In Practice Futures we begin to investigate the challenges and opportunities that arise out of the increasing adoption of digital fabrication within the design and construction industries. Specifically we focus on professional practice in the architecture discipline in Australia. We focus on unpacking the ecology of new modes of architectural practice falling around digital project delivery, how they relate to traditional modes of procurement and how they are shaped by critical factors such as scale, risk, responsibility and reward.

These questions are approached through two filters. The first considers the implications for our understanding of the role of the architect, and what the expanded roles might be for architects and new types of professionals. The second is the nature of risk, as architects start to be more involved in processes of fabrication, and for longer periods in the process. This document catalogues the first and early stages of the research in which we begin to understand the terrain that we are working with, to explore whether there is in fact any interest or validity in the research question itself, what material already exists and what form a more developed research question might take.

Background

We are indebted to the ARBV (Architects Registration Board of Victoria) who initiated a generous project to support all the Victorian architecture schools to undertake research. Under the Architects Act, the Board may “apply any money at its discretion, for the purpose of the advancement of architectural education in any manner the Board determines”. The ARBV sought to support independent research undertaken by students and to disseminate the project through the ARBV website. Apart from expressing the confidence for the involvement of students in the research the board did not dictate or have any involvement with the development of content therefore allowing for the independence of the research. The lead researchers for Practice Futures are Professor Vivian Mitsogianni, Ben Milbourne, John Doyle and Patrick Macaesa. The research springs from an initial proposition developed by Ben Milbourne through his development of the Master of Architecture Professional Practice 3 course which focuses on developing a series of local and international case studies investigating innovative practitioners and identifying new roles that are directly fabricated from the digital model, the component of the fee base will either be eroded or require redefinition in order to be partially or completely trained.

Approach

This project commenced with a series of workshops by the lead researchers at RMIT through which each participating project was set. This was followed by the Practice Futures Elective which was offered to RMIT Master of Architecture students and led by Ben Milbourne and John Doyle who were joined by Robert Fiasco, Alejandro Fabian Martinez, Richard McPhillips, Siti Shahir, Brijesh Shandilya, Aleksandar Tarabukin, David Thomas, Neus Valdebot, Biaiyang Wang, Zhuxi Yao, Anqi Ye and Yuanbo Zhang. As a provocation to students the Practice Futures Elective poster suggested that:

The increasing adoption of digital fabrication within the design and construction industries presents both significant challenges and opportunities for the practice of architecture. Over the last 50 or more years increasing consultant specialisation has arguably eroded the traditional role of the architect. Project Managers and other designers have introduced increasing levels of intermediaries between the architect and the construction process. Digital fabrication is the direct manufacture of three-dimensional objects using additive (3D printing) or subtractive processes (milling, laser cutting etc.). Adoption of these techniques allows for the fabrication of components, assemblies or increasingly whole structures directly from design models. In some cases architects are undertaking fabrication themselves, or sending the model to others for direct fabrication – however, in both cases the separation between the architect and the produced object is dramatically collapsed. This is a significant opportunity in the development of architecture – an opportunity that allows much greater agency in the fabrication/construction process, however it also delivers increased risks to architects engaging in these modes of practice.

Adoption of Digital fabrication also significantly affects the typical business model of architectural practice. Most architectural practices a high proportion of fees are generated in the production of Contract Documentation that is the translation of a 3-dimensional proposal into 2-dimensional representation defining the scope of 3-dimensional object. Where the final object is directly fabricated from the digital model, the component of the fee base will either be eroded or require redefinition in order to be partially or completely trained. This semester we will be examining the implications of new modes of project delivery through digital fabrication and as such to the practice of architecture. We will be focusing specifically on the context of practice in Victoria and Australia, and trying to understand how the legal, economic, cultural and other pre-conditions might shape the way these technological innovations shape the future of practice.

The Elective separated the research into three phases.

In Phase 1 students were charged with undertaking a broad survey of research into the area of digital fabrication, both in terms of technical innovation and its implementation in construction projects - through both local and international outlets, comprising both scholarly journals and general news outlets. Students were encouraged to venture beyond architecture into the realms of business, construction and law to find alternative views of the field. From this research a series of key questions and discussion points were developed which were used as the basis for a series of interviews - for the second phase - with Australian practitioners.

In the second phase of the Elective, students were assigned to one or a number of innovative local practices in Melbourne, Sydney or Brisbane that have been experimenting with digital approaches to project delivery, and/or expanding their role to include aspects of component fabrication. These interviews were conducted with the following practitioners: Rob Beson (Director of AR-MA), Pater Bickle (Principal at ARM), Julian Canterbury (Partner at March Studio), James Harbard (Elpenberg Fraser), Todd de Hoog (MAKE Architecture), Pete Sullivan (Senior Associate of COX), Julie Verstraete (Fieldwork), Toby Whitheld (Director of Shapashift Technologies), Nicholas Williams (Digital Practice Leader Vic/SA/ACT Aurora) and Elliot Wong (Lyons).

The final phase of the elective bifurcated with students then going on to produce a final project - to satisfy the requirements of the coursework – that sought to develop a speculative proposition which synthesised the ideas, technologies and models that were uncovered in the first and second phases of the semester.

At the same time the lead research team began to give focus to the research and to formulate a number of points for discussion for a public colloquium. The colloquium brought together RMIT staff and students, along with innovative practitioners from industry to consider the key questions identified through the research to date. The Practice Futures Colloquium was held on October 26 2017 at the RMIT Design Hub, Melbourne and involved the participation of: Bruce Allen (Director of Bruce Allen Architects), Rob Beson (Director of AR-MA), Melanie Sorenson (Director of MAKE Architecture), Julian Canterbury (Partner at March Studio), John Doyle (RMIT Architecture Lecturer and Director of Martínez Doyle), Laurence Gottlieb (Victoria State Manager of Planned Cover), Professor Carey Lyon (Director of Lyons and RMIT Professor of Architecture), Nicholas Williams (RMIT Architecture Lecturer and Director of Built Architecture), Professor Vivian Mitsogianni (RMIT Architecture, Associate Dean and Discipline leader), Amy Muir (Director of MIUR and RMIT Architecture Lecturer), Associate Professor Roland Snoeks (RMIT Architecture and Director of Studio Roland Snoeks) and Leanne Zilka (RMIT Architecture Lecturer and Director of ZILKA Studio).

How to read this compendium.

This document provides an edited summary of the most recent thinking and as such commences with an edited transcript of the Practice Futures Colloquium. This is followed by a section called “60 points” which is a focussed collection of observations, statements, reflection and concentrated groupings of the common themes that most consistently surfaced throughout the different phases over the 5 month period of the project. It is a summation of seven emerging themes and as such references to and is cross referenced against the Practice Future Colloquium, the research electives and the discussion by students with practitioners that occurred during the elective. The appendix features transcripts of a number of discussions led by RMIT Architecture students. We would like to thank all the practitioners that have been so generous with their time and who have agreed to participate in this compendium.
Vivian Mitsogianni: Good evening, I’m Professor Vivian Mitsogianni, Associate Dean and discipline leader of Architecture and Urban Design at RMIT and I want to thank you for taking the time to join us for the Practice Futures Colloquium. I would like to start by thanking the Architects Registration Board of Victoria, and Alison Ivy, David Islop, David Sainsbury and Ian Sutter, who were pivotal in initiating a project to support all the Victorian architecture schools to undertake research. We are delighted to be able to participate in that project with the Practice Futures research project.

Through the Practice Futures project we wanted to investigate and unearth the challenges and opportunities that arise from the increasing adoption of digital fabrication within the design and construction industries, particularly for the practice of architecture. In particular we wanted to focus on unpacking the ecology of new modes of architectural practice falling around digital project delivery, how they relate to traditional modes of procurement, and how they are shaped by critical factors such as scale, risk, responsibility and also reward.

We looked at these questions through two filters. The first is the implications for our understanding of the role of the architect, and what the expanded roles for architects and new types of professionals might involve. This is also an interesting question for us in the academy as we consider what it is that an architectural education might prepare you for in the world of work. The second part of the question was looking at risk, as architects start to be more involved in processes of fabrication, and for longer periods in the process.

We are in the first and early stage of the project and we wanted to cast a wide net, and consult widely, particularly within the profession to reveal what the questions are. Some of the early observations were that similar issues arise in other areas of the work that architects do, that may not initially appear to involve or relate to advanced fabrication or manufacturing processes. Another observation was that the scale of practice and the scale of the design are also factors.

In this first stage we examined local and international case studies within professional practice, by running a Master of Architecture elective which was led by Ben Milbourne and John Doyle. We would like to thank the RMIT Architecture students who worked with us on this: Robert Fiasco, Richard McPhilips, Siti Shahrizan, Sheng Wang, Andzhela Tarabunova, David Thomas, Neus Valdellou, Bajiang Wang, Zhuxi Yao, Anqi Ye, Yuanbo Zhang.

The format of tonight’s event will be a series of presentations followed by a panel discussion. John Doyle and Ben Milbourne will begin with an overview of the initial research developed through the Elective subject. This will be followed by our four invited speakers; Rob Beson from AR-MA, Mal Bright from MAKE, Roland Snooks from RMIT and Studio Roland Snooks, and Leanne Zilka from RMIT and Zilka Studio.

I will begin by introducing the speakers and panel. Ben Milbourne is an RMIT Architecture lecturer, and director of Bild Architecture and NAAU studio. John Doyle is RMIT Master of Architecture Program Manager and a director of Mártires Doyle. Both of them join Patrick Macasaet and myself as part of the Practice Futures research team.

Rob Beson is a founding director of Sydney practice AR-MA, Architectural Research – Material Applications, an experimental and transdisciplinary architectural practice. Mal Bright is a founding director of MAKE Architecture. Roland Snooks is the director of Studio Roland Snooks and a senior lecturer in RMIT Architecture. Leanne Zilka is the director of ZILKA Studio and a lecturer in RMIT Architecture.

On our panel we have Bruce Allen who is a director of Bruce Allen Architect, and the Convenor of Examiners for the Architects Registration Board of Victoria, Julian Canterburry who is a partner in March Studio, Laurence Gottlieb, who is a lawyer by profession and the Victorian State Manager of Planned Cover, providing insurance placement and advice, risk management and claims management services to construction professionals. Carey Lyon, is a Professor of Architecture at RMIT and a founding director of Lyons. Amy Muir is a director of Muir, and an RMIT Architecture lecturer. And we have apologies from Toby Whitfield the director of Shapeshift Design Technologies, a Design, Engineering and Project Management practice and specialists in the field of advanced composites. Toby was unexpectedly called.
away but has contributed to the research already through our Elective interviews. So we’ll make a start with John Doyle.

John Doyle I will briefly discuss the elective that we ran this semester as a Frame and lead in to the current conversation. In the Practice Futures elective, we tasked the students with engaging in the territory and doing a few things that would effectively foreground and open up the questions that we’re beginning to look at tonight.

The semester was structured into three parts, firstly a period of archival research - a literature and project review - in which students looked at the literature that’s been produced, articles, projects, things that come within the discipline but also broadly into other areas of design practice, dip their toe into the legal space, and starting to understand the context of practice in Victoria (particularly important for students coming outside from Australia or interstate).

From week five to 10 there was a series of interviews that were held with specific practices in Victoria, which were based in questions in the first phase of the semester. We’re now in week 14 running this symposium, and students for the last five weeks through both the first and second phase of the semester have been tasked with producing a portfolio of work with the reflection on what’s been uncovered during the elective.

In the first phase of the semester we made some important initial observations. Broadly speaking it seems to be a confusion when we talk about digital fabrication between prototyping for design and prototyping for construction. We’re interested in prototyping for construction. So rather than 3D printing an object, that sits on your desk and you use for judgment, we’re interested in the idea of full scale fabrication, and that’s quite different.

Most of the research to date has been focusing on implementation and technique. What we’re looking at, and what is missing, is research around the implications for practice, the implications in the legal space, and the implications for architecture as business. There’s not a lot that we could find that was covering those areas. Fundamentally this raises questions as to whether architecture is a service or a product. So in many cases the things that are being made out of these processes are objects, or leading into objects and the making of objects, and that raises a whole series of different questions which might be asked in terms of workflows there seemed to be a debate as to whether this meant architecture was effectively front-loading the construction process, or taking off, deeper and deeper into the process of construction on site, or both. More broadly speaking there’s an idea that the role of the architect or the design act gets extended in some way. Some of the major hurdles that we discussed were around the upskilling or ensuring sufficiently skilled students or graduates, costs and associated problems of scale.

We conducted interviews with the following practices; ARM Architecture, AR-MA, Fieldwork, Aurecon, COX, Elenberg Fraser, Lyons, MAKE Architecture, March Studio and ShapeShifting Design Technologies. Reflection upon those interviews assisted us to develop the talking points that we have put to the panel tonight. We noticed that there is no singular definition of what a digital fabrication practice might be. We talk about these things as if everybody’s doing the same thing, but in fact there’s a lot of different levels and ways of engaging. We have been able to uncover or map an ecology of different, new types of digital fabrication practice. Some practices engage with digital fabrication through a consultancy or through a consultant and hand over files. Some practices are making, designing and making and carrying it the whole way through. Some practices are just resolving design within fabrication and design through construction. We worked for the builder to take the design and prepare it for fabrication. In this case the builder usually drives the opportunity to engage in fabrication, so that can limit or open up possibilities. The conversation around risk has also been very interesting, and hopefully that’s something that we can tap into tonight. One of the counter-factual points that we have uncovered is that we assumed going into the conversations that more responsibility might begat more risk. That didn’t necessarily bear itself out in what the interviewees have been saying. So perhaps that’s a prompt for this evening.

As an extension of that, the idea that digital workflows connect one into the supply chain is a way of managing that risk, by being more closely associated with the project. And in fact, stepping out of that might be the point at which, or the point where you might be 2D or you hand over a project and walk away without control is actually a risk point in the project.

Lastly and most importantly the cost associated with taking on more responsibility. There needs to be infrastructure in place to allow for covering the resourcing required to do that. More risk, more responsibility must be associated with a greater fee base, and that’s another opportunity for the industry. So that’s where we got to in the Architecture Elective with Masters students and hopefully a departure point for tonight. I’m going to now hand over to Ben Milbourne who will act as moderator.

Ben Milbourne Thank you John. I’d like to welcome Rob Bason from AR-MA to give the first presentation.

Robert Beson Thanks for having me. It’s very good to talk about digital fabrication. From the beginning, digital fabrication was fundamental in setting up the practice. It’s thinking about coming through at a time when this was seminal and thinking how do we set up a practice in order to, as young architects, work at a certain scale in an urban environment? How do you do that?

ARM-MA is essentially a hyphenated practice, which from the very beginning, was conceptualised as a way of bridging between architecture and manufacturing, or architectural research and material applications. Part of the vision is to reconnect the divide between design and vision: I’m not going to go through the projects in any way tonight, I will show a video that shows some of the recent work.

Fundamentally, the way we work is that we take a very strong position about design intent, and we say that this is absolutely a flawed methodological design and that rather than produce design intent, as architects, what we should be doing is producing design. When I say ‘design,’ and make that clarification, it is to say that the goal is to produce comprehensive design which is fully specified - it is not a performance based approach. I would say I can’t think of any other discipline in industry that would produce a conceptual idea and then hand it off to other people to realise. I think the outcomes from doing this project are interesting in all the problems that we’re seeing in construction today.

Everything we do is, generally designed for manufacture. Everything is designed as assemblies of parts. We try to eliminate 2D drawings as much as possible, and we always design parametrically-driven models which are constructed as closely as possible to what’s happening on site. We progressively 3D scan everything in the building as it is being built to verify as built, to as designed.

For example, in the Wynyard Walk project designed by Woods Bagot and built by CPB, we worked for the builder to take the design and prepare it for fabrication. In this case there were over 5,000 panels, over 50% of which were unique, one-offs, and at maximum, all of the fabrication was done in Queensland. And between the design fabrication and the production, out of the 3,000 panels, only one was a defect that was wrong by 25 mm.

The Triforum (pg.12) is a small pavilion we did a couple of years ago, which comprised of over 3,000 unique parts. This idea that you need to work with tolerance, that you have to accept plus or minus 25 mm on concrete and steel, it’s rubbish. If it was like that, then planes would fall out of the sky and cars wouldn’t cut on the road. It’s a non-issue. And I think we have to stop accepting it. It’s just laziness.

There are five things that create these issues. Number one is industry fragmentation. As architects, we are part of a larger industry involving many stakeholders. The AEC industry (Architecture, Engineering and Construction) is a continuum of many people who come together to deliver buildings. Everyone, I think, could name very easily all of the automotive manufacturers in the world, but if you try to do the same thing for all the players in the construction industry, you’d have a hard time. It means that everyone is continually struggling just to survive, there’s never time or money for research and innovation. We’re trying to provide the corollary for that by again working with parts and assemblies, pushing everything to a DFMA model.

What is at stake? I think in terms of this whole discussion, if you ask yourself what is at stake, I would say, what do you prefer with this statement? Do you prefer design-led procurement, or would you prefer procurement-led design? That is literally what is at stake right now, is the entire industry about to be taken over where we’re being forced further and further away from the client, to literally being a
AR-MA is essentially a hyphenated practice, which from the very beginning, was conceptualised as a way of bridging between architecture and manufacturing, or architectural research and material applications. ROBERT BESON

AR-MA is essentially a hyphenated practice, which from the very beginning, or architectural research and material applications.

Robert Beson, Director of AR-MA

Problem number three, where because we have this fence in between design and construction, we're looking at huge amounts of rework. In a commercial building, let's say you have about 3% of the total cost of construction allocated for a design phase or design engineering. All of that work in any of the design and construct components of that build, as soon as they're passed over that contractual fence, get thrown into a bin and reworked at a cost of about 8%, which as architects we're not able to capture. We need to move to a more linear process, which we control as architects, and move away from drawing and towards a structured process of developing a 3D model for manufacture.

How do we harvest value from digital fabrication? It is also I think interesting to note that what we call digital fabrication and engineers call it digital engineering. There are so many different terms for this and I think it is very much contested at the moment. An option would be to vertically integrate, and offer end-to-end solutions. I think that it is crazy to call it digital engineering. There are so many different terms for this and I think it is very much contested at the moment. An option would be to vertically integrate, and offer end-to-end solutions. I think that as architects we don't employ engineers, in particular, mechanical engineers. I would start getting rid of quantity surveyors. There's absolutely no need to have a quantity surveyor today at all.

Number two, we need to stand next to the client. I think that when you have quantity surveyors as owner's agents in between you and the client, it is already over. I would say absolutely do not accept jobs unless you have direct contact with the client. Number three, remove the tender process. The tender mechanism is designed to produce downward cost pressure on the contractors for the benefit of the client. However it causes many more problems to delivery of buildings than it actually solves. It has become a liability. There are many other models for procuring buildings from early contractor involvement through to partnership models. We really need to push away from a fixed lump sum or a design-bid-build model.

I know that we mostly use Revit, but Revit is only a better way of coordinating 2D drawings. We need to move away from 2D drawings completely. If you are using pdf and looking at drawings, we're doing the wrong thing. We need to sit down and say "Okay, all of the drawings that we produce on a project, what are they used for?" For everything from approvals through to marketing, to sell the units, etc. and then say "Okay, these are all the things. What can we get rid of immediately? What do we need to lobby government to get rid of such as approvals, for example. And then what's left?" You could probably get rid of about 60% or 70% straight away off the bat without going back, and then looking to improve others.

Lastly, start to develop products. I think we're all at the mercy of projects and the cycle of projects and everyone feels the fatigue from that. There's a huge amount of products from architectural systems through to technical apps for construction. There's a huge opportunity for us to deploy the knowledge that we have in these ways.

Ben Milbourne Thank you Rob. Next I would like to invite Mel Bright from MAKE Architecture to provide the next presentation.

Mel Bright Thanks Rob. I think I might be here as the practice that could be helped by everyone and I'm looking forward to learning a little bit. There's a lot of things that I really agree with you, and in our very small, humble houses, alts and adds projects ways, we are doing some of those things. We're not digitally fabricating anything, so I'll just come clean up front. Maybe we can, I'll talk you through some of it.

MAKE is a small practice that I set up 10-11 years ago that started with a sort of kitchen and a bathroom. We might not be digitally fabricating anything but we are making things. We're not making them with our hands but I still see that the work we're doing is every house is almost treated like a prototype. It's either got new materials, old materials used in a new way, or some other combination, old methods/new methods, usually something that we haven't done before.
New materials. We test things and see each project as an opportunity to test a new material. We’re known for doing lots of brick buildings, but we do timber buildings and other things. In many ways I treated the practice like a little experiment about getting good at using different materials, we’ve just been practising for the last 10 years and trying to get a few things right. Using materials that are readily available, and trying to do something with them.

Simple things. We’re not being driven by a computer process that might output something. We’re driven by a design-led response that we want the computer to do something for us. Kind of banal dumb things, like a screen that’s really just our answer to a privacy or overlooking screen. Almost the only way in small alts and add ons that you can get architecture in is to say “Well, we have to have it for town planning”.

Or a brick texture [pg.18] – someone said “Did you use Grasshopper for that Mel?” or something like that when we first did it but it’s not there for that, it’s really our response to context. It’s not to say that – this is just what we do, and this is where I suppose MAKE come from. We work with builders, trades and craftsmen that use their hands and that’s the parameters within which I currently practice, and that we practice.

On messy sites with sticks of timber and two guys trying to get it up on a scaffold. Where the site is never really what you imagine, and it’s almost always not the right dimension. We might need the 3D Scanner but I don’t know if any of my clients can afford it. No matter how much work we go to, in order to work out a detail and carefully draw it, 3D model it in the computer, it’s never exactly what we imagine, and it’s almost always not the right dimension. We might need the 3D Scanner but I don’t know.

I wanted to quickly grab maybe out of some of the projects we’ve done a few examples of different things. I was trying to think about how we’re actually relevant to this conversation, and I think maybe it’s that some of the things we’re trying to do with our projects, while they’re not digitally fabricated, they could probably be, we could make efficiencies through that process. We’re probably on small houses and with the resources we have available, pushing the boundaries on what you would get a standard builder to do. How do you kind of get those things across and get them to happen?

This is that timber screen [pg.16-17], actually really quite straightforward. The builder in the end said this was the easiest thing of the job. Maybe not the easiest thing, but was surprised how easy that went up. The harder bit was that the whole building was supported on the concrete and we were waiting for the concrete to cure, which was the finished joinery and things like that.

We use ArchiCAD, which is a 3D software that we can output into 2D drawings. We do use it in 3D and we give our builders the 3D file on site. But I still get nervous when the steel fabricator asks us for our 3D model or our drawings, because then I’m worried that he might then say “No, that dimension’s not right”. In terms of risk, I then get my team to write a long big e-mail that says “You can have the file, but we’re not responsible”. It bothers me that we might operate like this and I think there’s a lot of room for improvement, but that’s the current situation on these little small jobs with no consultants.

We test things in 3D and then we work out how to represent them in 2D. In many ways, to make it look like something that might be seen as complicated, “Look, actually, no, no, no, this is just really straightforward, it’s just a repeating pattern and you just whack the timber on here and put a bolt through here, and it’s quite straightforward”. You can see the elevation, the 3D and the plan of the repeating pattern.

That’s how that got built with the 2D detail. I was thinking about this, because we can’t document, we can’t 3D model every single bit of our project, we haven’t got the time or the resources to do it. In some ways I was thinking sometimes to hold on to the 2D drawing, to leave the buffer between the site and the
material constraints is not the worst thing in the world. We do stand there with builders on site and do mock-ups and test them and decide whether that’s appropriate for the project, and up they go, and that’s the screen.

I think in some of this some of our clients accept risk. Like “Mel, how is this timber screen going to weather??”, and we have to have those conversations, and maybe it would be more straightforward to put aluminium battens on and go “Look, it’ll be fine”. Our builders become responsible in some ways and they do become responsible for the defects and how are we going to manage that. We do try and do some of the things you’re talking about. We don’t tender, we get builders on board early and we can do this because they’re houses. On our bigger projects, we’re like everyone else getting novated and being told what to do by the builder. On our houses we insist on this as a process. Sometimes we only talk to one builder and we start that process earlier on if we can get the client on board. That’s been incredibly useful because we then sit down with that builder’s trades and say “Hey, we want to do this thing, and how are we going to do it??”, and we work it through. It gets more and more expensive, and then we change the material and change the detail.

Similarly on this stair (pg 18), the clients had to accept that we weren’t quite sure if it was going to move and wobble or crack and it isn’t an exact science, and the clients kind of said “Oh, Mel, there’s a few cracks in there”; and I said “Well, you know, we haven’t done a stair like that before”, and the clients accepted it. Maybe not all clients accept that but that’s that stair worked out largely with the builder on site because the engineer’s scope didn’t stretch to helping us work that out.

This project, Perimeter House, had some sort of fancy brick pattern. It’s not even that fancy when I see what other people are doing with bricks, but on a small alt and adds to a house, it’s just how do you get bricklayers to not add a huge premium and blow the budget on a house that only has a budget of $800,000? Which is not much on the scale of many projects. How do you sort of document these patterns without modelling every single brick in 3D.

The windows, they are sort of odd, are all custom designed by us, which opens us up to a whole lot of risk and we’ve had issues with some of these that we’re going back for again, and the builder sort of said “Oh, Mel, that was a really tricky detail”, and I say “Yeah, I know, but you agreed to do it and you were comfortable with it”. We try and have those conversations early and in many ways try and get the builder on board with the detail. We say “We really want to do this, we want you to be on board, but you have to be comfortable with it”. We are diverting that maybe unfairly risk to some of the guys we work with.

We are often trying to deliver things in 3D to explain construction sequence, or how things might go together. I wonder sometimes if we are opening up too much risk. My dear husband who is incredibly skilled and clever, is almost bordering on an engineer, and I have to stop him doing all of the engineer’s work. In some ways I feel like we have an in-house engineer. I was thinking about your comments, and he will sit there modelling the mechanical ducts and everything, and I have to say “Hang on, can you just detail the bloody architecture?”. We’re very fortunate to have an incredibly old school architect that knows how things get built in our practice, with some fantastic graduates and architects. We do 2D details of windows.

This project, Raku House (pg 18), is the one we’re about to start, which is a ceramic screen that we’re working with Bruce Rowe from Anchor Ceramics who is an architect. He used to work at MAKE, and we sort of said “Oh Bruce, come on, let’s do some ceramic façade”. We’ve been talking with Bruce about extruding this façade piece together, and we’re testing that with him and prototyping it, and we’re trying to get the builder at the minute to sign off all the steel that goes together to hold it up. That’s the extruder.

This is our idea of how we think it would be going together, and what we first gave to the contractor. This is the sort of documentation that MAKE are doing that worry me because we’ve modelled all of the engineer’s details, and there’s a lot of overlap with what probably the engineer should do, but that’s what we’ve done for this house with screens set out and everything else. Thanks.

Ben Milbourne: Thanks Mel. I think we’re starting to get a sense of the spectrum of how different people operate in this space. Our next presenter is Roland Snooks, who will further expand that spectrum.
The most recent work that we’re doing is scales to make pavilions and installations. We’ve been used to bend rods of various different cases, gallery installations. These robots have robots to fabricate bits of buildings. In this we’ve been looking at the way we repurpose industrial Robotics Lab at RMIT, and a lot of the work has I wear, is as the director of the Architectural so we don’t need moulds.

A lot of this was explored through a series of competition entries which were often relatively whimsical. After about 10 years of working this way, I became quite frustrated that there was no way that I could see of building these things. The last five years, and in particular since I’ve been at RMIT, has been looking at the way we can use digital fabrication to start to realise some of this work. What I’m going to try and explain today is through two projects I’m going to try and explain four different ways in which we have set up a relationship between the design we’re doing, and then the way that gets fabricated.

In terms of digital fabrication over the last couple of years we’ve been looking at a series of things, partly through direct metal fabrication of small objects, a lot of composite fibre, looking at fibreglass and carbon fibre and the way they can be used to start to synthesise between structural ornament and form. Flat packed materials, looking at the way material can be cut flat and then can find its own form, so we don’t need moulds. Looking at a lot of the work I do, one of the hats I wear, is as the director of the Architectural Robotics Lab at RMIT, and a lot of the work has been looking at the way we repurpose industrial robots to fabricate bits of buildings. In this case, gallery installations. These robots have been used to bend rods of various different scales to make pavilions and installations.

The most recent work that we’re doing is through large scale 3D printing of polymers and this has started to feed back into the design that we’re doing. It started to change what it is that we design through an understanding of new modes of fabrication. In a way we’re going back to some of the highly speculative geometry we’ve been working with for 15 years but we’re coming back to them with an inherent logical construction built into those generative design processes.

The two projects I want to show today, one is a gallery scale installation, and another one is a fit out at a university. This project is called the Composite Wing (pg 22). It was developed and originally installed for the gallery in this building and subsequently went to Shanghai for the Biennale. It’s a fibre composite installation originally designed as a piece of exhibition design to try and exhibit the work of an exhibition called ‘The Future is Here.’ It’s made up of three large chunks and from those large chunks there’s eight smaller pieces. The algorithmic work that we’ve used developed fairly intense articulation and detail at two scales. One you can see it’s the larger scale of what is a foam inlay and a small scale of silicon inlay. These inlays are both structural as well as ornamental. The deflection at the tip of the three millimetre composite wing would have been a metre, but it was reduced to less than 10 centimetres through the inlay.

This project was largely produced at RMIT, at least all the particularly tricky bits or untested bits were produced here within the RMIT Architectural Robotics Lab. A part of that was things that were very known, like multi-axis milling for the large foam parts (pg 23) and then parts that were entirely experimental and a little bit haphazard. We built what basically is a glorified caulking gun, and stuck it onto the end of a robot, and started squeezing out silicon to make that fine grain inlay (pg 23). That was printed onto a very fine mesh, which is the same mesh they use in wedding veils, and then that is then inlaid into the fibreglass.

We’ve done a fair bit of fibreglass work at university but the bit we didn’t do is the fibreglass because it was quite large. It’s 70 square metres, it’s quite large for things that we do and it went out to a composites company called Composite Constructions whose background is in the boat industry. The other part that we made at RMIT is this mould, the
CA concentrated on one part of it called SensiLab. It is a research laboratory for John McCormack’s research group and there were three different ways in which we dealt with builders and fabrication in this project.

The project is a series of studios that sit within a large open space, in the old Denton Corker Marshall building. It is a 20 year old building with very high ceilings, very high floor to floor and a lot of it was built in a conventional way. It was built by carpenters on site using 2D drawings.

We wanted a particular finish on these [pg.21], which were enamel panels and had a very particular detail at the corner, which meant that we had to do all these panels CNC’d, produced off site, and we had to fit them together exactly. We’d given the builder less than a millimetre tolerance to do it. It was going to be seemingly impossible to do. The only way to do it was when we were at this stage of the project we then did a 3D scan which has billions of points, which we then went back and we produced all the drawings ourselves. We then had a big label on them saying “These are not shop drawings” but of course they were shop drawings. Then the shop drawer was paid quite a lot to then take that label off and then send them for fabrication - we learnt a valuable lesson in doing that.

We also produced all these drawings which were deviation drawings showing how much this surface, built by carpenters, deviated from the surface that they were installing on top of that. We had all these heat maps showing how much packing would be required at each point in order to get the tolerance to work. There’s a whole lot of research workspace that exists between each of these studios, there’s four of these studios and each one had a very particular role and some informal seating areas.

One of them is a sound studio. It has a very complex folded interior with some bumpy foam which was generated by an algorithm. This was beyond what the builder could get their shop drawers to do, we thought AR-MA would be excellent for doing the shop drawing, and resolve this but in the end, that didn’t work out. The builder came back to us and said would we do it, and so we asked our professional indemnity insurer could we do all the shop drawings, fabrication drawings and they said there’s absolutely no increase in risk because...
Left
Composite Wing project by Studio Roland Snooks exhibited in ‘The Future is Here’ exhibition held at the RMIT Design Hub 2014. Image Tobias Titz

Right Top
Custom robot extruder to extrude silicon fine grain clay.

Right Middle
Composite Wing assembly.

Right Bottom
Multi-axis milling for the large foam parts of the Composite Wing images: Studio Roland Snooks
if something goes wrong, you’re all going to get sued anyway, so go right ahead. They didn’t increase our premiums. Now, we’re shop drawers as well.

We shop drew this thing. It did come together on site and you get some sense of the paneling of that. That’s another method where we realised from the enamel panels that we basically did the shop drawings and didn’t get paid for it, now we did the shop drawings and did get paid for it on this. The last bit of this project is a little 3D printed bit. This is the little 20 square metres of 3D printed surface. This is a 3D printing technology that I developed here in the lab at RMIT, it’s generated by an algorithm hence it’s a bit wobbly. Our printer is an industrial robot connected to a plastic extruder where it’s doing layer by layer printing (pg 52).

A series of 10 panels, which range from one metre to 1.8 metres tall and about a metre and a half across were printed at RMIT. The way this was set up, RMIT became the nominated subcontractor for the construction company which is [KM], and knowing that RMIT’s the only people in the world who could produce it, it was a straightforward agreement.

We had to go through all the processes in developing a new technique, nobody’s 3D printed polymers for a permanent part of a building before, so we had to go through all the fire codes, print bits, get them fire tested, et cetera, in order to satisfy the building codes. Then do a whole lot of new details for that way of building.

Ben Milbourne Thank you Roland. Our final presenter is Leanne Zilka, also from RMIT, and Zilka Studio.

Leanne Zilka I’ve called this presentation Floppy Logic as it reflects my interest in the territory between fashion, textile design and architecture. I’ve spent a lot of time working with textile and fashion designers to understand and apply the techniques used to manipulate fabrics and form. This interest comes out of the desire to consider enclosure, form, structure and material at the same time. In fashion these things are considered simultaneously rather than separately. Where unlike architecture, form is developed first then a material system is selected and applied. One specific project I want to talk about is called the Frozen Curtain (pg 28-29). It was a project done in collaboration with Paul Morgan Architects and is why I have been included in this colloquium. The procurement process began with Paul who was responsible for the greater fit out of the RMIT Fashion and Textile Design School which included, coordination of all services, design of the teaching and staff spaces and related joinery. Paul asked me to design a backdrop for the space that was required to divide the back-of-house (change rooms, clothing racks and other equipment) with the main multifunction room. Students in fashion and textile design often present whole garments in the form of a catwalk with live models, sound and visual media. These presentations are often frequented by industry and the media so the screen was required to give the space some identity and impact.

Rather than design the installation first, I worked with the material first and did a couple of experiments to test pattern and structure with the acoustic felt. A pleated pattern was employed to give the felt structure and a way to fix to a frame without revealing the fixings. The pleat became a way of dealing with non-structured material, fixing in a way that gave the illusion of a curtain being drawn open or closed.

There was minimal documentation and prototyping, instead we explained the length of material needed, colour, lengths, spacing between pleats and the fixation positions, and left the installation to the fabrication team. It was a quick project and the university is happy as are the users, however some of the fixation details, were scrutinised by the fashion designers as they saw better ways to finish off the pleat at certain moments. The fabricator had no experience working with material in this way, as they were the equivalent of upholsterers, and the fabric manufacturer Autex were also not used to using felt without a backing board. But this way of working that looked to the condition of the material rather than freezing its behaviour through a system that involved a hybrid of elements (frame, board, structure), was a way to communicate the nature and weight of the material.

Ben Milbourne First of all I’d like to thank our panel for generously donating their time and joining us in this conversation. As an architect, I think it is enormously interesting that we seem to be on the edge of some fairly dramatic
I would like to touch on that point and ask whatever this idea that the disciplinary boundaries between what architects have traditionally done, and potentially what product designers or major project fabricators have done, and how potentially the Registration Board might consider some of those challenges. How would you respond to some of the suggestions that those disciplinary boundaries are starting to erode?

Bruce Allen

I can’t speak for the Registration Board because I’m not on it but I guess an avenue they’re taking is recognising that they need to put money into the profession and this is an example of that, where they’re funding research for universities in Victoria. I think once they see the results of this they will probably be funding with more direction.

I think in terms of the disciplines, what I see tonight is really very exciting and I’ve been familiar with it having been on visiting panels and so on. My one concern is just how rapidly the change can take place within the profession because there is a very large chunk of the profession that is still familiar with any of this. That’s going to be a bit of a challenge because there’ll be builders using these traditional systems and they then have to be trained, and cleared of development.

I find that the linkage has probably been going on for quite a long time. We had an industrial designer as part of our studio for quite a few years. He got too big and had to move out and set himself up. It was interesting that he was designing cool ears one day, smoke alarms the next, but all through this digital process.

What we really found quite alarming was that a mistake that he made would be a monumental stuff-up and that’s where the risk factor comes in, compared to mistakes we made, which was a bit of a difference. You can see it happening in that sort of combination in the input he could give to us and some of the assistance we could give to him, and it was all on prototyping. He would send off his digital material to China on Friday nights, DHL would arrive Wednesday lunchtime with the prototype and that would happen week after week after week and that’s been going on for some time.

I must say it’s a bit challenging for my generation. We’ve about to launch into our first digital fabrication equipment, and I’ve taken notes of the names of people around here, because I might say that to the phone. It’s very encouraging, and I think it’s going to be necessary for say the Registration Board, which is really administering an Act, and the change is glacial there. How often do they review the Architects Act, and how does that reflect latest modes of practice? I think we just have to face up to the fact part of our role will be as architects and part of it is as designers, and we can ignore the Act, and wear a different hat for the other things that we’re doing.

Ben Milbourne

I think that’s really interesting and one of the things that has come up through both the interviews that the students did in the context of the research elective, and the kind of broader research is in some cases architects are starting to act more like product designers. That has a number of implications, but one of those, I think, is, around copyright or patent protections which is not something that architects have had to worry about a lot in the past. It does come up but it’s not as much of an issue as it is for product designers and I think the issue of how you protect your intellectual property in an environment where it can be reproduced rapidly is a challenge.

It touches on a conversation that Rob and I had around patent protection in this area and how the value of patents is your willingness or the depth of your pockets to enforce them through legal means. Then there’s the fact that we found in some of the research that we’ve done, in the context of the RMIT Architectural Robotics Lab. The counter point to that is to be incredibly nimble and to innovate very rapidly.

Do you want to talk to that?

Rob Beson

Yeah, I think there’s two ways you can go. You can have one idea — it’s mean, if you’re not very good at having ideas, then you probably want to protect the ones you do have. On the other hand, at having ideas. Ideas are cheap, really. It’s executing them well that is the hard part or just having that idea and then moving it forward.

For us it’s much, much more important to continually push the idea. We try to hold on to it for a little while, we might not talk about it straight away, and you nurture it a little bit. Then you get a lot more from letting it out and seeing what happens and getting feedback, and that to me is a kind of significant opportunity. Certainly in the context of housing, which I work in a bit, I can see that as a very major opportunity. I think, as Carey could talk to the potentials of that, possibly, in larger scale projects.

Carey Lyon

2D documentation is just absurd. What we’re talking about here is that it will happen, it’s just how long it will take to happen, and the whole industry will be completely transformed, because that’s what architects do within it. But at the moment, it’s like a designer needs to translate what’s in their head into drawings, and then the drawings get into a model, and then the model has to be translated again into something else. It’s like Chinese whispers, like building a building by Chinese whispers because there’s four translations through shop drawings and other means of describing, it two dimensionally, it’s completely absurd. It’s what the industry does, and that industry has sort of grown into over the last decade, well, I guess since the industrial revolution.

So we’re seeing it, obviously, evidenced in our practice, I think maybe contrary to what Bruce is saying, architects and designers are very early adopters of technology. There is a very large chunk of the profession that is still not familiar with any of this. That’s going to be a bit of a challenge.

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Frozen Curtain project by ZILKA Studio in collaboration with Paul Morgan Architects and Isobel Moy, Robyn Healy and RMIT Property Services.
FUTURES Colloquium Transcript

Practice Futures

Rob Beson: It’s a cultural issue rather than a technological one.

Vivian Mitsogianni: Rob, you’ve got a good series of small projects. We get to do something a bit better, and we got to build something that we didn’t have before because we wouldn’t have been able to build before. We didn’t actually save money, we built something for a budget that we just built.

Julian Canterbury: Yeah, the client got something that everyone has to move really quickly. It could happen very, very quickly. For me I always go back to the value, what is the value we’re creating versus someone else, and how do you measure that, and how do we get rewarded for it? If you say, and I have to apologise, I’m just talking about commercial construction because it’s what I’m familiar with. If you sat on a commercial building, to make the numbers easy, if you say a commercial building costs $100, and to do the design on that, we’re getting paid about $2 on a high rise building. Of that building the MEP (Mechanical Electrical and Plumbing) is about 30% of the total cost of construction, and the facade is about 20 to 30 depending on the complexity of the facade. So let’s say on a big complex building 60% of the total cost of construction is in the facade and MEP. To do the detailed design on that, after it’s gone to construction, is approximately, to be conservative, say 4%, it could be up to 8%, but 6% of the package cost. So 6% of 60, which is what, $10, right? It’s not sexy work to draw plumbing, right. But if you did that, in-house, because it’s super easy, because it’s just a catalogue, you’re just dragging and dropping bits from a catalogue, there’s no design. It’s been engineered already, you’re literally getting paid three times what you get paid to design the entire building, just to do the drawing and the facade phasing. Which means literally doing your job properly, because that’s what you should have done, like as architects you should have done in the beginning anyway is just drawn it properly the first time. We’re giving away huge amounts of value. So the return on architectural investments can be critical, if you start to look at it like that.

Ben Melbourne: I think that’s a really interesting shift. Laurence, I’m going to ask you a question and I’m going to phrase this propositionally. This kind of shift and the adoption of digital fabrication seems to represent a fairly major shift in architectural practice. It’s not the first shift in architectural practice we’ve had, even recently. How would you describe the insurability of the insurance industry has responded to previous changes and how we work, either through the adoption of e-mail, or BIM, or the odd adoption of CAD?

Laurence Gottlieb: Right. Yeah, just at the outset, and as you’ve very cleverly set up a question about this whole bgittal fabrication. This does appear to be quite a significant jump as opposed to—certainly if you look at a cat obviosly on a project—what we’re familiar with, as it were. The insurance industry is much like construction, is also a very slow moving dinosaur, it’s not really set up to cope with the fact that everybody jumps up and down and starts to re-examine what we’re looking at and what we’re covering. The premise is really that professional indemnity covers the architect for their professional duties as architects. The definition of architect is not simple, there’s not one definition, it’s pretty broad. If in the event of a significant claim what will happen is another expert witness architect will be asked “Those services that you provided, would a reasonable architect in the circumstances have provided those?” and that’s where we can touch on in a minute.

In terms of how the insurance industry has coped, e-mails for example was very simple and straightforward. Initially there was some consternation, whatever’s gone to happen now, are they legal documents, or catenae. It’s very clear, obviously these have been used for many years, apart from, not architects, everybody hitting the forward button or the reply button instead of going to somebody else, obviously it’s easier to disseminate these than traditional letters. People are very good now in treating those as legal documents or as good as, which they are.

The main area with technology that we’ve found is the importance of record keeping, and in the event of a claim the way and the recovery of your records and how you can present those to the insurer to defend you is critical. Whatever that technology is. Whether it’s e-mails, as long as they’re stored in the right way. With BIM for example, one of the early concerns was because it’s more of a collaborative model, can you show “This was my drawing, this was where I stopped and somebody else took over and changed it,” it’s obviously important to keep records of exactly what you have done so if someone changes it, or there’s an issue, you can prove “Look, this wasn’t me that did this.”

The technology itself is not really the issue. It’s the profession of architecture. Technology’s obviously going to be evolving pretty quickly from here. A couple of the concerns that I can possibly foresee is that for example, not that I have any interest in protecting the livelihood of quantity surveyors, but we’ve always recommended that obviously on projects of size quantity surveyors are appointed, architects shouldn’t necessarily get into providing those estimates and being bound by them, but you can be outside your expertise. If you’re not outside your expertise, or rather if it’s within, that’s fine. Having a quasi-engineer on site who’s doing the engineering work for instead of an actual engineer, that is.

Mel Bright: We still have an actual engineer. Laurence Gottlieb: Okay. Oh, well, that’s fine. You don’t want a situation where a claim arises and it’s found, well, a structural engineer should have done this, not an architect, because then obviously you can be in some difficulties. There’s not going to be any sort of knee jerk reaction, there’s not going to be any changes necessarily in coverage, in wordings. It’ll evolve, it will see what happens. If it turns out there’s a particular area which causes a whole lot of issues, that will be different. At the moment I guess the only thing is to make sure that you guys stay within your areas of expertise and within your scope.

The last thing I don’t want to bore you about insurance, is that almost all PI policies have a manufacturing and construction exclusion, you’re covered for your profession and your duties as architect, but you’re not covered for actual manufacturing, actual construction. This seems to be where this is going.

Carey Lyon: This would prove my point that the whole industry is geared up around this weird way of delivering projects that is just traditional interfaces. What is a reasonable architect, what are your students being trained as, as architects, what are your competencies? Vivian Mitsogianni: Well, that is a big part of the question because contemporary architecture students are increasingly graduating with expertise in robotic fabrication, new materials and processes, new modes of practice. Accreditation, though is specific in terms of the expected competencies—in terms of what you would expect of a professional in the discipline. These questions are topical and have been widely debated in relation to the new Australian Accreditation Procedure. I see
all these questions - particularly in terms of the 'reasonable architect' and their scope - are interwoven.

Bruce Allen Yeah, I don’t think the competency system prevents schools from doing it.

Vivian Mitsogianni No, it doesn’t, certainly not.

Bruce Allen because they’re always following a precedent. And I think one of the things about reviewing the competencies every five years is so that they can be adjusted to deal with that. They’re followers, they’re not leaders.

Vivian Mitsogianni This is, I suppose where it’s tied together for me particularly as I think there are different roles that architects and the ‘reasonable architect’ and their scope - as interwoven.

Bruce Allen Well, I think those people just follow a different direction, they don’t worry about registration, or calling themselves architects. That’s why I think we’re getting a strata-ing and at the moment with the people we’re seeing here today are in a very definite strata at a level beyond the knowledge of most architects.

Rob Beson Yeah. I understand. I think for us it’s very important to call ourselves architects and to pursue registration. I think that if you did want to, if the goal was to really reconfigure the ‘reasonable architect’ completely, the first step you’d want to do is break it apart, atomise it, which is what we’re doing right now. There are mechanisms, in terms of ‘certainly’ around the question of risk but there are mechanisms in business to deal with risk and that’s one thing I wish that we had been exposed to in the Academy, where you can treat it in a sort of safe space, is contracts law, litigation, Securities of Payments Act, corporate set up.

Vivian Mitsogianni That’s it.

Bruce Allen We’ve asked the builder to build a prototype on site at the beginning of the build. So he’s going to do that. The current issue is we’ve nominated a part of a project that’s been delivered in a traditional way to be done in a non-traditional way. Of course we’ve done a lot of small projects which we build in experimental ways. Yeah, this was a hell of a lot of challenges. We were worried about whether the builders would demand warranties from RMIT, and if so, could the academic institution warrant a part of a building? In the end they didn’t want warranties on it.

There are a lot of unknowns. We’re doing something that has never been done before. We can look at all the spec for the whole of the material and do some testing, like fire testing for example, but we can’t do testing on the longevity of the material in terms of will it break down under UV. It’s got a UV rating for it, so we understand something about that. There’s a lot of unknowns, and it was interesting for Mel to hear you talk about your relationship with clients, and just asking whether the client’s okay with it. We had the same thing, talking to the user, who’s John McCormack, who was very much about saying “We’re doing this thing, it’s pretty risky. We’ve never done it before and nobody’s done it, we don’t know if it’s going to work”, and he just kept saying “Just take more risk”. It’s like “Roland, you’re being too conservative. We can definitely push this further”. Ben Milbourne Well, I think that’s a really important point. It’s not a kind of singular thing, like digital fabrication doesn’t all look like Roland’s projects, which are amazing. There’s a spectrum of people engaging in this space doing a lot of different things and the ceramics work has a very different aesthetic, but it’s kind of engaging some of these tools in order to deliver it, which I think is very interesting.

Mel Bright Yeah, I mean, the die has been laser cut. But that’s not really, you know.

Ben Milbourne Yeah, it keys into part of it.

Mel Bright You have to do that and then work out how much the ceramic’s going to shrink after it’s been fired and things like that. I’d love to be able to just do that, but we’ve got to build it and write a few performance specs and that’s it, and hand it to the builder, and they can do it, but I would be a bit wary about whether they’ll crack off and fall on their kids’ heads and things like that, and the dimensions that we changed.

Anne McSweeney We’ve got Bruce, Rowan, me sitting down about saying “We’re doing this thing, it’s pretty risky, we’ve never done it before and nobody’s ever done it before and nobody’s done it, we don’t know if it’s going to work”, and then we worked out the fixing techniques. One of the things I haven’t liked about ceramic façades is you see all of the fixings. We worked on extending the hole through, but that’s the kind of, I don’t know if you want to call it – well, not compared to what everyone deals with. I mean, March Studio are making all of their own stuff. I’m too sort of scared to do that.

Ben Milbourne Maybe. Then the only other aspect I thought about, because when Bruce was working at MAKE said “Let’s start making products” and we almost went and did this, and I had to just sort of think for myself if I wanted to do that, and actually I decided I didn’t want to do that. It’s maybe about just the scale of the business I want to run. It’s simple, just I’ve got a finite time in my life, and actually I think I’d prefer to do another couple of houses a year that make one light, and answer all the questions about the bloody light from the people that want to hang it in the house or something. I think I was in some ways a manufacturing – we almost started doing it, we were going to start doing it, and I decided “Oh, I think I’m just going to keep delivering a service, and talk to other people about doing it”.

Roland Snooks Well, it’s certainly the first time where we’ve ever done something where we’ve nominated a part of a project that’s been delivered in a traditional way to be done in a non-traditional way. Of course we’ve done a lot of small projects which we build in experimental ways. Yeah, this was a hell of a lot of challenges.

Bruce Allen We’re followers, we’re not leaders.
Mel Bright: Yeah. I think if it’s an open conversation, like our clients of that façade said “Oh, Mel, how’s it going to work?”, and I said “Well, we’ve never done it before, we don’t know”, and they’ve accepted that in some way. If it doesn’t work, at the end of the day we’ve sat down with the builder and some of his trades, and ‘we’ve essentially said – and the builder said “If I’m going to warrant this and guarantee and come back and fix defects, then I want to do it this way”. And so we’ve said “Okay”. The requirement at the point from our practice is to get the builder to do it to a point where he’s comfortable, and so we work very hard at doing that. And then I suppose if the ceramic breaks Bruce will make some more.

Vivian Mitsogianni: Before we finish, can I ask the panel: We’ve talked a lot about the building industry being behind but if we were to get all the players together and make the ideal scenario to revolutionise the industry what would that look like? Mel, you said before that you’d love to “just draw the drawings and give them to a builder”.

Mel Bright: Just give them – because we’ve 3D modelled the whole thing, it’s what Carey was saying, you just hand it off and stop sitting there and agonising over every bloody detail.

Maybe we should have had some builders at this conversation, so maybe next year we need to get Probuild here or someone, or Grocon.

Carey Lyon: In my extensive research for participating tonight, I rang one of my son’s friends, who’s just finished a Masters of Construction Management at a very esteemed institution. He was taught absolutely nothing, no subjects at all, on parametric issues. Not a single thing. An elective on how to do a bit more, and you go “Oh, you’ve got a really good model, if you’re a big enough, bad enough architect, like Gehry or Foster, or something like that, you can force everybody to do, and they do, force everybody to do it their way. If you’re a big enough, bad enough architect, you can force everybody to do it his way. That’s not going to be employed as a structural engineer, and you’re not going to be employed as a structural engineer, and you’re not going to be able to do all that sort of stuff. [GRABCAD]’s the sort of thing which is what we were trying to do tonight.

Leanne Zilka: I think the Academy, and with Roland’s projects, certainly, there is resistance to taking risk with projects. Frozen Curtain was all signed off ready to go to the contractor and they just said, “You know what, we can install school pin boards, make five times the profit, and there’s no complexity”, and I said, “Thank you”. We then had to test the fabrication at the University to document how it can be done so there is minimal time and effort required on the part of the fabricators. The Frozen Curtain was seen as complex but really it was designed as a way to give maximum impact with minimum effort, but as the manufacturer and fabricator had not done anything like it before, it was pushed into the highly complex basket.

Laurence Gottlieb: Another quick comment. I would make is over the last decade or so, maybe even a bit longer, we’ve seen that push maybe driven by developers, big builders, to transfer as much risk as they can to the consultants, and one of the speakers touched on it earlier, for no commensurate increase in fees. We see that all the time. Indemnities, warranties, all sorts of things being requested. With this new technology, I guess it’s important for you guys to make sure that you don’t assume even any additional risk, or if you do you understand what that risk is, and perhaps you get paid accordingly for it. If the profession as a whole can push back against some of the unrealistic demands or risks that are being put on to consultants which actually should not be, because they’re not within your control, that will obviously help the profession as a whole for sure.

Rob Beson: Yeah, it’s super interesting with head contractors doing that, because what they’re looking for is to exploit your insurance essentially. The number one defence against that is to have a commercial company which does not have PI insurance, because then you’re not exposed. For the head contractor to outsource the risk is really an illusion because at the end of the day they’re the ones that hold the liquidated damages. If anything goes wrong, or if any subbie goes broke on the job, the builder still pays at the end. This idea in their heads that they’re subcontracting the risk, it doesn’t exist. They understand that, it’s an illusion. So it doesn’t make any sense.

The question of how to, what would be the ideal scenario, and I think we’re going to see it, I think there’s two things that could happen, I think they’re both going to happen. Number one, we’re going to have vertically integrated mega firms that do design, develop essentially from asset management through to, well, from assets to assets…

Carey Lyon: Initiation, yeah.

Rob Beson: Yeah. So from buying a property, developing it, designing it, building it, to managing it in the same space…

Roland Snooks: Well, WE Work is like that, right?

Rob Beson: It is, yeah. That’s exactly what it is. We’ll see more and more of those. Then I think the second thing which we’re going to start to see are anything that can leverage the knowledge capture. Essentially if you look at any commercial building, they’re essentially the same. I mean, they look different, but the things that go into making them are more and more commoditised and productised. If you can find a way to develop templates which go into catalogues which you deploy again and again on new buildings, you can essentially get rid of the builder, the head contractor is friction in a process between design and construction. They’re just managing the process. All of the making is happening elsewhere. The next iteration is to get rid of that friction. Go from an architect who is completely designing the building to have them again a supply chain of vendors who are providing the bits that come on the back of trucks and get bolted together. But predictions, you know, it’s a fool’s game.

Julian Canterbury: As far as documentation is concerned, there are platforms already, like Tribe. You can upload from Rhino, from Tecla, from Revit, from whatever, and it’s all in the same space, and online, you can cut sections, you can do measurements, you can do all that sort of stuff. [GRABCAD]’s the sort of engineering version of that. I don’t know anybody that’s actually using it but I think that if you’re a big enough, bad enough architect, like Foster or a Gehry or something like that, you can force everybody to do it, and they do, force everybody to do it their way. I know Gehry did that, just say “If you can’t do it this way, you’re not going to be employed as an engineer, and you’re not going to be employed as a structural engineer, and you’re not going to do it this way.” and just forced everybody to do it his way. That’s not available to most, normally the developers are the biggest, baddest person but there are platforms out there where everybody can collaborate in the same space.

Ben Milbourne: On that note, I think we might wrap up for tonight. Thank you all very much for joining us, I think it’s been an incredibly interesting conversation, that I think propels our investigation forward into the next step, which is what we were trying to do tonight. Thank you very much.
1.0 ON ECOLOGY OF NEW MODES OF PRACTICE

“There is no singular definition of what a digital fabrication practice might be. We talk about these things as if everybody’s doing the same thing, but in fact there’s a lot of different levels and ways of engaging. We have been able to uncover or map an ecology of different, new types of practice.”

John Doyle

1.1 Currently, the majority of practices engage with digital fabrication through a consultancy or through a consultant and hand over files for fabrication.1

1.2 Practices such as ARM-MA and Shapeshift, although provide design services, primarily focus on the fabrication of highly complex projects. The majority of their projects are in collaboration with other practices and artists that require development in complex geometries and details. They also extend their practice through researching and developing new materials and fabrication techniques.2

1.3 The elimination of the shop drawing process is playing an extensive impact in the way architects practice and control the outcome of projects. Although it offers architects more agency, this effects and questions the amount of risks architects are willing to take. Who does it? Who gets paid?3

1.4 “...essentially what digital fabrication does for us is cut out the shop drawing process.” 4

John Doyle

1.5 Some practices aim to remove the shop drawing process completely by engaging the manufacturer straight away and handing over files and communicating through the digital files.5

1.6 The majority of practices engage in this manner for most of their projects. These practices include; ARM, Fielden, COX, Elenberg Fraser, Lyons and MAKE Architecture.

1.7 Practices such as March Studio, ARM-MA, Shapeshift, Elenberg Fraser and Studio Roland Gekoski to name a few have experiences in producing their own shop drawings. Reasons may include; reducing cost, agency, efficiency of the digital model the architecture practice already owns to provide the base drawing, the ability to communicate directly with manufacturers’ software.

1.8 John Doyle (2015, October 24). Practice Futures Colloquium. Also see ‘Practice Futures Colloquium Transcript’, p.4

50 Points

On the Current Digital Fabrication Landscape

This section is divided into seven key themes:

1. ‘On Ecology of New Modes of Practice’ considers how current architectural practices implement digital fabrication in their day-to-day operations, workflow and workspace, and how these shape their current mode of practice.

2. ‘On Procurement – Breaking Barriers’ questions the impact digital fabrication will have on traditional project procurement, supply chains and when digital fabrication expertise should be implemented.

3. ‘On The Digital Platform’ discusses the possibilities and issues of the digital model as a communicative and risk management tool.

4. ‘On Service or Product?’ reflects on architects beginning to operate in what have been traditionally product design disciplinary areas through digital fabrication. It considers questions of risk, IP, patents, and the possibilities for architects to develop products.

5. ‘On Practice and Project Scale’ points out the challenges and opportunities for small practices in adopting digital fabrication.

6. ‘On Value’ discusses the potential value digital fabrication can contribute to projects and practice.

7. ‘On Education & The Academy’ considers the impact of digital fabrication in the role of architectural education for future graduates.

The ‘50 Points’ is the first step. It is not meant to be an exhaustive or definitive list but a device that is both; reflective on the current landscape of digital fabrication in Australian practices and, projective in anticipating new possibilities and issues of the impact digital fabrication will have in future architectural practices.
'I think the issue around resistance is really interesting because this certainly represents a major opportunity to capture more value if we're talking directly to subcontractors. How do you think we'll get through that resistance? Because the current model of construction and the model of building procurement, there's a lot of invested players in that and maintaining that model. What do you think will be the thing that breaks that and actually unlocks the current model?'\[16

Ben Milbourne
That's how it should be but it's going to take a while to change the practice of industry on risk, commercial, money, copyright and ownership. In some respects the technological change might not be that complicated, it's more the way the industry operates that is going to take quite a bit of time. You have to collaborate rather than be adversaries, as an example.”

Carey Lyon Page 30
3.1

‘The digital platform represents a language that you all understand and you can try things and work together very easily. The fact that the end product then is able to be communicated to a machine or processed digitally that means that it’s going to be accurately articulated.’

Toby Whitfield

3.2

A live digital model, that continually grows and evolves as more information is overlaid with appropriate controls, can provide constant communication with all parties involved in a project.

3.3

Digitally modelling everything could effectively reduce the risk close to zero.

3.4

Digital fabrication also becomes beneficial in understanding the challenges builders may face on site in advance. As Toby Whitfield described a project they were involved in, ‘We can work out ascendant gravity for each panel, we can work out exactly how many trucks they are going to need, how we’re going to sling the project, we can storyboard through the whole design being cut up in 3D, we can give them a manual almost of how everything is going to happen. If they were all modeling in 3d, then we’d already known where all the conflicts were.’

3.5

Software development will play a crucial role in improving the workflow and implementation of digital fabrication. The ability for digital models that architectural practices produce to efficiently ‘communicate’ and interface with the software that varying manufacturers, designers and even builders use will be a key future investment. The challenge would be to create ‘bridges’ between software platforms.

3.6

If working on large projects, an issue arises when digital models become heavily detailed and some software packages struggle to maintain the model’s integrity. Digital models may become difficult to work with as practices may be forced to go through unnecessary technical steps to alleviate the problem. This may increase risk as it will diminish the capacity to review the model holistically.

3.7

Having multiple team members working on a single model may cause issues. For example, multiple members may have been working on similar components without their knowledge, hence, a systematic approach in cataloguing and specifying smaller model components that are then linked to a ‘master live model’ is crucial.


16 There have been a number of examples put forward by the contributors in both the colloquium and research elective interviews to mitigate risk through digital fabrication. Some of these include modeling everything for manufacture prior to construction; implementing digital fabrication expertise at the beginning of the project; digital fabrication can foresee future complications by storyboarding the construction process. See Interview Transcript – Rob Beacon with BIMT Architecture Lecturer Ben Milbourne, p.41.


18 Practices such as ShapeShift are looking to invest more in software than hardware in the future – software that allows more efficient communication between designers and manufacturers and builders. Development of software should also extend to the interface between client and the industry. This development then expands to the discussion of 2D documentation and shop drawings. If the digital fabrication file can be seen as a live model where multiple information is readily available, then what need is there for 2D documentation?
“To accurately answer this question, I think we need to differentiate responsibility and risk. Typically, we already have mechanisms in place that protects us, or rather, mitigate our project risk and liability. Whilst it has already become commonplace for architects to be obligated to formally issue the BIM model at completion of the project for building management, the shift towards using 3D models for digital fabrication in lieu of conventional 2D drawings certainly does expose us to additional risk if not managed appropriately.

This could be adjusted contracts that extend indemnity for the use of the model in fabrication, as we are already somehow doing this by sending 3D models across. It’s a basic data transfer agreement, with the receiver signing a waiver and releasing us from any responsibility in terms of dimensional or documenting errors. I suppose it then goes back to who is building it or manufacturing it. Does that responsibility shift beyond the design team? If not, then I would question what value this new technology will be to us, as it does open our exposure to unquantified risks, and in many cases would become unfeasible and too expensive for us to be involved.

However, I don’t think any of this reduces our professional design responsibility. Whether it is the architect, or other members of the project team, the core responsibilities of each member of the project team doesn’t change. The BIM process will change the way we work, communicate and co-ordinate, and certainly speed up the process, but whether our design is issued as 2D drawings or as a 3D model, this should not indemnify us from our professional duty of care under our respective regulatory bodies.”

Julie Verstraete

3.9
“The Jim Stynes bridge design was generated in Grasshopper; we provided our detailed 3D model to the steel fabricators who translated it into their preferred software which was Tekla. Centreline wireframe geometry was generated in Grasshopper and provided to our structural engineering team for them to run calculations and optimise the steel sizes. Data sets were also generated for the builders providing them with set out nodes for every structural member which were then confirmed on site.”

— Pete Sullivan

3.10
“For instance this project here; the whole thing was digitally kind of documented and was done by a builder with a drop saw, a lot of our stuff is very sophisticated sort of documentation and then there is a lot of manual labour. For the ceiling in Hotel Hotel that’s just people, that’s just getting a whole bunch of recycled timber, documenting it, cataloguing it, coming up with a design and then builders hanging it. The main digital side of that was coming up with a set of drawing that were not traditional architecture drawings but diagram drawings and how to assemble it.”

— Julian Canterbury
10 Points
On the Current Digital Fabrication Landscape (continued)

Top
Jim Stynes Bridge aerial view. Image: COX Architecture

Bottom
Jim Stynes Bridge. Image: Tommy Miller

Middle
'Hotel Hotel' digital model by March Studio exhibiting the numerous catalogued timber members for construction. Image: March Studio.

Left
'Hotel Hotel' Lobby project by March Studio. Image: John Gollings
4.0 ON SERVICE OR PRODUCT?

4.1

‘Fundamentally this raises questions as to whether architecture is a service or a product. In many cases the things that are being made out of these processes are objects, or leading into objects and the making of objects, and so that raises a whole series of different questions.’

John Doyle Page 8

4.2

One of the observations that is coming out from this research is that some architects are starting to operate more in what has traditionally been the product design disciplinary area through the adoption of digital fabrication - discussions around patenting or commercial-in-confidence start to become much more relevant whereas traditionally architects have had less issues with regards to copyright.

4.3

How do you reduce or eliminate risk when you begin to cross the threshold from architecture to product design or elements that traditionally are not in our scope? Bruce Allen notes that, ‘I think we just have to face up to the fact part of our role will be as architects and part of it is as designers, and we can ignore the Act, and wear a different hat for the other things that we’re doing.’

4.4

Protecting intellectual property has always been a challenge for architecture. In the research, what seems to emerge is a consensus that technology is continuously and rapidly changing hence, focusing on IP could be counter-productive.

4.5

“You’re always evolving in terms of technique, evolving in terms of material, you have to. We’re presenting to architects new technology all the time. That’s why we don’t focus too much on IP because whatever we are doing this year is going to be updated in two years time. We’ll be doing differently, we’re going to be using new materials, surfaces, finishes and techniques.”

— Toby Whitfield

4.6

Encouraging architects to produce and develop products from the knowledge they have accumulated could be a potential income opportunity for practices. Practices could develop technical apps for construction, architectural systems, furniture, fittings, and project management apps to name a few.

4.7

‘...it used to be a problem because we used to do projects and we would document whatever we wanted to build. Document it a lot more than what you would find in a traditional architect’s documentation and the builder would go get it made and make all the profits. If it went wrong then it’s our problem because it’s our drawings. In terms of things like furniture, we have started doing stores, tables and little bits of furniture. If we are going to take responsibility for drawings and mistakes then we are going to make profit from it as well.’

Julian Canterbury
Digital fabrication can provide opportunities in developing new materials and technologies for building construction. Below is an excerpt of Associate Professor Roland Snooks’ experiences in developing a new material polymer with 3D printing technology for their SensiLab project.

There are a lot of unknowns. We’re doing something that has never been done before. We can look at all the specifications of the material and do some testing, like fire testing for example, but we can’t do testing on the longevity of the plastic in terms of will it break down under UV, it’s got a UV rating for it, so we understand something about that. There’s a lot of unknowns, and it was interesting to hear you talk about your relationship with clients, and just asking whether the client’s okay with it. We had the same thing, talking to the user, who’s John McCormack, which was very much about saying “We’re doing this thing, it’s pretty risky, we’ve never done it before and nobody’s done it, we don’t know if it’s going to work”, and he just kept saying “Just take more risk”. It’s like “Roland, you’re being too conservative. We can definitely push this further”.

Ben Milbourne

That product service kind of divide I think is really interesting. In one of the projects that you presented (SensiLab), Roland, the 3D printing, from our discussions earlier I know that you’ve invested a lot of time into developing the material science for both the polymer to ensure that it performs in the way that you anticipated. Is that something new in your practice?

Roland Snooks

Well, it’s certainly the first time where we’ve ever done something where we’ve nominated a part of a project that’s been delivered in a traditional way to be done in a non-traditional way. Of course we’ve done a lot of small projects which we build in experimental ways. Yeah, this was a hell of a lot of challenges. We were worried about whether the builders would demand warranties from RMIT, and if so, could the academic institution warrant a part of a building? In the end they didn’t want warranties on it.
5.1 The scale and size of the project usually drives the opportunity to engage in fabrication, that can limit or open up possibilities. The scale of the practice will also affect this as more resources may be required to adopt the techniques and systems.

5.2 Residential projects are often difficult terrain to engage with digital fabrication due to limited budget constraints. As Melissa Bright expresses, ‘We’re probably on small houses and with the resources we have available, pushing the boundaries on what you would get a standard builder to do. How do you kind of get those things across and get them to happen?’

5.3 Smaller projects and budgets can also drive innovation through the lens of digital fabrication.

5.4 As an example, MAKE Architecture is currently developing a ceramic facade for their residential project, Raku House, with Bruce Rowe of Anchor Ceramics. The practice has been interested in developing frameworks and systems, that use existing materials and existing construction techniques to find new ways of thinking on how you can produce new systems using what is still manageable within budget, time and builders’ constraints that achieves something novel and new. Although costs implications on residential projects may delay experimentation and development.

5.5 For some small practices, there are extra challenges such as added responsibilities and fee structures to be able to engage with digital fabrication and experimental projects.

‘A lot of our projects wouldn’t go out if we did not. There was one project. We tendered it and we share this building here with a builder. That builder has done about ninety percent of our work. They understand how we work, they did Hotel Hotel. The client wanted to tender it and the price came in from the builder. Looking at our documentation the price doubled. Half the time we make stuff ourselves because otherwise it just won’t happen. The other thing is, we produce drawings, the manufacturer produces shop drawings, they charge for that, you check the shop drawings and that goes back. Instead we can just produce the part without any of that.’

— Julian Canterbury

References:
27. Bright, M. (2017, October 26). Practice Futures Colloquium. Also see ‘Practice Futures Colloquium Transcript’, p.13
28. Digital fabrication doesn’t always encompass high-tech equipment or technologies. It could also include the way projects are documented. As an example, MARCH Studio’s Hotel Hotel Lobby project. See ‘5.0 On The Digital Platform’, p.48. MARCH Studio has built up a portfolio of innovative small scale retail projects with their partnership with Aesop.
29. MAKE Architecture has continually practiced this design methodology to their series of award-winning domestic projects to include, Perimeter House, Little Brick Studio, Local House and Myrtle Tree House.
6.0 ON VALUE

6.1

‘I think the digital has to add value, whether that is by doing something much quicker or much more accurately or delivering some design that it can’t be done by hand.’

Nicholas Williams Page 77

6.2

The cost associated with taking on more responsibility, there needs to be infrastructure in place to allow for covering the resourcing required to do that. More risk and more responsibility must be associated with a greater fee base.

How do you measure value? How can architects be rewarded for it? 51

Nicholas Williams Page 77

7.0 ON EDUCATION AND THE ACADEMY

7.1

What is it that an architectural education might prepare you for in the world of work? 34

Vivian Mitsogianni Page 7

7.2

We can imagine that the new waves of graduates will emerge that have expertise in robotic fabrication, holo-lens integrated construction, scripting, software development and more. New technologies are always emerging and continually tested in academia. What might this mean for how we consider the profession and accreditation?

7.3

Through digital fabrication, what expanded roles for architects and what new types of professionals could emerge?

7.4

Digital fabrication will encourage graduates of the future that will become technically and materially deep. ‘Those are about understanding the machines and what they can do, how accurately they work, understanding how that assembly is going to work. Understanding material, differential movement, how to detail well. Those are challenges and risks but they have to be addressed by design solutions. Once the design is good then the fabrication technologies are pretty flexible.’ — Nicholas Williams

7.5

Education must be constant and continue through industry training. Perhaps contractors and manufacturers should embrace digital fabrication and be included into future discussions.
On the Current Digital Fabrication Landscape (continued)

Left Top
Hololens assisted fabrication as part of the RMIT Bachelor of Architecture Design Studio, Ex Nihilo, led by Gwyllim Jahn. Image: Cameron Newnham

Left Bottom
RMIT Architectural Robotics Lab – 3D Printing

Right Top
Hololens assisted fabrication research led by RMIT Architecture Lecturer Gwyllim Jahn.

Right Bottom
Hololens research at RMIT Architecture & Urban Design.
BM To what extent have digital fabrication processes become part of the day to day operation of your practice?

RB They’re completely enmeshed, everything we do is based on digital fabrication.

BM With regards to digital fabrication, which areas do you see as the most significant opportunities for your firm?

RB Within the architecture engineering construction industry we see one of the major problems, one of the systemic problems that the industry has, is in the production of design intent by architects and sub consultants, along with the design-construct procurement model. We believe that those two things, the production of design intent rather than the design, and the design and construct method of procurement leads to a whole host of construction issues, ambiguities and contractual problems.

Our method for solving this particular issue is to model everything for manufacture. We believe that by modeling everything what we’re effectively doing is reducing the risk to somewhere close to zero, which has a number of ancillary benefits; number one being that the building is cheaper to make, number two being that it’s also faster to make as well. In the end everything comes to, it’s cheaper, faster and safer, essentially. And part of what that is, essentially what we’re doing is, it’s not the right word but commoditizing the process where everything is then sent, and made in a factory and then sent in chunks of building fabric to the site.

Based on that, what we see as the opportunity right now is to start to template those processes and start to build reusable content that we can stick into, essentially reusable parametric content that we stick in catalogues and component libraries, which have engineering rules built into them and fabrication logics built into them, which we can then redeploys on subsequent projects.

BM Do you see that as a technique that is potentially patentable? Or is that something that would be rather be commercial-in-confidence?

RB It essentially becomes proprietary or commercial-in-confidence. The difficulty with patenting, and this is probably the perspective we’re taking on patenting stuff from the beginning, is that it’s possible to patent technology or areas of technology or process. The problem is that the usual reason that one patents something is to protect it. However, the protection itself does not lie in the patenting, but it lies in the ability to go out and protect the patent through legal means. So, the problems with patenting are that if you have a commercial secret, the very act of patenting it reveals it, number one, and number two, if you then want to protect it you need to fight that battle legally, which takes a lot of financial resources and time and energy.

So for most of what we do, the speed of change is so great that it seems on a cost benefit analysis that it’s easier to keep it secret and continuously develop it rather than go out and patent it and then try and protect the patent through court cases. I don’t know that that’s always the case but for what we do it seems to make more sense.

BM That’s certainly been our experience in some of the research that we’ve conducting here. It seems that, there’s a tipping point with volume where the repetition starts to operate at a larger scale, then patents become viable, however where the output is bespoke, or mass customized in any kind, patents lose the benefit.

One of the observations that is coming out from this research is that where some architects are starting to operate more in what have been traditionally product design disciplinary area through the adoption of digital fabrication - discussions around patenting or commercial-in-confidence start to become much more relevant whereas traditionally architects have had less issues with regards to copyright.

RB Yes, absolutely. For us keeping things commercial-in-confidence is important, so we have a large code library which is kept in-house and which we refactor after each project and then also the database of design templates and things like this.

BM What kind of digital fabrication tools have you recently experimented with and has it proved to be useful?

RB We typically will use the same set of techniques, so we typically use from a digital fabrication process point of view we’ll use 3 axis cutting techniques. For example laser cutting...
and a 3 axis routing and water jet cutting for standard sheet materials. That will then get supplemented with C&C folding, sheet metal, and turret punching; we usually laser cut some metal, turret punch it and then fold it. Then for frames we’ll often use either a tube laser for cutting, like RHS’ and CHS’ and then weld them all back together.

We do some rolling, but it’s mostly for the complex steel stuff we’re doing. It’s mostly laser-cut and then welded back together.

What else do we use on a more day-to-day basis? We don’t use 3D printing on a commercial scale, but for the actual production building components. We don’t do much casting. Glass is all water jet cut and comes from China. Aluminium is all routed and put together. I would say it’s your standard 2D processes.

BM Mostly subjective?
RB Mostly subjective yes
BM What percentage is the percentage of digital fabrication you’re currently using in projects?
RB Yeah everything we do is directed at taking chunks of buildings and then putting them together in the factory and then sending them back as chunks.

BM Yes, so assemblies.
RB Yes.
BM What are the key elements that make you think the project is suitable for digital fabrication?
RB If it’s not going to be digitally fabricated they don’t ask us. Pretty much everything that we do is digitally fabricated.

BM At what stage of the procurement process would digital fabrication expertise and capacity be most often valued to the architect?
RB Well I think, from the very beginning, from schematic design stage because if we’re doing architectural work we’ll generally have a good idea of the material and fabrication process from the beginning and that gets involved at the same time as the form. It’s much easier to do the thing, to have that conversation between the form material process at the same time, rather than trying to shoehorn one into the other layer.

BM How does digital fabrication technology change the workflow of design and construction phases?
RB It changes it a lot. Number one it completely destabilizes the head contractor, subcontractor, sub-subcontractor relationship. Because essentially in a traditional procurement model you have a head contractor, which is subcontracting the works, for a number of reasons, one of which is risk mitigation. However, because digital fabrication requires a complete virtual design and construction model to be built before you can actually make anything. What you’ve done is you’ve mitigated the risk completely through that process, and so, which then means that the head contractor is not mitigating risk anymore. They’re just giving away profit and their core capability, which is construction management.

So essentially, head contractor says, “Mr or Mrs sub-contractor please make this for me. It’s too risky I don’t know how to do it.” Subcontractor will employ us. We’ll model everything, we’ll remove the risk completely. Subcontractor then subcontracts out the fabrication and subcontracts the install. So essentially becomes a managing contractor, which replicates what the head contractor should be doing, their core capability.

And the head contractor pays dearly for that. So it’s upsetting the traditional model in the sense that, the value that we’re creating is being, we’re too far down the value chain. There’s a lot of incentive or there’s a desire, let’s say for head contractors to start to reclaim some of that ground, and not sub-contract out the works. There’s potential for head contractors to sub-contract out less of the works when the works are all designed for manufacture or digital fabrication. I believe that makes sense.

BM Yes.
RB Slightly confusing. It’s structurally changing the industry.

BM Absolutely, but it also fundamentally changes the architect’s role and risk profile. By digitally fabricating from a 3D model, rather than via a shop drawing process, the original designer starts to accept many more of the risk of the output. I’m not sure that it eliminates risk entirely. It eliminates coordination risk and eliminates uncertainty but there’s still the possibility of mistakes. That rests with whoever produced the model for fabrication to get certainly with the adoption of that risk there’s reward that’s associated with that.

RB Yes, absolutely. For example, the design philosophy for commercial high rise building let’s say, the designer fee is between two and three percent. Let’s say the building costs a hundred million, just to make the math easy. That means as an architect, we’re getting paid two dollars-fifty to design the entire building. Now let’s say that that facade is a design and construct facade because as an architect, I’m not a hundred percent sure how to do that. It’s some sort of curtain wall, but there’s a bunch of different types and I don’t know what the curtain wall system is. I don’t have an early works contractor involved. I can’t get advice and the client’s putting pressure on me to make, and the consultants especially are putting pressure on me to write a performance base specification rather than a prescriptive one because then we can leverage the knowledge of the market.

I essentially just design what I want it to look like, and let’s say I write a performance base spec for the glass and aluminum windows. Then it goes out to tender, a contractor takes it and puts it out to market. It gets coverage, someone wins the job and then it goes out to shop drawing now. In that shop drawing process, let’s say I write a performance spec. Let’s say the façade consultant is then employed again to write the prescriptive design, right? They get paid twice. That’s the façade consultant, that someone has to design it. The design and engineering fees on the façade alone for that, are about, I’m gonna exaggerate, they’re not quite 10 percent but let’s say they’re 10 percent to make the math easy right. That façade itself is close to 30 percent of the total cost of the building. 10 percent of 30 dollars is 3 dollars. The design and engineering fees on the façade alone are worth more than the design fees on the entire building. The design and engineering on the façade, that’s probably let’s say, a six month job for three people. You do it versus you do it how long it takes to design the entire building. Very, very quickly, with some sort of backing envelope calculation you can see that it’s very hard to actually make a case to do architecture.

This is the biggest problem for us is that well, you know, you know look at the numbers and you say well, can’t afford to do design. The tragedy is, and I guess for me looking at the industry the only way to actually afford to do design work, is by taking back all the other work that we said 10 years ago that we didn’t want to do anymore because like you said, there’s risk there’s also reward. By managing the risk, and by doing the job that we should be doing, we’re able to actually fund the design in the first place. That would be our take on that. That would be our position on that and the whole thing.

BM I think that some of the things that are driving these changes are kind of broader? The adoption of automation within the construction industry seems to be increasing, part of that is being driven through a Australia’s high labour cost environment and certainly some of the things that we’ve been hearing from suppliers and contractors in Victoria is that they’re very interested in automation.

RB Probably extra with labour, with the labour unions.
BM Yes.
RB There’s this ironic shift that, in Sydney at least, the unions are pushing the industry towards prefabrication.

BM That’s interesting.
RB Because it’s easier to do everything in a factory and not have to deal with the site issues.
BM That trend’s a sign. Yes, certainly the precast industry that I’ve been speaking with have been saying that pre-cast in Victoria is about five times the size of pre-cast in New South Wales and that’s purely because it’s cheaper and it’s quicker. It’s not particularly automated at the moment but other trades have started to adopt automation and prefabrication and offsite fabrication. The notion of kind of assemblies I think is interesting in that kind of context.

RB Yeah definitely. I mean that’s a big thing for us, is moving everything away from a 2D interpretation of lines on paper towards parts of assemblies framework.
BM What was the most challenging project using digital fabrication your practice has faced and how did you overcome it?
Third would be the scalability of the model itself as a problem. Number two, the scalability of the team on a single model is a problem. So itemizing, or breaking up the model into small enough pieces that multiple people can work on it at once and then maintaining a coherent master model of the whole thing. That’s another issue.

A third issue is using graphical coding. It makes it difficult to keep an up-to-date code library that can be refactored and kept workable. It makes it difficult for people to work to standards and procedures.

Fourth would be inventing. Some of the challenges would be inventing fabrication. It’s a problem with fabrication techniques but inventing fabrication, like the series of processes that are necessary to make a single thing, using often low-tech means.

Fifth would be it doesn’t matter how well planned it is, there’s always someone that decides to change things. Like the steel fabricator decides to like, not weld and bolt things together instead, or they do something that is totally not in the plan and then maintaining the ability to be agile and quickly fix or come up with a new solution.

Those are the five things: scale of your model, scale of your team… Whatever the third one was. The first three are technical, it’s a technical solution. The problem is Grasshopper’s so quick so we end up using Grasshopper a lot for prototyping stuff, but really there’s a big push to constantly, once it’s been done in Grasshopper and it was working, to refactor it as the Pythagorean code, because of the rapid pace of change, that it’s also introducing a lot of fear into the market, to do with the restructurings of the industry. Most of the fear that I see is particularly about who sits next to the client. That perceived relationship. It’s all to do with the creation of value and then the changing nature of relationships based on the value that you’re producing because there’s tremendous value in digital fabrication, it necessarily gives you a seat at the table, let’s say where the grown-ups make the decisions. In some cases where one has typically held a subcontractor role, or a subcontractor role, to then be elevated outside of that can threaten the relationship.

BM The ecosystem?

RB Yes, it definitely does help everyone. It helps our clients and our client’s clients but it can, if the whole thing isn’t managed sensitively - can be threatening.

BM Do you think that’s a result of, for want of a better word, the disruption that these techniques cause in the kind of existing ecosystems?

RB Yeah yeah absolutely.

BM And all of that will progressively change as these techniques become more mainstream?

RB It will change. Either the structure will change, or the systems and processes will become adopted by the existing structure. So that’s not so much a disruption, whatever’s the word, it’s a period right now where there’s a lot at stake and there’s a lot of things that are up for grabs, and especially for architects. There’s a potential opportunity to step in and reclaim some of that territory. However, it doesn’t... It’s-

BM It’s not a given.

RB It’s not a given. It’s not a given by any means. I’d say there’s a lot of work to do by architects because the current - you know the force on an object that’s moving. What is called?

BM Inertia.

RB Yeah, the inertia is for the industry to take it up, so for contractors and subcontractors to take on those roles and those skills. That’s where, if no one does anything, that’s where it will hit.

BM I was talking before about the Professional Practice course that I run at RMIT, in which I give an introductory lecture with examples of a series of quite prominent businesses in the late 19th century in the U.S. One of them was Frederick Tudor, who was the “Ice King” of New England. He had a business cutting pond ice out of ponds in Boston, shipping it to the Caribbean. He was one of the wealthiest people in the world at the time. With the advent of refrigeration he said, “oh this is a sad nobody will want it.” Within five years he was penniless. This idea that you have enormous inertia in existing businesses that are operating on a very particular model. Then the model changes through these external forces. Whether or not they can actually adapt, or if younger/ emerging practices, that are arguably native in a lot of these techniques will start to expand rapidly and start to fill those areas. Which I think is going to be interesting, and that’s the opportunity.

RB Yes exactly. I think from what you’ve just said and also from what I’m seeing... The number one benefit of these, like the people who could benefit most from these technologies with the least amount of work would be head contractors. For a head contractor to take on digital fabrication wholesale and to really own that space that would be an enormous benefit to them. Second would be the actual professional client like a developer. They have the most to gain but also they have slightly more work to do too.

BM Okay, yes.

RB The current sort of thinking is that we’ll get everyone to model everything separately or whatever and we’re going to federate the whole thing and then stick “as-built” on it and then send it over to the owner and they’re somehow going to do something with it. It’s somehow valuable for facilities management.

BM Yeah.

RB I just haven’t seen that work really well. Not that it doesn’t, it probably does, I just haven’t seen it.

BM Well, again I don’t think the facilities managers have really realized the value that the model offers.
RB: Yeah.
BM: And I mean certainly the software companies have been talking about the value of the model for facilities managers for years but it just hasn’t been taken up.
RB: That’s right.
BM: Again, I think it’s one of those tipping points, once somebody starts to do it, then it will become ubiquitous very quickly.
RB: Yeah, absolutely.
BM: Someone demonstrates the value of it and then you can’t ignore that in the market place.
RB: No. It has to be beyond what is currently passable in Revit, because let’s say you have a Revit model of... Let’s just say the façade right here, what’s that going to look like is it going to have... You’ll have your structural model from the engineers which will just be some RHS connected. Then you’ll have the disks and the housing from the architects and that’s it and so then, it’s not going to bear a lot of reality to what’s actually built or how what’s built was manufactured and sent to site, and tracked, and installed. Then, you’re left asking what value is that representation of the design intent? If it was a shop drawing model which had all the mechanisms, and gears, and screws, and fixings and everything in it and was linked to build materials and you knew which factory it came from and how much it cost at the time and what the lead times were for the parts and all that sort of stuff.
BM: And what is it’s lifecycle is, when does it need to be replaced?
RB: Exactly, exactly. Then it becomes a product life cycle model, then there’s huge benefit, there’s huge value in that. It’s taking their model from that next level.
BM: Yeah, absolutely. And I think that’s where the discussion around modelling for fabrication starts to become interesting because that’s where the value kind of is and a lot of the models at the moment are a description of the design performance rather than it’s fabrication.
RB: Yes.
BM: And I think there’s kind of quite a fundamental difference in that.
RB: Yes, exactly.
RB: It is.
BM: And that’s effectively about collapsing the value chain.
RB: It is.
BM: So instead of having the head contractor, subcontractor, sub-sub contractor...
RB: Exactly.
BM: In order to deliver a component of the building, you actually do it in a single step.
RB: Yes, yes. Absolutely. You can, but again, this has massive implications, right? This then only becomes available to the very big players in the industry and they move from being already big players to even bigger ones because they vertically integrate completely. They sign up, they start using supply chain agreements rather than going to tender and essentially transform the industry from what we know of construction today into much more, something that would look more like the automotive industry. Where you have an ecosystem of supplies and supply chain agreements where everyone works to keep the cost at a certain rate and produce a product at the end.
BM: Yeah.
RB: Rather than...
BM: A diffuse field.
RB: Diffuse field of lowest cost tenders. So I don’t know what the implications are. I mean you can see what’s going to happen but it means massive change, right?
BM: Yes.
RB: It has to happen because one person will do it and then it will be impossible for everyone else not to do it.
BM: I think that going back to the kind of discussion around innovation or design and construct? One of the values for design and construct or in design and construct for clients is fixed price, fixed time.
RB: Yes.
BM: Effectively, they’re shifting the risk of that onto the head contractor.
RB: Yes.
BM: So the model that you are describing is like the entire industry becomes design and construct effectively.
RB: Yes.
BM: So that everything becomes fixed price.
RB: Yes.
BM: The thing that you start to differentiate on is design, which is actually ultimately kind of positive I think.
RB: That’s right. Yes, there’s a couple of risks I think for architects. The first one is that in an industry which moves from design led procurement to procurement led design.
BM: Yes.
RB: Architects are maybe in a position where they’re working... Well, we’re already in a position where we’re working for head contractors, right?
BM: Yes.
RB: I don’t know that it changes that much but there is a risk to lose further control over the design process.
BM: Yeah, but I think that’s where digital fabrication actually is the interesting part of it because it actually facilitates more control. So there’s a discussion around risk.
RB: Yeah.
BM: We adopt more risk but there’s also a discussion around control. We increase our control and that allows us to mitigate our risk but as part of adopting that risk, we capture value as well.
RB: Yes.
BM: There’s value, risk and control.
RB: Yes, absolutely. Yeah, that’s very interesting.
BM: We don’t have an issue with risk, it’s never been something we’ve worried about.
BM: Yeah. Which I think is interesting but I think that’s about agency.
RB: Yeah.
BM: Because if you’ve got agency in the process, you’re in control of the risk so it’s not something that you worry about.
RB: That’s exactly right. If it’s your work, it’s your work.
BM: Yeah.
RB: It’s a risk when you’ve sub contracted that and you’re not sure is it being done properly? Are they checking the work?
BM: Yeah.
BM Yeah, but you can control for that.

RB Control for that, you have a checklist and there’s procedures but it’s not an issue.

BM Yeah. How much does digital fabrication reduce your business operating costs or increase costs?

RB I don’t know any other way. We started the company six, seven years ago now. Since 2011 and we were doing same thing we’re doing now from the very beginning, its digital fabrication. There was a cost to that which is that you have to model everything. We reduce our costs as much as we can through automation and re-use. Rather than look at it from a cost point of view, we’re always tried to look at it from a value point of view and to try to ask ourselves what value can we create through doing this and then charge for it appropriately.

BM Yeah. I think that’s the interesting part. So how do you communicate the value?

RB Yes and that’s taken six years, and we’re still trying to work that out. And that’s the biggest challenge, is how you communicate the value.

BM Yeah.

RB That’s a daily challenge.

BM How can architects draw profits from the shift to digital fabrication technology?

RB I mean I think it’s very easy. It would be very easy because you draw something which is hard to make, which can only be made through digital fabrication and then you sell the service to actually do the fabrication. Then if you want to get further, you sell the service to actually do the fabrication. Then depending on how much of that process you want to own. But it’s so simple in my mind, right?

BM Yes.

RB Like you just draw something that you can’t build any other way. The trick is convincing the client that that’s actually a smart way to approach things.

BM Yes.

RB It means no one else can do it except you and it also means you can set the fees for the next stage. Essentially you give yourself the chance to be in future subsequent stages.

BM Yeah, absolutely.

RB It’s harder to do in a more conservative architectural climate where desire is for things which are square and boxy.

BM Which is interesting because a lot of your work has been in Sydney.

RB Yeah, it is. It’s strange, right. I don’t know why I guess it’s just a product of being in Sydney. Yeah, it seems like there’s huge potential in Victoria.

BM Do you see any value in the potential of mass customized building components over mass produced as is currently the standard.

RB Yeah, absolutely huge potential. A lot of the time what we do is in the design engineering of these components. So if you can build in a parametric or a customized or logic to the component itself so that it can maintain it’s engineering rules and flex based on different applications. It reduces your development cost.

BM 3D printing technology is advancing rapidly, it is just a matter of time before it becomes a reliable consumer product. Do you see your firm engaging in printing one to one scale components or assemblies for projects?

RB Not yet. We’re not looking towards 3D printing or five plus axis fabrication techniques.

BM The market is saturated with CNC machines and they’re very easy and cost effective to use. Robot arms are not, they’re hard to program. They’re too flexible, and not rigid enough and they’re too slow. So we don’t ever try to do anything with robots and we don’t see 3D printing as being commercially viable yet. It could be that within six months, a year or two years, three years that it is, but at the moment it’s... We’ve tried it but it was too cost prohibitive.

BM The growing use of 3D printing allows for a giant shift towards mass customization without a price variation on the level of complexity. Do you see a future where the complexity of the object has no price penalty?

RB I feel like we’ve reduced that a lot already. That the price penalty for complex design is less than what it used to be. It’s still a little bit there and I think that if the promises that 3D printing holds out come to bear fruit, then that will have a huge impact. However I don’t see that happening in a near enough term for us to strategically use it in the business.

BM Going back to the discussion around CNC techniques, the interesting thing about CNC techniques is the technology is 25 maybe 30 years old?

RB That’s right, yeah.

BM It’s only, I would say, in the last maybe 10 years, that it’s become more widespread and certainly in the last four or five years, it has probably been good as in certain traits for cabinetry and joinery, et cetera. So that kind of shift, that 30 year shift to now, it’s ubiquity has made it cheap and easy to adopt. Potentially, we’re in for the same sort of timeframe for 3D printing.

RB I think so. That sounds reasonable to me. I think so, which is why I find it less interesting because I feel like I personally have a five year horizon of what I find interesting, and beyond that I tend to lose sight of it until it comes towards that.

BM It’s a bit hard to see beyond the horizon.

RB Yeah, it is but I mean there’s definitely potential there and it would make a lot of things much easier.
Interview Transcript
Recorded 15 September 2017

Toby Whitfield, Director, ShapeShift (TW) with RMIT Master of Architecture students Andzhela Tarabunova and Neus Valdelou (AT/NV)

AT/NV To what extent have digital fabrication processes become a part of the day-to-day operation of your practice?
TW Our practice is 100% digital. We rely on the architects providing 3D models. We’ve been doing it for 15 years. The main document for us has always been a 3D model to articulate design and from there we start our process which is going down the part manufacture. It starts with the engineering and we use software DEA analysis to look at the shape from the digital source file provided, we workout the engineering and then we break up the job all the way through delivering on site. We will pack the containers, so logistics, some basic things that 3D helps you workout, solutions working out with challenges that are in delivery of the project. The whole build is modeled and the solution delivered digitally. When we moved our manufacturing offshore, when we had it, the design studio was upstairs and the manufacturing was downstairs, we had no 2D people anywhere. If someone had a problem or didn’t quite understand, they would come upstairs and we’d look at the screen together, we’d rotate the model, we’d take a measurement maybe we’d understand this problem then go down and just do it.

The whole 2D has become a backward step for us and that has become a requirement to interface with the building industries. When we were doing our own fabrications it was largely pieces of art, where I didn’t need a builder, I was building it myself. It’s only when we’re doing larger projects where there are lots of stakeholders, we have to go back to 2D printed forms. I suppose you see interfacing this industry, this industry is not digitally competent and so, our practice is now becoming more 2D than it was 10 years ago, simply because we want to work in this industry, but it is a backward step.

AT/NV In regards to digital fabrication, which areas do you see the most significant opportunities for your firm?
TW In terms of client?
AT/NV Generally speaking?
TW Generally. Look, our business is digital manufacturing. From the file that we just talked about, I send it to very large format machines 14m by 5m by 5m machines and they cut the shape out. That particular technology of creating shapes in a cost-effective manner, I don’t see that is going to significantly change, till such time as something like 3D printing will become commercially viable. We are a subtractive manufacturing business, I could put on a head that would turn very large machines in to the largest 3D printers in the world, but it is not the best way to use that asset. I can do it faster but not smarter, I can do it faster and cheaper in existing technologies. For the moment our design 3D engineering, we use composites, so carbon fiber and those kind of materials - fabrics, CNC to develop the shape, I don’t see that we are going to suddenly make a huge step forward in that process, it’s already quite refined and very well suited for the built environment. Where we see the opportunity is the recognition of the builder and of the architects, to see what impact those manufacturing techniques and those materials can deliver to your structures. That could be span, shape, it’s weight, so the whole structure can be quite different. We use 3D printing to prove our design but we don’t use it in the actual delivery of the product.

AT/NV What kind of digital fabrication tools have you recently experimented with and has it proved to be useful?
TW I think that probably the only one that we don’t use on a regular basis would be the 3D printing. Experimented is not quite the right word. We’ve used it as to say we’ve used it to prove our design and it was very helpful in communicating a design for a client. Quick, cheap, small scale stuff. In that domain I think that it works very well. We’re playing with software, the developments of software in terms of analyzing communicating through client and engineering is something we’re playing with or probably don’t do enough. Our components, so we don’t have that many interfaces with the rest of the building let’s say to justify a very sophisticated program but that’s probably where we would invest next, more in the software rather than hardware. That investment will be wanted if the industry or our clients start to move more in to that 3D digital space.

AT/NV More requests for it?
TW Yes, more requests for it. At the moment the industry standard is REVIT. Which is not a very great program from our point of view. So we always have to get REVIT exported in...
TW: I think probably relevant to Melbourne is this building behind us (William Barak Building project by ARM), so that was in terms of digital. That was 406 different panels. The whole impact of that design was only disclosed when it was complete. You don’t know the face is there until you see everything. To get that accurate and also to do the engineering, because every shape is different. Then the manufacturing method has to be one that was adaptable to 406 different shapes and then curved. That was probably very challenging in terms of the total delivery process, working with the builder who is trying to build the building as fast as he can, and in the end it was - like all the projects - a lesson on the way you take what worked best last time and you refine and change it as you go. In the end, as always, the way you do the last panel, if you could do that from the very beginning the whole project would be that much easier. It works everything out at the end.

AT/NV: Are you always changing your ways of doing things?
TW: Always. You’re always evolving in terms of technique, evolving in terms of material, you have to. We’re presenting to architects new technology all the time. That’s why we don’t focus too much on IP, because whatever we are doing this year will be updated in two years time. Well be doing it differently, we’ll be using new materials, surfaces, finishes and techniques.

AT/NV: During the process of constructing the building, does it happen sometimes that maybe some pieces are not fitting, so you have to redo them again or change something?
TW: I think one of the benefits of digital manufacturing is that if you’re thinking about doing something, if you think this method would be very good. What do you think?” and together we would work that out, and we could bring to the table “well it’s going to weigh an X amount per square meter therefore I found out that this might be the most efficient way to take this kind of loads.” The ability to communicate digitally upfront, allows the building to be built in the most efficient way with all things considered at the beginning.

AT/NV: What was the most challenging project using digital fabrication? Our practice has faced and how did you overcome it?
TW: The most is probably the 3D model of the Cremorne project, the Marquette project, or the skateboard kinds of objects, because when you’re working with a 3D model or you might have a 3D model that is starting to articulate what are you trying to achieve. Then we would come on board and we would work with you to try to identify where the challenges are. We would start to suggest: “This part of the design is easy and that’s no problem but over here this is a real problem to build. How else can we do it?” We would start to talk about methods and materials that we might use to deliver that shape or building. Until such time as we’ve got a final model and everybody is happy. Some people are happy to see it rotated in the computer other people need prototypes or something that they can touch. From there, you go to a point where you have a level of comfort from everybody saying: “I understand what it is and we can go forward”; and from there we would go to tooling and from tooling we would start building it.

AT/NV: At what stage of the procurement process would digital fabrication expertise and capacity be of most value to the architect?
TW: At the very beginning, the ability to collaborate around a digital asset, design or whatever you want to call it where you are engaging with the manufacturer, and understand how you can develop the design in a collaborative sense. It allows the design to be the best it can be because you are assuming, you are not saying it can or can’t be done, you are sharing that design and you are saying: “My idea, the architect, I don’t know about all the things, but I’m thinking this method would be very good. What do you think?” and together we would work that out, and we could bring to the table “well it’s going to weigh an X amount per square meter therefore I found out that this might be the most efficient way to take this kind of loads.” The ability to communicate digitally upfront, allows the building to be built in the most efficient way with all things considered at the beginning.

AT/NV: The part that is missing is the communication between the different parties, for example the company and the builders because they are a step behind as you said before?
TW: To start the project, I would have to have the source document that is created by the architect, that is the 3D model and everything and from there we all work from that model. That’s how we work and that’s the way we often work with architects because you can visualize, you can break it up, you can divide up the project and send it up to the different fabricators, let’s say you do the facade, you do the carpentry, but when you get to the builder, they don’t. They have many many trades to manage so it’s not a simple task particularly but if there was that step, if there was a commitment if we find the people that were constantly saying this is a great program we use it, it articulates all of our design plus it gives you all the information that you need then that’s what we would invest in.

AT/NV: What is the percentage of digital fabrication you are currently using in your projects, and how do you see these numbers in 10 years time?
TW: I don’t make anything without modelling it, engineering it, cutting it using a large format CNC machine. We create the tools, from there we manufacture out of those moulds, so that part is not digital, it’s an advance manufacturing technique, but it’s not integrated. Up to that point all of our work is digital. Forward going, are we going to do more? I think we are going to do the same, we’re going to do that. We don’t have a way around it. We work with a 3D model, if we don’t have a 3D model we can’t make the part. Maybe that is something that comes from all those people that are still working in 2D. I’m one of those, I can’t read a 2D, I don’t understand it very well. I suppose we are one of the few but we’ve been working in that way for a long time.

AT/NV: To start the project, how do you proceed?
TW: Depending on how competent you are with the 3D. When we work with artists, they are typically about sketches. They have an idea, then they might bring in a Marquette the model or bring in, they might bring in a leaf and say this is my inspiration, and somehow you have to capture this ideas and bring them down to a design. We would start the process to try to understand what are the key elements that can’t be changed and what perimeters about that idea or concept can we play with to make it buildable. Once we have a 3D model or alternatively if you are competent in 3D modelling you might sketch your ideas up, preliminarily, and then you might model that up once you’ve got your concept right, you then send it to the engineers and from there, we might work with the artist to create a 3D model or you might have a 3D model that is starting to articulate what are you trying to achieve. Then we would come on board and we would work with you to try to identify where the challenges are. We would start to suggest: “This part of the design is easy and that’s no problem but over here this is a real problem to build. How else can we do it?” We would start to talk about methods and materials that we might use to deliver that shape or building. Until such time as we’ve got a final model and everybody is happy. Some people are happy to see it rotated in the computer other people need prototypes or something that they can touch. From there, you go to a point where you have a level of comfort from everybody saying: “I understand what it is and we can go forward”; and from there we would go to tooling and from tooling we would start building it.

AT/NV: What is the ultimate for us would be to have the source document that is created by the architect, that is the 3D model and everything and from there we all work from that model. That’s how we work and that’s the way we often work with architects because you can visualize, you can break it up, you can divide up the project and send it up to the different fabricators, let’s say you do the facade, you do the carpentry, but when you get to the builder, they don’t. They have many many trades to manage so it’s not a simple task particularly but if there was that step, if there was a commitment if we find the people that were constantly saying this is a great program we use it, it articulates all of our design plus it gives you all the information that you need then that’s what we would invest in.
more accurate that that piece can be allowed to go to 3D. People still be passed down the line. We work to the millimeter. Then we allow - and we design to have - 30mm in every plan available to the builder. If you were manufacturing by hand, over 3 meters, we might be passing 15mm, by hand that would probably be considered quite good. If systems are already out by 15mm and the builder needs 30mm that means the design tolerance is off 45mm. Where you see the breaks in those panels they’re supposed to be 20mm, but because the slab of the building goes in and out that 20mm, we were able to absorb that through the design of the bracket. If there was accumulating tolerance and panels weren’t accurate then, maybe those would have to be 40mm, because you would need a bigger range to build. I think that idea is important. You start with as good as you can get and then you allow for the trade or the reality of the building site as much as possible.

AT/NV In the relationship between your clients and you changing or has it already changed as a consequence of the digital fabrication? Is it changing in a good way?

TW Yes, changing in a good way. Our clients start off being the architects, the designers, and the artists then once we have reached a solution, the next step is it goes to the builders, they are also our clients. They have very different needs. In the beginning when we were dealing with the design with the designer, the architects, the relationship is developing because the technology that they are using is unlocking tools that are unavailable, manufacturing techniques, working in 3D, using advanced materials, it’s like having a whole new set to work with. That’s very positive and we enjoy that interaction because it’s a challenge. A good design might be a challenging one. The relationship with the builder through digital fabrication is increasingly positive because we are able to understand that the more we learn about the problems that they face, the more we can plan and use our tools to help them. We can work out availability for each panel, we can work out exactly how many trucks they are going to need, how we’re going to slang the project, we can store board through the whole design being cut up in 3D, we can give them a manual almost of how everything is going to happen. If they were all modeling in 3D, then we’d already known where all the conflicts were. Which is what often takes a lot of time and energy, so any electro work is in the wrong place when nobody has realized that electrical work is actually crossing over this beam or whatever. There are errors. In both cases there’s a strong benefit. Architects are already first hand and the builders’ second hand. They are the front line. In both cases there’s a lock on a whole range of things that just can’t be changed, so it requires management and systems and control just like anything else. I don’t think there’s probably more opportunity to scrutinize and analyze a 3D model to search out those problems. A problem found in a 3D model is probably a simple fix, it just exists in the computer, it is what it is. It’s a design. If that same problem is allowed to come through all the way on the site, then, you’ve got a big problem. The opportunity to take the risk out of the project is significantly greater. When you’re making a mistake in a 3D file or a 2D file, that’s going to be the same, that same problem might happen. That same human error exists. I don’t know that you’re necessarily in the right controls, I mean drawing protocol that’s part of your standards, it’s still a huge risk, isn’t it? You have lots of people checking and signing off and all the signatures on every drawing are there. The same thing applies to a 3D file if you want to be very careful but, at least you’ve got the muscle power of computations helping you find where those errors are, rather than you being the fourth person trying to find the problem that the last three people didn’t find.

AT/NV Do you think there are some certain areas that architects should stay away from in the design process? Is it the tool that can guide the process?

TW No, I think that the level of sophistication that is currently out there is very low. You can get a copy of Rhino for free or a student copy, and the base model 3D design programs are good enough to deliver for a lot. There’s more in a package, 3D modeling package than you’ll probably need. The more sophisticated packages have lots of bars on, so they can give you a pile of materials, they can give all sorts of very clever calculation. If we’re just talking about working off the same design, the same 3D drawing, 3D file, then you can do that very simply. From there, they can still print this 2D drawing if they want to. The important thing is that the 2D drawings come from the 3D model, not two separately created elements. That would be enough for the builders to still make all the 2D drawings as long as it came from a master 3D file. The 3D file is the master not the 2D file.

AT/NV Arguably, more responsibility means more risks. How can you manage risk when doing a digital fabrication project?

TW More risk, more control, more responsibility. It depends on your attitude, I suppose. If you prefer to have control and be responsible for the outcome that necessarily has a risk. I think there’s less risk when you’re working on a source file that you have direct control over and it makes mistakes like it’s a reality. There are certain things that you can set up in a file to prevent people from doing changes. Certainly, in parametric modeling you can lock off a whole range of things that just can’t be changed, so it requires management and systems and control just like anything else.

AT/NV In what way you find where those errors are, rather than you being the fourth person trying to find the problem that the last three people didn’t find. You start working with that source file and it starts working for you and you use it all the time and everyone uses it, then it unlocks so much much more than what we talked about. We only use 10% of that software, even the most sophisticated software. I’m probably only using a fraction of the capability it has. The more you use it the more people will progress with it the more you’ll start using not 10% of that capability but 60%. And then the mental will grow. That’s what I enjoy about it.

you can talk about the problems that you are facing. Here is the challenge. “You guys are the experts in composites or metal or whatever, here’s what I really love I don’t know quite how I’m going to do it, I’ve got this idea, I’ve done a prototype here, what do you think?” That creates the conversation and if I’m any good our response to that challenge is “Oh, it’s a great idea, I’d love to see that happen, I’ve got some ideas too, let me go away and I’ll come back to you.” You create something, and with that process you also build the trust and you build the relationship, and so the next time there’s a challenging interesting design that you’re working on, a commission, you’ll probably going to get those key people around the table and go “let’s do this together”. The digital world represents a language that you all understand and you can try things and work together very easily. The fact that the end product then is able to be communicated a machine or processed digitally that means that it’s going to be accurately articulated.

AT/NV It is the tool that can guide the process?

TW It’s the medium that you’re all working in, that you all understand. It’s a communication tool method but has so much more. Once you get it right, even at the start, if you can only do renders, the simple things, more importantly, all of that behind that it can offer you, and if you start working with that source file and it starts working for you and you use it all the time and everyone uses it, then it unlocks so much much more than what we talked about. We only use 10% of that software, even the most sophisticated software. I’m probably only using a fraction of the capability it has. The more you use it the more people will progress with it the more you’ll start using not 10% of that capability but 60%. And then the mental will grow. That’s what I enjoy about it.
Research Elective

Interview Transcript
Recorded 20 September 2017

Nicholas Williams, Digital Practice Leader, Aurecon (NW) with RMIT Master of Architecture students Fabian Alejandro Martinez and Anqi Ye (FM/AY)

FM/AY In regards to digital fabrication, what has been a remarkable challenge or risk, and how did you manage it?

NW Challenge and risk are different things. The challenge occurs because of the disconnected nature of the supply chain. Architects working on design generally don’t have any understanding of who the contractors will be for a project. Even if you know one of the fabricators and they’re available, it is very hard to have any confidence that they would be a part of that chain. That is the big challenge. The risk is primarily a design risk that you are creating. While something can be fabricated because of digital fabrication technology, that may not survive the process of engaging a contractor and working through many links outside of the architect’s control. Good examples of how this is being managed in a few projects more closely related to my previous business AR-MA. We would aim for multiple contracts; a small contract before tender and then trying to work with the winning tender afterwards. Through doing that contract pre-tender, and working with the fabricator, you can generally get a price for an item which is less risky than a provisional figure for your tender.

There are challenges and risks in terms of actually fabricating and working with tolerances as well. Those are about understanding the machines and what they can do, how accurately they work, understanding how that assembly is going to work. Understanding material, differential movement, how to detail well. Those are challenges and risks but they have to be addressed by design solutions. Once the design is good then the fabrication technologies are pretty flexible.

FM/AY How have you marketed your abilities within the digital fabrication field?

NW Right now you can market to architects as being able to work alongside them or you can market yourself as an architect. I think part of that marketing is to pitch for the right mix of technical and creative. It has been out of fashion for architects to talk about being technically deep as well as anything creative. If you’re marketing to architects then you emphasise the technical ability to help connect downstream. If you’re marketing yourself to a fabricator, you talk very much about technical aspects of workflows but being able to meet the design intent as defined by the architect.

It does depend on who you’re talking to, it’s very difficult for companies to try and be architects and evolve to digital fabrication. You tend to become a digital fabrication business or you tend to become an architect. It’s very hard to work across, currently there hasn’t been any way.

FM/AY What is the percentage of digital fabrication you are currently using in your projects, and how do you see these numbers in 10 years time?

NW It depends what you mean by digital fabrication percentage. The projects I’m doing as an architect - its key elements of two systems basically. Cutting CLT and perforated sheet metal. Those things are CNC driven no matter what. That is just the standard manufacturing process. That is where the suppliers are taken on board.

A bit of the work I do at Aurecon is facade work and that is all digitally fabricated. Curtain wall systems are designed around extrusions and cutting those extrusions. One can have some digital control over the machinery, though it’s a long way from that ideal of digital fabrication into a managed product. And the digital chain is broken. There is design intent then someone else generates some data for the fabricator. Now I would love to think in ten years time that is shifted but the challenge there is whether the design consultants start to take more of a role in that construction process or whether the contractors eat up more of the design space and the architects become more and more limited in what they are paid for.

FM/AY Why do you continue to use conventional methods of fabrication?

NW I think the digital has to add value, whether that is by doing something much quicker or much more accurately or delivering some design that can’t be done by hand. Even for so-called digital projects, Zaha towers to pavilions, that springs to mind the work that Thomas Bock and co were doing in the 90’s using robots to assemble blockwork walls were very generic tasks. That ceased to be viable when the Asian financial crisis happened and the cost of labour came down suddenly. I don’t know the figures...
but it wasn’t radically cheaper to do anything with the robot it was just harder and there were plenty of good labour supply. The other side is of course all this digital fascination with materials and processes is still young and the early manufactures that have been doing things in a certain way for 30, 40, 50 years are efficient in key cost drivers. Stud frames on houses they are very very quick they can go up in a few days. Another point to distinguish is between digital fabrication and assembly. Assembly on site hasn’t got a lot of attention though this is changing. It is a major cost consideration.

PM/AY What are the key elements that make you decide a project is suitable for digital fabrication?

NW Firstly around who the client is and what the brief is. It’s more and more to do with a particular approach to design and connection across the execution of that design. It’s also knowledge of specific materials and processes. You might say “Hey this is an option for design response for a particular material”, whether we are going to need perforated panels on a facade or whatever it is. This demands understanding across design and delivery and is reflected in the research I have done which creates and interrogates these broad systems.

More broadly, while digital fabrication is something that architects could get on board and drive in a particular way, there’s still a big gap between what architects have been doing within academia and what is out there commercially available. But this is changing very quickly. You look at UN Studio or Zaha’s work in China and their facades are becoming increasingly well executed. Even five years ago the Guangzhou Opera House which was poorly executed, we can see the radical shifts happening across this time period.

The increasing adoption of digital fabrication within the design and construction industries presents both significant challenges and opportunities for the practice of architecture. Over the last 50 or more years increasing consultant specialisation has arguably eroded the traditional role of the architect. Project Managers and others have introduced increasing levels of intermediaries between the architect and the construction process.

Digital fabrication is the direct manufacture of three-dimensional objects using additive (3D printing) or subtractive processes (milling, laser cutting etc). Adoption of these techniques allows for the fabrication of components, assemblies or increasingly whole structures directly from digital design models. In some cases architects are undertaking fabrication themselves, or sending the model to others for direct fabrication - however in both cases the separation between the architect and the produced object is dramatically collapsed. This is a significant opportunity in that it allows more much greater agency in the fabrication/construction process, however also delivers increased risk for architects engaging in these modes of practice.

Adoption of Digital fabrication also significantly affects the typical business model of architectural practice. For most architectural practices a high proportion of fees are generated in the production of Contract Documentation that is the translation of a 3-dimensional proposal into 2-dimensional representation defining the scope of construction of 3-dimensional object. Where the final object is directly fabricated from the digital model, the component of the fee base will either be eroded or require redefinition in order to be partially or completely retained.

Phase 1 Archival Research
Firstly, we will be undertaking a broad international survey of research into the area of digital fabrication, both in terms of technical innovation and its implementation in construction projects, and also how these shifts have or will result in changes to the legal frameworks and business/financial models that govern architectural practice. This exercise will take the form of archival research, focusing on projects publications, journals and scholarly articles. We will encourage to venture beyond architecture into the realms or business, construction and law to find alternative views of the field.

Phase 2 Local Practice Consultation
In the second-phase of the semester, students will be expected to familiarise themselves with the specific context of practice in Victoria, as defined by the Architects Act, insurer expectations, AIA by laws and the myriad of cultural and market expectations that influence practice. Based on this and the findings of the initial research students will be asked to approach innovative local practitioners with a series of questions and prompts for discussion.

Phase 3 Projective Modelling
In the final third of the semester students are expected to develop a speculative proposition. The proposition should synthesise the ideas/technologies/models uncovered in the first phase of the semester, with an opportunity or gap uncovered in the second. The proposition must be specific to practice in Australia, and respond critically to our context, however it can take the form of a future scenario, leverage technologies that do not yet exist, or expand upon an existing case study that has the potential to be scaled up. Ultimately the ambition of this exercise is to understand, through speculation and proposition, what would have to shift in order to fully integrate digital fabrication processes into architectural practice, and what the implications of their adoption would be on the discipline in Australia.
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