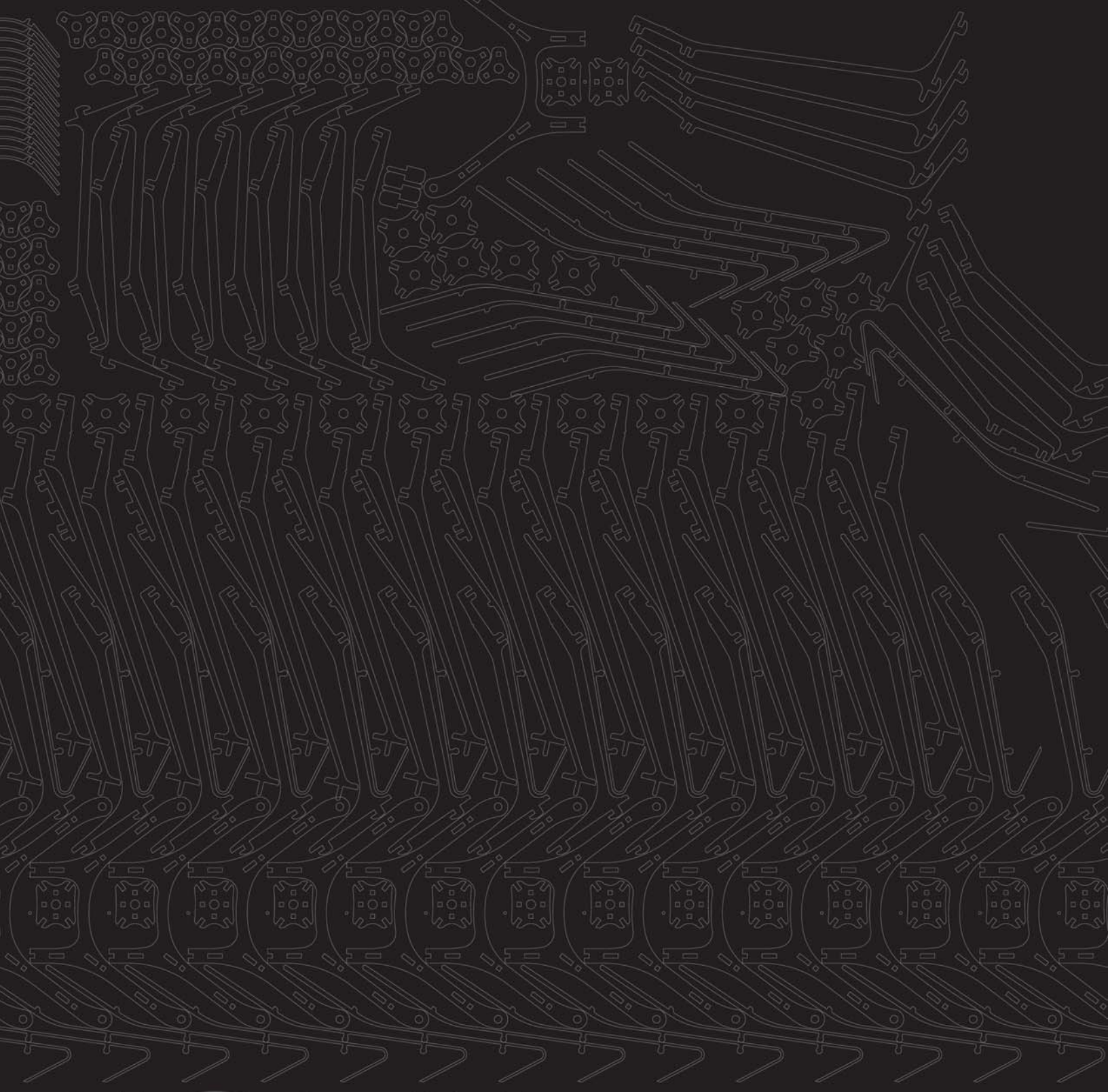


DIGITAL FABRICATORS

MICHAEL STACEY · BUILDING CENTRE TRUST · CAMBRIDGE GALLERIES
WATERLOO ARCHITECTURE CAMBRIDGE · UNIVERSITY OF TORONTO AL+D

Digital Fabricators

Curator
Michael Stacey Building Centre Trust and London Metropolitan University
with Philip Beesley and Vincent Hui, University of Waterloo

cambridge

DESIGN AT RIVERSIDE

Cambridge Galleries
November 11, 2004 - January 30 2005

in association with the
2004 AIA/ACADIA Fabrication Conference

Hosted by
University of Waterloo
School of Architecture in Cambridge
and
University of Toronto AL+D

University of Waterloo

al&d

Canada Council for the Arts

Conseil des Arts du Canada

ONTARIO ARTS COUNCIL
CONSEIL DES ARTS DE L'ONTARIO

The Corporation of the City of Cambridge

Design and Production:
Philip Beesley, Farid Noufaily,
Marianne Magus, Jonathan Tyrrell, Shane Williamson

Produced in cooperation with Cambridge Galleries Design at Riverside
Mary Misner, Director and John McMinn, Coordinator

In association with the
AIA/ ACADIA Fabrication conference,
University of Waterloo Cambridge and University of Toronto AL+D

Printing by Coach House Press, Toronto, Ontario

Library and Archives Canada 1-897001-03-7
Digital Fabrication
Michael Stacey, curator
with Philip Beesley and Vincent Hui

Digital Fabricators
Curator
Michael Stacey Building Centre Trust and London Metropolitan University
with Philip Beesley and Vincent Hui, University of Waterloo

ISBN 1-897001-03-7
1. Architectural Design
2. Architectural Practice
3. Building Construction

I. Michael Stacey
II. Philip Beesley
III. Vincent Hui

Mary Misner
Director, Cambridge Galleries

Cambridge Galleries are pleased to present the exhibition, *Digital Fabricators* in conjunction with the AIA/ACADIA Fabrication Conference, hosted by the University of Waterloo School of Architecture and the University of Toronto School of Architecture, November 8 to 13, 2004.

Curated by Michael Stacey and the *Digital Fabricators* Research Group at London Metropolitan University with the Building Centre Trust, the Digital Fabricators exhibition is prominent in our exhibition schedule not only for the vision put forward by its curators, but because it is one of the inaugural exhibitions in our new gallery space, Design at Riverside.

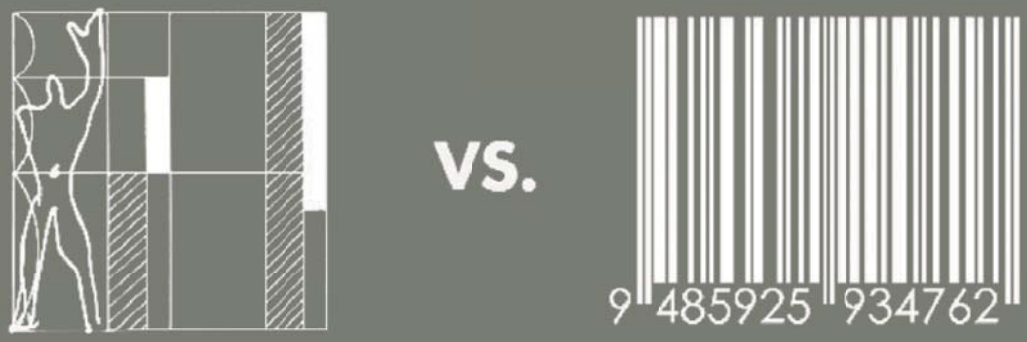
This gallery is dedicated to the exhibition of architecture and design and we look forward to working with the University of Waterloo School of Architecture in accomplishing this mandate.

Working with Philip Beesley, Vincent Hui and the Conference Committee on the preparations for the *Digital Fabricators* exhibition has helped us establish this partnership. We are most grateful for their cooperation and goodwill. Our special acknowledgement goes to Michael Stacey for his curatorial wisdom and insightful essay.

We welcome this extraordinary exhibition and the opportunity to share it with a wider audience.

Digital Fabricators

Curated by Michael Stacey and the Digital Fabricators Research Group

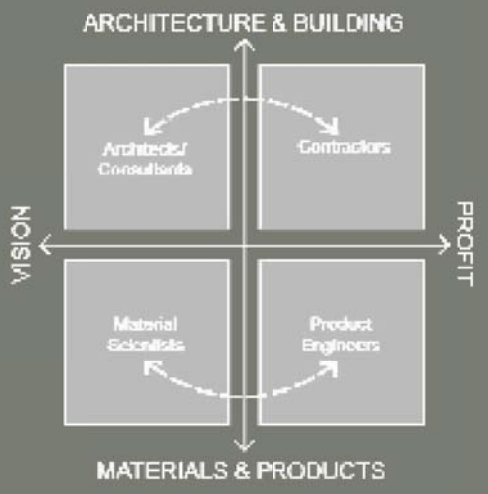


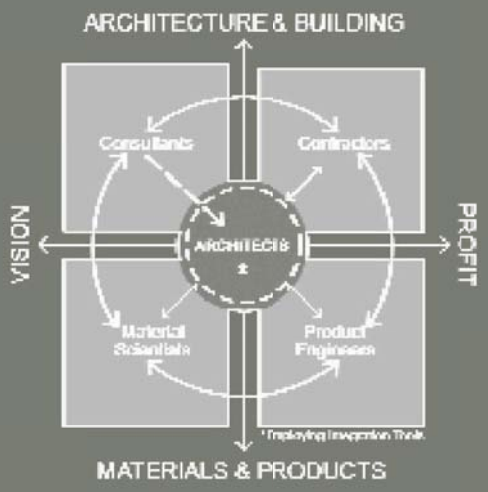
This exhibition explores the relationship between architecture, manufacturing techniques and digital technology.

The landscape of every architect's office has changed over the past 20 years. Gone is the gentle squeak of Rotring pen on Mylar or tracing paper to be replaced by the hum of computers and the intense clicking of mice. This change has been embraced by architects and engineers. But two-dimensional drafting still dominates the construction industry and is used primarily for its flexibility and a hoped-for efficiency. The revolutionary potential of three-dimensional modelling is used fitfully and only by a few. This article, like the exhibition, explores the use of digital design to inform the built environment. The emphasis is on experiential and tactile architecture, not the theoretical.

The potency of the sketch and the three-dimensional models held in an architect's imagination are beyond doubt. But the communicative potential of digital design, in all stages of the design process from concept to direct communication with the fabricators, is still in its infancy in the construction industry.

The exhibition includes the timeline of the development of digital design and fabrication technology. For example, the introduction of AutoCAD in 1982 had a much swifter impact than the introduction of stereolithography in 1988. The projects illustrate the expanding diversity of digital fabricating techniques, from laser cutting to five-axis routing, and stereolithography to three-dimensional physical printing. The exhibition includes a taxonomy of current digital fabrication technology. The following classifications of digital fabrication have been used: two–dimensional, subtractive, additive and formative. Within each category there is a delta of possibilities, and many of the fundamental issues of tectonics in architecture, the joining of materials and components, remain unchanged by the use of digital fabrication. This is leading to a re-engagement with the means of production by the profession and a rediscovery of craft in architecture. Additive processes including laser sintering, sterioltigraph and three-dimensional printing produced components that appear to be the products of subtractive sculpture but are all formed topographically layer-by-layer. Thus the conventional sculptural distinction between constructional and subtraction has been totally subverted.





Some are concerned that rapid prototyping in particular lacks any sense of materiality; however, Ulrika Karlsson of Servo notes that the layered topography of the stereolithography rapid prototypes of lattice archipelogics has it *own and unique materiality, which is a direct result of the setting of the resin by exposure to laser light, layer by layer*. Laser cutting uses the nature of the chosen material directly – Philp Beesley and Diane Willow's Orpheus Filter is an accretive installation formed from laser-cut acrylic and Mylar film. Thus they are using the very film one used to draw on to create working drawings.

Parametric design

The combination of parametric design and single project models offers the architect a potent real-time tool to generate options and iterate the design to access the potential within a conceptual approach. Parametrics define the parameters of a particular design and not its shape. This is a powerful new tool in form-finding for architecture. A parametric definition of a circle is $r2 = x2 + y2$, and the parametric definition of the arch of Waterlco Station as defined

by Robert Aish of Bentley Systems as *hx = ((29152 + (B+C)2)0.5)*.

This is not to suggest that practices should all hire mathematicians, which Foster has done, nor that you should enrol for a maths degree. Thankfully, major software companies are developing visual interfaces or 'self-programming' for parametric design. The parametric capability within Bentley's Microstation suite is called 'generative components'.

The Swiss Re office building is a pioneering exemplar of parametric design. It takes the market preconception of an office layout and, through parametrics, transforms it into an optimal design where aesthetics emerge from performance criteria applied to design. Francis Aish, an aerospace engineer by training and now an associate at Foster and Partners, describes this parametric process as 'two and half D' as the parametric qualities of the seven tangential arcs that form the profile were applied to the sectional geometry and related to the circular plan.

One does not need to be the architect for a regional arts centre or major office building to use parametric design. Urban Future Organization's design for a house conversion in London called Nested House V1.03 ably demonstrates this on a budget of under £60,000. It is also vital to remember that the development of digital design is about the investment in people – Gehry transformed his office by hiring Jim Glymph and Rick Smith. The realisation of Foster projects such as the GLA and Swiss Re is only possible because of the investment in key software skills, in people, by fabricators such as Wagner Biro and Schmidlin.

Foster versus Gehry

In the use of software there is a strong contrast between the approach of Gehry and Foster. Gehry has adopted an approach inspired by Boeing and uses CATIA (computer aided three-dimensional interactive applications). Furthermore, it requires the complete supply chain to adopt this single software to ensure continuity and compatibility. Foster's approach on Swiss Re, however, was to seek a robust software that everyone had access to – Excel. The geometry of the project was communicated as an Excel spreadsheet and a method statement on how to 'generate' the geometry. The specialist subcontractors' resultant geometry was then inspected by Foster's design team and any divergence discussed and eliminated. Swiss Re also very excellently demonstrates the interaction of physical models, made by the architects, and their digital models, a flip-flop from the physical to digital and back again, until all the consequences of the geometry are fully understood. It is salient to note that as soon as true depth is applied to a specific geometry, for example the straight line or ruled geometry of the hyperbolic paraboloid roofs of Richard Rogers Partnership's Antwerp Law Courts, a curvilinear geometry is encountered. This was resolved by the close collaboration of Avtar Lotay, the project architect, and the specialist timber fabricator Merk. On Swiss Re, Foster's design team resolved the geometry to clad it exclusively with flat quadrilateral panels with the exception of the crowning double-curved rooflight at the apex of the tower.

When reviewing the progression from digital representation to digital fabrication, it is easy to overemphasise the importance of technology transfer from the aerospace and automotive industries. This is not to deny the importance of software such as CATIA – however, progress within the construction industry, which includes CIMsteel, should not be overlooked. It is also pertinent to note that CIMsteel was a European initiative, which has now been taken up in North America.

No other industry is willing to undertake the risk of putting its prototypes on street corners and then standing back for, say, 20 to 30 years to see what happens. The building industry at its best is capable of putting together flexible project teams with disparate skills in the pursuit of common project goals. The use of digital fabrication technology need not be part of a more corporate future – the dialogue with industry should be a two-way process.

The possibilities generated by the direct manufacture of digital designs are both an opportunity and a challenge to the architectural profession. The technology is accessible and cost-effective. The inventive skills and editorial judgement of architects are needed more than ever.

The *Digital Fabricators* exhibition was curated by Michael Stacey and the Digital Fabricators Research Group at London Metropolitan University with the Building Centre Trust. Digital Fabricators North American stage of the exhibition was co-curated by Philip Beesley and Vincent Hui in cooperation with the Cambridge Art Gallery and the AIA/ACADIA Fabrication Conference.

Venues were:
Interbuild Birmingham 25-29 April, Building Centre London 10 May-26 June, and University of Waterloo, Cambridge Galleries and University of Toronto AL+D, Canada, from 11 November 2004-29 January 2005.

"Twenty years ago it was common for engineers to spend long tedious hours working out the way in which a two-storey building frame worked, longhand, on paper. Sometimes, ideas were incidental to the process. Thankfully, those days are past. The arrival of interactive design software has revolutionised the way we design things… It means that engineering has become more of an art, architecture more of a science, and all design more intuitive" (Professor Chris Wise)