# THE WELDING INSTITUTE
# FROM HAND TO COMPUTER TO LASER CUTTING
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Why & When did we realise the potential to utilise CNC Laser Cutting?

Ian Ritchie Architects were commissioned in 1988 to design a "charismatic enclosure" for the proposed **Ecology Gallery** at the Natural History Museum in London.
The principle concept was to create a fragile environment - gallery walls of low-iron content glass, using toughened glass panels structurally glued to toughened glass ears, which in turn were mechanically fixed to a supporting frame. These two walls, through their colour and form, symbolised fire and water. The black floor, of recycled Michelin tyres symbolised the carbon earth. Crossing the chasm of glass were a series of bridges, each with its own floor finish - rubber ("the carbon earth"), wood, metal and finally glass representing stages in mans' exploitation of the earth's resources.

***Ecology gallery image of bridge across chasm***
The forms of these bridges were curved in plan and section, and were also placed diagonally across the space, intersecting with a straight glass wall and a curved glass wall.
These forms were an attempt to symbolise a characteristic of man to be complex or clever and heavy handed in the environment. To draw these forms by hand would take a great deal of time, and with the slightest modification of the bridge or wall geometry would entail many hours of scratching & redrawing.

The design of these bridges was the first time that Ian Ritchie Architects had generated forms by computer which clearly exceeded our ability to draw and produce manually the precise geometric information required by the fabricators.

Working with Sarah Meldrum of Ove Arup & Partners, the structure evolved as a series of profiled plates, each different, acting as cantilever fins from a central beam - composed of two horizontally braced tubes and twin cables, which acting against the fin plates, provided the beam depth. The individual plate profiles were generated by computer from the complete bridge form model, but then, perhaps surprisingly, slightly modified as hand drawings which were finally issued to the steel fabricator.

The reason for modifying them by hand, which may appear somewhat perverse, was to rediscover a natural fluidity of the individual plate profiles which we felt was not apparent in the computer-generated design. The fabrication of the plates followed the traditional procedure - shop drawings, checking & correcting, and machine flame cutting - following the drawn line - with the ensuing edge grinding to provide an acceptable finish.

This project taught us that not only had we failed to fully coordinate the eye/hand with computer modeling to finalise the profile and bridge form (we were using Gable CAD software at the time), but also that the subsequent procedure to achieve the fabricated bridges seemed somewhat archaic. We sensed that there should be more efficient methods for both ourselves as designers, the way we communicated the information and the fabrication procedures.

A few years earlier, in 1987, we had experimented, in France, with a small glass processing company, the use of the new technology of computer controlled high pressure water cutting of glass sheets - a method of cutting which enabled complex shapes to be cut anywhere within or along the boundary of the sheet (the first machines having been made circa1985). Somehow I had failed to make the connection!

We know that this cutting technique is now used in the steel fabrication industry - on plate up to 3mm thick.

In 1990, we began designing the 3 Glass Circulation Towers for the **Reina Sofia** Museum of Modern Art in Madrid.

*Insert Reina Sofia Image*

The specific components, which had the potential to be cut using NC machines, were the individual suspension assemblies supporting the glass panels, and those which restrained the glass panels under wind load. These were to be made from 316 grade stainless steel.

Simon Conolly of our office, working with John Thornton and Bruce Gibbons of Ove Arup & Partners, developed the profiles and threaded assemblies, both as a function of the structural performance that they had to provide and their visual articulation, such that they could be legible and hence have meaning to anyone looking at them. The profiles were explored by hand drawing, (sometimes at a scale of 5:1) - seeking that quality which comes from the brain-eye-hand way of working. The resulting drawings produced profiles which did not increase the amount of material, either in content or position, by more than 5% of that required to function structurally. These drawings were then digitised into computer files at our office - a procedure which appeared straightforward, but interestingly, because of the complex line form of the hand drawing created some difficulties in achieving exactly the same qualities in the computer files. Once we were happy with the computer files, it was clear that the opportunity existed to by-pass the tedium of the shop drawings procedure by transferring these files directly to the fabricator to load into his NC cutting machines. All profiles were to be cut from 6mm plate, and the potential to laser cut them was evident - minimising edge finishing. Since Reina Sofia, five years ago, the use of data transfer between designers and designers and designers and industry/fabricators is increasing. As architects, we still wish and want to know about the latest IT and industrial techniques in order to take full advantage of the possibilities to economise at all stages of the process without any need to compromise the quality of the designs and products we conceive for our collective built environment.

Inevitably, it is the larger industrial companies which are best placed to take advantage of these developments, but we have found, working in many parts of Europe, that it is often the motivated smaller firms who asses the risk and invest first.

*Insert Pylon Image*

In 1995, collaborating with RFR and landscape designer Kathryn Gustafson, Ian Ritchie Architects won an international competition for the design of the next generation of 400kV Transmission **Pylons** for the Electricity Board of France (Electricité de France). The principal material is steel plate - 15 to 30mm thick -and as we explore the potential to achieve a new aesthetic of soft curved silhouettes for these tall structures - we are simultaneously researching throughout Europe, and beyond techniques for the fabrication of the form, even designing new machines for curving partial cylindrical forms, and reinvestigating explosion forming. Integral to the design is an appreciation of the all the erection, maintenance and attachments necessary for their good functioning. These include cutting access doors, holes and profiled plates, and we hope that our approach will yield even better ways of communicating with industry to achieve the aspirations of economy, efficiency and elegance.

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