaha Hadid

members connecting to supporting ribs at the underside (Figure 3 + 4). Using these bridges as a launch pad, some ideas about framing parts of a building to the spine were tested. The idea of a bridge over water (pools) was intriguing and exploration of creating a walkway-like structure hovering above the pools that also supports the building was carried out.

Figure 3, 4
Campo Volantin
Footbridge, Bilbao
Spain, Santiago
Calatrava

Other sources of inspiration were found in different types of buildings. Whether curvy, irregular, rectilinear or a mixture of both, these examples showed interesting ways to create the form of a building. The Cellular Operations Limited building in Swindon (Figure 5) intersects a curving volume of glass with a rectilinear enclosed block. The two volumes intersecting might be a programmatically sound way to deal with the two types of pools in the aquatic centre, competitive and recreational. The curving glass façade was an interesting study to look at, and there was certainly no shortage of innovative connection and joinery of skin to structure (Figure 6)

Figure 5 Cellular Operations Limited in Swindon, Great Britain. Richard Hywel Evans.

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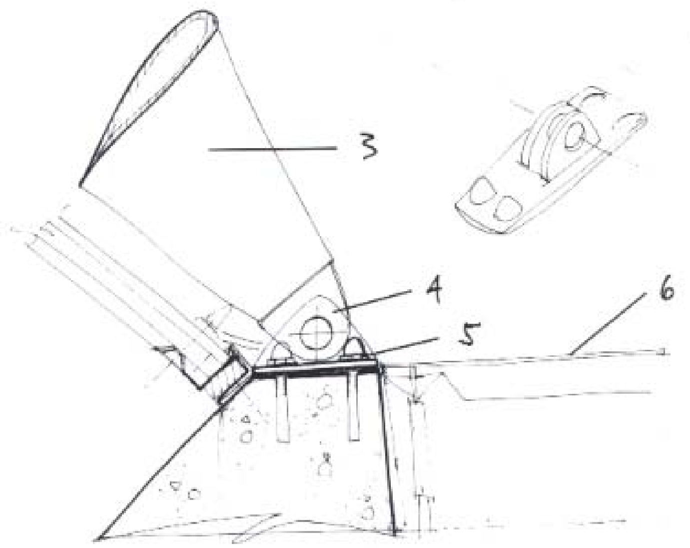
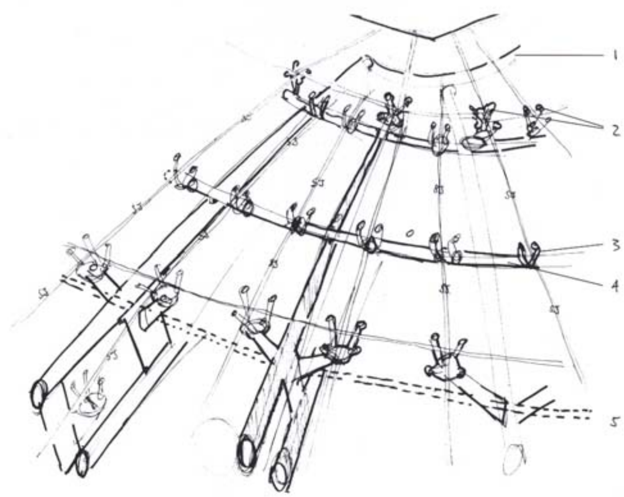
Figure 6

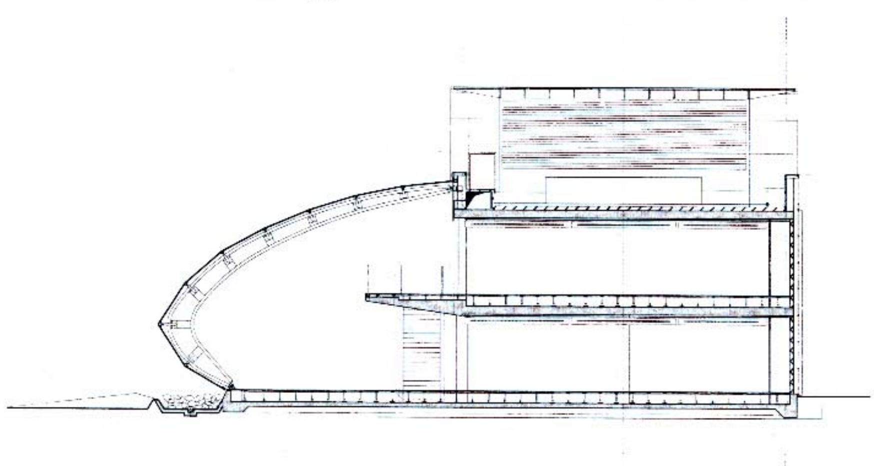
Cellular Operations Limited joinery and connection details.



Foot and support of the steel structure.



1 Crown
2 The spiderlike structure on the two-way silicon joint are fixed to ring-shaped girder
3 Two-armed spider-structure for ring-shaped girder only
4 Ring-shaped girder
5 Ring-shaped girder replaced by "spider" arms



Section BB 1:400

Other interesting feats can be achieved in steel in more rectilinear forms as well. In Toyo Ito's Sendai Mediatheque, the structural system becomes a main feature in the spaces as they penetrate through each floor slab in dynamic forms. Through visual connection between the floors, having the structure broken up into tubular parts, and allowing light to penetrate through at these points, the structure feels very light (Figure 7).

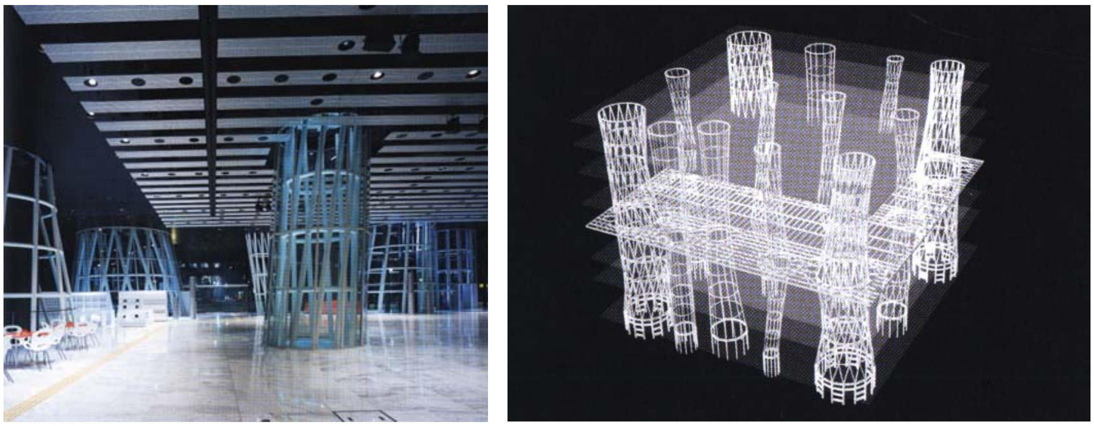


Figure 7
Mediatheque, Sendai. Toyo Ito

The Printing Centre in Rendsburg achieves lightness in its form by lifting the upper volume on a colonnade of columns. Mostly clad in glass, a feeling of openness and lightness is generated. (Figure 8)

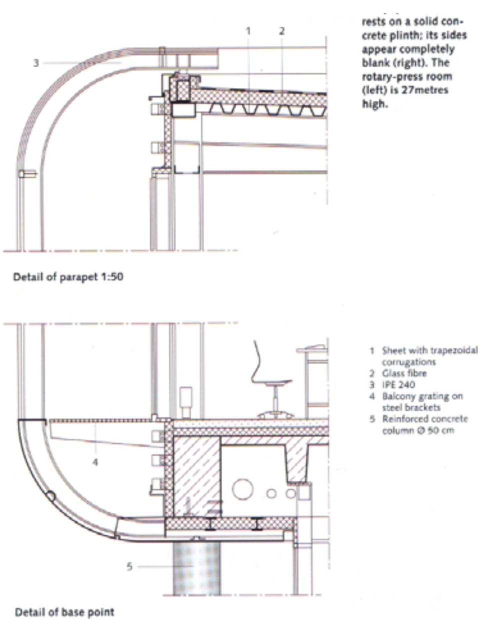


Figure 8
Printing Centre in Rendsburg, Germany.
Architekten Bothe, Richter, und Teherani

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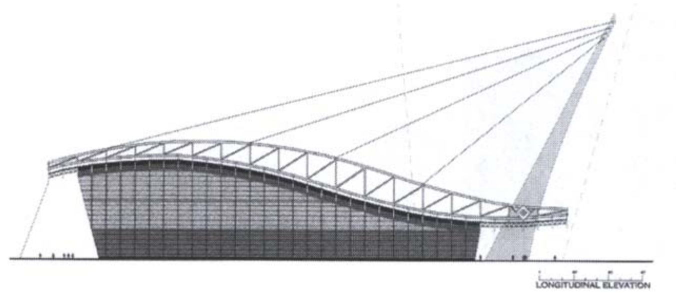
The Concepts

After looking at different forms and types of structures, experimenting with a bridge over water, various wave-like forms and grand gestures, a simpler direction was taken. The first concept that materialized involves three volumes with curvilinear roofs of varying curvature and heights on each volume that form a wave-like roof line (similar to Figure 9 + 10). The structure would be a system of curving triangular trusses supported by columns at the perimeter of the blocks. The three volumes represented a different program, namely the competition pools, the recreational pool, and the core (admin, concession, change rooms). This concept, while creating an interesting form, takes up a majority of the lot. By placing all programming on the ground level would mean very little to no additional exterior space for outdoor activity. Keeping in mind the desire to create large, open, useable communal spaces, alternative ways to lift part of the building up off the ground to free up more space on ground level had to be found. Giving back to the community was very important in a limited lot meant for communal use. This changed the strategy in programming the interior spaces and the type of structure to use as well.

Figure 9

Award of Merit for ACSA Structural Sections Competition 1999-2000



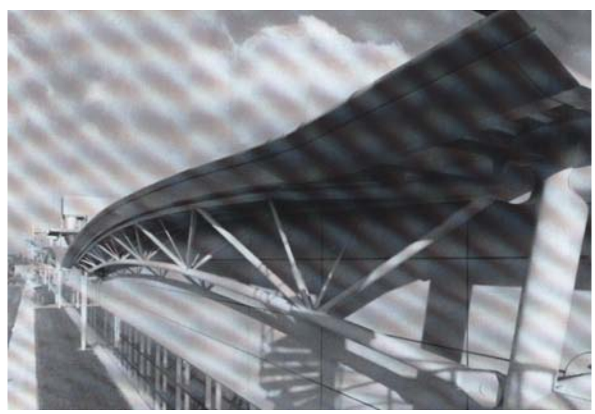


Figure 10

Curved Triangular Truss

The second concept was formed by separating the pools into two volumes and moving these volumes around. The result became one volume containing the recreational pool lifted off the ground one-and-a-half storeys high intersecting another volume which contains the swimming/diving pool. The resultant space at the intersection forms an important double height communal space for the aquatic centre users as well as the larger community. This junction provides the core circulation, admin, entry, and concession areas and is thus programmatically resolved. An advantage to this design is the amount of ground level exterior space left free of obstructions. A structural system or systems must be used to allow these volumes to contain large, open spaces.

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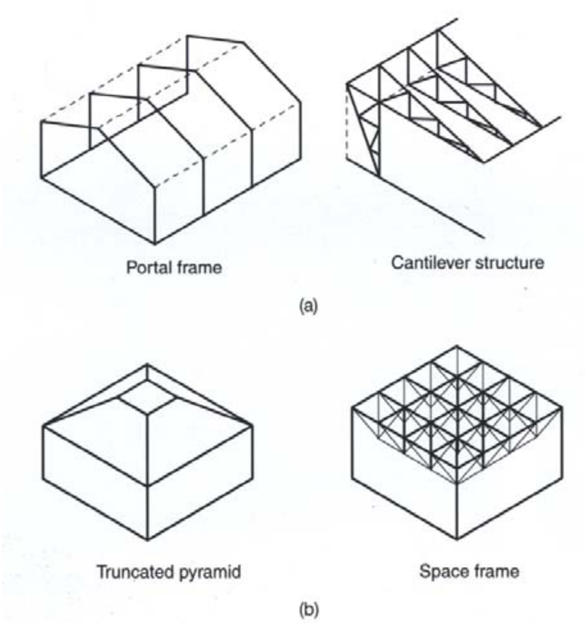


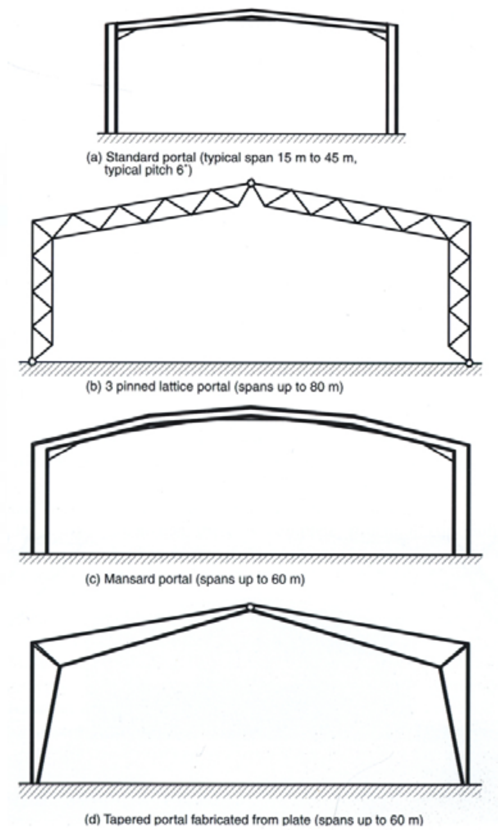
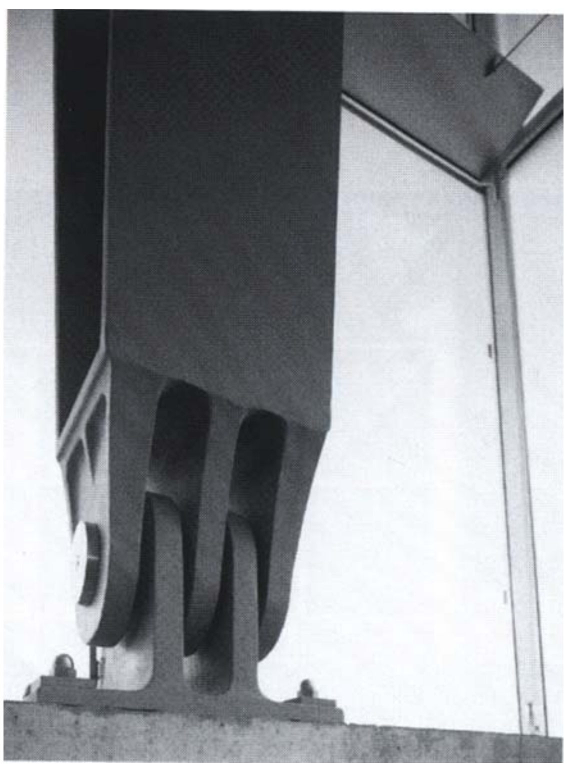
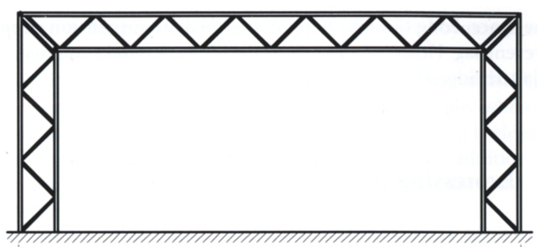


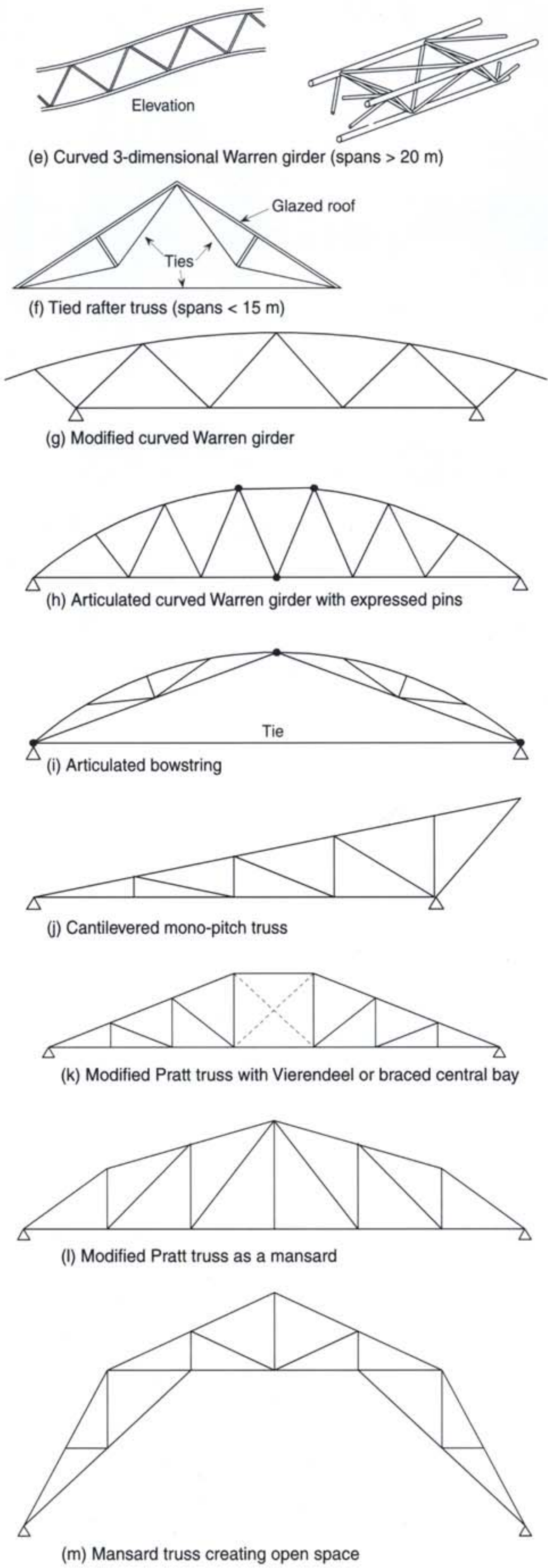
Figure 11
(Above) Framing strategies, (Right) Portal framing, (Below) Pin joint connection





3.11 Long-span portal frame used to create an arch structure

3.12 Tied portal frame used at Clatterbridge Hospital (architect: Austin-Smith: Lord)



1.12 Stuttgart Airport Roof using tubular column 'trees' — see also Colour Plate 9 (architect: Von Gerkan Marg & Partners)

1.13 Tubular trusses at Kansai Airport, Japan (architect: Renzo Piano Workshop)

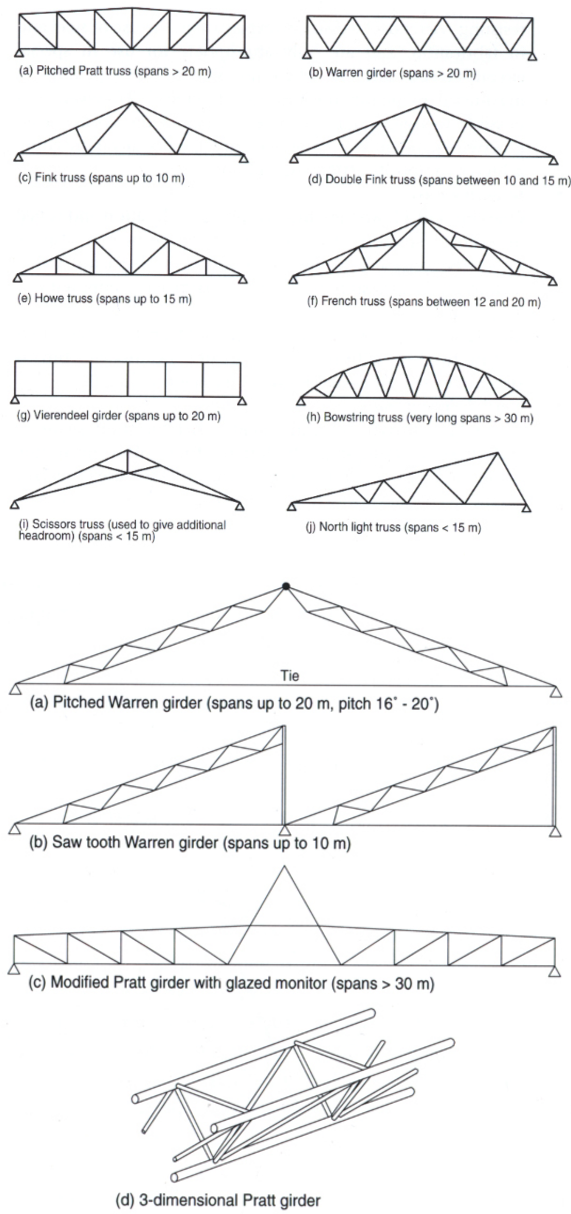


Figure 12
Truss and girder strategies

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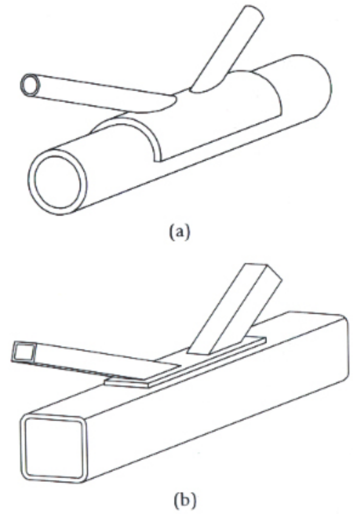
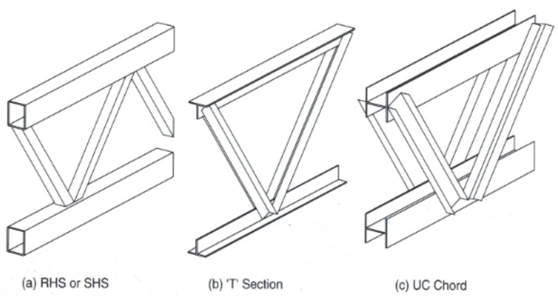
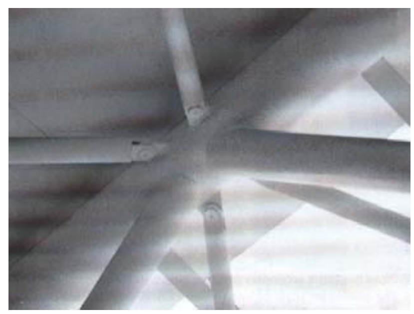
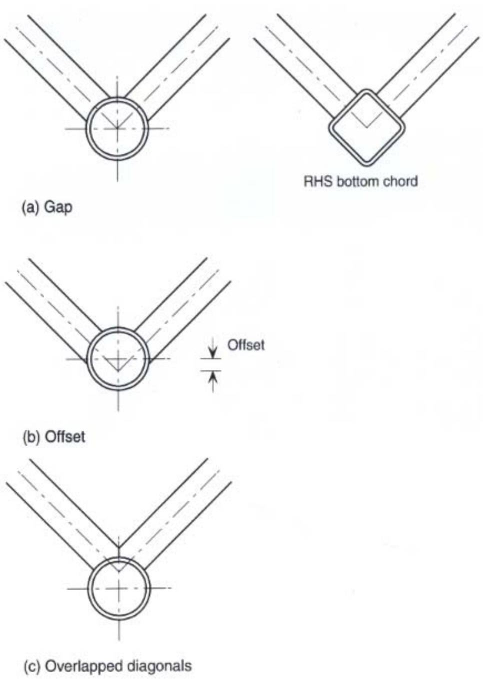
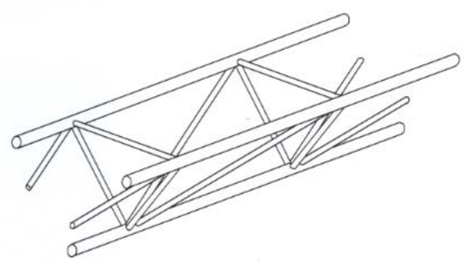


6.29 Reinforcement to tubular sections to increase their local resistance to forces from the bracing members: (a) saddle reinforcement; and (b) flange plate reinforcement

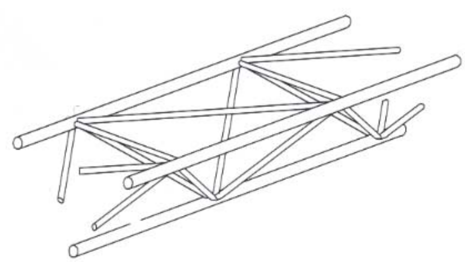






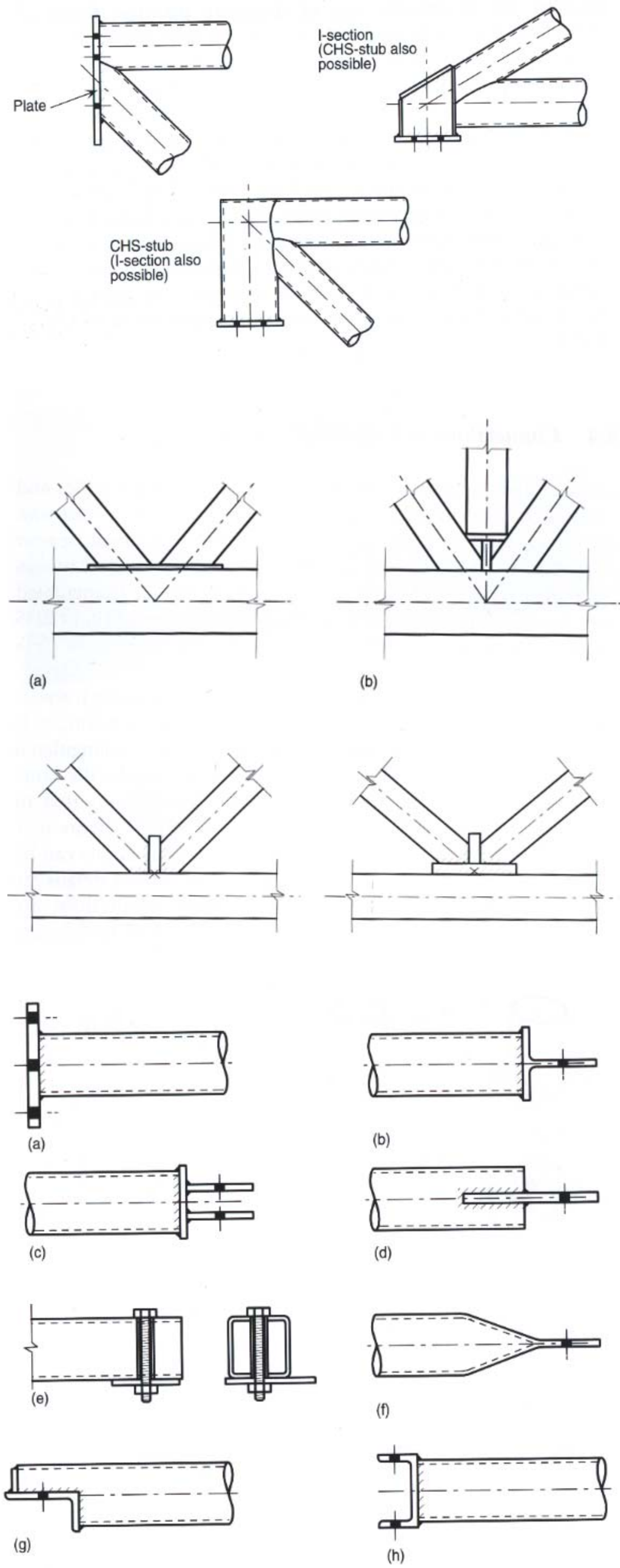


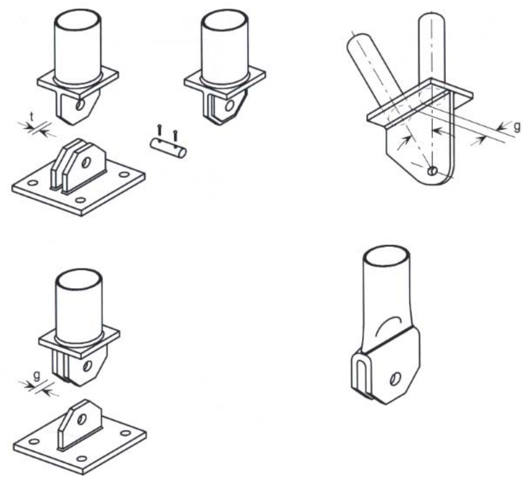
(a) A relatively complex member requiring precise cutting, welding and grinding of the joints (see Colour Plate 23)

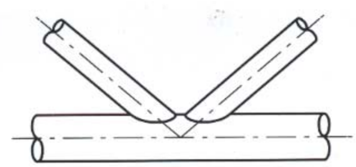


(b) Simplified connection detail

Figure 13
Tubular truss examples and connection methods

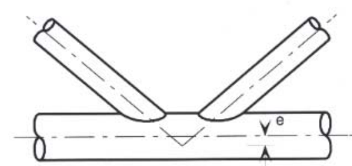




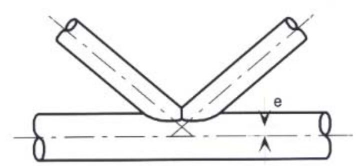


Gap joint noding

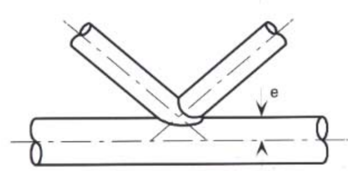
6.17 Illustration of the alignment of centre-lines of tubular members in a welded connection



(a) Gap joint with positive eccentricity



(b) Partial overlap with negative eccentricity



(c) Total overlap joint with negative eccentricity

6.18 Examples of noding with modest eccentricity

Figure 14
Tubular truss examples and connection methods

The Design + Structure

As part of the research process, innovative and traditional ways of putting together the skin and bones of a steel construction building were looked at. Different parts of steel construction were examined for how it contributes to the form and function of the building. Different trusses, columns, joinery details including connections to glass facades and framing strategies were researched and they inform some of the decisions made about structure and form of the aquatic centre (Figures 11 - 14). The Toyota Showroom in Swindon, Great Britain shows a tubular triangular truss system supporting a skylight roof (Figure 13 top left corner). This image was a starting point for the design of the competitive pool area structure. Figure 14 informs the complexities in the welded and bolted connections in designing a tubular truss system.

There are three primary structures at work in the building, all of which are exposed. Programmatically, there are three spaces created by the intersecting volumes: the competitive pool area, the recreational pool area, and the core. The two primary volumes are clad in separate strategies and in each volume there is a unique structural system designed for that space.

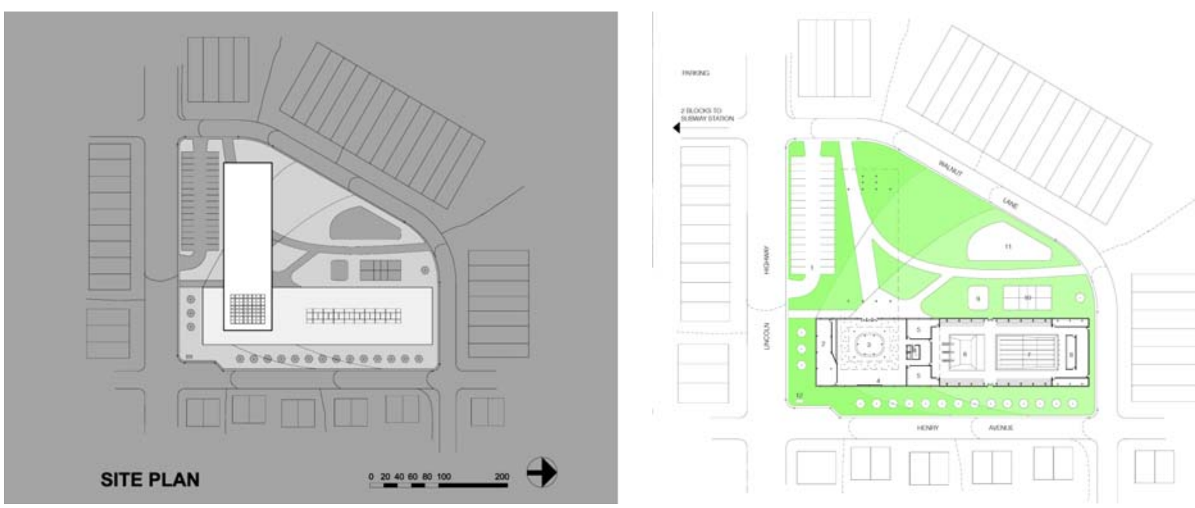
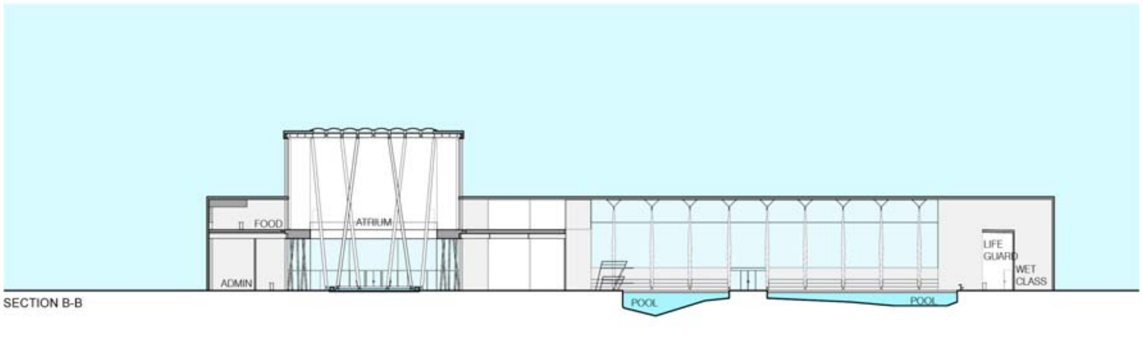


Figure 15
Competition drawings showing site plan and ground floor plan



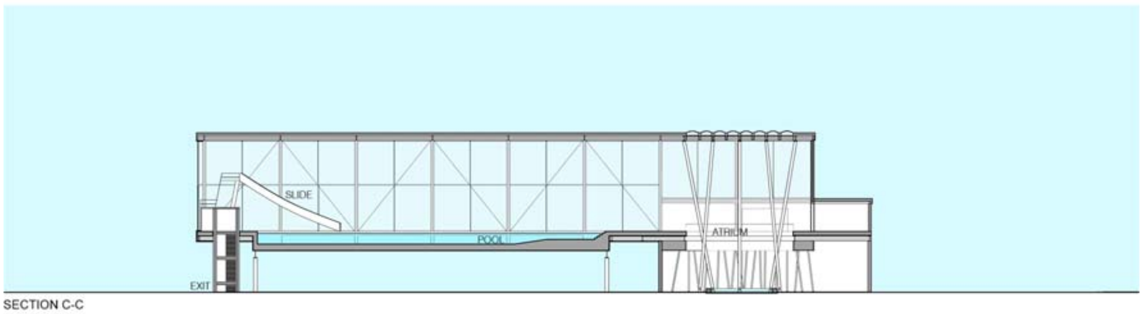


Figure 16
Competition drawings showing sections at competitive and recreational pool level. Drawings also show the intersection that forms the atrium space and surrounding support space

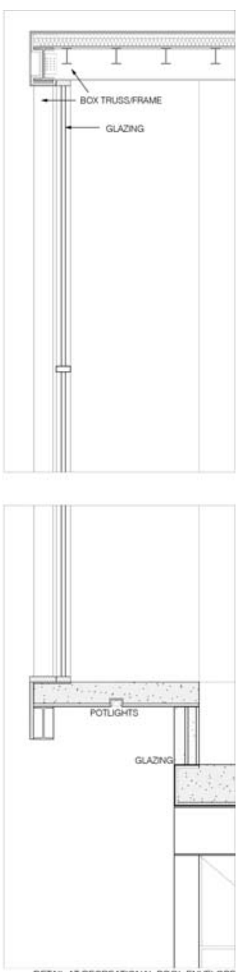


Figure 17
Competition drawings showing section at recreational pool level building envelope.

The volume containing the recreational pool becomes an esthetic feature of the building and in the community. A glass box lifted off the ground feels light and airy in the day and glows like a light box at night. As an oasis lifted above the roofs of this urban community, this volume requires a structural system that contributes to its lightness and openness. A structural box truss frame with tension rods for reinforcement was used to keep the volume rigid. This box frame incorporates a deep concrete slab that contains the recreational pool. The underside of the pool slab follows the shape of the pool. The whole system is then lifted up off the ground one-and-a-half storeys high and supported at four points. Columns are located at both ends of the pool's underside, at a structural exit stair and at another end near the entrance and again by poles in the atrium space. The roof is typical metal decking with a parapet and the glass is framed on the inside of the exoskeleton-like box frame. Glazed on three sides, the openness is achieved and creates a contrast to the other more enclosed volume. The dialogue at the atrium between the open and enclosed volumes creates a dynamic space.

Figure 18
Competition rendering showing interior of recreational pool.

The ground level (level 1) pool was placed for ease of access as well as to suit the regularity required for competitive pools. The volume is enclosed except for 2 large openings in the pool area exposing the structure within. These windows allow the public to view into the pool area thus establishing a closer relationship with the community. A triangular truss system supported by a series of uniquely designed columns with pin connections at the base provides an open obstruction-free space for the pools with columns only at the perimeter. The esthetic, along with ease of construction, is achieved by repetition of the structural members creating a portal-frame-like system.

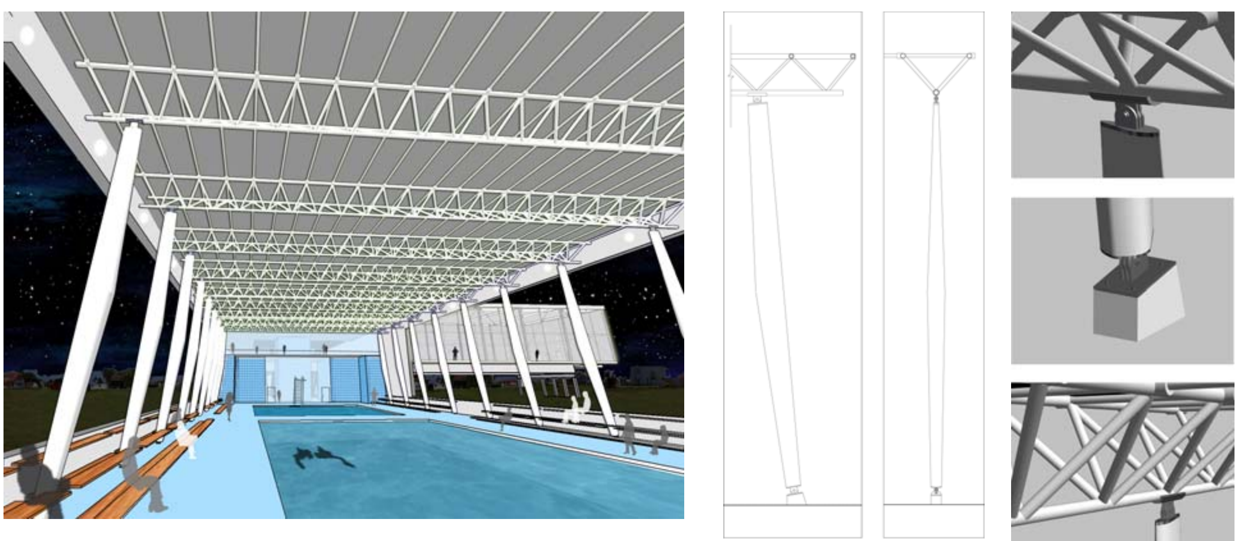


Figure 19
Competition renderings showing interior of competition pools and framing details.

The atrium space is created from the intersection of the enclosed competitive pool volume and the open recreational pool volume. This space includes an entrance lobby, administration offices, circulation (elevations and stairs), viewing platform, concession and eating area. While mostly enclosed on the lower level, the intersection with the glazed upper volume creates a series of clerestory windows. With the addition of a skylight system, the atrium becomes a more dynamic space. A system of large poles (hollow tubular sections) bolted at each end holds up the skylight roof structure. These large poles reach up through the double height atrium making visual and structural connection to both volumes and create continuity in this circulatory and structural intersection. Another forest of small poles constructed in the same way hold up the floor of the upper volume. These poles while seemingly random are in fact strategically placed to resist the loads carried down through the roof and the floor resulting in an interesting pattern. Each large pole is painted a bright colour for visual interest and becomes a main feature in the lobby. In addition, a feature wall with flowing water and a large fountain pool integrates the element of water.

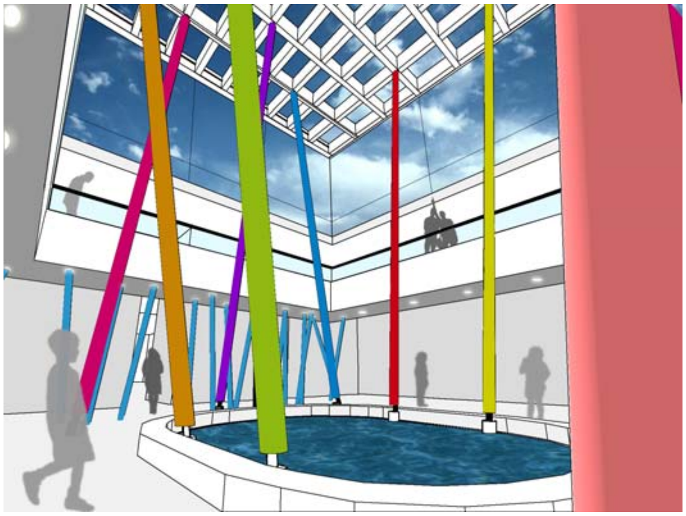


Figure 20
Competition renderings showing pole details (above), and interior of lobby entrance in atrium space (right).

A great advantage of this scheme was the amount of exterior space made possible even with a fairly large building occupying the lot. A park-like atmosphere was generated through a gradual sloping site with grassy, open spaces, foot paths, a volleyball court, a sand box, and a water fountain/wading pool. With the recreational pool lifted up, it is possible to walk through the site from one end to another in the North-South direction allowing pedestrians to be fully engaged with the entire site. The park area is also very viewable and accessible to the surrounding community and the lot becomes a public “backyard” to the community.

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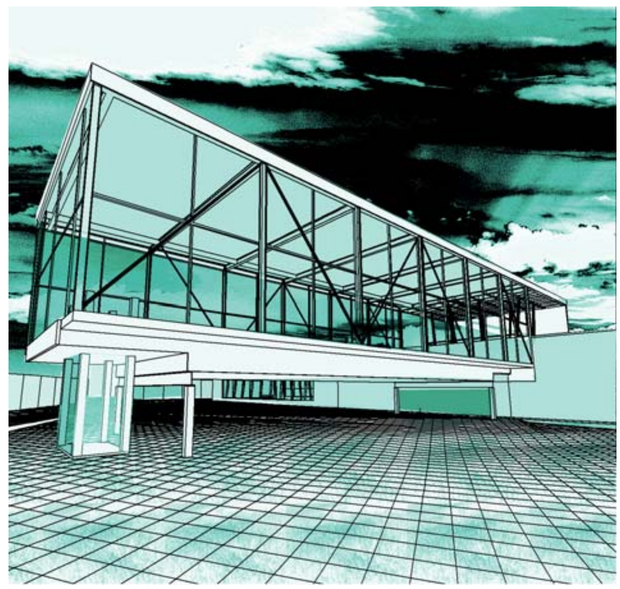
Conclusion

Given the scope of the competition, with primary building material and program tightly defined but the form and structure open, it leaves the student with infinite possibilities of design. Often, initial ideas seem to run away with ones imagination looking to grand and flashy precedents and schemes. However, keeping in mind the kind of context the Community Aquatic Centre is situated in, an urban community of low-rise housing and the size of the lot, the integration of this building into the community calls for an approachable, comfortable, and useable space. The finished design is not one that screams for attention or dominates the urban landscape but achieves structural integrity and is visually pleasing in its own right. The spaces are welcoming, open, and functional while the structural members achieves great feat, simply. By using the power and flexibility of steel, a simple building becomes interesting to look at and be in.



Web Sites

1 – "Vector Foiltec Wins Contract for Beijing Olympic Aquatic Centre", PR Web. http://www.prweb.com/releases/2005/5/prweb241809.htm. (May 2006) [Figure 1]
2 – " Zaha Hadid London Aquatic Centre" 40 Artists, 40 days, Tate Online. http://www.tate.org.uk/40artists40days/zaha_hadid.html (May 2006) [Figure 2]
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3 – Burkhard, Frohlich, "Metal Architecture", Birkhäuser, 2003. [Figures 5,6,8]
4 – ACSA/STI Hollow Structural Sections Student Design and Engineering Challenge (Summary) 2000-2001 [Figure 9]