Handcraft and Machine Metaphysics

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Abstract: As the cost of 3D digitisers drops and PC price performance rises, opportunities for hand - computer co-operation improve. Architectural form may now be experimentally moulded or carved using manual techniques in close association with the computer. At any stage the model can be mechanically digitised and translated to a computer database for explorations that go beyond simple physical manipulation. In the virtual environment, the resulting forms can be rationalised using an ordering geometry or further de-rationalised. This potential for debasing intuitive, sensually haptic and responsive handwork through its translation into numerically cogent formulations is risky business. But it may also bring new and unlikely rewards. This paper considers the implications and aesthetics of negotiations between handcraft and consecutive or synchronous computer digitalisation of intentions. Two situations will be discussed and compared. The first is the nature of computer modelling and its representation *per se*, and the second is the relevance of using handcraft as a sponsor for computer-based manipulation and morphological experimenting.

Background

The work described here draws on my experience in extracting Cartesian information from 'form' and adapting it in a very particular way. In this regard the subject of my investigation has been Gaudí's 1:10 scaled plaster models of the Sagrada Família Church. The ruled-surface (second-order) geometry requires an exact interpretation in order for the building to continue to be built as Gaudí had modelled it during his final twelve years on the project. This surviving *codex*, based entirely on rational geometry and number, describes the building precisely.

Initially these measurements were made using a provisional physical apparatus that provided an 'x', 'y' and 'z' co-ordinate for each spatial event. Latterly a 3D digitiser has extracted this information with a facility and precision that prevents any return to the previous laborious methodology. The 3D digitiser is a mechanical devise that measures the location in space and transmits the information electronically directly to a CAD program. We have used a combination of AMAPI and Rhino. The instrument is accurate almost to a fault, and is a spin-off from the medical technology industry.

The digital translation of architectural archaeology for the purposes of construction would seem too singular an interest (in both senses of the term) were it not for F O Gehry and Associates using the same device for the same but more widely celebrated purpose, and over a similar period. They use the digitiser to transcribe the formal surface qualities of handmade models directly to the computer. I have a research association with their office, which in combination with my years in the Sagrada Família Church design office, provides a practical insight into this method of using hand-eye methods to investigate form physically for subsequent digitally based operations. I am aware therefore of the relative ease with which we can now take manual deliberations through into the electronic realm. As an architectural design educator I have naturally pondered on the applicability of this medium to the design studio.

A Position

The bogey of how best to integrate the computer into design studio has been laid to rest somewhat of late. Most design educators seem aware of the potential (both good and bad) for the computer to compete with more traditional methods to explore architectural form. Whether or not there is an electronic equivalent to sketching seems less of an issue now, as does the questionable and elusive quest for design automation. Instead, new dilemmas are emerging despite the concerted delusion of CAAD acceptability as real projects come to fruition as proof of its viability. Success in the field

is combining with the talents and skills of recent school leavers who are often more familiar with computers than many of their design educators. Other attributes come from the improved user-friendliness that helps enfranchise the non-cognoscenti, the greater flexibility in software use away from prescriptive methodologies, and user-interfaces that are matched more closely to 'how architects think'. The more the rapid changes in computer and software performance are embraced as design instruments, the more they risk displacing or disjointing theory from practice – can contemporary commentators keep up with this rate of change? Pérez Gómez and Pelletier's observe:

> "The tyranny of the computer-aided design and its graphic systems can be awesome: because its rigorous mathematical base is unshakeable, it rigidly establishes a homogeneous space and is inherently unable to combine different structures of reference" (Pérez Gómez 1997)

In seeking to locate the computer within architectural education, it is difficult not to have some sympathy with this view. With it comes the need to ensure that students come to consider that an understanding of the place of the computer in contemporary society is at least as important as its contribution to the practicalities of making previously unbuildable architecture buildable. As a consequence, I share a number of positions with my students. One is an intense interest in why we might or might not invoke the aid of current technology as a means to an end. Another is a healthy scepticism of the alleged advantages that come from the speed of iterative design experimentation, and the risks of further eschewing time-honoured means of production, including pencil and paper. A means of keeping technology, theory and practice in perspective might be to avoid using the computer deliberately in studio as an agent for production. In my school we currently run a senior computer applications course where design is examined through the computer by adopting a critical stance of the medium first, then the output (http://www.ab.deakin.edu.au/src421).

It would seem that by working obliquely, insights are gained that may be subsequently applied in design studio should the student so wish. They are free in the main to use whatever medium they prefer for studio work. I would be reluctant to run an assignment with any sophistication that specifically calls for computer-use other than as a means to introduce students to fundamentals of use at an early stage in their education.

The ineffable exactness of the computer's spatial determination and representation thereof does not necessarily equal a reliable and consistent companion. Another influence on our judgement of what might be appropriate and what might be less so in determining a 'proper' relationship for the computer in a design studio is its capacity for apparent serendipitous 'discovery'. We have all observed the computer's propensity for doing unintentionally 'interesting things', "deliberately embracing chance and computer "errors"" (Pérez Gómez 1997). It is quite easy for both student and tutor to be coaxed into believing in a particular outcome by divorcing it from its unknown means of production. An unquestioning credibility in the aesthetics of a given result from this obscure technology, and an unknown and therefore unlikely to be repeatable series of actions in manipulating the black box, is quite different from the equivalent 'emergence' from doodles. A comparison between eye-mind-hand-pencil or mouse appears as sophistry unless we look for a connection between pencil and mouse, or to return to the subject here, model and digitiser. Student enquiry into the broader issues of computers in architecture can challenge a soft comfort zone maintained through a belief that an existing aesthetic sensibility can be used to select one worthwhile computer-generated outcome from less worthy candidates.

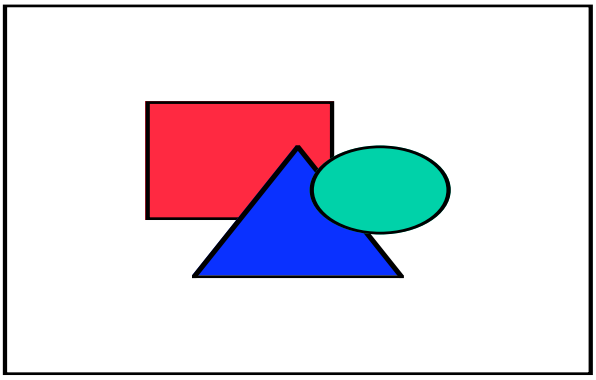
Why should we need to understand the means of production if the product is seductive for the intangible and ethereal sensations so convincingly evoked? The dilemma is one of an unfamiliar disconnection of the agent from the object, one that has no previous equivalent, the "radical homelessness" (to refer to Pérez Gómez and Pelletier again). In dismissing the importance and long-term viability of a contemporary furniture designer's work on an arts programme seen on our television recently, a critic claimed that the designer lacked "intellectual backup". The implication contained in this remark is that where founded solely on the visceral, creativity might reach a premature nadir unless topped-up by regular doses of 'thinking' as against merely 'acting'. Most schools of architecture have accepted the need for a fundamental appreciation of theory as a basis to design. Can we allow the CAAD facility of extravagant form making and visualising to blur the intellectual engagement with the design process simply because the black box processes are beyond us? As a reaction to the easy and insensate, to the disembodied and surrogate dependence on a remote tool, students seem to thrive when encouraged to engage with the medium head-on, but in a course predicated to an awareness of the computer per se, not any alleged role in design as a creative sponsor.

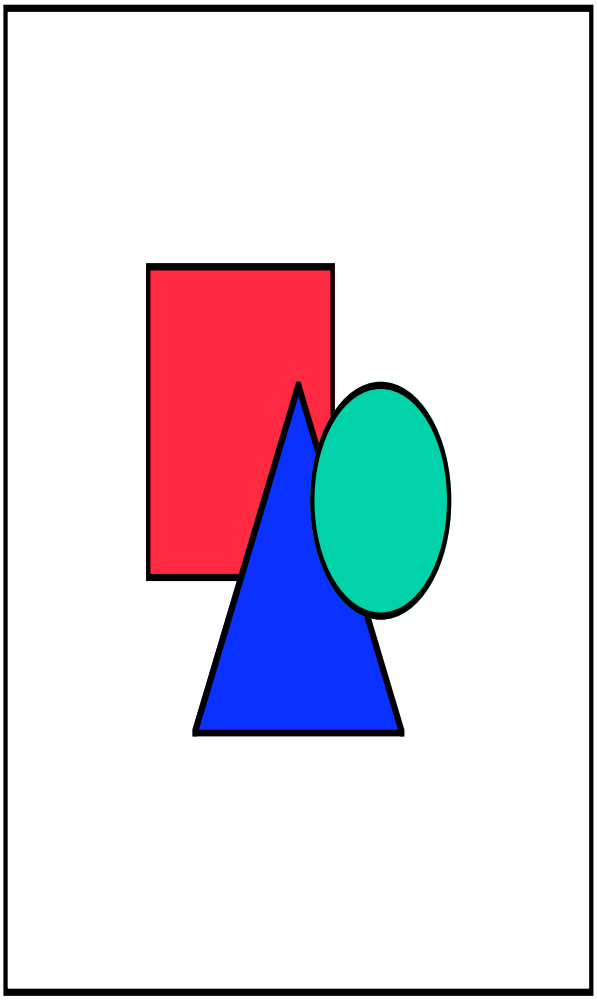
Haptic and Virtual Realms

The digitising assignment described in detail here is one of a suite of three possible approaches offered to the students in the advanced computer applications course; the students can choose to do one, two or all three activities in combination. The choices are between digitising a hand-made object, programming a design metamorphosis, and a re-examination of solid and void relationships using Boolean operations.

This year the digitising assignment was selected in equal numbers as the programming assignment in Australia, while in a course run during a visiting appointment in Germany earlier in the year, the students were unanimous in selecting the digitiser based assignment, perhaps for its relative novelty. Whatever the significance of the national traits, the opportunities for first exploring by hand, and then in a virtual environment is one way to maintain the physical presence of 'form' while at the same time delving into the metaphysical dimension implied by the virtual realm.

It would seem that both Gaudí and Gehry have used similar methods to explore form making [Figures 1 and 2] but with opposite accents. Whereas Gaudí used an atypical geometry (though a geometry that dominates surfaces in nature) to facilitate the continuation of the Sagrada Família Church long after his death, Gehry evinces no such rationalism regardless of how well it is disguised: in fact quite the opposite. This seems to be the curious paradox as we close this millennium. The Bilbao Guggenheim has proved to be extraordinarily influential from almost every standpoint. Gehry neither flatters nor denies the computer its role in the enterprise. The computer seems to have emancipated Gehry in assisting highly individual architectural form to come into being in a way quite impossible in ordinary commercial circumstances less than a decade ago. In a book dedicated to the project and its construction, inarguably pivotal in the theory of design as in the history of construction, discussion on the role of the computer is relegated to an appendix entitled 'On the Use of the Computer' (Van Bruggen 1997). For so long as the computer is being used in a support role, such demotion is appropriate. In studying the computer and architecture, students are encouraged to allow it to be a little more axiomatic in their deliberations on synthesis. In the digitising assignment, the device is not presented as a pragmatic or specific design agent but as a means of releasing an object from its physical substance; a contemporary transubstantiation. Figures 3 and 4 show the digitiser in use.





Figures 1 & 2. An example of Gaudí's working methodology using ruled-surfaces. The image above is an example of approximate form finding for the Sagrada Família Church using clay with its ultimate realisation as exact 1:10 gypsum plaster models. The latter, in many pieces following the sacking of the building during the 1936-9 Civil War, has been digitised in order to provide the data that reveals the mathematics of the geometry used for all the hyperbolic surfaces represented by the model.

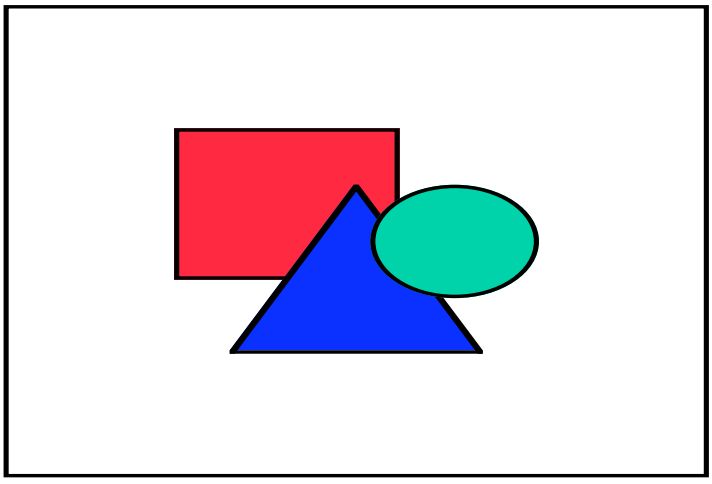


Figure 3. Photograph of the digitiser being used during a student workshop.

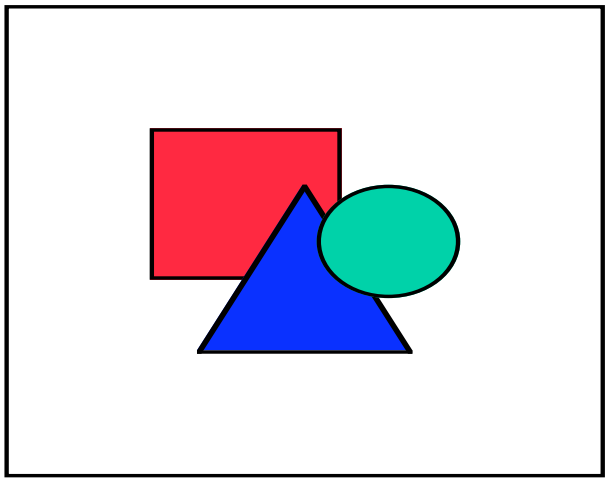


Figure 4. Detail of an 'organic' clay model being 'digitised'.

The use of the digitiser has recently become easier as it has become a ‘plug and play’ device interacting directly with software such as Rhino and Form Z. Prior to this, we had to use rather esoteric French software (AMAPI) and significant set-up time.

The digitiser produces either a stream of points or a NURBS based curves with a predetermined number of control points. Ordinarily, the instrument has the probe played against the contours of the object being measured. With each click of the foot peddle, a data point enters the database directly while being represented instantly on the screen. After a few such points, spatial confusion reigns in the user unless the points become a

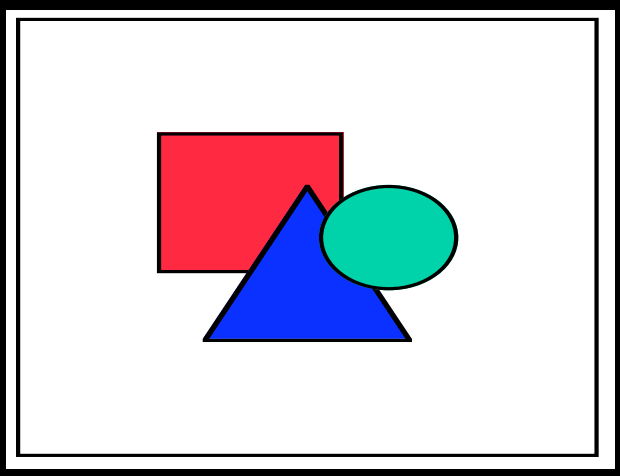


Figure 5. Photograph of driftwood

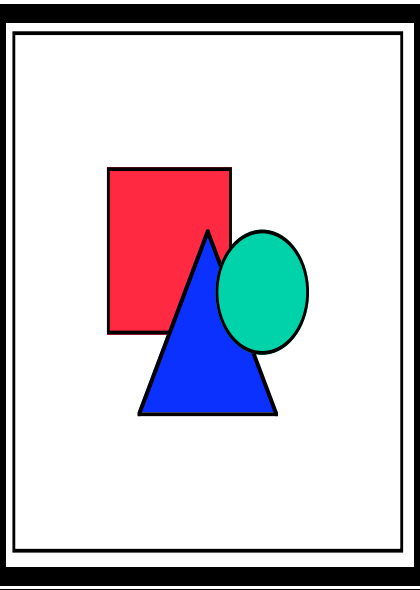


Figure 6. Crafted object

(Figures 5-16 produced by Nick Stephenson)

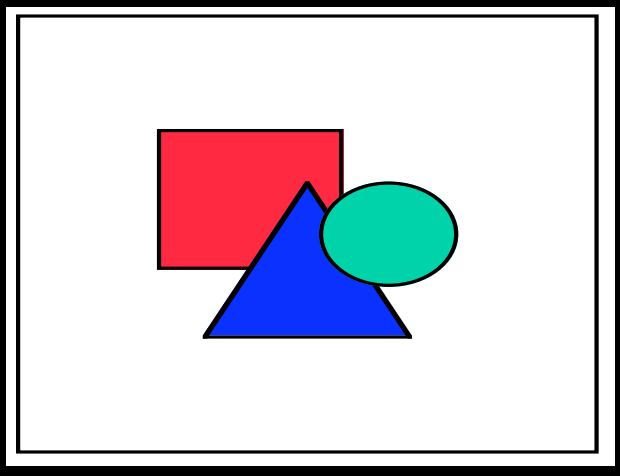


Figure 7. The entire process from digitising through to surfacing. To the right, the input points can be seen to make up a four-sided patch. Roughly parallel to these in

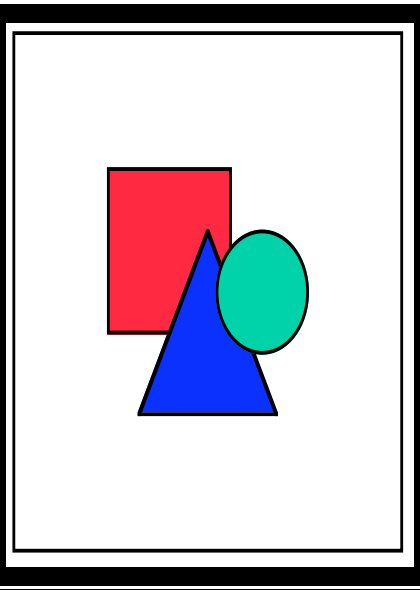


Figure 8. A ruled-surface builder places a mesh between two lines, in this case the two perimeter curves. The process is repeated by choosing the next

both directions, intermediate contours provide extra information..

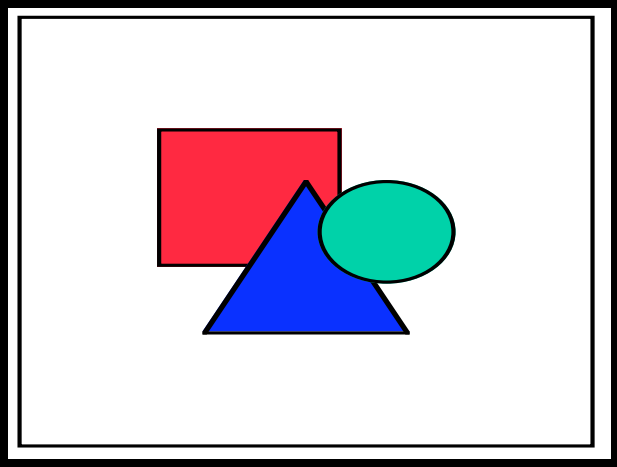


Figure 9. A partial render shows clearly how the digitising has been structured to produce patches to make up a whole

contour with the result being a straight mesh approximation.

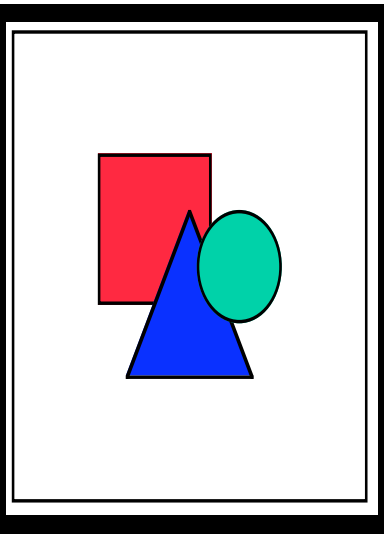


Figure 10. Shows the original approximate mesh and examples of a smoothed section.

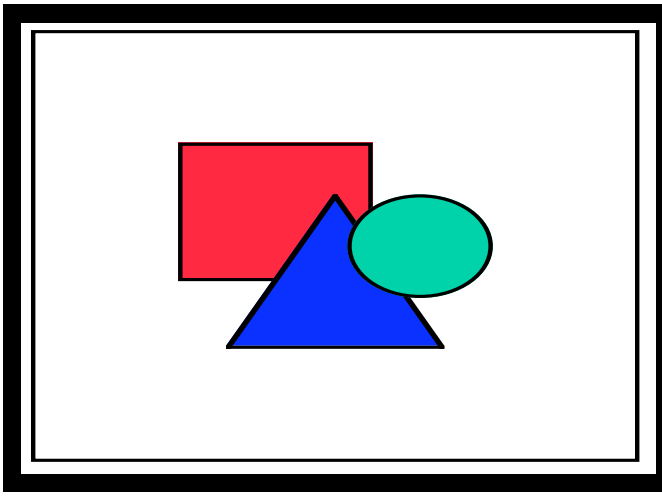


Figure 11. The pearl material imported as a standard library map.

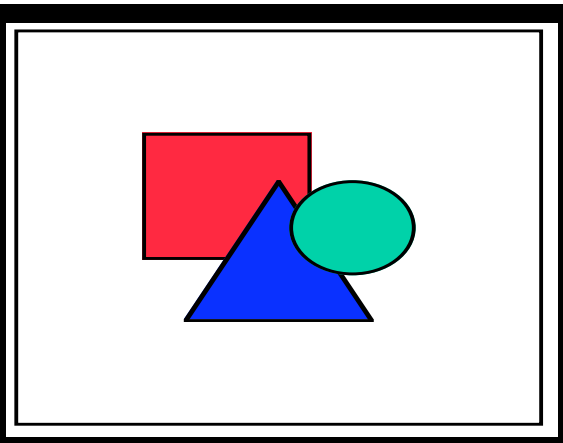


Figure 12. Shows an imported image of a zebra, manipulated in Adobe Photoshop and texture-mapped to the surfaces of this model.

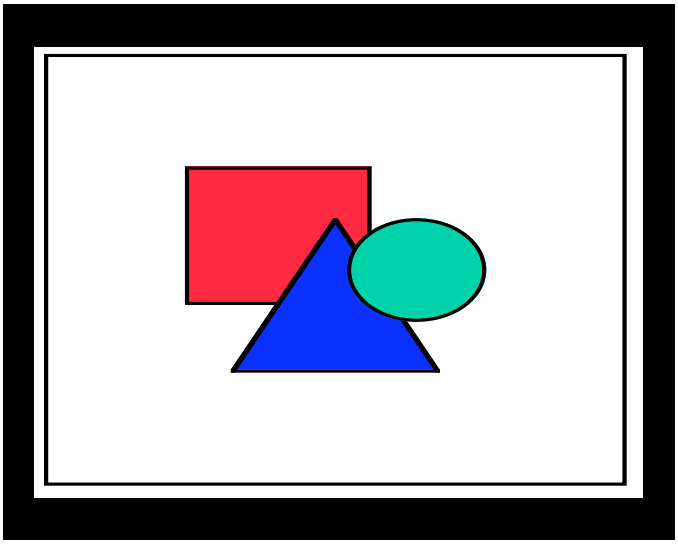


Figure 13. This map is a variation of another standard material and has been altered to appear translucent and highly glossed.

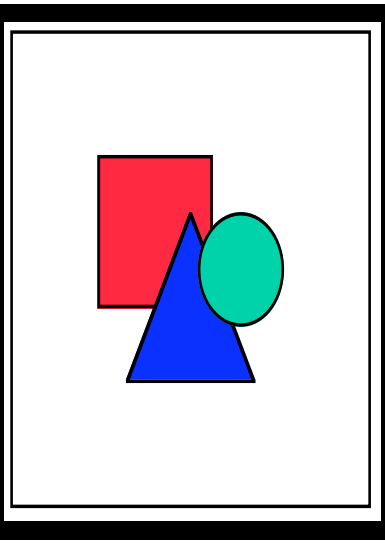


Figure 14. Wet paint', another item from the library has been applied here as a 'shrink-wrap' to the model.

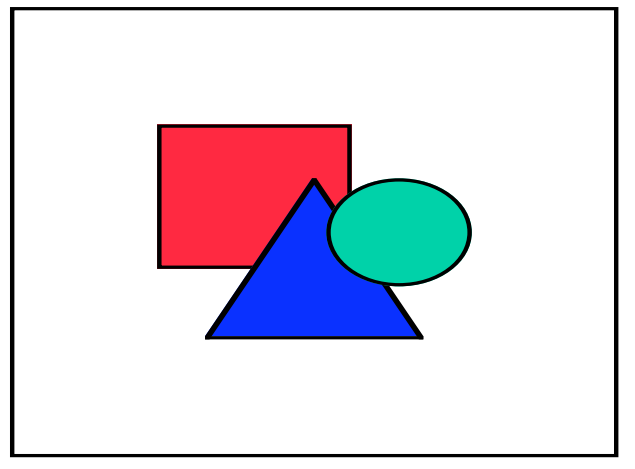


Figure 15. A basket map is applied and gives the illusion of a woven model although the actual model is still intact. Lighting has been manipulated to highlight the transparency of the map.

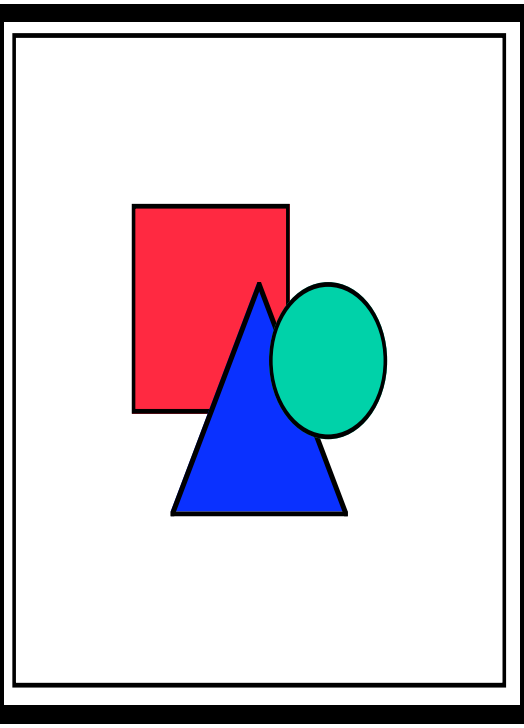


Figure 16. Polished 'golden glass' material has been used for this render with a slight transparency using the materials editor.

curve, the curves wireframes, and the wireframes surfaced. The software facilitates this series of transactions, just as it also allows a stream of points to describe a curve *in acto*. The curve so described need not emerge from a physical object. An adept user can sketch in space, as it were, describing a series of curves leading to otherwise intangible surfaces.

The first exercise is to produce a digital version of an everyday object with a view to imbuing the digital rendition with chimerical surface attributes quite different from its true physical substance. The exercise calls into question perceptions of the real by reinforcing the new realm of the artificial, which can only be represented and not substantiated in any tangible way. At a theoretical level, such rescheduling of concepts of normalcy hover somewhere between surrealism and suspended reality given that there remains the physical prototype for comparison. It is difficult to achieve such direct challenges to the privileging of the real or actual through any other means, including using light and photography. The series of images figures 5-16 above show comparisons between the wooden *objet trouvé* (left-hand side) with its crafted counterpart (right-hand side) and, mutually, the comparison between these objects with their electronic material transmutations.

Model to Digital

Students are encouraged to work with a variety of modeling materials as a means to experiment with form prior to making a digital version. Examples of these models are shown below in figures 17-20.

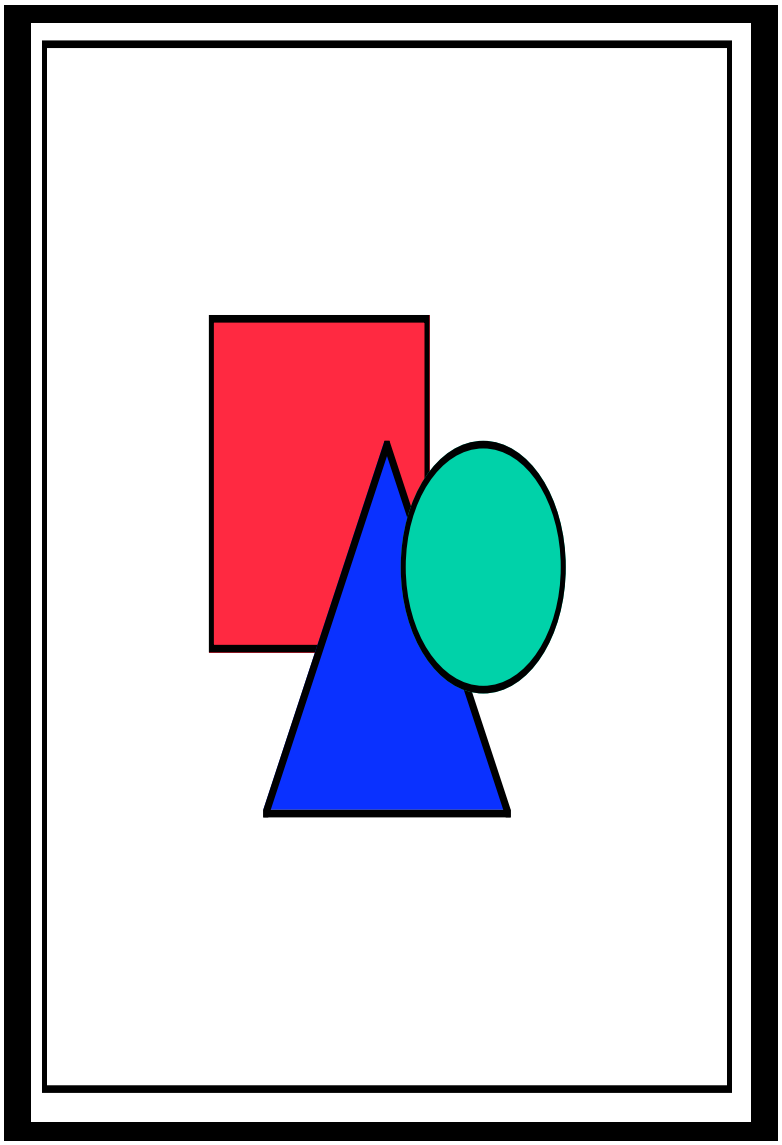


Figure 17. Photograph of the digitiser being used during the 'Kompaktwoche' student workshop at GhK School of Architecture

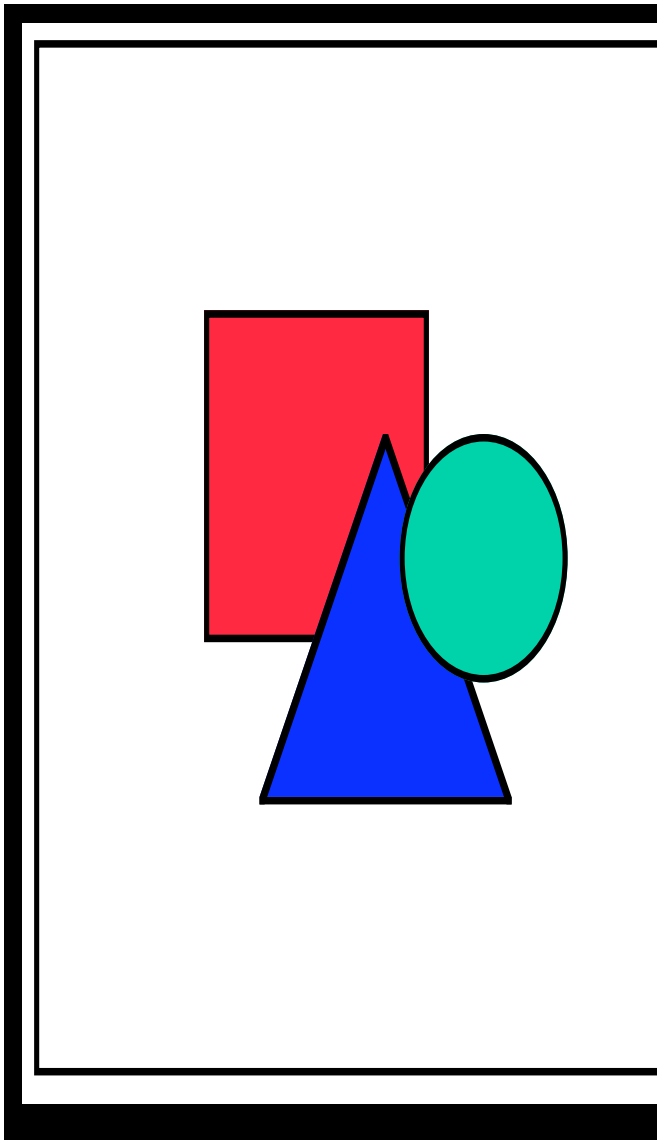


Figure 18. Photograph of model as 'armature' which was during the 'Kompaktwoche' student workshop at GhK Sc

(Tilly Henselek).

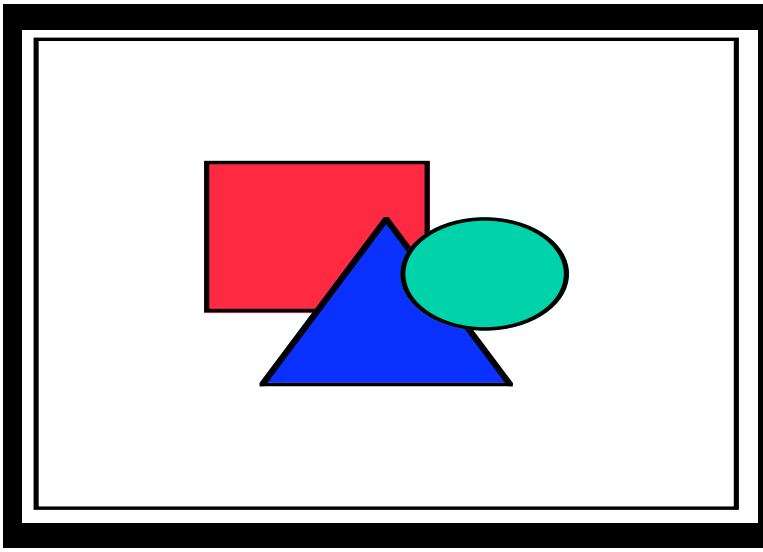


Figure 19. Photograph of 'folded' model digitised during the 'Kompaktwoche' student workshop at GhK School of Architecture (Erik Gatzen).

Architecture (Svenja Bakran).

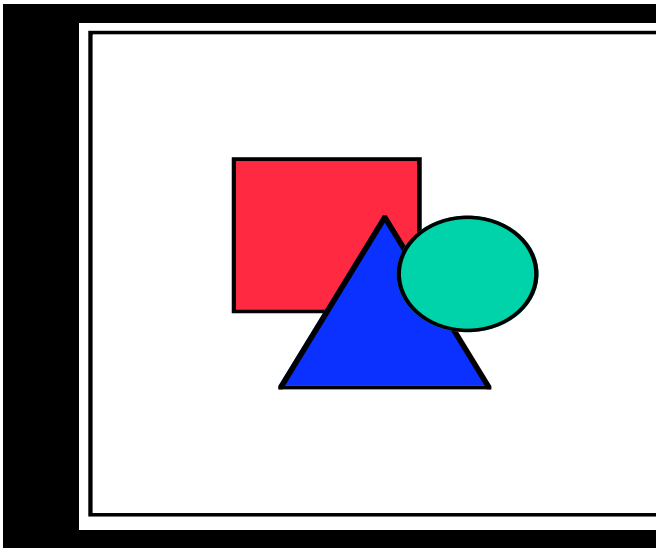


Figure 20. Photograph of one of the 'haptic' models whi digitised during the 'Kompaktwoche' student workshop a School of Architecture (Maike Pöhl).

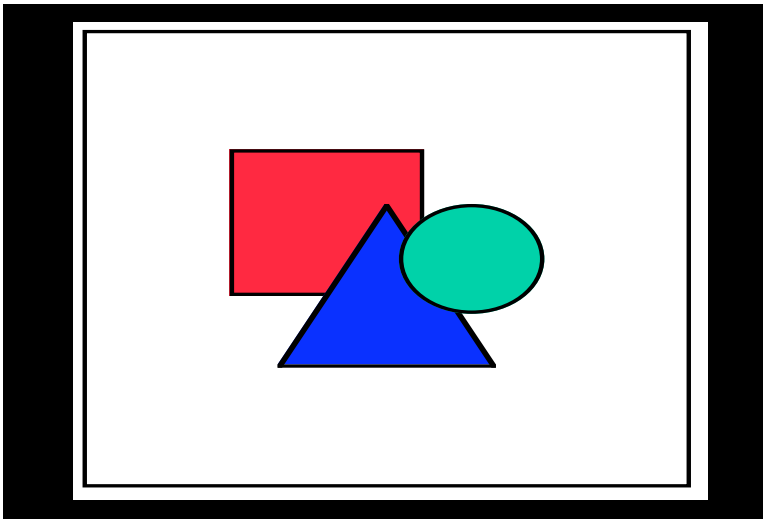


Figure 21. Wireframe model digitised during the 'Kompaktwoche' student workshop at GhK School of Architecture (Erik Gatzen).

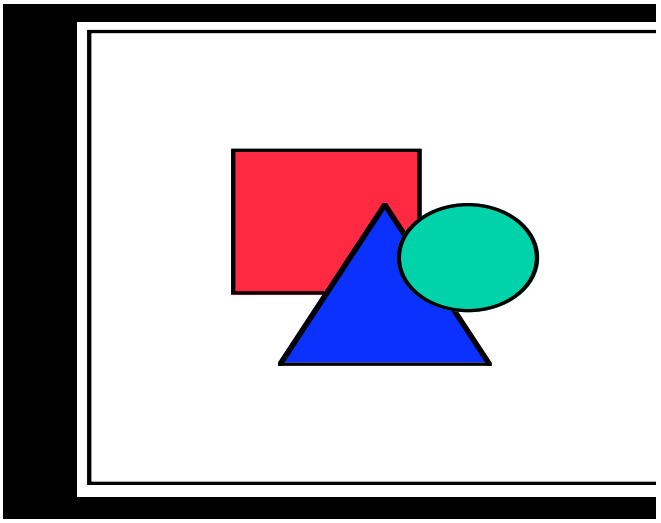


Figure 22. Rendered model digitised during the 'Kompakt student workshop at GhK School of Architecture (Erik G

The following figures 23-26 are examples of digitised models developed a little further as an architectural response.

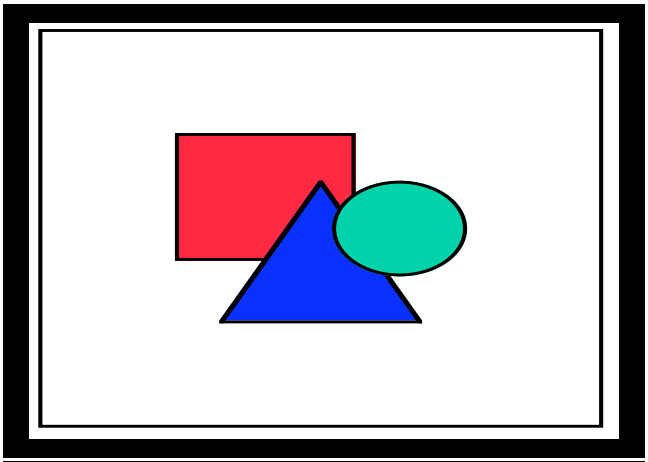


Figure 23. Jumping Centre by Amber Hobson

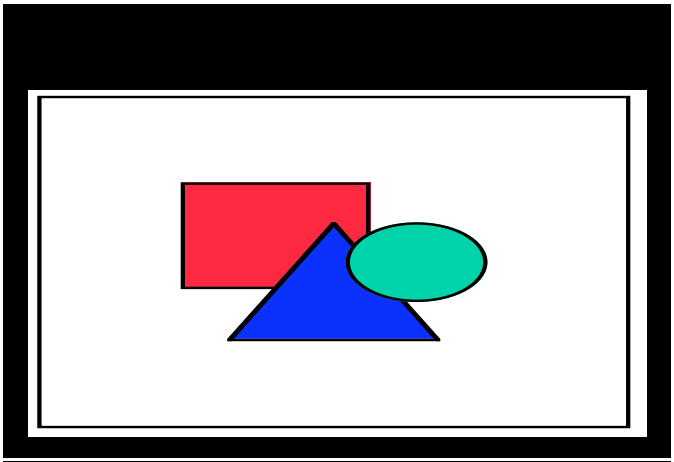


Figure 24. Melbourne Community Arts Centre by Ryan Strating

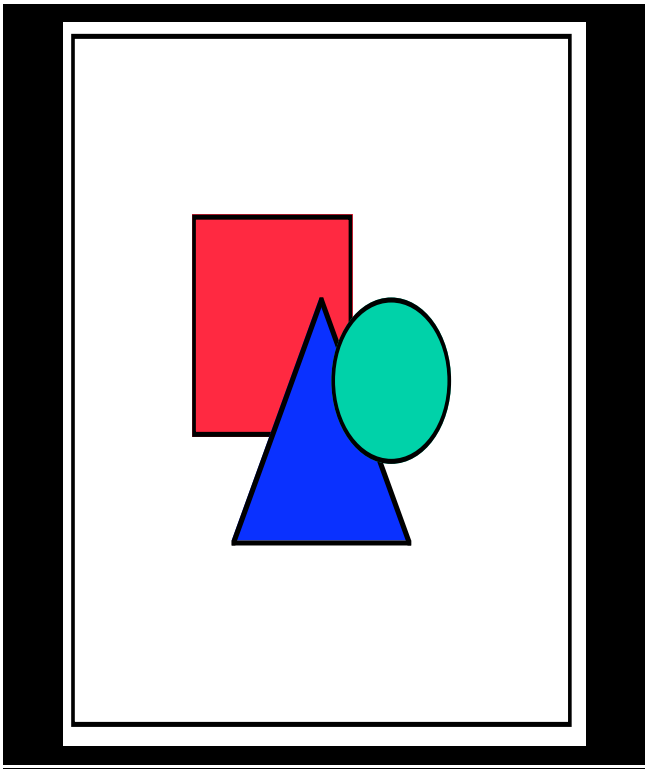


Figure 25. Virtual Urban Park, Barcelona
Tilly Hensellek and Erik Gatzen

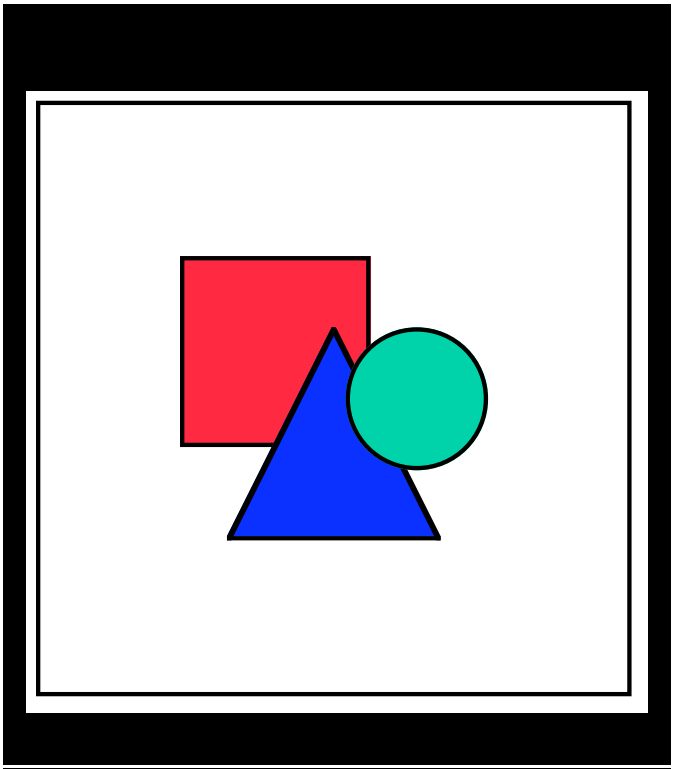


Figure 26. Virtual Urban Park, Barcelona
Tilly Hensellek and Erik Gatzen

Concluding Remarks

In the hands of Gehry's collaborators, and for those working at the Sagrada Família Church, the digitiser performs well and is an important aid. In the hands of students it is quickly found wanting. While the computer modelling of the original object enter the digital domain well, models quickly become unstable despite fairly sophisticated hardware and software being available to the class. Surfaces can become too complex for changes to them to be possible. It may be that a tool developed to help technicians match surfaces for bone replacement cannot quite be extrapolated to the extent to which architects wish to experiment with form. The issue is not with the measuring tool, however, but with the

related software and hardware. Notwithstanding the limitations of the software, and therefore the experimental usefulness of the digitiser, most of the students enjoy the working relationship between handcraft and computer model, and all the metaphysical nuances that go with such an unusual opportunity to test the interface between *real virtuality* and *vice versa*.

Acknowledgments and references

My thanks to the students of Deakin University School of Architecture and Building and to those at GhK (University of Kassel) who have contributed their enthusiasm and inquiry to the projects offered, some of whose work is shown here as examples of the techniques discussed.

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VAN BRUGGEN, C, *Frank O Gehry: Guggenheim Museum Bilbao*, 1997, The Solomon R. Guggenheim Foundation, New York