设计智能

高级计算性建筑生形研究

DESIGN INTELLIGENCE

ADVANCED COMPUTATIONAL RESEARCH

学生建筑设计作品

DADA 2013 STUDENTS

徐卫国 / 尼尔 · 林奇（英） 编

Xu Weiguo / Neil Leach [eds.]

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前言 / PREFACE

本作品集收录了“设计智能：高级计算性建筑生形研究”学生作品展中的作品。该作品展作为 DADA 2013 系列展的一部分，将会在 751 D-Park 时尚设计广场举办。自从 2004 年以来，徐卫国与 Neil Leach 为北京建筑双年展合作策展了一系列的展览。第一次是 2004 年在 UHN 国际村举办的“快进 >>”展，之后三次分别是 2006 年在世纪坛举办的“涌现”展，2008 年在 798 时态空间举办的“数字建构”展，以及 2010 年同样在 798 时态空间举办的“数字现实”展。

本次主题“设计智能：高级计算性建筑生形研究”展示了在建筑教育领域中的一系列新进展。第一，“智能”指的是在设计加工领域中越来越普及的智能系统以及新型材料的使用；第二，“高级”一词指在例如 Grasshopper 等的算法软件以及三维打印这样的加工技术已经普及的时代中，逐渐成熟的计算机技术和技能的应用；第三，“研究”指的是在许多研究生课程近年来明显的转变：即由主要基于设计的硕士研究生课程向基于研究的课程设计转变。这些课程往往为之后的博士研究铺设道路。

This is a catalogue of the works on display in the 'Design Intelligence: Advanced Computational Research' exhibition of students' work at 751 D-Park, Beijing, as part of the DADA 2013 series of exhibitions. Since 2004 Xu Weiguo and Neil Leach have been collaborating on a series of exhibitions for the Architecture Biennial Beijing. The first exhibition, 'Fast Forward >>', took place in UHN in 2004. This was followed by three further exhibitions, 'Emerging Talents, Emerging Technologies' in the Millennium Museum in 2006, 'Immaterial Processes: New Digital Techniques for Architecture' in 798 Space in 2008, and 'Machinic Processes' in 798 Space in 2010. This exhibition is a continuation of that collaboration.

The title, 'Design Intelligence: Advanced Computational Research', signals a series of new developments within architectural education. Firstly, the term 'Intelligence' refers to the use of increasing use of intelligent systems and smart materials in the design and construction of buildings. Secondly, the term 'Advanced' refers to the increasingly sophisticated use of computational techniques and technologies, in an age when the use of algorithmic software programs such as Grasshopper, and fabrication processes such as 3-D printing have become commonplace. And, thirdly, the term 'Research' refers to a shift evident in many postgraduate educational programs away from the once dominant culture of design master classes towards a research based agenda that often lays the foundations for PhD research.

本作品集为世界上顶尖的建筑院校的先锋数字设计作品提供了一个展示的平台。包括英国建筑联盟建筑学院，美国南加州大学，哈佛大学，美国南加州建筑学院，同济大学和清华大学等。本作品集收录的是将在 751 D-Park 举办的系列展览的一部分。这些展览包括由宋刚和 Philip Yuan 所策展的装置展，高岩、王鹿鸣策展的中国建筑师作品展，以及由 Patrik Schumacher 所策展的大师展，其参与者包括扎哈·哈迪德事务所，Reiser& Umemoto，让·努维尔，蓝天组，Morphosis，Gehry and Partners。

展览的举办离不开许多个人和组织的帮助。特别感谢 751 D-Park 时尚设计广场为展览提供的场地支持。

我们十分感谢为作品集编排和设计付出努力的所有人。特别感谢：金漪、李晓岸、刘傲、刘春、吕帅、娄晓一、林秋达、沈源、王捷、翟炳博、罗丹……为作品集的编排、设计和翻译所做的贡献，以及为作品集贡献材料的各个学校。

徐卫国

尼尔·林奇

The catalogue offers a showcase of the most advanced computational design work from some of the leading schools of architecture in the world. These schools include the Architectural Association, University of Southern California, Harvard GSD, SCI - Arc, Tongji University and Tsinghua University, etc. The work included here is part of a larger exhibition being held in 751 D - Park, Beijing, that includes a series of installations curated by Philip Yuan, Gang Song, and an exhibition of some of the most famous architects in the world - including Zaha Hadid Architects, Reiser & Umemoto, Jean Nouvel, Co (op) Himmelb (l) au, Morphosis, Gehry and Partners - and curated by Patrik Schumacher.

The organizers are grateful to all those who have contributed to the preparation of this catalogue. In particular, they would like to thank Yi Jin, Xiaoan Li, Ao Liu, Chun Liu, Shuai Lv, Xiaoyi Lou, Qiuda Lin, Yuan Shen, Jie Wang, Bingbo Zhai, Dan Luo for their invaluable contribution in helping to design, translate and compile material for this catalogue, and to the schools themselves for submitting that material.

Xu Weiguo

Neil Leach

对话 / DIALOGUE

徐卫国–尼尔·林奇
XWG-Neil Leach

徐卫国（以下简称徐）：你对全球蓬勃发展的数字建筑教育怎么看？

Neil Leach（以下简称 NL）：我认为，我们处于一个对于建筑院校的数字化教育而言非常重要的时间点。对于中国尤为如此。在我 2004 年第一次来到北京的时候，没有人知道什么是编程。而现在种种数字化研习班层出不穷，包括现在清华大学正在举办的这个。在为这种变革欣喜之余，我们也需要面对一些新的问题。由于当下，数字化已经逐渐普及，所有人或者说绝大多数人会使用 Grasshopper。那么在当今环境下，数字化到底扮演着什么角色？数字化展览的定位究竟是什么？因此我认为，这就是为什么“高级数字化”一词必须囊括在本次展览的标题之中。因为如果我们想要有重大的突破和发现，我们必须找到一些新的革命性的数字技术应用方式。

徐：你提到了“高级的”一词，你认为在数字建筑技术领域，“高级的”数字建筑技术主要是指哪些方面？

NL：在我的概念中，这包含两个方面。其一是在设计过程中高级软件技术的应用，而高级数字化技术的另一方面是在制造中的应用。对于软件技术而言，我们可以区分诸如 Rhino 和 Maya 这样随处可见的特定软件，越发流行的算法工具例如 Grasshopper 和 Processing，和像 Catia 和 Digital Project 这样的参数化工具。持续处于高级领域的是代码的使用，即编程或者算法。换句话说，即生成的算法手段等等。当然，所有这些每一天都在进步着。还有许多 Grasshopper 的插件也变得越来越专业化。

另外一个方面是数字化生产。如同我们可以在许多学校（例如 AA, Bartlett，清华，同济，IaaC，SCI-Arc，ETH，南加州大学，密歇根大学）里面看到的那样，他们现在都在投资机器人。事实上，许多学校都在尝试利用机器人的生产模式。目前，三维打印并不意味着什么，因为所有人都在使用它。这并不是高级的。但是机器人是，以及交互工具的使用也变得越发重要起来。在中国，这方面越来越流行。因为 Arduino 模块以及 Servo 在这里均非常便宜。我注意到在例如 SCUT 和清华这类学校，许多工作精力都投入交互设计的领域。在 USC，DIA 以及 Bartlett 中，我们也在使用 Kinet，记忆纤维等等。许多不同的技术在被使用。世界自 2004 年我们举办第一个展览以

XWG: The title of the catalog is Design Intelligence: Advanced Computational Research. Where do you think digital education is leading?

NL: Well, I think that we are at an interesting moment in terms of the use of computation in schools of architecture, especially in China. When I first came to Beijing in 2004, nobody knew what scripting was. Now there has been this revolution. There are many computation workshops including the one here in Tsinghua University. But now we have a different issue, because now computation is everywhere. Everybody - almost everybody-can use Grasshopper. So, what is the role of computation today? What is the role of an exhibition that is looking at computation? So I think that is why the term 'advanced computation' has to be in the title of this exhibition, because if we want to find something significant, we have to find some new revolutionary, progressive use of computation.

XWG: When you use the word 'advanced', what do you mean in relation to digital technology?

NL: To my mind, there are two aspects. One is the focus on the use of advanced software techniques in the design process, and the other side is advanced computational technologies in fabrication. In terms of software techniques, we can distinguish between the use of explicit modeling tools that Rhino and Maya that are used everywhere, algorithmic tools such as Grasshopper and Processing that are becoming extremely prevalent, and also parametric tools like Catia and Digital Project. What is advanced and remains advanced is the use of code - the use of scripting or algorithms, in other words-and especially the use of techniques such as genetic algorithms and so on. And of course these are getting more advanced every day. There are also a lot of plug-ins for Grasshopper that are getting more and more specialized.

The other aspect is digital fabrication. And we can see that many schools-such as the AA, Bartlett, Tsinghao, Tongji, IaaC, SCI-Arc, ETH Zurich, USC, Michigan and so on-have now invested in robots. In fact many schools are looking at robotic fabrication. And so simple 3D printing means very little these days, because everyone is using it. It's not advanced. But using a robot is. And the use of interactive tools has become increasingly significant also. In China these have become especially popular, because Arduino boards and Servos are extremely cheap. I noticed example, especially in schools such as SCUT and Tsinghua, a lot of work is going on with interactive technologies. And in schools like USC, DIA and the Bartlett we are also using Kinect and Shape Memory Alloys; so many new technologies are being used. The world has progressed a lot since 2004, when we held our first exhibition.

来有了大幅度的进步。

徐：那你是不是认为我们的数字建筑教育上了一个台阶？

NL: 绝对的。很明显自从 2004 年以来有很大的变化。事实上，我的预测是在这个十年，即 2020 年结束的时候，我们甚至不会再提“计算机辅助”这个单词。因为它将涵盖所有方面，以至于没有哪里是特殊需要专门被提出的。因此再讨论这个是没有意义的。就像在施工现场，我们不再讨论电动设备因为所有的设备都是电动的。

徐：这种在建筑教育上的变化对将来的建筑实践意味着什么？

NL: 事实上，建筑实践与建筑教育之间的关系从来都是一个有趣的课题。在许多方面，我认为建筑实践已经走到了建筑教育的前面。在中国的某些学校，我听说当学生使用计算机工具的时候他们的教授说：“不要使用这些工具，我们应当使用包豪斯的方式。”事实上，我正在包豪斯任教。那里我们对于计算机技术的使用已经达到了一个非常高的程度。许多学校的老师和教授依然对于新的计算机工具的使用持保守态度。但是，让我们看看最好的那些建筑公司，例如盖里、福斯特、扎哈·哈迪德的事务所，在其中我们会发现它们都有研究小组。他们正在研发计算机工具以帮助今天的复杂建筑得以在预算以及限定时间内实现。在盖里的事务所中有盖里技术公司；在诺曼·福斯特事务所中有专业建模小组；在扎哈·哈迪德事务所中有 CODE 等等。当你咨询商业公司时，他们也会告诉你他们需要会使用 Grasshopper 的学生。但是还是有很多学校连 Grasshopper 都不教授。

徐：我同意你的观点，现代的建筑实践在某些方面是领先于建筑教育的，但是实际上，在建筑学院里面的教学和研究，比如在软件程序方面和构件加工方面的研究，是实践单位及实践事务所所无法做到的。比如说，在清华，我们多年以来从事的对于建筑形态的研究，是通过实验来找到平常不存在的动态的形象，这样做拓展了建筑的形态领域。因为从传统的建筑设计的角度来看，那些基于几何的形态数量是有限的；那么如何发现一些新的动态的形象，就需要通过研究来发现，如果没有这些研究，那些几何的形态会被用得越来越少。通过学校的 studio 对形态的发现会给建筑带来更广阔的景象，

XWG: Do you mean that digital education has progressed to a new level?

NL: Absolutely. Obviously things have changed since 2004. Actually, my prediction is that by the end of this decade - by 2020 - we won't even use the word 'computation', because it will be everywhere - everywhere and nowhere. So it would be pointless using the term. Just as on the construction site, we don't talk about electrical tools because everything is electrical.

XWG: How will this shift in architectural education impact on architectural practice in the future?

NL: Well, in fact, the relationship between architecture practice and education is an interesting one, because in many ways I believe that architectural practice is often more advanced than education. In some schools in China, for example, I hear that when students use computational tools, their professors tell them: 'No, no. Don't use these tools. You should use the techniques that they use in the Bauhaus.' Actually I teach in the Bauhaus, and there we use these computational techniques at an often very advanced level. So we often find in schools of architecture that the professors are reluctant to open up to the use of new computational tools. Meanwhile, when we look at the leading architecture practices, such as the offices of architects like Frank Gehry, Foster, Zaha Hadid, we will find research groups in each of these offices, where they are developing computational tools that are necessary in order to get the complex buildings of today built on time and on budget. So in Gehry's office you find Gehry Technologies; within Norman Foster's office is the Specialist Modeling Group; within Zaha's office CODE, and so on. When you also talk to commercial firms, they will tell you that they need students that can all use Grasshopper. But there are still schools in the world that don't even teach Grasshopper.

XWG: I agree with your comments that the current architectural practice is more advanced than architectural education. But, in fact, within the curriculum of the department of architecture, research on software and programming and fabrication technology is beyond the capability of practicing companies. In Tsinghua for example, within the past several years, we have done a number of experiments based on formal studies. Through experiments, we try to capture the dynamic forms that do not exist in normal practice. Thus in this way the realm of architectural geometry is expanded. In traditional architectural design, there are only limited forms based on rationalized geometry. It is worth researching how to discover new dynamic forms. Without this type of research, we would exhaust the current library of geometrical forms. Through the studio experiment within the school, we may enlarge the perspective of architectural design. This is one aspect that practicing architects are not capable of.

这些是那些实践单位没有办法实现的。另外一个方面，就是你刚才所谈到的关于高级技术用于加工领域的问题。其实，现在各建筑学院，包括西方的建筑学院，例如：ETH、哈佛 GSD、AA School 还有中国的华南理工大学、清华大学等做了很多关于互动建筑的研究。这些研究完全是探索性的，使用了高级技术来操控建筑的构件从而形成互动或环境响应装置。这种装置它不具有实际建筑的功能，但是它是一种探索，为将来建筑有可能变成互动建筑提供了基础。同样，在这点上，实践单位及建筑事务所也是做不到的。

NL：我完全同意你的评论。我认为在计算机革命之后的二次革命将会在教育领域发生。这并非一个全球化的过程，但是已经露出了苗头。我将设计课视为一种实验室，一个探索性的实验室。这个概念起源于屈米于 1990 年代在哥伦比亚大学创立的模式，他们往往将设计课称为实验室。但是我认为这个概念被例如 AA DRL 这样的项目带到了一个高度。在那之后这种模式被 Achim Menges 及他所在的斯图加特的电脑设计学院（ICD）带上了另外一个层次。在那里，他非常严谨地面对研究问题。因此，在我的设想中，这次展览的参展学校将从多方面反映此变化。

这是一种由传统老师—学生式的设计课程向新的扎根于研究的工作模式的转变，新的模式往往关注于材料以及计算机的研究。我认为这是一个重要的转变。在我的设想中，我们应当重新审视我们的硕士教育：它应该逐渐由一个单纯的本科教育的延伸，向为博士做准备的研究导向性的项目转变（同时我认识到博士项目也成为了另外一个严峻的问题，因为世界上许多地区仅仅接受具有博士文凭的教授）。一个非常重要的进展是我们在建筑院校中试图建立一种博士文化，换句话而言，硕士项目对于变革我们对研究生工作的认识非常重要，它定位于将设计课转变为研究型实验室，并为博士课程做好准备，从而提供有博士学位的专业学术人才。

徐：是这样的，学校里的设计课程确实是作为一个实验室在创造着新的知识。那么，你认为学校课程所创造出来的新知识将怎样有益于建筑实践及影响未来建筑设计？

NL: 我们可以观察到在实践事务所中有一部分研究实验室在进行软

The second aspect is, as you've just mentioned, the application of high-tech architectural fabrication. In fact, within many architecture schools especially in the West such as ETH, Harvard GSD, AA, or in some schools in China, such as SCUT and Tsinghua, there is a lot of research being done towards interactive architecture. This purely exploratory research uses high - tech driven architectural components to form interactive installations. These installations don't have the function of real architecture. But they are the foundation of a potential interactive architecture of the future. Similarly, this is also another undertaking that cannot be done in the architecture practice or firms.

NL: I agree with your comments. I think that the second revolution happening beyond the computational revolution is the revolution in education that is beginning to appear. This is by no means universal, but it is beginning to appear. And I see the design studio as a kind of laboratory, an experimental laboratory. That started maybe with people like Bernard Tschumi in Columbia in the 1990's. He always referred to the studio as a laboratory. But I think this has been taken to another level by programs such as the AA Design Research Laboratory(DRL). And since then this in turn has been taken to another level by people like Achim Menges in his Institute of Computational Design (ICD) in Stuttgart where he is very rigorous in the way that he approaches the question of research. So, to my mind, this is reflected in many ways by some of the schools in this exhibition.

There is a shift from the old fashion design studio, which is only about design and the traditional master-student relationship, towards a new kind of project which is fundamentally grounded in research, often in terms of both material fabrication and computational research. That I think in an important shift. In my mind, it's a shift in re-envisioning the master's program especially from simply being a continuation of the undergraduate education towards one with a greater research orientation that lays the foundations for PhD research. And I think that PhD research is another issue that is becoming really important, because many countries in the world will now only accept professors who have PhDs. One of the important developments has therefore been trying to build up a PhD culture in schools of architecture. So, in other words, it seems to me the master's programs are really important in revolutionizing our understanding of what postgraduate work should be - in changing the design studio into a research laboratory and then feeding into a PhD program in order to produce professional academics with PhD degrees.

XWG: The design studio acting as a laboratory is generating new knowledge. What is the benefit of this knowledge generated in the school to professional practice, and how might it even further influence architectural design in the future?

件研发，甚至研究材料特性，同时在建筑学校中也有。这两者之间具有沟通交流的桥梁。在许多案例中，曾经就读于例如 AA EmTech 硕士项目的学生很大比例进入了实践事务所的研究室里。由此，两者之间存在一定沟通和联系。

同样的，我们也可以看到那些与学校教育有直接联系的实践事务所，最好的一个例子就是 AA DRL 项目和扎哈·哈迪德事务所。许多学生在 AA DRL 学到必须的技能后去扎哈·哈迪德这一类的事务所工作。这里有一个直接向特定事务所提供具有技能的毕业生的过程。因此，我认为我之前观察到的，建筑实践领先于建筑教育的趋势有一个潜在的转变过程，逐渐变为它原本就应当成为的模式。我们在过去曾见过这个模式，如 BIM 最初起源于 MIT 这一类的教育机构，但它在实践中发展。因此，我们看到了一个更为自然的模式。即理念最初在学校中探讨，之后通过建筑实践发展成熟。

徐：比如用互动建筑作为例子。实际上，让建筑能动，让建筑能够适应于环境，或者说建筑能够随着人的活动自调节自适应，可以说这是人类自古以来的理想。谈到建筑能够适应人类、适应自然的要求，其实在建筑的历史上有很多的探索。例如赖特的有机建筑，还有布鲁斯·高夫的连续的建筑，再比如巴特 . 普林斯直接模仿动物形态的建筑，也有以生物习性为基础来设计建筑的例子，这些努力都试图让建筑融入环境，其目的都是希望建筑与环境互动，创造更宜居的居住环境。可是在过去，受限于技术，他们只能做到一定的程度，设计受到了局限。但是现在，比如说建筑学院对于互动式建筑的研究，这些技术如果成熟的话，它将真正意义上实现建筑与环境之间的互动。从而实现历史上建筑师乃至人类对于动态建筑的崇高理想。从这个角度来说，建筑学院里的研究可能会导致将来建筑变成环境中真正的一个生物，就像人一样，可以活动。

NL: 是的，我同意。 我认为问题是计算机如何能帮助我们实现那个梦想。此时很重要的是我们需要回顾一下计算机发展的历史阶段。我认为在 1990 年，那时我们几乎是对于虚拟现实的一种类似于科幻小说一样的认识。人们想象着未来的可能性却又不了解它们到底是如何实现的。之后，进入了另外一个我称作“数字建构”的时代，

NL: We can observe that there are research laboratories both inside architectural practices - developing software, and in some cases even working on materials, material behaviors - and also in architectural schools. There is dialog emerging between the two. In many cases, students who have been working in the master's programs such as the EmTech program in AA then go to work in research laboratories in architectural practices. So there is obviously some kind of dialog going on. And we can probably distinguish between practices that are connected to education, and other practices that are not. The best example of the former might be the relationship between the AA DRL and Zaha Hadid Architects (ZHA). Many of the students develop techniques and skills while studying on the AA DRL program and then go on to work in offices such as ZHA, so that there is a continuation and a direct way of feeding certain architectural offices with skilled graduates. So I think there is a potential of reversing what I have seen in the trend recently, where practice has been ahead of education, and getting back to what it should be. I think this has been seen in the past, where, for example, the development of Building Information Modeling came out of work at academic institutions such as MIT, so that we are getting back to a relationship that's much more natural, where the idea is first explored in schools, and then becomes matured in its application within professional practice.

XWG: Let's take interactive architectural research, for example. My own opinion about interactive architecture is that it will have a big influence on future architecture. Fundamentally speaking, the goal of interactive architecture is to create architecture that could adapt to the environment, or, in another sense, architecture that could self organize according to human activities. This has been the fantasy of human since ancient times. Speaking of how architecture would accommodate human needs, there have been many explorations in architectural history such as Frank Lloyd Wright, Bruce Goff, and other designers producing Organic Architecture. Some of the designs are the direct mimicking of organic forms from nature, while some are simulating the habit of living creatures as the foundation of architectural design and so on. These are all fantasies aimed at creating interaction between architecture, environment and people, generating better living conditions. However, there were only certain possibilities in the past as they were limited by technologies. If the technology that they are being developed currently within interactive research teams in design institutes were to mature in the near future, it would achieve the fundamental interaction between architecture and human beings. It would realize the dream of a dynamic architecture that we have dreamt of since ancient times.

NL: Yes, I agree. I think that the question is really how computation helps that dream. I think

我们有史以来第一次开始利用计算机来了解结构和材质特性。现在，我们进入了第三个阶段，此时计算机的使用成为必须的。它不仅仅可以帮助我们了解材质特性，更有助于我们控制建造的过程。如此，我认为这里存在三个明显的阶段，同时在电脑控制的交互设计中我们也可以看到这三个明显的阶段。

在我的概念中，许多 1990 年代的交互式设计工作仍然局限于科幻世界中。人们有一个建筑可以适应并且改变行为和外形的意识，但是没有人知道它应当如何实现。最成功的早期试验的范例有例如 Mark Goulthorpe 的 Aegis Wall 项目。在这个项目中他与 RMIT 建筑空间信息实验室（SIAL）的 Mark Burry 合作开发了一个可以移动的表面。它在很多方面是个非常原始的原型，但却是一个重要的开端。现在突然之间，我们拥有许多现成的廉价技术，至少在中国它们很廉价，就如同 Arduino，Servos 等等，使得这一切价格合理、可行。我自己的看法是最终这一切将从目前的几乎是对技术的迷恋开始进化，即目前人们仅仅将特殊的技术制作成艺术装置来展现我们到底能做什么，就像当我们最初开始使用机器人以及数字加工技术时也有对于技术本身的迷恋。但是在我们自己的展览目录中，David Ruy，2010 年东海岸区域的策展人，有一句评论：“我们现在进入到了一个并不仅仅是对于技术本身而盲目迷恋的阶段，而是我们应当如何在日常的设计中创造一种新型的敏感又精致的设计方式。这就几乎已经超越了单纯对于技术的迷恋，而致力于产出更加精妙的设计，这些技术将像假肢一样帮助人们行动和生活。”

对于交互技术而言，同样的事情也会发生。就目前而言我们大量的精力投入于开发我们到底能做什么，以及这个技术本身看上去非常特别。但是我认为技术逐渐会变成日常生活的一部分。交互设备将以非常实际的方式被使用。我们不会将它们变成艺术装置，它们会变成建筑语汇的纯粹的一部分，就像计算机已经成为我们工业设计的一部分一样。Perry Hoberman，我在南加州大学的交互媒体的同事，曾经说过：在未来，交互技术将变得如此常见以至于我们不会注意到他们，例如有时当你去洗手间时，灯会自动亮起，就是这么简单。我认为我们将会有对于环境反馈的智能建筑，甚至会出现对我们的

it's important maybe to look into the history of computation in terms of different phases. I like to think of what was happening in 1990's was when there was an almost science fiction like understanding of what they called 'virtual reality'. People were dreaming about a possible world without really understanding it. And then, the next phase is what I call 'digital tectonics' - when for the first time we started using computers to understand structural and material behavior. And now we have entered a third phase where it's absolutely necessary to use computation not only to understand material behaviors but also to control the whole building process. So I think there are three distinct phases. I think you can also begin to see computational driven interactive architecture in terms of these three different phases.

In my view much of the work done in the 1990s about the possibilities of an interactive architecture was still locked in to this world of science fiction. People had this idea that the architecture could adapt and could change its behavior and its form, but nobody knew how to materialize it. The most successful of the early experiments were examples such as Mark Goulthorpe's Aegis Wall project where he collaborated with Mark Burry of the Spatial Information Architecture Laboratory (SIAL) at RMIT developing a surface that would move. That was primitive in many ways, but it was an important start. Now all of a sudden we have readily available technologies that are extremely cheap - cheap in China anyway - such as Arduino, servos, and so on, making all of this possible and economically viable. My own view is that eventually this is going to evolve from its present state which is really almost like a fetishization of these technologies - with people making art installations showing what you can do, simply because it seems so special. In a way in the beginning when they first used robots and digital fabrication technologies there was a kind of fetishization of the technologies themselves. But in our own exhibition catalogue there was a comment made by David Ruy, the curator of the East Coast section in 2010, that we have now entered a new stage where it's no longer a question of simply fetishizing these technologies, but about how we might use them as part of everyday design, and create new sensitive, exquisite forms of design. So it is almost as if you transcend that sort of obsession with the technology and produce something exquisite as though these technologies simply become a prosthesis to human operations.

I think that the same is going to happen with interactive technologies. At the moment we are heavily involved in what we can do and it seems very special. But I think eventually it will become part of everyday life. Interactive devices will be used in very pragmatic ways, and