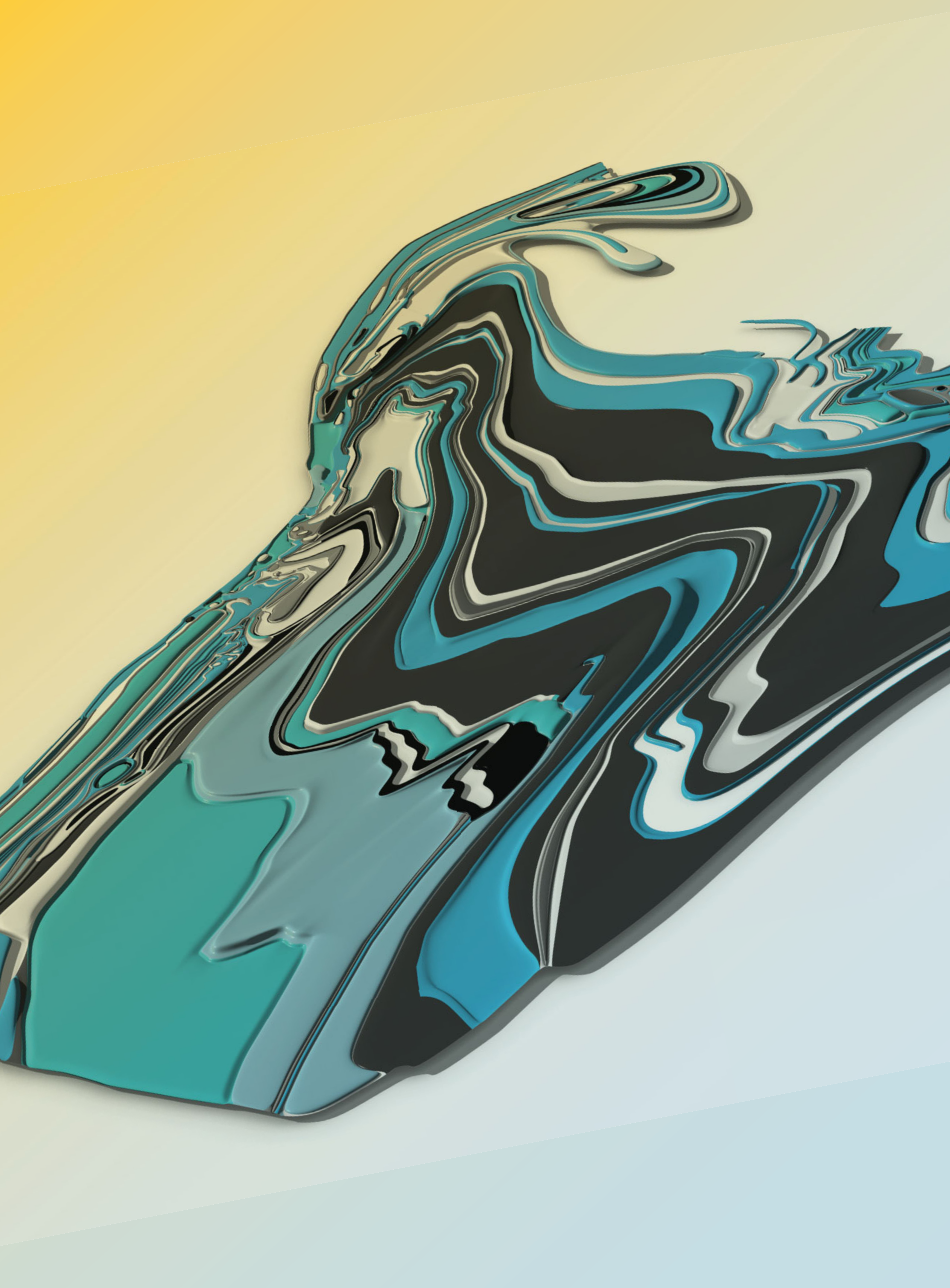
Guest-Edited by
RICHARD GARBER

Expanding Architecture's Territory in the Design and Delivery of Buildings

WORKFLOWS

03 | VOL 87 | 2017



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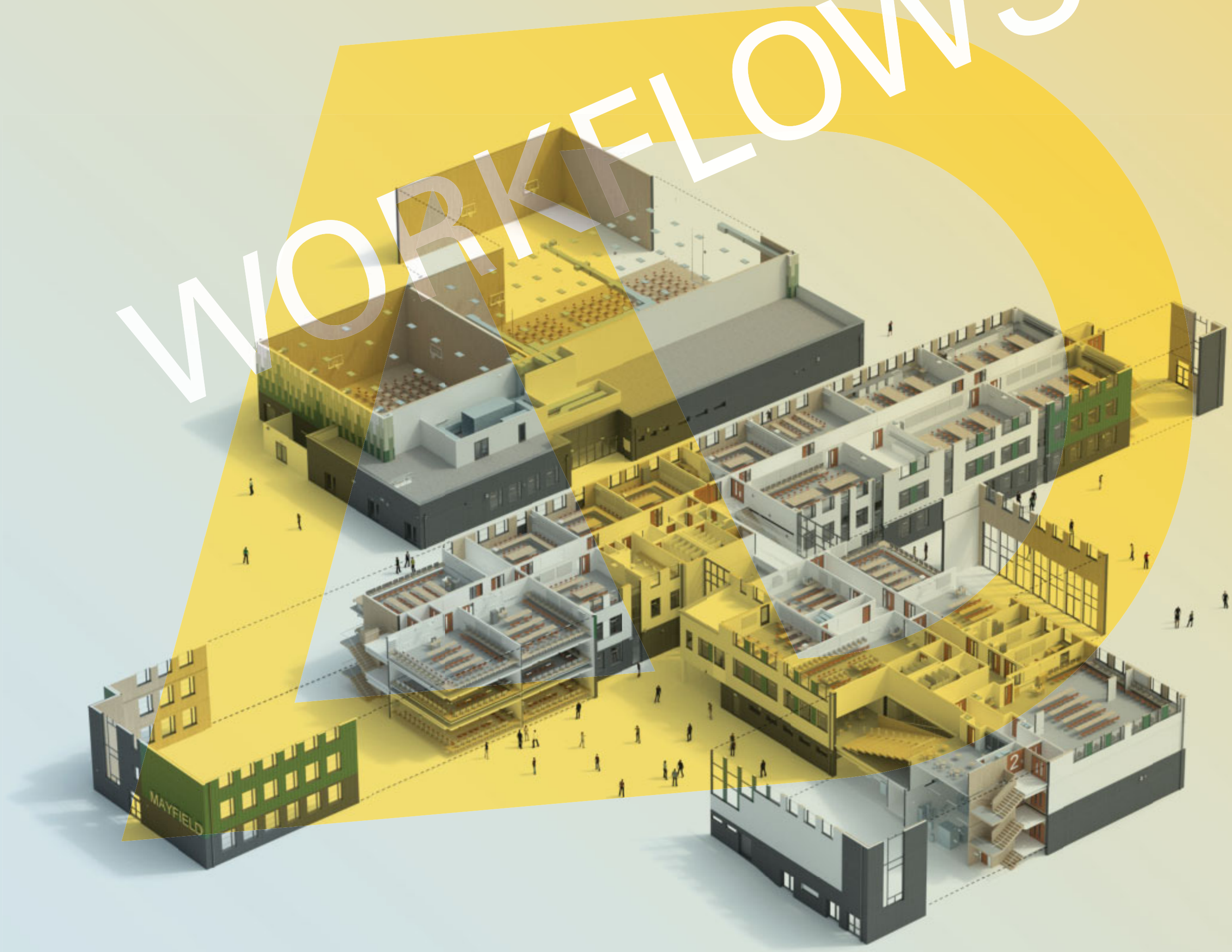

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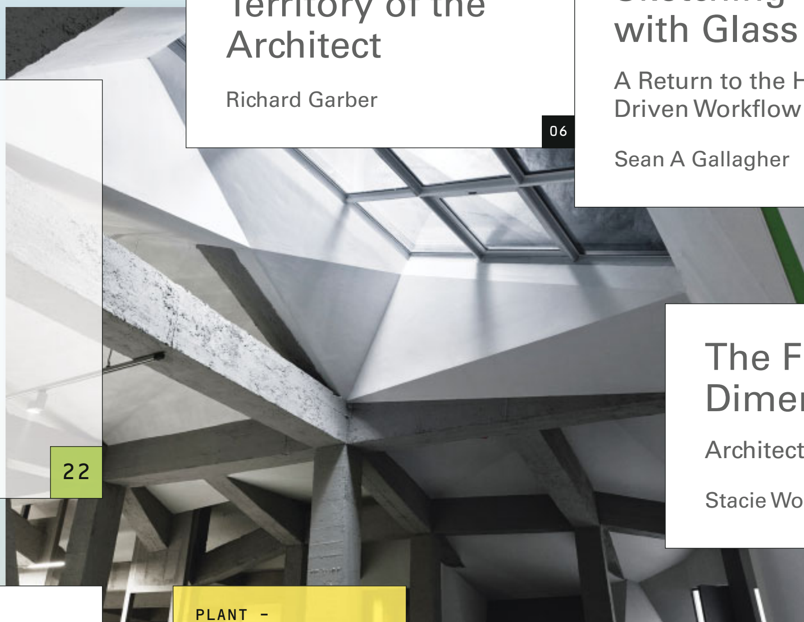
May/June 2017

Profile
No 247



PLANT – Atelier Peter Kis, The Great Rock, Budapest Zoo & Botanical Garden, Budapest, Hungary, 2012

David Miller Architects, Refurbishment of the Media Centre, Lord's Cricket Ground, London, 2017

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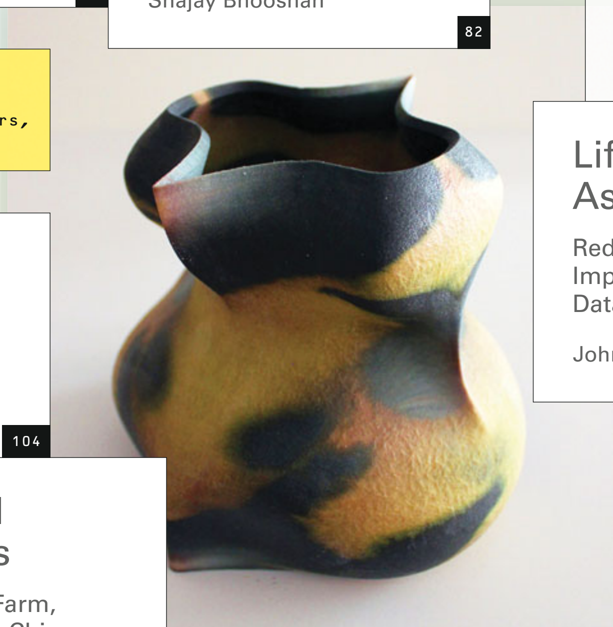
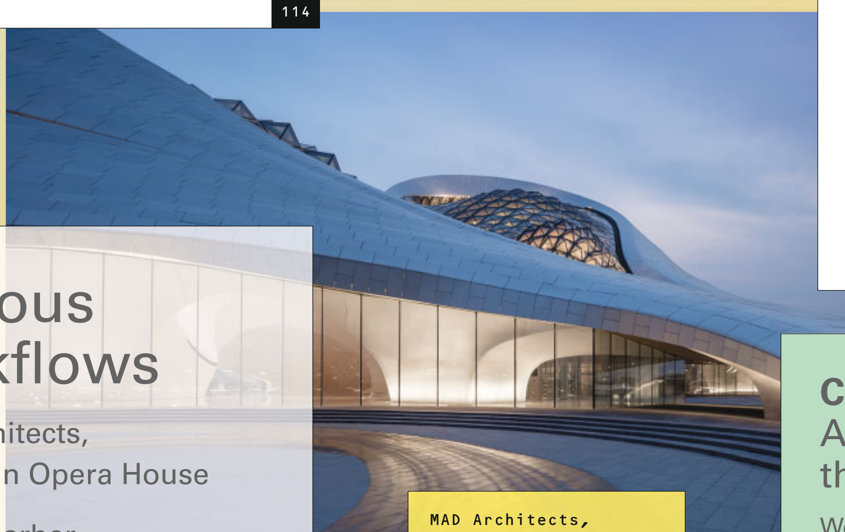


Young & Ayata, Geological Vessel, Donkeys and Feathers, 2014



MAD Architects, Harbin Opera House, Harbin, Heilongjiang Province, China, 2015

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Front and back cover: Henry Grosman/BanG studio, Workflows vector diagram, 2006. © Henry Grosman/BanG studio

Inside front cover: Specific Objects, European Ceramic Workcentre. Oisterwijk, The Netherlands, 2016. © Rhett Russo

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ABOUT THE

GUEST-EDITOR

RICHARD GARBER

Richard Garber is a partner at the award-winning New York-based firm GRO Architects. In his work, he utilises technology as it relates to formal speculation, simulation, manufacturing and building delivery to generate innovative design, assembly and construction solutions. He is the author of *BIM Design: Realising the Creative Potential of Building Information Modeling* (John Wiley & Sons, 2014), and Guest-Editor of *AD Closing the Gap: Information Models in Contemporary Design Practice* (March/April 2009). Both publications examine the capacity of design computing and building information modelling (BIM) to augment design-side operations, as opposed to simply making them more efficient. This led to the idea of architectural workflows, and their ability to expand the territory in which architects operate.

Garber has taught and lectured on design and technology internationally, most recently at the New Jersey Institute of Technology (NJIT). He holds a Bachelor of Architecture from Rensselaer Polytechnic Institute in New York, and a Master of Science in Advanced Architectural Design from Columbia University's Graduate School of Architecture, Planning and Preservation (GSAPP). The December 2010 issue of *Dwell* magazine named him as one of the 32 new faces of design, and showcased his precast concrete housing prototype PREttyFAB.

Over the last 15 years, he has been involved in numerous projects that have been acclaimed as novel for their design and delivery. As a designer at SHoP Architects he was involved in early projects such as A-Wall (2000) and Dunescape at MoMA PS-1 (2001) in New York. SHoP has since applied the design methods and workflows developed for these to larger-scale projects, including the Han Gil Sa Book House in Seoul (2002–03) for which Garber was project manager. At GRO he has developed workflows that link material systems such as precast concrete and modular construction to building projects during the design, pre-construction and construction phases. These include PREttyFAB (2009), for which a workflow with a precast concrete fabricator was imagined, and the Jackson Green affordable housing (2014) in Jersey City, New Jersey, for which a workflow engaging a modular construction company was devised.

His recent work engages the increasing influence of ecological thought on architecture, and has yielded planning projects in the US and China, including Zhangdu Lake Farm, a new community in the Chinese countryside designed to incorporate ecologically sustainable infrastructure. The project received the Bronze Medal for Excellence in Planning from the City of Wuhan, Hubei Province. In addition to his work with SHoP, he was designer at Greg Lynn FORM on the Korean Presbyterian Church of New York (1999).

INTRODUCTION

RICHARD GARBER

DIGITAL WORKFLOWS AND THE EXPANDED TERRITORY OF THE ARCHITECT

Zaha Hadid Architects,
Guangzhou Opera House,
Guangzhou,
China,
2010

The 1,800-seat auditorium of the structure houses the very latest acoustic technology, and the smaller, 400-seat multifunction hall is designed for performance art, opera and concerts in the round. The architects utilised BIM and a workflow that included acoustic, theatre and cost consultants and a lighting design team. Architects are increasingly coordinating larger teams in the design and delivery of buildings within their workflows.

The synthesis of building information modelling (BIM) platforms with digital simulation and increasing access to data in the form of building performance has allowed contemporary architects to develop workflows in collaboration with others in the design and construction process. Beyond design intent and process, workflows now occupy an expanded territory within architectural practice, merging digital design operations with construction activities, project delivery, and post-occupation scenarios in both virtual and actual formats.

WORKFLOW ORIGINS

In current business practice, a workflow is defined as a 'progression of steps (tasks, events, interactions) that comprise a work process, involve two or more persons, and create or add value to the organization's activities'.[1] However, workflows date back to the industrial processes developed in the 18th century. In their book *Workflow Modeling* (2008), Alec Sharp and Patrick McDermott illustrate the need for workflow design by tracing the demise of the role of craftworkers, 'highly skilled people like weavers, blacksmiths, or jewelers who were responsible for all phases of making a complete, finished product'.[2] With the development of James Watt's steam engine in 1781, they suggest, as manufacturing processes and products became more complex, the work of such artisans was instead divided among teams of workers, each performing a specialised task. Specialisation led to a huge increase in the number of products that could be produced. However, the 'real legacy' of the Industrial Revolution was not any individual product, such as the steam engine, but the idea that complex work could be subdivided into more simple tasks.[3]

At the start of the 20th century, advances in manufacturing technology such as the Fordist assembly line made mass production and mass consumption possible, at the same time revealing that the specialists who worked the line in fact needed no special skills at all – they simply needed to be trained how to repeat a particular task. By the 1950s the term 'workflow' was already being used in office management systems, taking hold in the 1990s with the widespread adoption of information technologies in business and manufacturing practices.[4]

Sharp and McDermott see this shift as a 'reengineering' of work processes: 'Measurement would shift from individual tasks … to the achievement of value … The innovative use of information technology was a crucial factor, but so was rethinking the *flow of work*, the measurements that motivated performance, the underlying policies of the enterprise, and other enabling factors.'[5] It is useful to think about such processes as part of the design and delivery of buildings – two equally important yet sometimes opposing aspects of architects' work that have not always enjoyed a seamless transition.

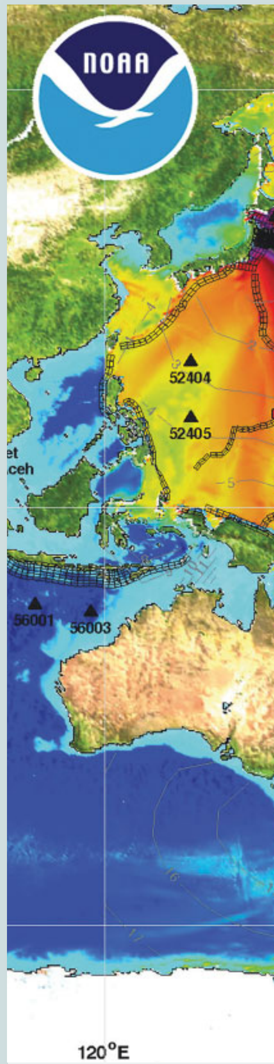
RE-ENGINEERING THE 1990S

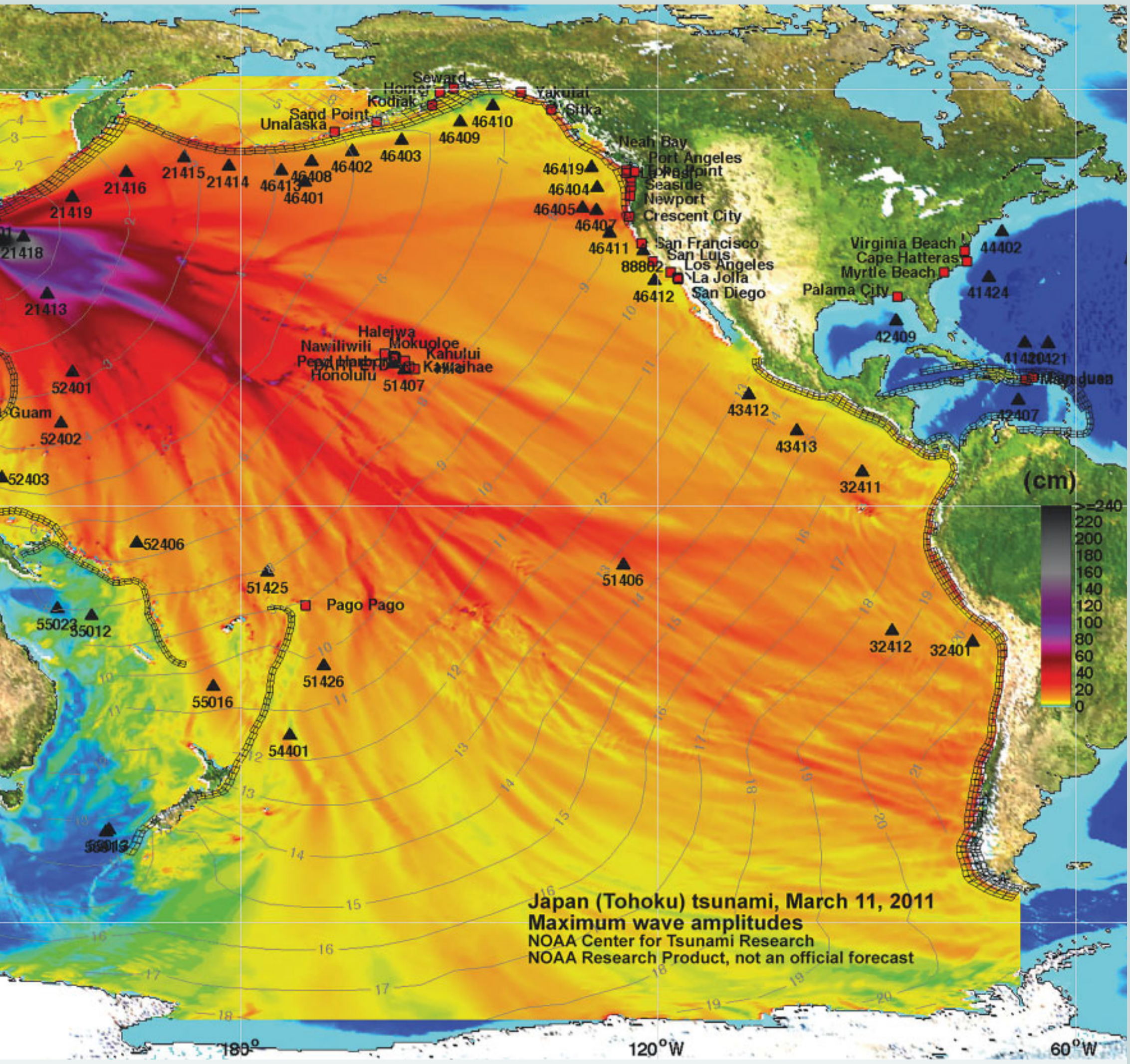
As a way of positioning the divide, I recall an exchange that occurred when I was a graduate student at Columbia University in New York in the late 1990s with the then Dean James Polshek. At that time, students were being introduced to state-of-the-art software packages to be utilised in the design of their projects. While these were inherently parametric – they could be numerically driven as well as employed as more standard 3D modelling tools – the ability to understand a proposed design's impact on a site, or the functional or performative relationship of its architectural componentry, were not yet achievable. Accordingly, such tools quickly drew criticism from a group of malcontents who posited that architects were in essence using them simply to advance their interest in novel architectural formalism.

Though generally complimentary about my formal variation and embracing of the new tools available to Columbia students, Dean Polshek's commentary took a turn when he said: 'But you made a building.' This criticism caught me off guard, not least because I had specifically gone to graduate school to design buildings, but more importantly because he seemed to suggest that these novel tools did not really have a place in the making of real architecture. Even back then, in the midst of what has since become characterised as the 'digital turn',[6] myself and likeminded colleagues were very interested in devising ways to move geometric data through different analogue and digital processes, a precursor to the more robust workflows described in this issue of AD, to propose building designs that were measurable and, ultimately, constructible.

My exchange with Dean Polshek really spoke to the emerging divide between those who embraced a more traditional way of designing and constructing buildings, and those of us who believed in something new that would give way some years later to the BIM systems that revolutionised the way we design and build today. In the late 1990s, this computer-driven geometric project was truly experimental in terms of formal exploration, but led to a sort of excess in geometry that was seen as disconnected from a social agenda. Simpler geometric configurations that could be more readily understood by the masses were the preferred option; and it seemed impossible that an architect might give equal attention to complex formal strategies while simultaneously addressing the complexities of social problems at the time.

The idea of formal exploration was seen as a kind of esoteric practice on the fringes of architectural design, detached from the social objectives of the broad profession. Still, these computing adventures would eventually lead to advances in how architects design buildings and communicate with others, as witnessed in the early collaborations between SHoP Architects and Buro Happold Consulting Engineers, such as the Porter House in New York City (2003), and the Carousel (2001) and Camera Obscura (2005), both at Mitchell Park in Greenport,





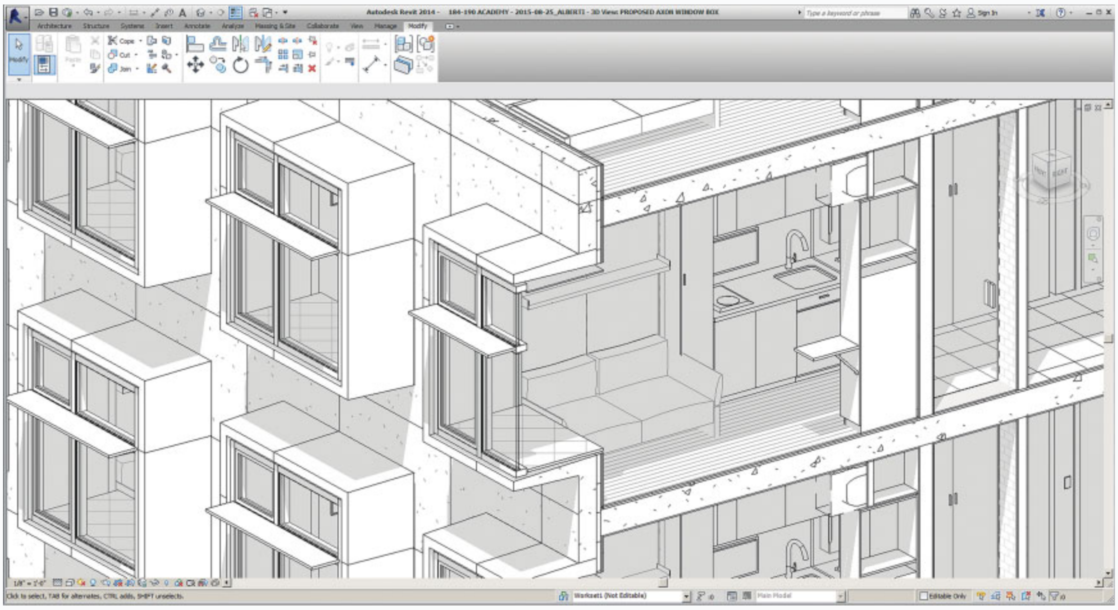
National Oceanic and Atmospheric Administration (NOAA),
Tsunami Energy Map,
Japan,
11 March 2011

Advances in visual and information technology, and its management, have enabled the design of new and innovative workflows. The NOAA's Center for Tsunami Research produced this graphic of wave energy in the Pacific Ocean following the 2011 earthquakes in Japan.

In current business practice, a workflow is defined as a 'progression of steps (tasks, events, interactions) that comprise a work process, involve two or more persons, and create or add value to the organization's activities'.

Plane factory assembly line,
England,
c 1900

This factory, somewhere in England, shows a floor filled with spitfire fighters in the making. It is quite similar to how US assembly lines at the time were organised, however in England it was not the planes themselves that moved, but rather the workmen. This seems to challenge the Fordist idea that unskilled workers repeat the same task continuously.



GRO Architects, Academy Street Micro-Housing, Jersey City, New Jersey, 2015

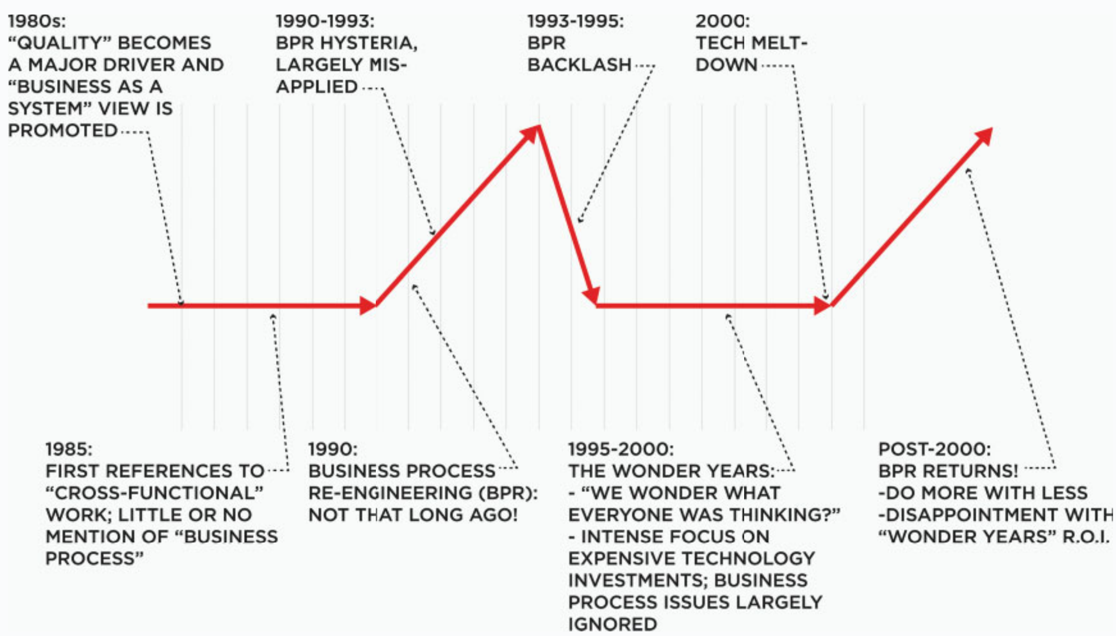
BIM suites such as Autodesk's Revit are used by architects to virtually construct a building prior to actual construction. GRO's micro-housing proposal imagines 18.5-square-metre (200-square-foot) fully furnished living units that need to be outfitted with all of the amenities of a more typically sized apartment. The Revit model was shared not only across the design and engineering team, but was also crucial for subcontractors such as plumbers and electricians to understand their scope of work within a very small space.

New York.[7] On this point, professor and practising architect Scott Marble has written: 'the impact that this work had on the development in industry has become the foundation for new design approaches that are more responsive to, and even inspired by, the possibilities of digital fabrication techniques.'[8]

FEEDBACK AND THE FLOW OF WORK

Ultimately, the workflows architects and designers use today have shifted from the more linear processes of the assembly lines of the 20th century to those that allow for feedback across the design team and project timescale. The adoption of BIM has enabled new workflows that are more iterative and collaborative, and more than ever coordinated with the downstream processes of manufacturing and building delivery. This idea, that an architectural workflow can encompass pre-construction design activities, construction phases and, ultimately, the occupation of a building, moves the discussion of a design process to one that is more broad and defined by and with collaborators across the architectural, engineering and construction (AEC) spectrum. Process is no longer an explicitly design-side operation; architects are increasingly involved in component manufacturing and construction, allowing them to expand the territory and traditional role in building design they have held since the time of Leon Battista Alberti in the 15th century.[9]

Workflows, in fact, are a kind of hidden phenomenon in completed buildings. Buildings alone, especially complex ones, cannot convey the collaborative activities that design teams have developed in the service of construction execution. Though in many instances designed by architects, workflows are participatory, engaging engineers, fabrications, contractors and others within the building delivery process. This issue of *AD* demonstrates the importance of adopting virtual-to-actual workflows in contemporary architectural design by linking access to various data and material flows with specific design and

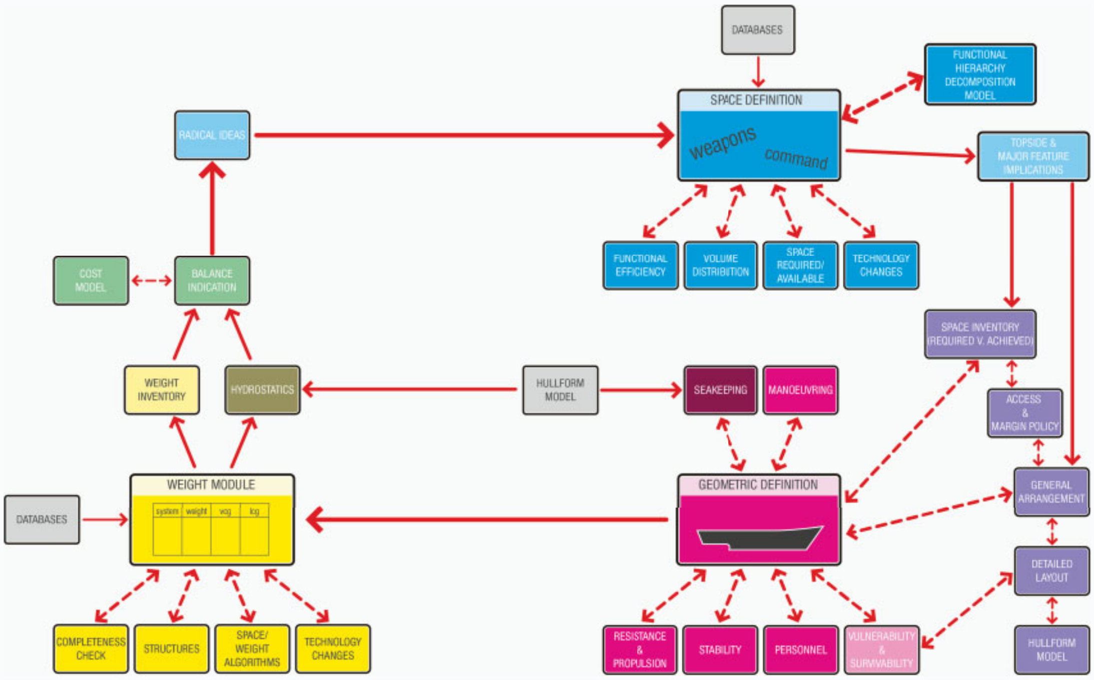


GRO Architects, The rise and fall of continuous process development, 2016

In their book *Workflow Modeling* (2008), in a graphic referred to as the 'rise and fall of continuous process development', Alec Sharp and Patrick McDermott trace the role of information technology in refining business workflows from the 1980s through to today. Analogous technologies were transforming the AEC industry during the same period, with similar missteps.

GRO Architects,
Design building block,
2012

The 'design building block' method for ship design and construction, as developed by DJ Andrews and others. Here, the different parts are developed at the onset of a digital design process and iterated through simulation and analysis both discretely and as an assembly. The building block represents a fully integrated workflow from initial design to final production.

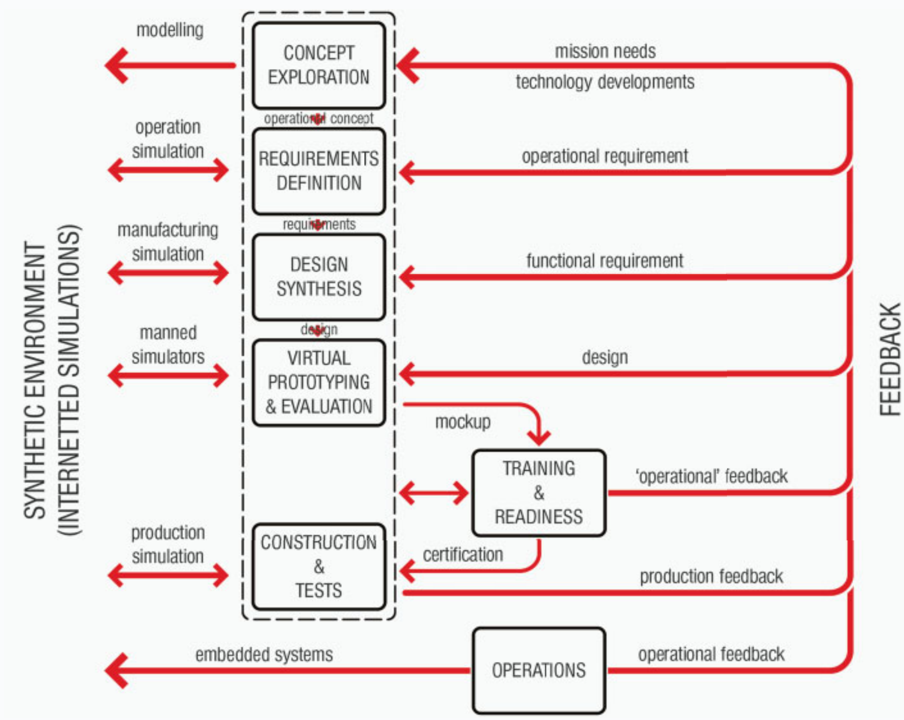


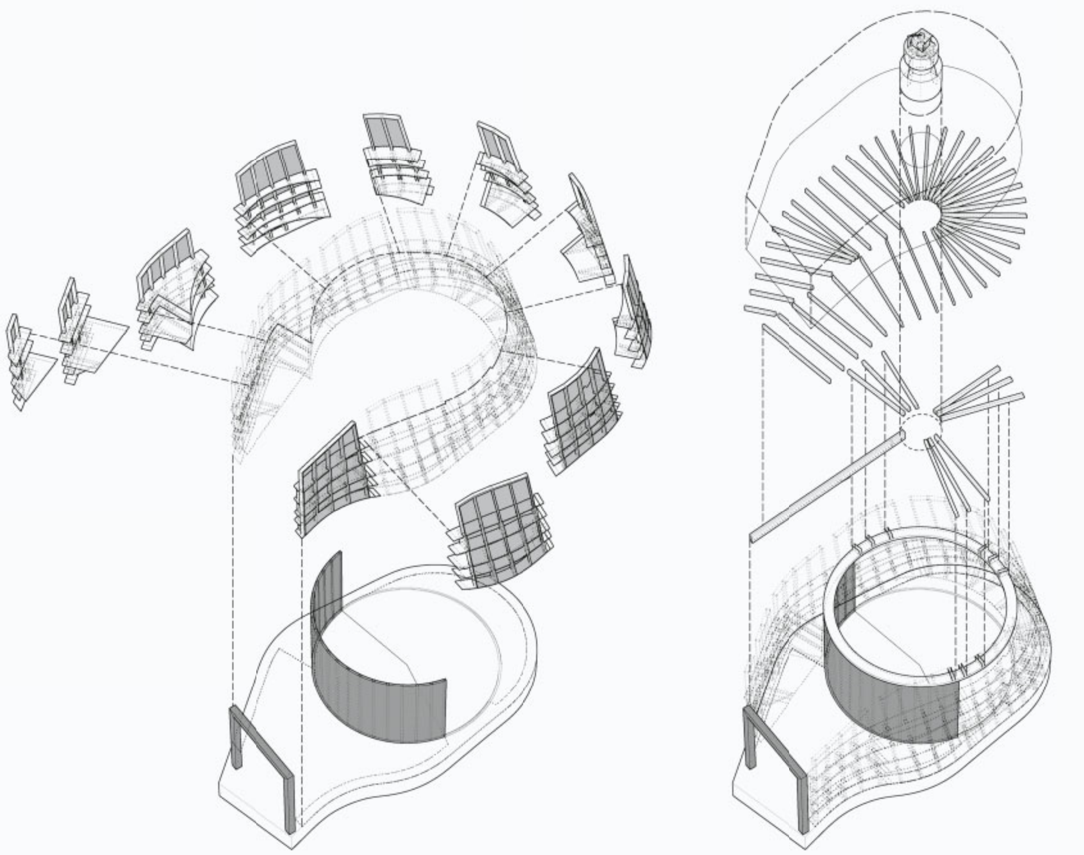
production techniques, and exposing how both small and larger practices are leveraging digital technologies in novel and efficient ways of delivering increasingly complex building projects. It also looks at how logistics and systemic organisation in related fields such as manufacturing and retail are influencing the way architects approach design problems.

For Scott Marble, the 'logics of digital workflows in architecture have begun to structure the way that architects design, the way that builders build, and the way that industry is reorganizing'.[10] The design of workflows and their value in the actualisation of large and complex building projects has followed the more robust adoption of BIM platforms as well as the idea of integrated project delivery (IPD), both the results of an expanded interest in 3D modelling made possible by advances in computing some 30 years ago. Writing in 2015, Randall Newton, a principal analyst at design industry and business consultants Consilia Vektor, pointed out that more recent developments in information technology and collaborative online environments have made it clear that the 'processes that became standard before the arrival of computers cannot support a fully digital, fully 3D, fully collaborative construction project'.[11] Through BIM, however, much greater degrees of collaboration, efficiency and coordination are possible in operations including costing, fabrication and virtual construction. Yet some sectors of the AEC industry have been slow to adopt these tools.

GRO Architects,
Design workflow with feedback,
2012

Design workflows in other industries have been developed with a highly articulated relationship between modelling, simulation, prototyping and, ultimately, production. In such a workflow, the linear design and production process shifts to one that is more iterative and allows for feedback from all team members.





SHoP Architects,
Camera Obscura,
Mitchell Park,
Greenport,
New York,
2005

SHoP's Camera Obscura was an early experiment in direct-to-manufacture construction. The building was modelled entirely in Rhino 3D and rationalised for digital data transfer to manufacturers who produced its components, primarily from laser-cut sheet steel. The project represents a shift from the mass production to the mass customisation of architectural componentry.

BIM CULTURE

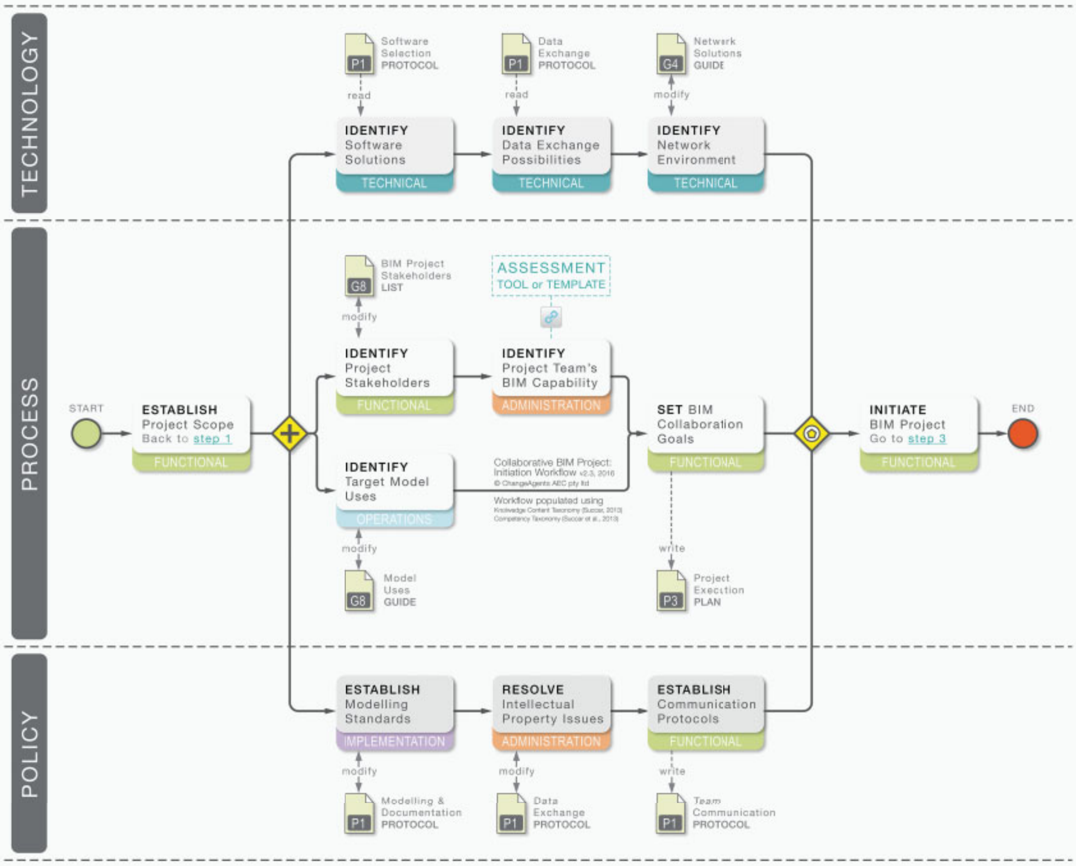
Many architects, though, have embraced such objectives, through a more nuanced and developed relationship between architectural design and current technologies. Mass production, for instance, has given way to mass customisation, where instead of people working linearly on an assembly line to produce a single part, the workflow involves a smaller group of workers with some specialised knowledge who can program hardware to variably produce multiple parts. Current workflows thus allow for more bespoke solutions that can be tailored to specific building performance needs. How this differs from the 1990s is in the design team's ability to develop a building scheme that engages various criteria including form, performance, material and energy use, and cost using 3D modelling and simulation tools. Design decisions such as siting and orientation, bulk considerations and accessibility can now be controlled very early in the design process and linked to downstream activities such as material selection and the fabrication of structural or architectural components. Whereas formal variation could always be numerically controlled, it can now be directly connected to the highly specific criteria that creatively drive design decisions.

Design decisions such as siting and orientation, bulk considerations and accessibility can now be controlled very early in the design process

The increasing use of social media over the last decade has also led to a more widespread international adoption of BIM culture. Passionate about sharing developments, BIM users publish their knowledge and lessons learned through blogs and Twitter. Organisations such as SmartGeometry and the Association for Computer Aided Design in Architecture (ACADIA) also disseminate this thinking across academia and practice. Architects are no longer unwilling, as previously, to share their knowledge with others in the field, and many digital workflows are now explained via YouTube tutorials and described in publications such as Dominik Holzer's *The BIM Manager's Handbook* (2016).[12]

WORKFLOWS AND ARCHITECTURAL PRODUCTION

In a recent white paper published by Autodesk, Lance Parve, a hydrogeologist with the Wisconsin Department of Transportation, speaks of creating 'cross-generational training' opportunities within firms, with 'younger, less-experienced staff working alongside … senior people who don't have … familiarity with parametric modeling tools. The shift offers the impetus for a cultural boost within the organization, with opportunities for mentoring and instilling the firm's values and expertise within the next generation, while taking advantage of the newer skill set.'[13] In their 'From Pencils to Partners' article in this issue of AD (pp 74–81), Autodesk's Ian Keough and Anthony Hauck outline new online environments in which workflows exist that enable such training and collaboration, and facilitate a more horizontal organisation of the design firms themselves.



Bilal Succar/Change Agents AEC, Collaborative BIM project initiation workflow, 2016

BIM assessment firm Change Agents AEC helps design firms build BIM competency. Its project initiation workflow merges modelling and data exchange standards, and project scope, across a collaborative and shared environment.

The workflows described in the issue speak broadly to how digital tools have been adopted by architects and engineers and merged with building delivery methods. In her article 'The Fifth Dimension' (pp 28–33), Stacie Wong explains architect-led design–build (ALDB), a form of practice developed by GLUCK+ 'in which the social capital and tacit knowledge of architect and contractor influence the built environment for the better'. In assessing workflows in global practices, Randy Deutsch (pp 56–67) illustrates how prominent architectural firms are engaging in the development of digital workflows to expand both iteration within the design process and direct-to-fabrication potentials in the production of architectural componentry. This is reiterated by Shajay Bhooshan of Zaha Hadid Architects (pp 82–9), where very specific ideas about fabrication can be drive through the development of digital geometry.

Rhett Russo (pp 48–55) and Kutan Ayata (pp 90–95) write about new workflows that merge vector-based geometry with images; and Arup's Seth Wolfe and colleagues (pp 120–27) highlight how technology is changing engineering design operations and leading to further collaboration with architects.

The design of workflows also offers something that critics of digital technologies suggest we have lost: the possibility of bringing a social dimension to the design and delivery of buildings through active stakeholder engagement and participation. In this sense, workflows allow architects to come full circle, by closing the gap between those who have argued that architecture is primarily a social project, and those who have embraced the technologies that have revolutionised architectural design. Featured projects by SHoP Architects (pp 110–12) and GRO Architects (pp 112–19) illustrate how the practices are integrating concepts of local inclusion and knowledge transfer within their work. Other works, including the Duke University Marine Laboratory Campus by GLUCK+ (pp 28–33), demonstrate how through workflows architects are involving local communities as both stakeholders and workforce, bridging the gap between the sometimes irreconcilable social and technical dimensions of a building project.

The inclusive nature of workflows means they can accommodate the personalised design processes of architects as well as integrated engineering strategies and collaborative ideas about building delivery. Through the contributions of a group of accomplished architects, engineers and software designers, this issue of AD attempts to touch on each of these aspects, and to explain how technologically infused workflows will continue to influence 21st-century design practice. AD

Notes

1. See www.businessdictionary.com/definition/workflow.html.
2. Alec Sharp and Patrick McDermott, 'A Brief History – How the Enterprise Came to Be Process Oriented', *Workflow Modeling: Tools for Process Improvement and Application Development*, Artech House (Boston, MA), 2008, p 16.
3. *Ibid*, p 19.
4. See http://macsparky.com/blog/2013/4/history-of-workflow.
5. Sharp and McDermott, *op cit*, p 23.
6. Mario Carpo (ed), *The Digital Turn in Architecture 1992–2012*, John Wiley & Sons (Chichester), 2013.
7. SHoP/Sharples Holden Pasquarelli, *AD Versioning: Evolutionary Techniques in Architecture*, Jan/Feb (no 1), 2003.
8. Scott Marble (ed), 'From Process to Workflow: Designing Design, Designing Assembly, Designing Industry', *Digital Workflows in Architecture: Design – Assembly – Industry*, Birkhäuser (Basel), 2012, p 8.
9. See Richard Garber, 'Alberti's Paradigm', in *AD Closing the Gap: Information Models in Contemporary Design Practice*, March/April (no 2), 2009, p 108.
10. Marble, *op cit*, p 8.
11. See Randal S Newton, 'Bim Workflows are Evolving', *AEC Magazine*, 20 April 2015: http://aecmag.com/59-features/840-bim-workflows-are-evolving.
12. Dominik Holzer, *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering and Construction*, John Wiley & Sons (Chichester), 2001.
13. See www.autodesk.com/solutions/bim/how-to-adopt-bim-workflow-for-civil-projects.