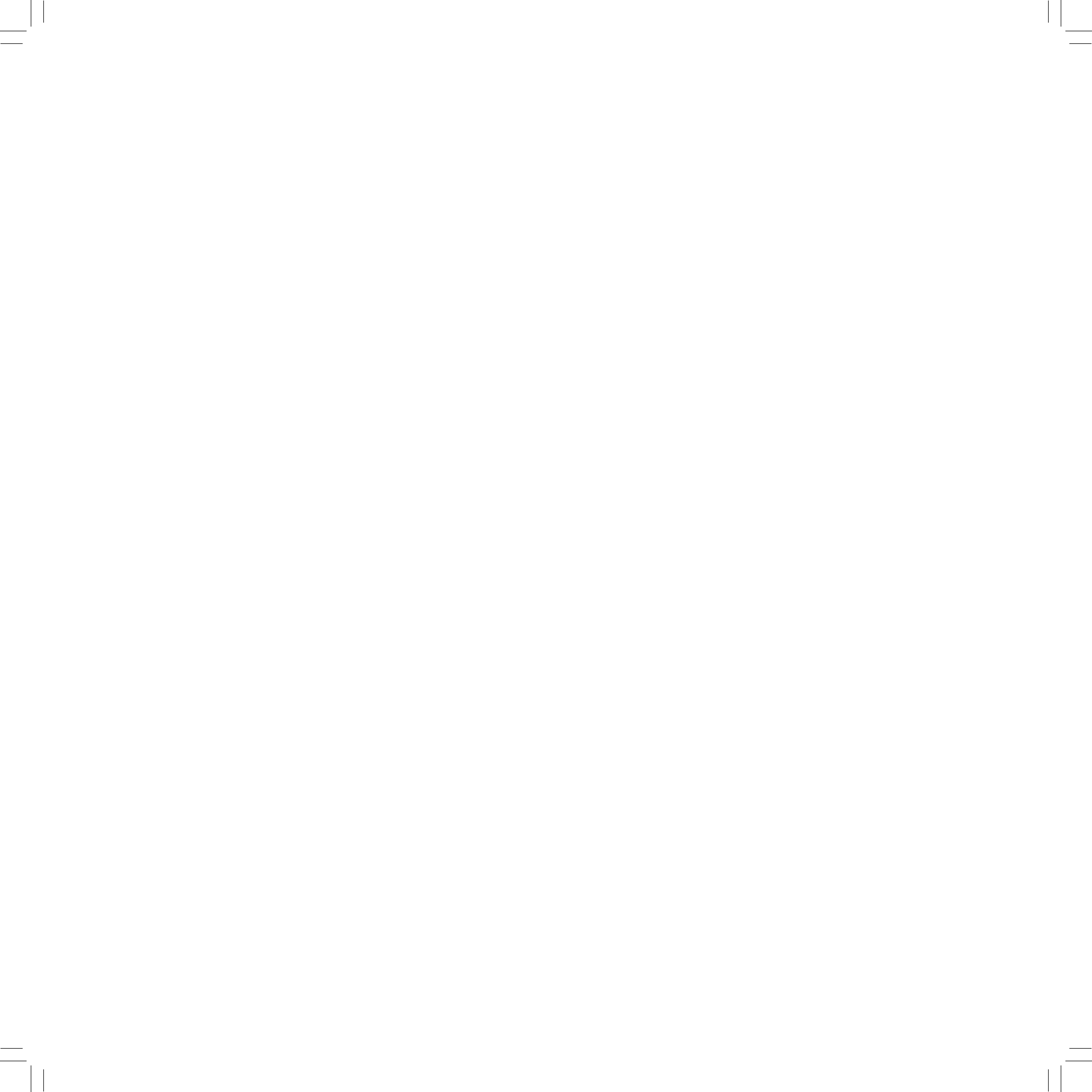


An Interview with Philip Beesley and Michael Stacey

Philip Beesley and Michael Stacey

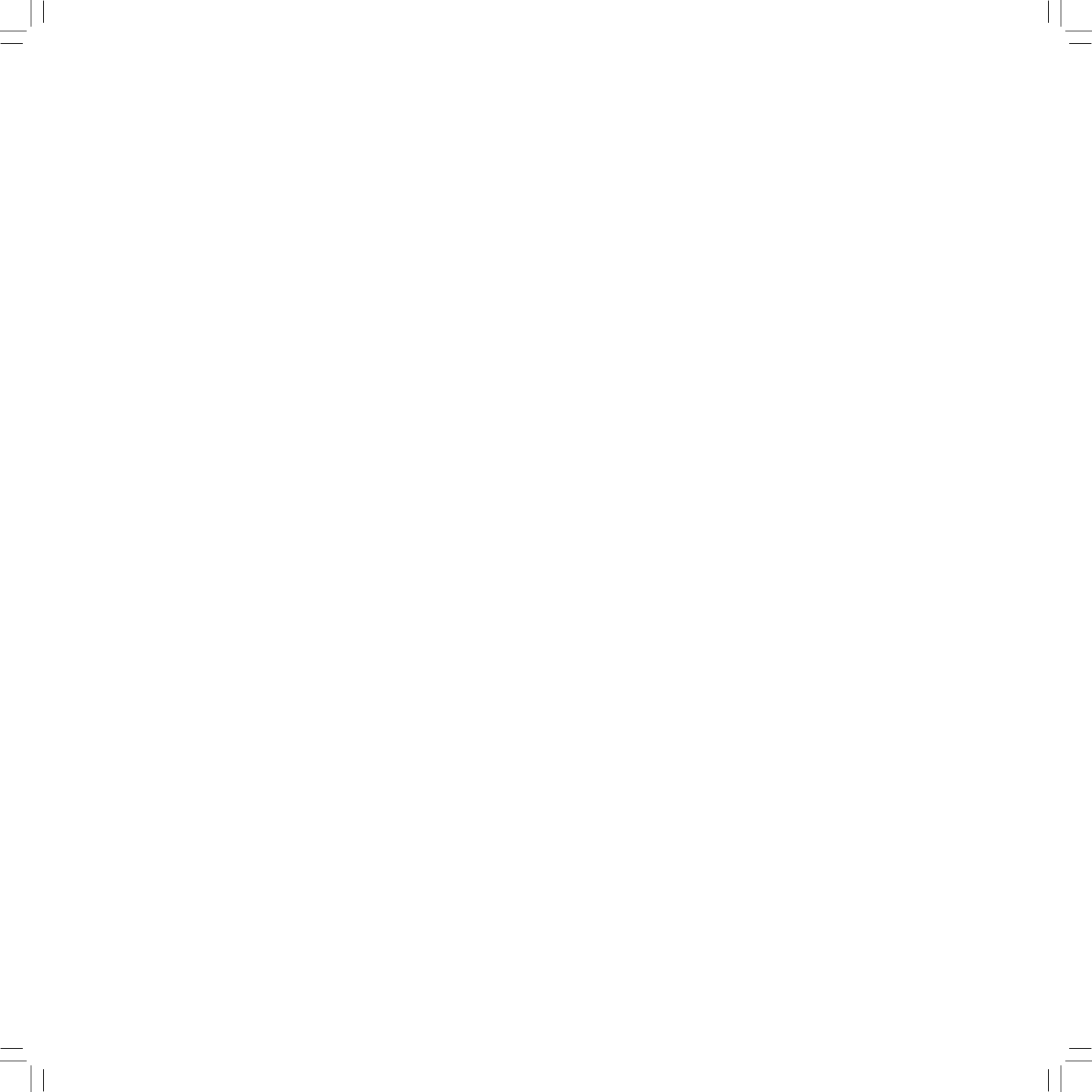
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FABRICATE: MAKING DIGITAL ARCHITECTURE RUAIRI GLYNN & BOB SHEIL

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We wish to make a special thanks to Marilena Skavara, who has tirelessly assisted us in organising FABRICATE 2011's conference, publication and exhibition.

Ruairi Glynn and Bob Sheil

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END



**PHILIP BEESLEY
MICHAEL STACEY**

Michael Stacey / Phillip, as you well know, back in 2004 I curated the Digital Fabricators Exhibition, and you kindly hosted the North American stage in the Cambridge Gallery, the first ever exhibition there, and Bob Sheil's work with his colleagues, sixteen*(makers), was included. Do you think it's significant that the 2011 conference drops the word 'Digital' and is just called 'FABRICATE'?

Philip Beesley / I do see significance in that. The implication for me is that specialised craft rooted in material manipulation is a key for quality in the field of building today, while the ubiquity of the computing medium is something that could be taken for granted. I don't completely agree, because there are a myriad of issues surrounding digital tools, but it might be well to uncouple the term 'digital' from 'fabrication', and allow each its own forum, rather than focusing (as we did many years ago now) on the novelty that made digital practice coupled to fabrication seem innovative. 'Fabrication', by stripping away the 'digital' term, opens 'fabricare', with existential and poetic implications of that eternal term. History and theory come to the fore in this gathering, alongside technique and craft.

MS / Interesting response, Phillip, because I think people have been encouraged back to the workshop, but I am concerned that today there are too many, essentially similar, parametric projects, and some of the papers submitted for the conference really reflected this, trumpeting the parametric tools, rather than making inventive architecture. It's actually less inventive than architecture from almost any other era, and they're not engaging in the realisation, and I think that part of the

field has already collapsed, which is perhaps a bit negative of me to say.

PB / Certain languages in parametric design appear generic: Platonic waves that ripple out, organised in gradients, perhaps salted with certain variants that appear like viruses to interrupt the field. Random functions create difference wilfully, seeming to correspond to the tutorials that are embedded in next-generation software. A kind voice might say this reflects extraordinary progress made in skilling up a generation of designers. Yet, along with emergence of these skills, there also comes a kind of exhaustion: languages sometimes reveal themselves to be static, disappointing, when the concrete examples replace the visionary impressions that preceded them. But I'd like to see that as a healthy thing. My Darwinian hat sees this as a large project where waste and excess inevitably boil off. The rather abject state of Dubai might suggest these tools are sometimes playing uncritically, but that comes with any experimental territory.

MS / That's my concern; the uncritical use of such tools. Although you could also say that our profession has been quite slow to adopt building information models, as a better mode of collaboration. But before you can answer that, I'd like to move onto an earlier conversation we had in the summer; you suggested maybe that a future version of a BIM tool could accommodate ambivalence and improvisation; could you say more about that idea?

PB / Ambivalence can be an enabling term. I move back and forth between hard-core measurement and performance testing and,

on the other hand, open, rash speculation akin to lighting matches with tinder. I wonder whether design tools might include a variable focus that invites both impression and precise analysis, akin to drawing with charcoal alternating with silverpoint. When I speak about ambivalence, I'm thinking of designers using new tools and practices to meet the challenges of our day, however unspeakably grave those might be on bad days and however inspiring and playful they might seem on good days. I want to move back and forth between optimism and pessimism as a designer. I'm trying to find a kind of human experience grounded in my own body and feelings and rooted in motivation for changing the world constructively.

I do wonder if the monster of BIM software might be improved with integrative tools for conscious play. Many of my students and colleagues are worried about how management-oriented BIM tools are influencing design. BIM tools might imply profoundly negative clerical work. There is a risk of these tools creating sub-classes of desk workers prevented from working intuitively, obligated to punch in specifications and hyperlinks to catalogue sources. Its power for control and administrative depth is clear but can BIM be a freely creative tool?

MS / On one level your description terrifies, the practice of architecture reduced to people choosing from the existing and choosing from the manufacturers who insist on talking about solutions without ever asking what the problem might be. I actually quite enjoy writing a specification because I find it a way of thinking about architecture, but the old Skidmore, Owens & Merrill model, which had a separate floor of specification writers,

I think is just a waste of human endeavour and is wrong. The key question here is how one creates very strong and direct human relationships with the people that actually make things. I saw a lecture last night here in Nottingham where a London-based architects' practice described working directly with industry; they were using parametric tools, but the workshop relationship was direct, perhaps in a way that you could have seen in many generations. So I do worry that a very static view of a BIM is an institutionalisation; I almost want to say a set of malpractices, rather than a set of best practice within our own industry. I think the relationships within sixteen*(makers), for instance, is a much more productive and interesting possibility because it steps out of the conventional structure of the fabricator, of the architect and the academic, and looks for something a lot more fluid and interesting.

PB / Returning to the question of ambivalence, we've just lurched in our conversation – we started with an almost despairing sense of the sameness, reacting to trivial qualities of sine waves and gradients characterising some parametric design today. We've touched on integrated building information modelling, implying a stultifying mass of static cataloguing, a contrary of agile play. If that practice doesn't promise opportunity, then what might we offer? A kind of agile substance is implicit in your question. I admire collaborative practices where people have profound grounding in certain crafts, while at the same time they have the confidence to act as generalists. Lateral play – specialised languages transferring into new hybrids – marks that kind of work. When we look at the architectural practice

sixteen*(makers), we have an example of individuals in specialised silos that have the ability to do steel manufacturing with advanced craft in that specific discipline; side-stepping to another silo, ability in computational simulation with formidable craft; then to yet another, performance based scripting. 'Emergent' design has teeth in this picture.

MS / I think the simple starting point is that, as architects, we shouldn't be embarrassed about discussing our own skill. I think the twentieth century was almost burdened with architects who said they were only generalists and they weren't good in mobilising their own skill, or mobilising the skill of others. I think that's what interests me in fabrication, is that exchange, or a dialogue between a group of people, all of whom know that they actually have very relevant skills. That's when I think the exchange becomes exciting; because you are building with them a whole set of positives, to me that's part of what your body of work eloquently demonstrates.

PB / It's a very curious question about how unskilled things seem to play so readily in architectural disciplines. The question of individual skill and the fostering of craft is something that any musician would take for granted, because that culture is rooted in the rigours of language; sound exposes its technical qualities immediately to the limbic quarters of human perception. Perhaps in that medium we take facility for granted. But perhaps, before arguing for craft, we could take the other side of the coin: did you take macramé in your art class in school?

MS / I did yes and I can knit as well.

PB / The enabling qualities of physical experience are fundamental to my view of architectural creativity. But physicality isn't automatically inspiring. It can speak for a kind of dreadful silence, a kind of forlorn, blind quality of intimacy as well. There is an implied silence of the individual thing moving again and again interminably.

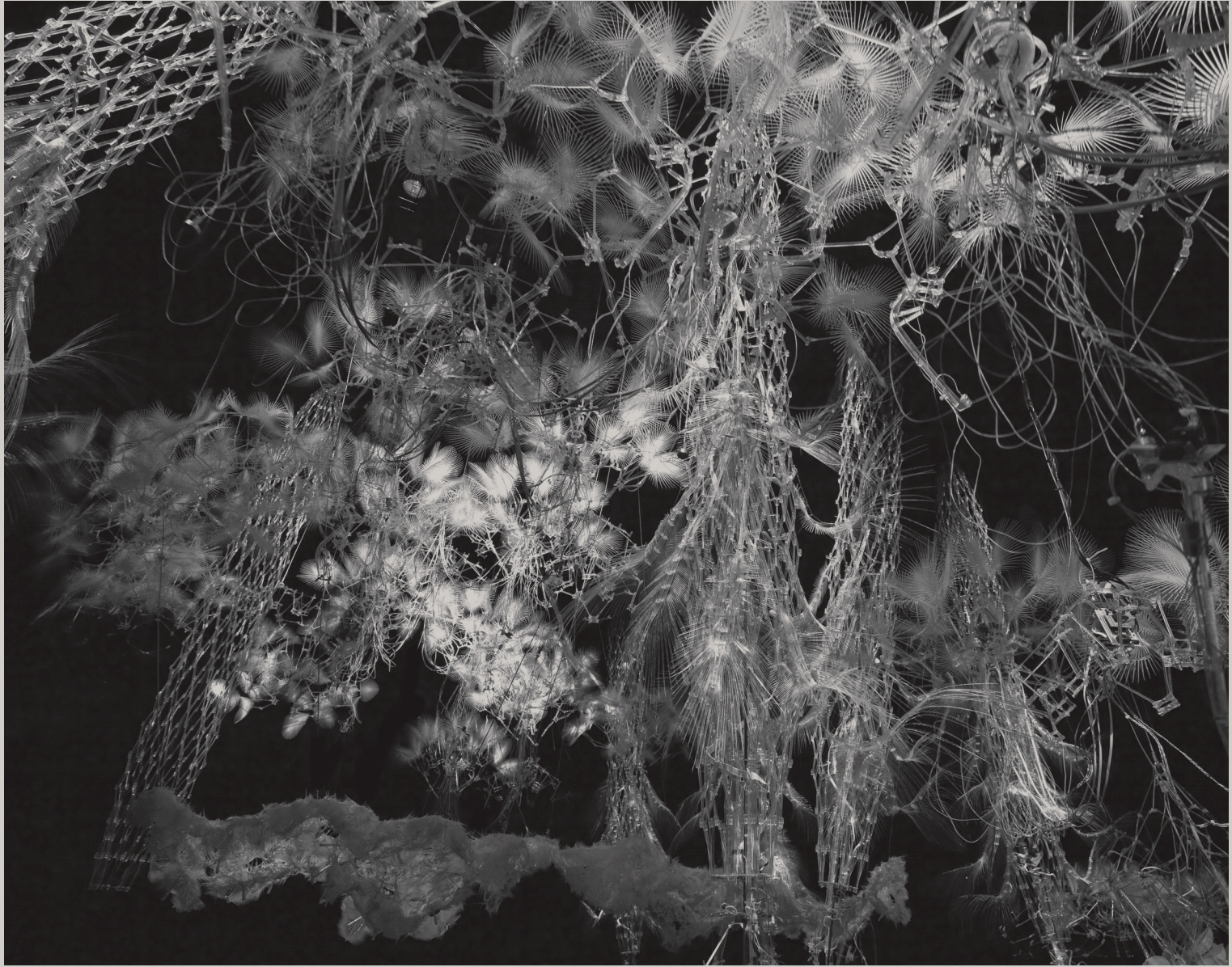
After a brief period of enthusiasm for the craft of macramé, the practice of decorative knotting, the overwhelming labour and slow progress of that private craft put me off. But yes, with caution, let me suggest fabrication and material embodiment offers a fundamental start to my version of design education. Would you go that far? What would be the first steps in the first year for a designer?

MS / Well here we have another complete conversation that we could have Philip. The thing I feel strongly is that there has been a sort of false dichotomy between the intellect and the hands, whereas your installations demonstrate a holistic approach very well. To discuss your installations, you need to discuss some of the making, some of the philosophy. I think there's too much architecture where it's neither built well, nor is it a constructed line of thought, to use Sverre Fehn's phrase.

I've always found that it's in the physical where ideas become evident and real to everybody, that's probably why I like workshops and also the power of the mock-up and the prototype. I've gone to appointment meetings with samples, and the committee have looked at me quite strangely. Sometimes it works and sometimes it doesn't, not to presume what the project was going to be made of...



Protocells in Filter Field
Hylozoic Soil: Méduse Field,
'Mois-Multi Festival', Centre Méduse,
Quebec City, 2010.



Hylozoic Soil: Méduse Field,
'Mois-Multi Festival', Centre Méduse,
Quebec City, 2010.

PB / I can agree, but I wonder whether there is a risk of this insistence on materiality being mistaken for something negative, an earnest and stultifying quality.

MS / That is a bit of a misunderstanding. I was actually going to ask you, and maybe we should store this, whether we could describe architecture as a collective craft, because your earlier comment sounded very much like we were knitting on our own, rather than quilting, to use James Timberlake's analogy.

PB / Yes. But this tangent might imply that the collective craft and physical embodiment risk a kind of hair-shirt architecture. To counter that we could point to some of the qualities that come of this sensibility. I'm finding myself focusing on failure and the outer edges of performance, where things diffuse and dissolve and collapse. I'm finding that material manipulation is an effective conceptual link that fosters experiment. Instability, or sources of irritation catalysing design spaces might offer performance akin to hiccupping or convulsing, a link into temporal performance. Being able to wind up a piece of sheet metal or plastic right to the very outer edge, past its performance, fosters a grasp of what it can actually do. This kind of design space welcomes dissolution and disorientation.

MS / I think it's almost essential that we give back to the students the opportunity to fail. Often that can be in the physical construction, as long as they understand what's happened, because, I don't know about Canada, but in British education, absolute certainty of success has been so ground into the current generation, they want to know

whether they've passed the module before they've even started. So you have to feed the space back in to create the experimentation, and then once that's there, I feel that they become like people from anytime. I think, as professional architects, we have an interesting dilemma that we might engage in experimental processes, and yet we might have finite budgets and finite delivery dates, and so we have to almost somersault from the experimental to the certain. We had exactly that on the Nottingham house we built for the Solar Decathlon 2010 competition in Madrid, which also reminds me of your earlier comment; I think sustainability has been set back by the sort of hair-short, dour, desperate duck-and-cover approach. If we take an analogy from the Slow Food movement, it should be deeply enjoyable, and the process should be enjoyable for all of the participants. It's how we sustain ourselves and future generations, so that we're not making sacrifices to sustainability.

One of the terms you used was efficiency. I think material efficiency is incredibly important, liberating and dynamic. But too much of the discussion about too much architecture is simply about efficiency, whereas if we take the creation of a home, for example, there's so many more issues that are actually much more interesting than whether a particular solar panel is specified and whether it's 83 per cent efficient or not. It is more important whether the technology is used and appropriated. I know it's some people's role to measure, but it's almost the least interesting quality, and in some areas of architecture, the technocratic discussion just totally dominates.

Just going back several steps, I think that understanding the past, and understanding

what humankind has done through time, is actually a means of being radical, and not conservative. It's actually how one seeks the radical edge.

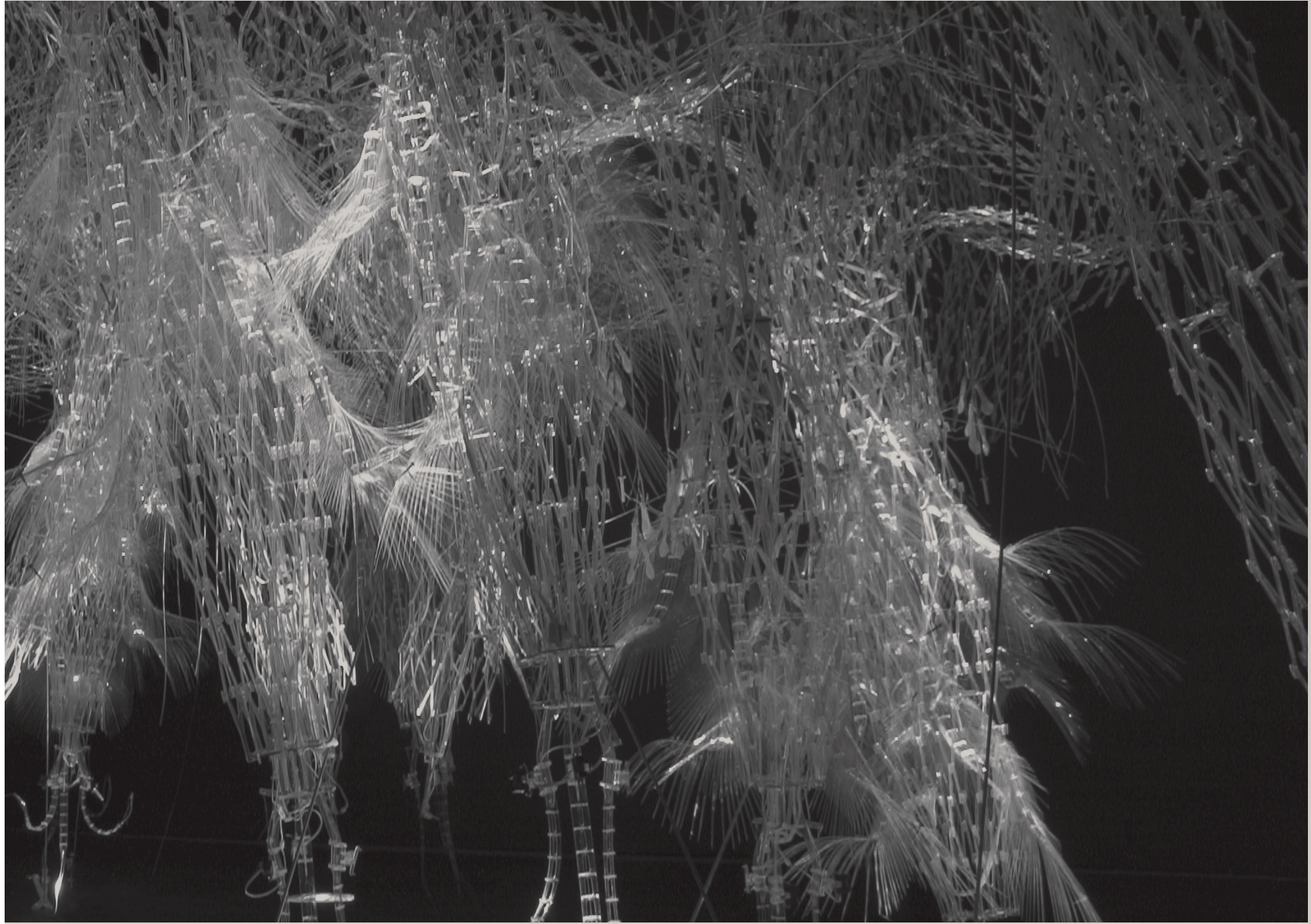
In that sense, I want to come back to your own body of work, because on one level I understand some of your installations to be a metaphor for healing the world; am I being too simplistic Phillip?

PB / Well, no, you're not being too simple. I'd be nervous about saying 'yes this is about healing the world', because everyone in the room might take a step back! But I wonder whether such an earnest term might be grounded both in radical delirious experiment and at the same time in fundamental human existence, anchored in a sense of the deepest history. I'd like to think so.

In the work that's in Venice right now, one strain is rooted in origins. You and I have often spoken about my encounter with blood deposits that lay under the north gate of the city of Rome. I learned that those corresponded to thousands of blood deposits and substitution burials running throughout building foundations. That archaic space seemed to offer almost unspeakable abject fragility, rounding the act of building the city into the earth.

It had a resonance with the sense of trying to create something direct and living, rooted in the soil and spreading out into the realm of agriculture and, further, into a sense of general stewardship in creating, earning the ground. I think this sensibility of trying to grasp space and ground as an active design space is an absolutely current sense. Air, water, earth and rock have vital and tangible qualities. This seems a valuable way of approaching the environment.





Hylozoic Soil: Méduse Field,
Musée des Beaux-Arts,
Montreal, Quebec, 2007.

Perhaps that implies an opposite paradigm to a modern idea where we're independent figures, strong, full of liberty, acting in a void; the void left by killing any stuffy sentiment about God and organised institutions. That empty space might be felt as a kind of liberating openness for human action. But that sensibility, which proudly eliminated history from architectural education and practice, also resulted in carelessness. In my quarter, that meant you could just throw your crap out of the back of your cottage and the wood will absorb it. The vengeance of that way of working is upon us. Making space tangible, where we can literally feel the impact of our actions, has such incredible urgency for us as architects. That to me implies a continuum between cultural history and material measurement and the material efficiency that you were speaking of before. I love the sense that we can work with those kind of realms. I think that the kind of mythic presence that they can have offers an enabling state-of-mind. Plastic, rock, paper, water and soil are not neutral; every one of them has a presence that we can manipulate. We can access the archaic when we approach them.

MS / Would you call that a gentle accessing of meaning? For example, the architecture of the 1960s was very rhetorical – often the writing was fantastic but the physical experience, of housing in particular, was appalling, so there was a gap between the claims and the reality. What I heard you describe was a sort of rootedness, and I want to use the word 'gentle', but it is meaningful; maybe if I was writing a paper I would sit for an afternoon and think about that. The other thing I heard is an understanding of technology in a transparent way, so it's not

important whether the Egyptians or Romans invented concrete, or it's not important that you're perhaps using the latest of technology to make your installations, but you're actually seeking immutable qualities that communicate past the modern project as it's articulated by a particular school. I should ask you whether you're alluding to French philosophy because I can hear philosophers implicit in your comments, and perhaps I should ask you to be a bit more specific; but already I've packed in about six thoughts into that reply.

PB / I could start with your 'gentle' comment and maybe go for the jugular: there's a risk of a tangent of our conversation as invoking a kind of happy clan of harmonious villagers. But the kind of materiality that we're talking about has a kind of roaring visceral side that is not obedient. The forces that are embedded in the concrete encounters that underscore this conversation are by turns wild, disruptive, and sometimes enabling.

MS / No, I take that more to be a reference to Ruskin and Morris, and a certain sort of medievalism; it was hardly helpful as it wasn't altogether the reality of what they did.

PB / Together with Ruskin I think it's quite justified to speak about Georges Bataille and maybe even Hermann Nitsch as agreeing with this tangent. Invoking them, a tangent of design leaves control; rather, the energies that are being worked with can eviscerate the body and disorient it. Material parts of what they speak about are rooted in fertility and vitality. That might help close a loop, which might otherwise have been rather static in its earnestness and thoroughness.

I prefer a group of twentieth century thinkers focused on vitalism to the kind of displacement that sometimes shows itself in continental philosophy.

MS / So much discourse is directly technophobic isn't it, as if the inventions of human kind are a problem, which in part they are, but they also bring us comfort and joy.

PB / Yes. I was heartened by a curious gathering recently at the ACADIA conference at Cooper Union. A group rooted in French philosophy and history were sitting alongside parametrically grounded designers focused on computation. There were two large assembled camps with enough depth that they could start shouting at each other. It seemed to be a sense of a next generation of emerging thought. Picture Buckminster Fuller's transcendental structures, and then the mongrel monster that Donna Haraway would concoct with her flesh and robot amalgam; picture them sitting side-by-side and speaking to each other; it was really quite encouraging to see how hybrid language might be projecting forth. Amidst amazing amounts of noise, the occasion spoke of a re-tracing of postmodernism in an optimistic sense of that word, regaining lyricism and poetry and embodiment. This joined to the intellectual pursuits to the interrogation of power and the possibility of consciousness and reflection. There is a sense that the ethical qualities of being able to manipulate life might allow a new generation of postmodernism to emerge.

MS / The two things that I definitely agree with there: I think one of the problems of architecture is that postmodernism collapsed in on itself as a sort of surface imagery,

I almost want to use the word 'style', which is a word I typically avoid in architecture. I think it's one of the problems of contemporary architecture that postmodernism as a chain of thought wasn't profoundly sustained, it collapsed. So it's interesting if you're saying that within ACADIA that becomes of interest again. But the other word that you used was 'power', and one of the things that I've been thinking about the way that sustainability is articulated, it's that the politics of the world is not discussed, when actually it's fundamental to human ecology. I think there's been a false presentation of sustainability, as if we can all do it without having a discussion about how we manage resources, and to build we need resources. I think there's a political dimension to the discussion that has been uncomfortably shuffled underneath the carpet.

PB / When I hear you speaking about power, it makes me think about the agency of an architect, rooted in building. I think about widely polarised positions: on the one hand, I might think about the confidence that I see in some of your own work. I think about some of the early component-based envelope systems that you developed for example, with direct engagement in industry, so that integrated building systems can be used and played lyrically. Polarised against that, I think of the picture of a weak architecture of Ignacio de Solà-Morales, who claimed you could hardly participate in the world meaningfully; the only thing architecture could do [according to him] would be to have a weakly resonant frame where you hover at the edge of things. Perhaps, in that view, you

could create ornament that can wrap around whatever is going to play at the centre. The centre would be controlled utterly by others. Those are two opposite pictures of agency and participation.

Perhaps, some new tools and thorough involvement in new materials makes possible exquisite subtlety, and perhaps those might reconcile those two positions. For example, materials can be wound up so that they're sensitive, so that they can tremble and so that they can act as environmental registers in an envelope.

With direct manufacturing the prototype can go through generous cycles of development, and competence can emerge, qualifying systems for application at a general public scale. New generations of architectural skins and surfaces can offer qualities of sensitive and responsive phenomena. I'm trying to point to the possibility of new generations of fabrication offering some lyrical qualities.

I imagine detailing systems that might capture temporal and dynamic qualities, speaking of flux, exchange and flow. I imagine this entering the iconography of public institutions, articulating public power. I would love to explore this in terms of ornamental systems integrated with construction component systems, speaking of emplacement.

MS / Okay, Phillip, to me that sound like it could be a really inventive architecture and that's one of the qualities that I enjoy. I worry about the sort of vaguely innovative architecture that is so common, let's not dwell on that though. I think my final question is; what are you designing now? What's next? What's the optimist doing at the moment?

PB / I'm trying to move into emotional kinetic patterns in the responsive fabrications that have been in the studio this past year. Some of those first layers of kinetic response are really dreadful. They are plagued with similar qualities to the parametric exercises that we were criticising earlier, strikingly predictable and rigid patterns. The risk of this is creating a new generation of B.F Skinner's horrific mid-century experiments; the Skinner Box, where a child would grow and be happy in a Pavlovian container. But I'm trying to anticipate and find patterns of response that can show care about their occupants; trying to achieve qualities of mutual relationships. The opportunity opens a lovely kind of play and invention.

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THAW IMAGINING A SOFT TECTONICS

1 The textile is developed in collaboration with Prof. Behnam Pourdeyhimi, North Carolina State University, College of Textiles. The material is a blend of polyester and co-polyester. The co-polyester melts at a lower temperature and 'binds' the fibres together. The structure was made by carding crosslapping, followed by needle punching, and then passed through the over to partially melt some of the co-polyester. Prof. Pourdeyhimi used a very special experimental needle that densifies the web to give it density. The web is ~ 300 g/square metre.

2 'Geodetic Construction: Vickers-Wallis System Explained: Advantages of Concentrating Material. Balancing Tension Against Compression', *Flight* (16 January 1936), p. 67.

3 Graefe, R., 'Vladimir G. Suchov 1853–1939. Die Kunst der sparsamen Konstruktion' (Stuttgart: Deutsche Verlags-Anstalt, 1990).

4 This parametric modelling of the material performance is developed across a series of projects in CITA and

has been first implemented in the research workshop 'Digital Crafting: How to Join as Part of a Cross-national Research Network': www.digitalcrafting.dk

5 The research collaboration is part of the Velux Guest Professorship with Prof. Mark Burry, Spatial Information Architecture Laboratory, RMIT, Melbourne. The project is a broad collaboration between the two research centres and includes collaboration with Prof. Mark Burry, Jane Burry, Mette Ramsgard Thomsen, Martin Tamke, Phil Ayres, Alexander Pena, Daniel Davis, Jacob Ribber Nielsen, Stig A. Nielsen, Anders Holden Deleuran, Morthen Winther and Sigurdur Ormarsson.

FABRICATING INDETERMINATE PRECISION

1 Todorov, Tzvetan, *Symbolism and Interpretation*, trans. from Marjorie Perloff, *Poetics of Indeterminacy* (Evanston: Northwestern University Press, 1999)

(FAB)BOTS CUSTOMISED ROBOTIC DEVICES FOR DESIGN & FABRICATION

1 Referring to research conducted by Behrokh Khoshnevis (University of Southern California), Rupert Soar (Loughborough University) and Gramazio & Kohler (ETH Zurich), amongst a growing number of fabrication-related courses and workshops at several universities worldwide.

2 The studios are titled 'Machinic Control 1.0' (AA) and 'Digital Tectonics RS3' (IAAC). The three projects from the AA are produced during a 12-month period of research, while the seven projects from IAAC were conceived in a period of five months. Both design studios supported the work through tutorials in programming and building customised devices using a standard CNC stepper motor control module or the open-source electronics prototyping platform Arduino, which is based on flexible, easy-to-use hardware and software. Student teams were encouraged to benefit from and contribute to a large on-line community sharing experiences with interactive devices and installations.

3 BEAM is an acronym for Biology, Electronics, Aesthetics and Mechanics. This is a term that refers to a style of robotics that primarily uses simple analogue circuits, such as comparators, instead of a microprocessor in order to produce an unusually simple design (in comparison to traditional mobile robots). BEAM robots typically consist of a set of the aforementioned analogue circuits (mimicking biological neurons), which facilitate the robot's response to its working environment.

4 Braitenberg Vehicles are conceived by the Italian-Austrian cyberneticist Valentino Braitenberg and

illustrate the abilities of simple agents. The vehicles represent the simplest form of behaviour-based artificial intelligence or embodied cognition; that is, intelligent behaviour that emerges from sensorimotor interaction between the agent and its environment, without any need for an internal memory, representation of the environment or interference.

5 BOIDS is an artificial life program, developed by Craig Reynolds in 1986, which simulates the flocking behaviour of birds. As with most artificial life simulations, BOIDS is an example of emergent behaviour; that is, the complexity of BOIDS arises from the interaction of individual agents (the BOIDS, in this case) adhering to a set of simple rules.

CNCATENARY TOWARDS A DIGITAL FABRICATION METHOD FOR CATENARY SYSTEMS

1 Chak, D., M. Galbraith and A. Kilian, 'CatenaryCAD: An Architectural Design Tool' final project report for a class on computer graphics, MIT (2002)

MATTER & MAKING

1 'The 2003 Inductees', The Robot Hall of Fame Webpage, The School of Computer Science at Carnegie Mellon University: www.robohalloffame.org/unimate (accessed 5 December 2010).

2 The designed wind was calculated for a reduced wind speed of 50 mph yielding a pressure of approximately 5 psf. For reference, the Safir-Simpson Hurricane Scale defines winds of 50 mph as a tropical storm.

3 A Change of State is constructed of polyurethane sheet material. The sheets were CNC profile cut into custom construction units. These units were cold bent, twisted and bolted to their neighbours to occupy the third dimension. By aggregating this system, volume was occupied in the form of a space truss spanning a full column bay.

4 Drawn Dress is an interdisciplinary project addressing the custom needs of dress design with advanced technologies such as digital body scanning and CNC fabric cutting. The designs produced during the project all hug tightly to the body as a way of testing the precision and fit, though they leave the body to enter the volumetric space of digital modeling. The seams of these dresses are truly 3D and are conceived of as volumetric objects, though implemented through 2D patterns.

5 AtmoSPHERE is a proposal for a building envelope for a factory building in Los Angeles. This proposal questions the idea that building envelopes need to be hermetic seals. Instead, when given depth, an envelope could perform closer to a sponge or the leaves

of a tree. This volumetric envelope shades the interiors, while allowing ventilation to move freely through the envelope and condition through its filtering technique.

6 This research is not obligated to EPS foam as a material, but rather volumetric materials as a larger category. While EPS foam was used for this case study, further research is taking place to engage these other volumetric materials listed.

7 The EPS foam for Periscope was sourced in Michigan, fabricated in there, and transported to Atlanta. Sourcing in Atlanta was possible; however, the fabrication facilities available to the project in Atlanta were not equipped to handle the material or the method developed. As a proposal for a larger making process, it must be clarified there is an assumption that these fabrication techniques would be local as well.

8 Stereotomy is the technique of cutting solids to specific forms and dimensions.

9 Evans, Robert, 'Drawn Stone', in *The Projective Cast: Architecture and Its Three Geometries* (Cambridge, MA: MIT, 1995), print.

10 For the stonemason, this line was not a physical object, but rather a geometric principle allowing 2D traits to describe a 3D form. The hot-wire performed as this principle in real time.

TERRA THERMA

1 See www.water-technology.net/projects/thameswater

INVESTIGATIONS IN DESIGN & FABRICATION AT HYPERBODY

1 Arduino is an open-source electronics prototyping platform, for more information please see: www.arduino.cc

2 NedCAM is a company based in the Netherlands that specializes in large-scale CNC fabrication and have worked on a number of interesting architectural projects. Its important to point out that NedCAM has been experimenting with hot-wire cutting for the roughening foam blocks that will be further milled.

INTRODUCTION BOB SHEIL

1 See Sheil, B., 'Transgression from Drawing to Making' in *Architectural Research Quarterly* Vol. 9 Issue 1, (Cambridge University Press), pp 20-32, 26 Illustrations ISSN 1359-1355

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LARGE, COMPLEX, PERFORATED ENCLOSURES IN EXTREME ENVIRONMENTS CONTROL OF STRUCTURAL & THERMODYNAMIC BEHAVIOUR, FROM MACRO TO NANO-SCALE

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FURTHER READING

CNCATENARY TOWARDS A DIGITAL FABRICATION METHOD FOR CATENARY SYSTEMS

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DESIGN FOR POTENTIAL LARGE-SCALE ADDITIVE FABRICATION FREE-FORM CONSTRUCTION

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END NOTES

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RESEARCH PAVILION ICD/ITKE

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Responsible for the scientific development were Moritz Fleischmann (project management), Simon Schleicher (project management), Christopher Robeller (detailing/construction management), Julian Lienhard (structural design), Diana D'Souza (structural design) and Karola Dierichs (documentation).

PROJECT CREDITS

Institution: University of Stuttgart. Department: Faculty of Architecture. Institutes: Institute for Computational Design (ICD), Prof. Achim Menges, and Institute of Building Structures and Structural Design (ITKE), Prof. Jan Knippers. Project Team (Concept and Realisation): Andreas Eisenhardt, Manuel Vollrath, Kristine Wächter and Thomas Irowetz, Oliver David Krieg, Ádmir Mahmutovic, Peter Meschendörfer, Leopold Möhler, Michael Pelzer and Konrad Zerbe. Scientific Development: Moritz Fleischmann (project management), Simon Schleicher (project management), Christopher Robeller (detailing / construction management), Julian Lienhard (structural design), Diana D'Souza (structural design), Karola Dierichs (documentation).

LINKS

<http://icd.uni-stuttgart.de/?p=4458>
www.itke.uni-stuttgart.de/de/forschung/Forschungspavillon.htm

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THAW IMAGINING A SOFT TECTONICS

AUTHORS

Mette Ramsgard Thomsen, Karin Bech and Martin Tamke, Centre for IT and Architecture, Royal Danish Academy of Fine Arts, School of Architecture.

ACKNOWLEDGEMENTS

Thaw was exhibited as part of the digital material exhibition at R.O.M Gallery for Art and Architecture, Oslo, in May 2010. The exhibition was kindly supported by the Nordic Culture Foundation and Henrik de Miniassen, director of R.O.M. Thaw was further developed as a larger-scale installation for the Lisbon Architecture Triennale as a 10-metre-high installation Thicket.

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(FAB)BOTS CUSTOMISED ROBOTIC DEVICES FOR DESIGN & FABRICATION

Design Studio: 'Machinic Control 1.0': Tutors: Marta Malé-Alemany, Jeroen van Ameijde. Architectural Association School of Architecture, Design Research Lab (DRL) Graduate Programme (2009–10). Projects: DIGITAL VERNACULAR: Shankara S. Kothapuram, Mei-ling Lin, Ling Han, Jiawei Song. FIBR(H)OUS(E): Amrita Deshpande, Saahil Parikh, Akhil Laddha. FLUID CAST: Ena Lloret, Maria Eugenia. Villafañe, Jaime De Miguel, Catalina Pollak. Design Studio: 'Digital Tectonics RS3', Tutors Marta Malé-Alemany, Victor Viña, César Cruz Cazares (assistant), Lluís Fraguada (collaborator). Institute of Advanced Architecture of Catalonia (IAAC), Master in Advanced Architecture (2009–10). Projects: SANDBOT: Joel Letkemann, Viraj Kataria, Fabio Lopez. HELIOBOT: Felipe Pecegueiro, Jorge Orozco, Kfir Gluzberg. FAB [A]THING: Jun Huang, Jessica Lai, Asim Hameed. DREAMWEAVER: Melat Assefa, Brian Peters, Joao Albuquerque. NGPS: Ali Basbous, Miquel Lloveras. PNEUMORPHOSYS: Natalija Boljsakov, Brian Miller, Carlos Naranjo. MIMICRY: Mia Gorretti Layco, Georgia Kotsari, Tomasz Starczewski. Exhibition:

(FAB)BOTS, Customized robotic devices for design and fabrication, 16 June to 12 September 2010, Disseny Hub Barcelona (DHUB). Curator: Marta Malé-Alemany. Coordination: Catalina Pollak.

LOGIC MATTER

Logic Matter was made possible by the support, inspiration and critique from collaborations at MIT with Erik Demaine, Patrick Winston, Terry Knight and Neil Gershenfeld.

CNCATENARY TOWARDS A DIGITAL FABRICATION METHOD FOR CATENARY SYSTEMS

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SCANLAB

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FREE-FORM METAL INFLATION & THE PERSISTENT MODEL

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Persistent Model #1 was an exhibit in the show entitled *digital.material* which showcased four recent works by CITA. The exhibition ran from 23 April to 23 May 2010 at the ROM Gallery, Oslo.

MATTER & MAKING

PERISCOPE FOAM TOWER

AUTHORS

Brandon Clifford and Wes McGee

PROJECT CREDITS

Design Team: Matter Design – Brandon Clifford, Wesley McGee. In collaboration with Supermanoeuvre – Dave Pigram. Structural: Simpson Gumpertz&Heger – Matthew Johnson. Build Team: Matter Design – Brandon Clifford, Wesley McGee, Johanna Lobdell, Deniz McGee, Kris Walters, Maciej Kaczynski. Rigging: Boutte Tree – TiersonBoutte. Fabrication: University of Michigan Taubman College of Architecture and Urban Planning.

WAVE PAVILION

Designer/Fabricator: macdowell.tomova. Consultants: Wes McGee, Matter Design; Dave Pigram, Supermanoeuvre.

BENT

Kendra Byrne and Nick Rebeck: www.b-e-n-t.com

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MATERIAL ANIMATION A NEW INTERFACE TO CUSTOM FABRICATION

Work developed on robotic folding methods was done in collaboration with Robofold Ltd., Gregory Epps. Field Condition is supported by the University of Kentucky College of Design – School of Architecture, College of Engineering – Dept. of Computer and Electrical Engineering, and the Institute of Sustainable Manufacturing. The team for Field Condition is Anton Bakerjian and Ian McHone.

MINIMAL COMPLEXITY

The Minimal Complexity prototype was developed during the Certificate of Advanced Architectural Research Postgraduate Course at The Bartlett, UCL, between 2009 and 2010, and it has taken part in ‘Constructing Realities’, the final exhibition of the Course’s research work between July and October 2010.

The theoretical paper ‘Minimal Surfaces as Self-Organizing Systems’ describing the computational framework for generating the final prototype was developed as part of the MSc. Adaptive Architecture and Computation Course at The Bartlett, UCL, 2009, and has been presented at ACADIA Conference, in New York, in October 2010.

The Minimal Complexity structure winner of the TEX-FAB REPEAT Digital Fabrication Competition was built in Houston, Texas, in February 2011.

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INVESTIGATIONS IN DESIGN & FABRICATION AT HYPERBODY

PROTODECK

AUTHORS

Marco Verde Eng, MArch, MarkDavid Hosale, Ph.D.

PROJECT CREDITS

Property Developer: Hyperbody | TU Delft. Direction: Prof. ir. Kas Oosterhuis. protoDECK system development and manufacturing engineering: Marco Verde Eng, MArch. protoNODE system development and manufacturing engineering: Dr MarkDavid Hosale. Digital Fabrication: NEDCAM, HYPERBODY CNC DIVISION. Project Sponsor: Missler Italy – TopSolid

PROTOSPACE 4 MOCK-UP

AUTHOR

Jelle Feringa, PhD candidate, co-founder EZCT Architecture & Design Research

PROJECT CREDITS

Design of the protoSPACE 4 pavilion was completed in the context of the MSC2 spring 2009 design studio. Hot-wire manufacturing: Jelle Feringa & Haiko Dragstra (Komplot Mechanics). Components connections: Owen Slootweg. Final Assembly: Owen Slootweg & Chris Kievid & Jelle Feringa. Project management: Chris Kievid.

PROTOTYPE FOR A SPATIALISED INSTRUMENT

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www.mishasmith.com

VILLA NURBS

City: Empuriabrava. Country: Spain. Construction: started 2003. Office: Cloud 9 (Barcelona, Spain; est. 1997)

Architect: Enric Ruiz Geli. Collaborators: Felix Fassbinder (Project Architect), Jordi Fernández Río (Project Architect). Arquitectos Técnicos: Daniel Benito Pò (Architect), Xavier Badia (Architect), Agustí Mallol (Architect), Víctor Llanos (Collaborator [office]), Miguel Carreiro (Collaborator [office]), Emmanuel Ruffo (Collaborator [office]), Rosa Duque (Collaborator [office]), André Macedo (Collaborator [office]), Ura Carvalho (Collaborator [office]), Hye Young Yu (Collaborator [office]), Marta Yebra (Collaborator [office]), Mae Durant (Collaborator [office]), Angelina Pinto (Collaborator [office]), Randall Holl (Collaborator [office]), William Arbizu (Collaborator [office]), Max Zinnecker (Collaborator [office]), Laia Jutgla (Collaborator [office]), Manel Soler (Collaborator [office]), Megan Kelly-Sweeney (Collaborator [office]), Alessandra Faticanti (Collaborator [office]), Susanne Bodach (Collaborator [office]), André Brosel (Collaborator [office]), Konrad Hofmann (Collaborator [office]), Nora Graw (Collaborator [office]), Cricursa/Vicky Colombet (Glas Manufacturer), Toni Cumella Ceramic Manufacturer), Frederic Amat (Ceramic Artist), Industrias de la Fusta (IFV) (Corian Manufacturer), Covertex (BTFE Manufacturer), BOMA SL (Engineering), Obres i Construccions Joan Fustè (Construction), Diorama (Wood), Caldereria Delgado (Steel Framework), Ramón Presta (Hydraulics), Industrias BEC (Tensile Structures), Aiterm, PGI, Reindesa (Installations), Aislater, Inoxcolor (Installations), Estudi Ramon Folch (Construction), Emiliana Desigestudio (Graphic Design), BAF (Audiovisuals), Led’s Go (Illumination). Client (Private): Family Emilio Gallego. Programme: housing.

C-STONE & C-BENCH

This project is dedicated to Christel Vandewaerde (4 December 1963 – 18 December 2010).

GALAXY SOHO LARGE-SCALE CLADDING CONSTRUCTION IN CHINA

Client: SOHO China Ltd., Beijing, China. Architect: ZAHA HADID ARCHITECTS. Design: Zaha Hadid with Patrik Schumacher. Project Associate: Cristiano Ceccato. Project Director: Satoshi Ohashi. Project Architect: Yoshi Uchiyama. Project Manager: Raymond Lau. Project Team: Stephan Wurster, Michael Hill, Samer Chamoun, Eugene Leung, Rita Lee, Lillie Liu, Rolando Rodriguez-Leal, Wen Tao, Tom Wuenschmann, Seung-ho Yeo, Shuojiong Zhang, Michael Grau, Shu Hashimoto, Shao Wei Huang, Chikara Inamura, Lydia Kim, Yasuko Kobayashi, Wang Lin, Yereem Park, Christoph Klemmt, Dorian Bybee, Kyla Farrell, John Klein. Local design institute:

BIAD (Beijing Institute of Architecture and Design), Beijing. Facade engineer: KT Kighton Ltd., Shanghai. Timeframe: 2008–12. Programme: Mixed Use Commercial & Retail Complex, Shell & Core Fit Out. GFA: 360,000m² + 150,000m² Below Grade. Site Area: 50,000m². Height: 67 metres = 16 Floors Above Grade.

MEDIA-ICT

City: Barcelona. Country: Spain. Completed: January 2010 (started 2005). Office: Cloud 9 (Barcelona, Spain; est. 1997)

Architect: Enric Ruiz Geli. Collaborators: Josep Maria Forteza (Building advising), Agustí Obiol (Structural engineering), David Tusset (Engineering), Hector Yuste (Project management), Joan Buj Cotes (Construction), Carlos Siscart González (Construction), Ben Morris (Construction), Lluís Renom (Construction), Edouard Cabay (Architect), Javier Pérez Contonente (Architect), Francesco Ducato (Architect), Felix Fassbinder (Architect), Nora Graw (Architect), Konrad Hofmann (Architect), Victor Llanos (Architect), Max Zinnecker (Architect), Marta Arranz (Collaborator [office]), Ruben Alonso (Collaborator [office]), Luis Borunda (Collaborator [office]), Marta Banach (Collaborator [office]), Daniel Corsi (Collaborator [office]), Cristina Guadalupe (Collaborator [office]), Albert Lopez (Collaborator [office]), Mireia Luzarraga (Collaborator [office]), Patricio Levy (Collaborator [office]), Alex Muiño (Collaborator [office]), Beatriz Minguez (Collaborator [office]), Veronica Mansilla (Collaborator [office]), Federico Ortiz (Collaborator [office]), Mireia Pallarès (Collaborator [office]), Marisol Verges (Collaborator [office]), Hale YoungBlood (Collaborator [office]), Pep Bou (Art), André Macedo (Design). Client (Public): Consorci de la Zona Franca and 22@. Programme: Office.

THE SPHERE GENERATE, FABRICATE, CALCULATE

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WAVED WOODEN WALL

Kilden Performing Arts Center, Kristiansand, Norway. Architect: ALA Arkitekter AS, Helsinki, Finland.

General Contractor: AF Gruppen AS, Oslo, Norway. Timber Facade Contractor: Trebyggeriet SA, Hornnes, Norway. FaCade Cladding, CNC-Fabrication: Risør Trebåtbyggeri AS, Risør, Norway. Facade Structure, CNC-Fabrication: Blumer-Lehmann AG, Gossau, Switzerland. Façade Engineering: SJB Kemper-Fitze, Eschenbach, Switzerland. Consulting, Digital Planning: designtoproduction GmbH, Erlenbach/Zurich, Switzerland.

LOUVRE ABU DHABI 1:33 LIGHT-TEST PROTOTYPE

Construction of the 1:33 prototype has been a cooperation between: 1:One | Computational Geometry (programming), George Ackermann GmbH (manufacturing & assembly) and Honkahe Interior+Furniture (modelmaking and consulting).

PHOTO CREDITS

RESEARCH PAVILION ICD/ITKE

A. Menges, 2010: 1, 7; C. Robeller/S. Schleicher, 2010: 2, 3; A. Eisenhardt/M. Vollrath/K. Wächter/S. Schleicher, 2010: 4; A. Lautenschlager, 2010: 5; A. Eisenhardt/M. Vollrath/K. Wächter, 2010: 6, 9; S. Schleicher, 2010: 8.

UNIKABETON PROTOTYPE

All images © Per Dombernowsky and Asbjørn Søndergaard 2010.

FREE-FORM METAL INFLATION & THE PERSISTENT MODEL

Anders Ingvarsten: 1, 3; Anders Holden Deleuran, CITA: 5.

MATTER & MAKING

PERISCOPE FOAM TOWER

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BENT

All images: Kendra Byrne and Nick Rebeck.

MATERIAL ANIMATION A NEW INTERFACE TO CUSTOM FABRICATION

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KOHLER/KARA

All images: Gramazio & Kohler, Architecture and Digital Fabrication, ETH Zürich.

BEESELEY/STACEY

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All photos: Neri Oxman.

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Photo by Luis Ros © Cloud9: 1, 2, 4; Victor Llanos © Cloud9: 3, 5, 6, 7.

GALAXY SOHO LARGE-SCALE CLADDING CONSTRUCTION IN CHINA

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MEDIA-ICT

Photo by José Miguel Hernandez © Cloud9: 1, 9; Photo by Luis Ros © Cloud9, La Chula: 5; Photo by Iwan Baan, Cloud9: 3, 11, 12; Photo by Luis Ros © Cloud9: 2, 13.

THE SPHERE GENERATE, CALCULATE, FABRICATE

All images © Bollinger + Grohmann Ingenieure, 2010.

THE RICHMOND SPEED SKATING OVAL ROOF

Fast + Epp Engineers: 1; StructureCraft Builders: 2–8.

THREE PROJECTS A COMPARITIVE STUDY

Amanda Levette Architects: 1, 3, 4, 5, 6, 7, 8, 10; Edmund Sumner: 2; Leo Torri for DuPont™ Corian®: 9; © Meinhardt Façade Technologies: 11.

MULTI-SPHERICAL MIRRORED SCULPTURE

M. Hess photography: 1; Arup photography: 2, 3, 4, 7.

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RADIOLARIA PAVILION

Credit: Blueprint, 2009: 1; Credit: Shiro Studio: 2, 4;
Credit: D-Shape, 2009: 3, 5, 6.

WAVED WOODEN WALL

1, 2 © Trebyggeriet; 3, 4, 5 © designtoproduction.

RUAIRI GLYNN

Ruairi Glynn is Lecturer in MSc Adaptive Architecture and Computation, and tutors the MArch Architectural Design Programme at The Bartlett School of Architecture, University College London. He is Associate Lecturer in MA Textile Futures and MA Industrial Design at Central Saint Martins, University of Arts London. Collaborating across design disciplines through digital and analogue practices, he and his students develop responsive environments, from hybrid materials and software systems up to architectural scale installations. He has run workshops and acted as visiting lecturer to leading centres of architectural and computational design including ETH Zurich, TU Delft, and CITA Copenhagen.

In 2010 he was awarded an Engineering & Physical Sciences Research Council scholarship to support doctoral research on the animation of architecture through robotics. Since 2005 he has been developing a series of interactive environments titled '*Performative Ecologies*'. His work examines gestural interaction between inhabitant and architecture, through the use of sensory and servo motor actuated systems. Recent exhibitions include the Los Angeles' 'Beall Centre of Art & Technology', Seoul's 'SOMA', São Paulo's 'Itaú Cultural' and Madrid's 'International Contemporary Art Fair', leading to a international awards including the '*Europrix*', European Award for Digital Media and the '*Concurso Internacional de Arte y Vida*'.

In 2009, he was organiser of the multidisciplinary '*Digital Architecture London Conference*' at the Building Centre. Divided into panels on Space, Biotechnology, Interaction, Form and Fabrication, London's leading Architects, Artists, Interaction Designers, and Scientists were invited to discuss the state of the art, the similarity and differences between approaches and to speculate on post-digital futures. Bringing together work of London's leading Architecture Schools, the AA, Bartlett, RCA and Westminster, a complimentary exhibition '*Digital Hinterlands*' co-curated with Jennifer Greitschus was held at London's Phase 2 Gallery. '*Digital Architecture, Passages Through Hinterlands*' co-authored with Sara Shafiei and designed by Emily Chicken was published in parallel.

BOB SHEIL

Bob Sheil is designer, maker and educator. He is Senior Lecturer and Director of Technology and Computing at The Bartlett School of Architecture UCL, where he also runs MArch Unit 23 with Emmanuel Vercruyse, a workshop based unit exploring relationship between the digital and analogue in issues such as craft, prototyping and adaptive architecture. In 2007 he was awarded funds of £0.5m and established The Bartlett's Digital Manufacturing Centre, representing the school's most significant new investment in decades. He has lectured extensively in the UK and overseas, and is an active contributor towards evolving architectural education at a national level.

He founded sixteen*(makers) with Nick Callicott in the mid 1990's, later to be joined by Phil Ayres, Chris Leung and Vercruyse. Their most recent work, '55/02', a forestry shelter in Kielder Park, Northumberland UK is an exploration of digital design and manufacturing, in collaboration with manufacturers Stahlbogen GmbH, of Blankenburg, Germany. A monograph on '55/02' will be published this year through Riverside Architectural Press.

Sheil has authored and edited a number books, papers and articles on his interest in the relationship between design and making, including two guest edited issues of AD 'Protoarchitecture-between the Analogue and the Digital' (2008) and 'Design through Making' (2005). In 2011 he will complete a

collection of 16 critical essays by pioneers in design and making, including Peter Salter, Rural Studio and Mark Burry, in 'Manufacturing the Bespoke' an AD Reader published by Wiley.

His latest design and build project, for a mobile performance space, is a collaboration with former Unit 23 students and the Central School of Speech and Drama, it was presented at the Adaptive Architecture Conference March 2011, and will be exhibited and presented at the Prague Quadrennial of Performance Design and Space.

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For further reading:

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