Towards an Appropriate Technology

The Need To Bridge the Divide in Architectural Education Between Those Who Fear Technology and Those Who Are Seduced by It

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ABSTRACT

The pressures of building procurement frequently leave us with an Architecture bereft of meaning and constructional coherence. It is also a fact that in the field of technology, the means exist to resolve this problem.

The rate of technological advance is breathtaking. In education there is neither the resource nor the hardware to fully take advantage of the latest technology. We believe that a role is not being fulfilled in Schools of Architecture in this respect and that new teaching tools must be developed now. We will develop this thesis through a discussion of our own proposal for a computer based teaching package, allowing an exploration of architectural form through the process of analytical and aesthetic manipulation of components.

INTRODUCTION

In Architectural education there is a need to develop the way in which students can apply the knowledge gained through oral presentations, in the form of lectures and seminars, to their project work. A wealth of information is available to students in the form of technology teaching. It is wholly inadequate that this information is typically applied to their project work via the use of cardboard models and sketches on paper using a drawing board, set square and ruler. This is a time consuming process and a technique that leaves limited scope for further imaginative experimentation and testing. The architects of the future will find themselves having to be as versatile as Leonardo Da Vinci, an artist, sculpture, scientist, inventor, and a predictor of the future.

Few of the world's finest monuments have been designed primarily by architects. Examples range from the Pyramids, Stonehenge, the Churches of the Gothic, Baroque and Renaissance, the great bridges of the Western European Industrial Revolution and the Eiffel Tower.

Whilst much of the architecture of the modern movement had more to do with form and surface than a true exploration of technology, the work of architects such as Jean Nouvel with the Arab Centre in Paris, Norman Foster, with the Sainsbury Art Gallery and Office Block, William Owens, Meis Van Der Rohe and many others began, for the first time to fuse the roles of the architect / engineer / technologist. This trend has continued through the work of Architects such as Peter Rice, Tony Hunt, Ken Yeang, and most spectacularly, Calatrava.

Conservation is perhaps the "buzz - word" of the present era. What is meant by conservation when the term is applied to Architecture is the need to develop an approach to the environmental control of buildings which will limit the destruction of our fossil fuel resources. Clearly this is necessary in order to prevent any further increase in the global warming of the planet and to stem the destruction of our planet's natural evolution as we present day humans envisage it. We are constantly reminded that the environmental control of the indoor climate of our buildings accounts for approximately fifty per cent of the world's energy consumption, and it is hardly a surprise therefore that we should be concerned. However, our concern does not seem to be producing any significant changes and we are told that we continue to slide into increasingly warm oblivion. Surely, therefore those who are responsible for educating students of Architecture could do more to educate future generations?

Conservation of all forms of energy can be considered even at the relatively small scale of architecture and construction. In schools of Architecture this subject is rarely touched upon. However those, relatively few, architects who both practice and teach are acutely aware of the effect upon energy consumption that construction sequencing can have. Current teaching tends to concentrate on the energy consumption of the building once in use and construction sequencing is something students simply do not consider It would not be difficult to simulate construction sequencing in order to allow students to explore the numerous methods of jointing and connecting different components, and to go on to explore other critical aspects of construction including the physical manipulation of components, either by people or by robots. This might have further "spin - off" benefits such as an understanding of safety aspects of construction work on site. Again, those involved in actual construction are acutely aware that current legislation with regard to Health and Safety is heavily influential to the construction process and to the assembly techniques adopted on site. These are all issues, which those who preach "design" as a subject of purity on its own ignore with startling arrogance. An increased awareness of safety and the continued refinement of both services and building components demand an educational pedagogy that responds to this and takes inspiration from the likes of Calatrava.

If, in addition to the points outlined above, we take a broader look at "conservation" and consider our environment, in particular the alarming loss of the world's Tropical Rain Forests, we should not only consider carefully the type of timber we use for construction, but also the amount of paper we use.

It is now possible for architects / engineers to learn more and faster through an ability to visualise via 3D imagery on computer screens. The separation of the two professions due to an inability to communicate ideas may perhaps be bridged through this means of interaction. In addition however, we believe that a more interdisciplinary mode of education is also necessary.

In addition to highly technical and problem specific research, there is an urgent need for input into education to allow a rapid and meaningful exploration of components and forces by future generations of architects / engineers in order that the benefits of technology are put to constructive use. The comparative isolation of architectural education in the past, which to a large extent is still a phenomenon that exists today, cannot be allowed to continue. We must develop new teaching techniques and exploit new technologies if we are to change this.

The use of self teaching techniques will be relevant in the future due to diminishing time and resources allowed for teaching and discussion. This seems inevitable. It is an unfortunate fact that, as more people take advantage of education, governments are not responding with increased funding. The ratio of teaching staff to students is worsening on what feels like, to those of us who have to cope, a logarithmic scale. If a reasonable tutor to student ratio is no longer possible then we must take advantage of all available forms of individual learning possibilities, and critically, we must develop more.

At the School of Architectural Studies at Sheffield University we are proposing to develop a computational visualisation tool for use by undergraduate architecture/ engineering students in order to demonstrate a range of possible three-dimensional solutions to steelwork constructions. The use of such a tool by students will increase their awareness of the complexity of these structural problems, and enable them to make assessments of the aesthetic impact of different types of steel constructions in their design .

What does a student need to know in order to consider how best to construct a building? A generalised understanding of the type of structure to be used, whether load bearing, frame or tension is clearly the first consideration. This leads to the need for an awareness of the different types of materials that are available in each case. Load bearing construction will generally mean concrete and brick; frame construction can be as varied as timber, steel, aluminium, concrete, and reinforced brickwork. Even within these broad - headings there are concealed a further myriad of techniques, for example, timber frame can mean platform frame, balloon frame, specialist techniques such as green - oak construction and so on ad infinitum.

Comprehension of how these materials are connected to allow for structural forces as well as how the connections are physically achieved is essential if students are to produce coherent design projects which embrace a design philosophy, or approach, allied to an appropriate expression of constructional detailing. If these two components of the design process do not coalesce it is simply not Architecture.

The means of assimilating all this knowledge is usually through lectures, research drawing and sketching and model making to visualise and explore an idea. This is effective eventually, but it is slow and limiting, and it exerts an enormous drain on teaching resources. Developing a simple self - tutoring package to allow students to simulate structural design and assess component assembly options using computers could speed up the process of exploration and learning in the drawing and assessment stage.

We are proposing to develop a computational visualisation tool for use by undergraduate architecture students in order to demonstrate a range of possible three-dimensional solutions to such steelwork constructions. The use of such a tool by architectural students will increase their awareness of the complexity of these structural problems, and enable them to make assessments of the aesthetic impact of different types of steel constructions in their design.

The graphical depiction of structural steelwork is a highly complex three-dimensional problem. A typical junction will often be made up of several intersecting members coming from any number of different directions. Resolving the geometrical problems to produce satisfactory junction details is a complex issue. The resolution of these types of problems using traditional drawing methods is beyond the experience of architecture students to successfully resolve.

Our teaching experience has taught us that students of Architecture are keen to explore the potential of using steel frame structures in their studio design work. However, the problem they face is how to evaluate quickly which of the daunting range of structural components available would be the most appropriate for their particular project. For example, should they use circular, rectangular, or I section beams? Would a lattice or space frame structure work better?

In order for students to arrive at meaningful answers to these and other questions, it is necessary to equip them with a means by which they can explore the junction details between columns and beams, primary and secondary structure and so on, in order that the full implications of their structural decisions may be understood.

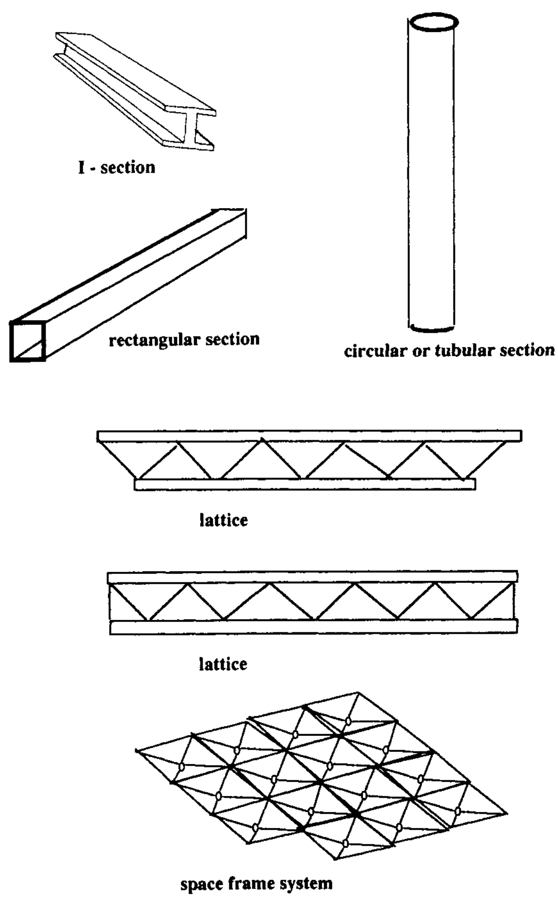
Although students have a reasonable awareness of the range of sections available, they are inhibited from experimenting with different forms and assembly configurations due to the enormous time constraint of having to physically draw these often complex forms in order to assess their possibilities.

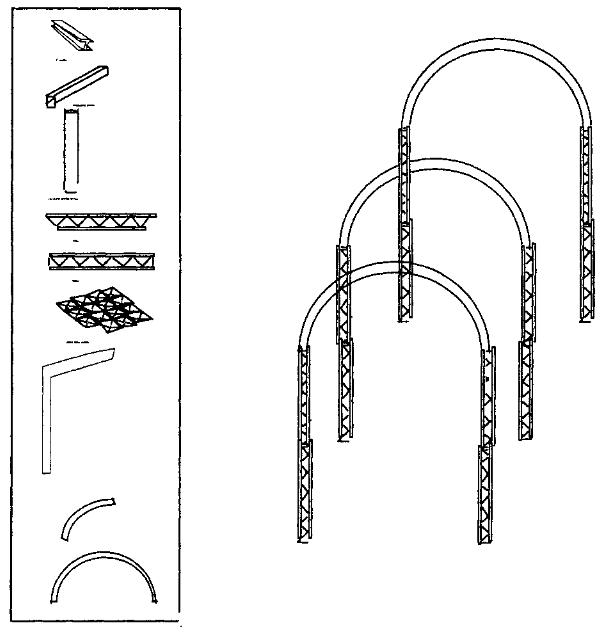
A computer program would equip students with a palette of steel sections from which any number could be selected to form the design. These may then be assembled in a variety of configurations to produce the required shape and viewed as a 3 dimensional form through 360 degrees.

The initial objective of this project will be to allow students to describe a design problem associated with the design of a steel frame structure using a variety of steel sections. The computer system will allow experimentation with a range of sections to form the initial frame (i.e. beam and column), and exploration of the entire form, including structural logic and assembly sequence through 3 dimensional views.

The proposal is to create a library of steel forms to present as a "palette" for students to choose from. This would involve the compilation of information on different type of steel sections available by means of CAD modelling. These will include I sections, circular and rectangular sections, lattice beams, and space frame systems, which can be used to create a steel frame form. Such a library would therefore be sensibly broken down to include structural primitives, structural compositions, a facility for the manipulation of elements, either primitive or composite, and a facility to allow an exploration of the options available for connecting the selected and manipulated components.

a) Creation of a library of structural primitives, for example, I sections, rectangular and circular sections ;
b) Creation of a library of structural compositions; examples of lattice components using primitive sections.



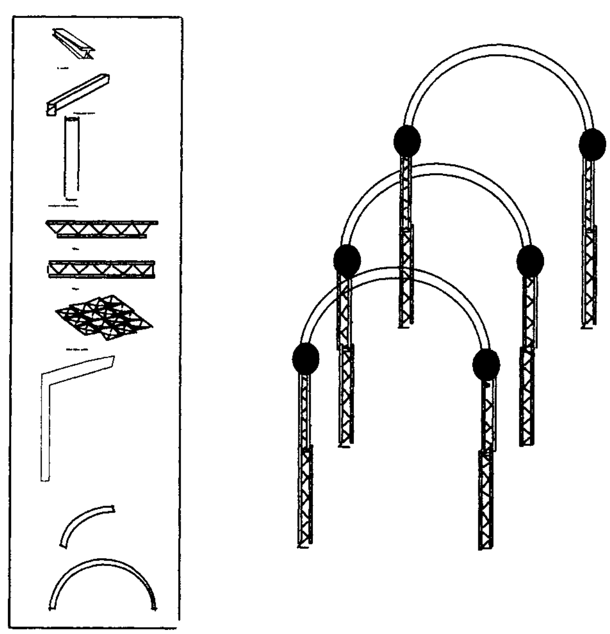


c) The manipulation of components

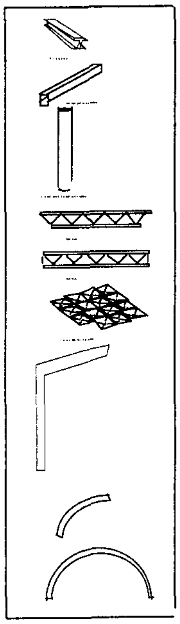
The student will then be able to select any of the primitives and or compositions to produce a desired form, to experiment with the design, and reject or develop the idea further. This will eliminate some of the time spent in sketching to assess initial ideas and allow for greater experimentation without the fear of running out of time.

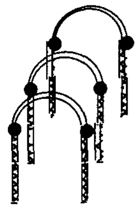
d) An exploration of the options available for assembling selected and manipulated components.

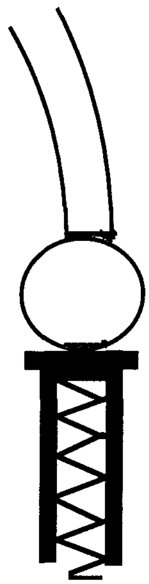
The student will now need to make a decision as to how to connect sections of steel. The major junctions are likely to be between columns and beams. There is the standard connection for bolting I sections to form column and beam construction, and riveting steel sheeting to the beams to provide the



formwork for a concrete floor. However, the most necessary investigation is the appearance of the column and beam junction when exposed as part of the architectural aesthetic, either internally or externally. This may involve the design of a special connection, which is a feature of the design, or may just be an investigation into the method of jointing steel. For example, options might include a welded joint, a bolted joint, or the use of riveting. These options and others may be explored, as well as allowing for the addition any special jointing design feature.







Possible joints requiring specialist investigation might include the connection of solid steel sections to cables, cables to cables, non structural elements such as cladding sheets to other non-structural elements, such as rails and purlins, and non-structural elements to structural members. This will again include riveting, bolting , welding, screws and the necessary waterproofing when screws are used.

The ultimate goal is for the student to be able to zoom into key junctions in order to be able to take a closer look at the assembly of the components and refine the detailing.

CONCLUSION

This type of teaching tool is only a means of allowing the rapid development of initial ideas. It will be of enormous value to beginners who are struggling to put their concepts into a form that they can visualise and, critically, can discuss with their tutor. It may also help more advanced students to experiment rapidly and allow an exploration of many more possibilities before adopting a solution, frequently influenced more by pressure of time than conviction.

It may be considered that the development of the teaching tool we propose will dissuade students from developing their ability to draw and sketch. We would strongly refute this. The development of the typewriter did not dissuade people from calligraphy, nor did the tape recorder prevent journalists from producing exciting reports. This teaching project, along with other developments in technology can only serve to speed up the rate at which we accomplish any projects we set ourselves, and leave us more time to achieve even more.