

Future of Project Management



UCL

apm

ARUP

About Arup

Arup is an independent firm of project managers, designers, planners, engineers, consultants and technical specialists offering a broad range of professional services. Through our work, we aim to make a positive difference to different communities. We shape a better world.

Founded in 1946 with an initial focus on structural engineering, Arup first came to the world's attention with the structural design of the Sydney Opera House, followed by its work on the Centre Pompidou in Paris. Arup has since grown into a multi-disciplinary organisation. Its work, such as the National Aquatics Center for the 2008 Olympics in Beijing, has reaffirmed its reputation for delivering innovative and sustainable designs that reinvent the built environment.

Foresight + Research + Innovation is Arup's internal think-tank and consultancy which deals with the future of the built environment and society at large. We serve Arup's global business as well as external clients from a broad range of regions and sectors. We help our organisations understand trends, explore new ideas, and radically rethink the future of their businesses. We developed the concept of 'foresight by design', which uses innovative design tools and techniques to bring new ideas to life and engage clients and stakeholders in meaningful conversations about change.

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Foreword from The Bartlett School of Construction and Project Management



Andrew Edkins

The Bartlett School of Construction and Project Management, part of UCL's Faculty of the Built Environment

The Bartlett School of Construction and Project Management at UCL has been privileged to be part of this collaborative effort to collectively consider what the longer-term future of project management may be.

Scanning the horizon and beyond is always stretching and fraught with mistakes and oversights. Whilst knowing we are not predicting the future, FoPM is a useful exercise to conduct and publish as it will stimulate both further thinking and possible reaction.

Academics add value by being thoughtful. We like to be certain of what we know as that is what makes us authoritative. So speculating about the future, especially the long-term future, is an exercise in going beyond simply extrapolating past and current trends. We only claim to know some of the issues and practices as we at UCL have tended to concentrate on the more strategic topics of project management. This has been our way since at least the 1990s, when our thinking of project management was inspired by the seminal work of Peter Morris. He extended the prevailing view of project management

by proposing a more strategic consideration, which he termed the 'management of projects'. To this we have subsequently blended other similarly thoughtful research, such as that which resulted in the work on 'Complex product Systems' as captured in the book 'The Business of Projects', by Andrew Davies and Mike Hobday.

The academics at the School of Construction and Project Management research many different areas, as is to be expected, but there are common threads. For example, we look at the projects and their lifecycle, but we are also keenly interested in the temporary organisation that delivers projects. We also explore the way project procurement strategies and practices alter action and behaviours. This is most acute in the cases of the many forms of Public Private Partnerships (PPPs). We have been observing and learning as those parties and organisations required to deliver projects grapple with moving from specifications based on the inputs to the project, to those of the outputs of the project, and now to the outcomes of the project. Such changes cascade through project supply chains and networks, creating new issues around risk management

and the economics and finance of both projects and project-based organisations.

From this academic platform and our location in the heart of London, we are, we believe, at the cutting edge of strategic-level project management understanding.

What are the big-ticket items that we see as we scan the horizon? The answer is to be found in the pages that follow this, so no spoilers. Suffice to say that much as project management has changed over its life to date, so it will continue to alter. What will shape its future? The answer is to be found in two areas: the types of project that project management is tasked to deliver; and the context in which project managers will find themselves.

Andrew Edkins



Foreword from APM



John McGlynn
Chairman,
Association for
Project Management

I am delighted that the Association for Project Management is supporting this collaborative thought-leadership project on the Future of Project Management.

This comes at an exciting time for APM, which has just become a chartered body. Indeed, ‘The Chartered body for the Project Profession’ will be the strapline for APM going forward. As part of this new definition of the profession we are also keen to promote and develop new and innovative thinking, as well as challenges to orthodoxy.

But thinking ahead, even if some of our forecasts are wrong or arrive at varying speeds, it is essential to the development of our world and the speed of change impacting economic, demographic, political, social and environmental landscapes, that we try to identify and anticipate the big game-changers for project management.

This project is a great way to involve professionals, academics and other commentators in collaboratively mapping out the future, and we look forward to seeing how the project develops through the year.

John McGlynn



Introduction and Preface



Rob Leslie-Carter
Director, Arup

Future of Project Management is a partnership and collaboration between Arup, The Bartlett School of Construction and Project Management at UCL, and the Association for Project Management, with crowdsourced inputs from the global project management community. It is a compilation of best practice, emerging trends, and forward thinking. We hope it will be a thought-leadership resource for project teams seeking inspiration to find a better way, and an interactive site for debate about change in the project management profession. Most importantly, we want to create a virtuous cycle prompting future research that in turn will provide fresh insight to develop and improve FoPM.

In July 2016 a workshop to prompt ideas about collaboration opportunities quickly evolved into an excited conversation about the future of work, machine learning, MOOCS, millennials, and the influence project managers will have in collectively creating, designing and building that future. Since then the ideas behind FoPM have evolved to produce something that really challenges people's thinking — to jolt the project management profession beyond the

day-to-day focus on current challenges, and to think about the forces shaping our longer-term future more proactively.

FoPM is presented in three sections that set the context for the future through emerging megatrends, then imagine that future through the eyes of clients delivering projects, and finally outline plans and priorities for future action and research.

I want to acknowledge the contributions to FoPM from colleagues, friends and the project management community around the world — a full list of contributors is included — and in particular from the three contributing partners. Individually, each contributor has brought their own unique perspective, and this kind of exercise has never been more relevant as we each seek to make sense of the future in a landscape of rapid and profound change.

Input from the global project management community — some targeted but most generously unprompted — has kept the principles and objectives of FoPM honest and grounded. This will be a resource that must be freely accessible and relevant to all project

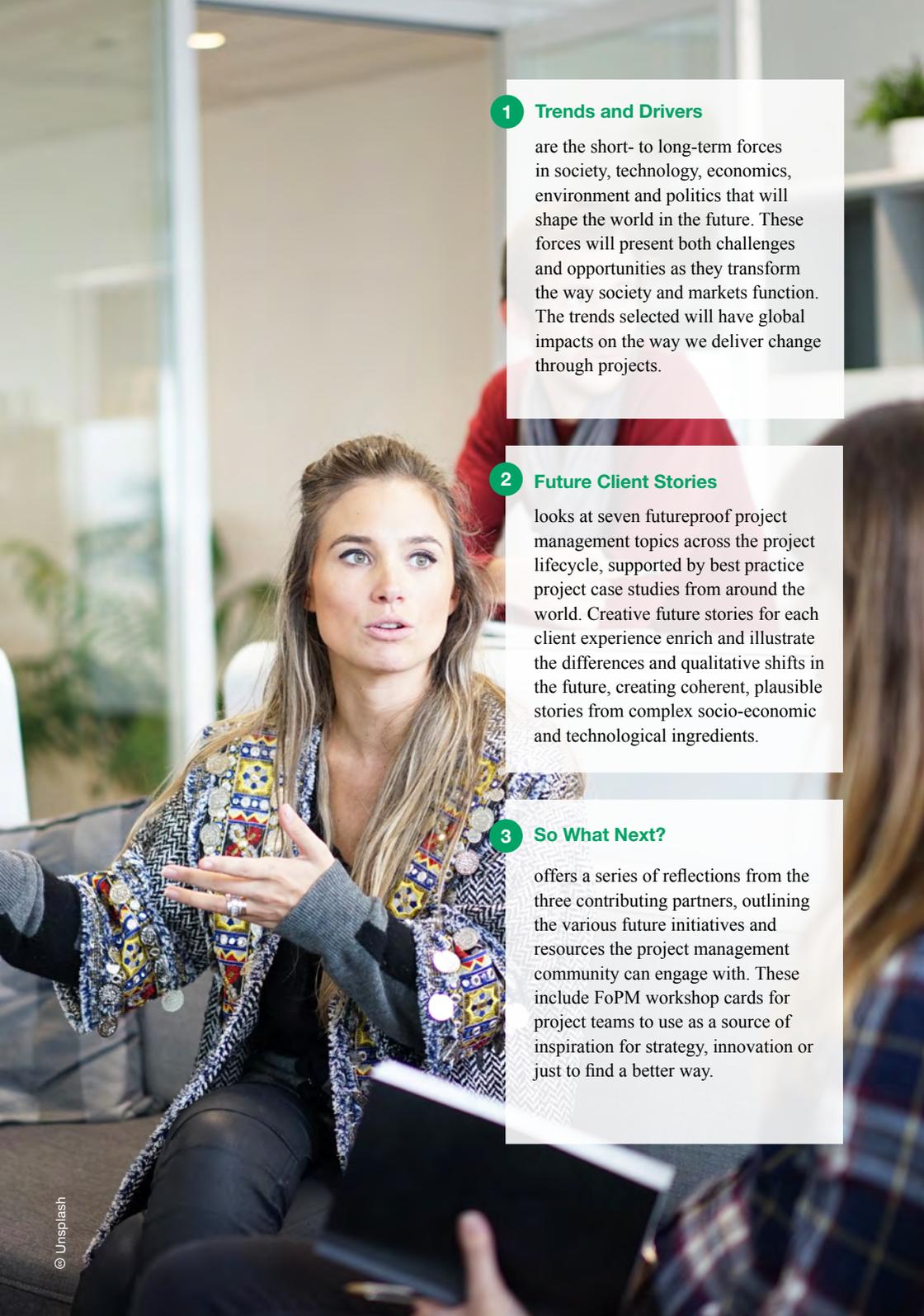
managers. It is designed for use, reuse and continual improvement based on feedback and interventions from the community itself. Its interactive online format at arup.com/FoPM can be explored, making it less communication and more conversation.

Collectively, these diverse mindsets have provided breadth of insight, balance, an endless supply of intellectual and creative fuel, and a common vision to wrestle a seemingly overwhelming topic into a piece of work that we want to make sure really matters.

No exploration of the future of work could ever be definitive, but FoPM is already provoking reflection and debate as part of the process of preparing for the challenges and opportunities ahead. We hope you enjoy exploring FoPM for yourself and look forward to engaging with you!

Rob Leslie-Carter





1 Trends and Drivers

are the short- to long-term forces in society, technology, economics, environment and politics that will shape the world in the future. These forces will present both challenges and opportunities as they transform the way society and markets function. The trends selected will have global impacts on the way we deliver change through projects.

2 Future Client Stories

looks at seven futureproof project management topics across the project lifecycle, supported by best practice project case studies from around the world. Creative future stories for each client experience enrich and illustrate the differences and qualitative shifts in the future, creating coherent, plausible stories from complex socio-economic and technological ingredients.

3 So What Next?

offers a series of reflections from the three contributing partners, outlining the various future initiatives and resources the project management community can engage with. These include FoPM workshop cards for project teams to use as a source of inspiration for strategy, innovation or just to find a better way.

A Project Management Journey to 2040



1990

Arup launches Programme and Project Management business



1995

Prince 2 published by CCTA



2000

The Project Management Body of Knowledge (PMBoK) becomes a standard

Agile Project Management manifesto written



2020

Frugality of resources peaks



2025

Social Responsibility becomes a chapter of the PMBoK



2030

First domestic installations of 1TB/s fibre

Every top-100 firm has a project management professional in at least one C-suite role

Glossing over the Pyramid of Giza, the Great Wall of China and Henry Gantt, modern project management has its roots in the aerospace, construction and defence industries of the 1960s and 1970s. It wasn't until the 1990s when standardised procedures and approaches were formalised and project management as a client-focused, continually improving profession emerged.



2005

Heathrow Terminal 5 opens



2010

The London 2012 Olympics and Paralympics Games



2015

Number of mobile devices and connections surpasses the number of people on the planet

APM become the Chartered body for the project profession



2035

Project management becomes part of the UK National Curriculum



2040

Smart algorithms proven to be better than expert judgement



2045

Virtual telepathy dominates personal communications

Trends and Drivers

The world is changing fast. A wide range of trends and challenges have a direct bearing on the future of project management.

It is vital that we understand these trends, so that we can better manage the risks facing our profession, and make the most of emerging opportunities.

Our economy is increasingly driven by project-based work characterised by high degrees of collaboration. Innovation and creativity are the key components of value creation, while employee expectations and working cultures are changing all the time. We are seeing new forms of working that are enabled by digital technologies, on projects that are both complex and global. Understanding and managing these changes is vital, if we want to continue to provide solutions that truly meet the needs of our clients and stakeholders.

In this section we look at the trends and drivers affecting project management across social, technological and economic domains. We examine their impacts on future work environments, professions and project management approaches.

1 Globalisation and Virtual Teams



2 Open Innovation Culture



3 Diversity of Workforce



4 Gig Economy



5 Changing Corporate Culture



6 Automation and Human-Machine Collaboration



7 Digital Construction and Project Complexity





Globalisation and Virtual Teams

With globalisation, we've seen the development of tools and processes that enable effective collaboration and coordination between teams and employees separated by thousands of miles. Advances in information and communication technologies have made it possible for international businesses to rely more and more on virtual teams, rather than traditional team structures based in one place, to deliver their projects. In 2015, estimates put the number of these 'virtual workers' around the world at 1.3 billion. Looking forward, it's likely that we'll see highly centralised workplace models based on long-term planning replaced by decentralised models of flexible and adaptable innovation hubs.

Virtual teams offer the advantage of access to a more diverse workforce. It's relatively easy to set up a team of global specialists based on a project's requirements. Such teams are usually only temporary, based on shared goals, working across regional borders and time zones. Communication happens through digital technologies and often relies on virtual rooms to manage projects. And advances in mobile technologies mean individuals and teams are now able to work from anywhere at any time — all they need is a connection to a network.

But the shift towards virtual teamworking also brings challenges to the management of projects. Those running projects need new skills in communication and team management. The challenge might lie less

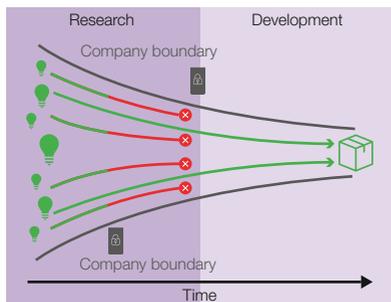
“Technological, socioeconomic and demographic shifts are transforming the way we work, demanding flexibility in the way individuals, teams and organisations work.”¹

—Lisa Annese, *The Guardian* (2016)¹

in finding the right employees and more in finding managers with the necessary skills to manage a virtual workforce.

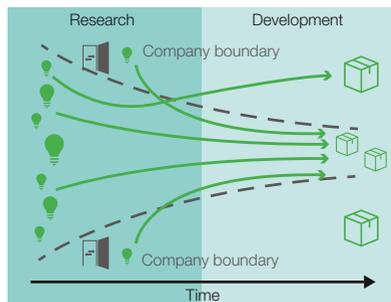
What's also likely is that on-demand, always-available working will reshape our understanding of career development and project development, disrupting traditional restrictions of location, length and flexibility of contracts. In the future, we'll see new human-machine interfaces enable the development of virtual, network-based companies and value chains.^{2,3}

Closed Innovation Concept



Source: GE Global Research⁴

Open Innovation Concept



VS



Open Innovation Culture

Across industry, we can see a shift from closed to open innovation models that are potentially more productive both in terms of innovation and value creation.

On one hand, there are more and more companies tapping into the public's intellectual capital by crowd-sourcing product ideas and solutions. In exchange, they are giving creative consumers a direct say in, and rewarding them for, what gets developed, designed and manufactured.

On the other hand, collaborative practices are becoming more commonplace within industries. There's a greater readiness to cooperate and collaborate with other organisations to produce and deliver services. 'Coopetition' occurs when companies forge alliances across traditional boundaries in order to share common costs. The auto

industry has used coopetition to a great effect: Peugeot, Toyota and Citroen created shared components for a new city car, which was then marketed under different names.

Another example is Procter & Gamble, whose 'Connect + Develop' open innovation programme yielded more than half of its innovations in 2010. Ten years earlier, only 10% of their innovations were sourced externally. This shift could give rise to new business ecosystems with companies being defined more by their ability to connect remotely to valuable skills and resources than by the skills and resources they hold in-house. Around 40% of CEOs globally expect that the majority of their innovations will be developed with external partners in the future.

In contrast to the traditional innovation stream, an almost entirely in-house affair, open innovation processes use external, complementary knowledge to generate products and ideas. Modern communications have made it easy to share and exchange knowledge and ideas and to collaborate

across traditional boundaries, enabling businesses to get ideas to the market faster.

In the professional services space, open innovation culture will probably lead to changing relationships between client and supplier. Suppliers might operate more as laboratories, where data and new forms of cooperation are drawn on as projects require. This kind of collaborative partnership will enable shared strategy building, more open innovation and a shift away from traditional client definitions.^{5,6,7}



Diversity of Workforce

Organisations today are able to access a hugely diverse workforce. New technologies, global connectivity and shifting demographics are all helping to make people of all ages, skills and cultures available, wherever they are. For talented and educated individuals in particular, globalisation and regional skills shortages could lead to a market that offers a much wider choice of location and employer.

Older workers are retiring later, leaving organisations with a wider-than-ever range of ages to manage. In 2013, the dependency ratio (the ratio of people aged 65 and above to the population of traditional working age, 15–64) was 28% in Europe; it's expected to rise to 50% by 2060. In terms of Europe's labour force, the largest increase is expected in the 55–64 age group.

At the same time, a new set of employees will bring a very different kind of change to

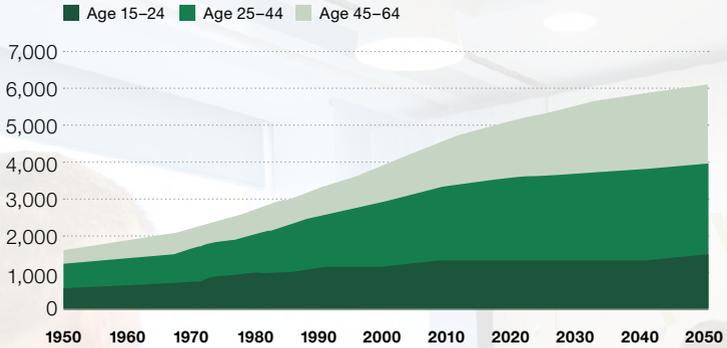
the workplace. By 2020, half of the global workforce will be made up of Generation Y-ers; those who have been brought up in the digital age. Multi-generational workplaces will become the norm, and companies will need to rethink the way different generations work together.

There will be a need for more flexible working arrangements, too. Changing family patterns, a greater sharing of responsibilities between men and women, and a growing number of single parents will lead to more part-time opportunities and flexible child-care arrangements. Projections suggest that women will make up two thirds of the net growth in higher-skilled jobs until 2025.

The interaction of these shifts brings fresh challenges. For workplaces to remain attractive to all age groups, they'll need to develop a culture of mutual respect and potentially flatter hierarchies. Contrasting educational standards and lack of cultural knowledge in the workforce could demand new skill sets of future managers. Organisations will need to find and establish effective flexible structures for people to work together, despite their difference in age, culture, tech-savviness and expectations.

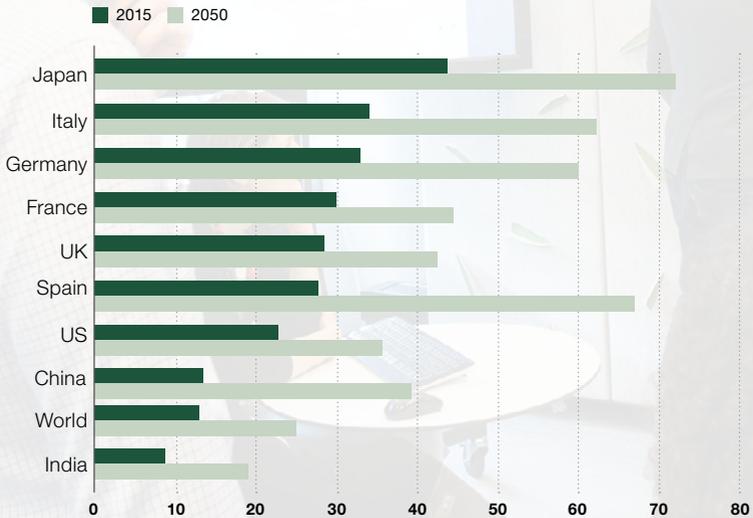
It's not just within physical spaces that this increasing diversity of personalities and cultures will influence organisations. It will become a factor in the virtual networking arena, too, where teams collaborate and communicate across national and time borders.^{9,10,11,12}

Shifts in distribution of global workforce population by age group (Number of people in millions)



Old-age dependency ratio (%)

(Number of people aged 65+ as % of labour force (15-64), forecast)



Source: UN Population Division





Gig Economy

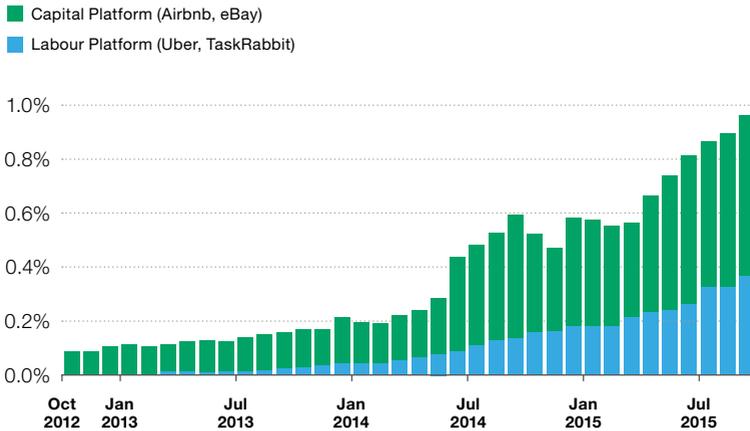
We've heard a lot about the 'gig economy' in the media, but what exactly is it? The gig economy (aka platform capitalism, on-demand economy) refers to web-enabled marketplaces that connect businesses and other organisations to freelancers, independent consultants and service providers. Platform capitalism can be seen as an extension of the freelance economy and the sharing economy. We all know about Airbnb, where under-utilised accommodation is rented out, and Uber, where the skills of drivers for hire are made available. These new online platforms act as intermediaries, allowing millions of individuals with expertise and specific skillsets to access a fast-growing global marketplace.

The sudden boom of the gig economy is the result of pairing an available workforce with digital technology. Established sharing economy principles have been extended to the sharing of talent, expertise and creativity, potentially disrupting the professional and business service sector. As more and more workers in the knowledge economy are providing their skills on a freelance basis, employers no longer need to 'own' a wide range of skills. In the United States, for example, it is estimated that as much as a third of the total workforce can be classified as freelance (i.e. independent workers, contractors and temporary workers). According to Forbes, half the US workforce will be freelance by as soon as 2020. In Europe, the number of

freelancers grew by 45% in 2013 to almost nine million, making it the fastest-growing segment within the EU labour market. The market for freelance workers is thriving. According to a report by Elance, the freelance job site, 2013 saw a 46% rise in the number of businesses hiring freelancers online. In its analysis of Generation Y and the Giggling Economy, freelancing is now seen as a highly attractive and lucrative career option by 87% of students with first or second-class degrees.

“To the optimists, it promises a future of empowered entrepreneurs and boundless innovation. To the naysayers, it portends a dystopian future of disenfranchised workers hunting for their next wedge of piecework.”¹³

—Arun Sundararajan, *The Guardian* (2015)



Gig Growth Share of U.S. adults earning income in a given month via online platforms, often referred to as the gig or sharing economy (Source: JPMorgan Chase Institute)¹⁴

Not surprisingly, we're seeing a new generation of agencies spring up, bridging the supply of freelancers and global demand. Upwork, for example, is a platform that connects businesses with over nine million registered freelancers, professionals and consultants from a range of disciplines: law, accounting and consulting, engineering and architecture. Would-be employers can search for available freelancers, and access a secure online workspace that allows multiple parties to work together in collaboration. According to the website, three million jobs were posted on Upwork last year, representing a total of \$1bn in fees.

The management consulting firm Eden McCallum 'employs' all of their 500 or so senior level consultants on a freelance basis. Overheads and other fixed costs are kept to a minimum, allowing the firm to offer the services of experienced, senior consultants at more affordable prices than their competitors.

What the shift towards digital labour platforms means is that employers have access to skills on an ad hoc basis and need fewer staff on their payroll. Routine, repetitive and commoditised tasks can be packaged and outsourced easily. Freelancers, meanwhile, can carry out specific, finite tasks and projects repeatedly for many clients, sharpening their specialist skills and quality of service. Personal reputation will become vital in promoting value in the future.

On the flip side, the gig economy poses challenges in terms of job security, staff loyalty and approaches to training and professional development. And there may be a need for new forms of employment contracts, to provide freelancers with appropriate benefits and protection.^{15,16,17,18,19}



Changing Corporate Culture

Today, fewer people are identifying with the standard way of working — full-time and full availability. Especially with more and more millennials entering the workplace, traditional relationships and corporate cultures are changing, or have to change. For example, leadership styles need to adapt, to offer flatter hierarchies and more flexible working arrangements.

Beyond flexibility, reputation in terms of culture is becoming increasingly important for companies, especially when it comes to employee retention. Employees are looking more and more into corporate statements about values, culture and social responsibility. Talent Board, a US non-profit that promotes job candidate experience, found that 41% of applicants would look into a company's culture before applying. Corporate social responsibility (CSR) is increasingly becoming a differentiator: 88% of millennials choose an employer based on strong CSR values. CSR can also influence overall corporate reputation by 40%. And there's a correlation between employee engagement and strong CSR or sustainability programmes. Employers with strong principles can achieve a 55% better working atmosphere, a 43% more efficient workflow and 38% better employee loyalty compared to companies with weak CSR principles.

This means that employers need to look beyond standard measures such as salary packages to make their workplaces attractive,

and focus on emerging expectations such as employer responsibility and work-life balance. Boundaries between work and private life are becoming more fluid and a decoupling of place and time emerges, bringing with it opportunities and challenges.

In terms of the physical workplace, this means adjusting to a more creative work and learning environment. Fixed workplaces are giving way to spaces tailored to specific activities such as interactivity, creative working, meetings and concentration areas. A new generation of technology-adept employees expect workplaces with very high quality technical equipment. And for employers, what matters is that employees are more responsible for performance as opposed to following fixed rules, times and locations.^{20,21,22,23,24,25}



Automation and Human-Machine Collaboration

Driven by rapid advances in digital technologies, the nature of work is being transformed. While artificial intelligence (AI) and robotics grow more sophisticated, jobs are being reinvented. Collaboration and communication through increasingly intuitive user interfaces could lead to fundamental changes in workplace structures and may offer new possibilities for productivity and creativity in the workforce. Human-machine collaboration will open the way to virtual and network-based companies and value streams.

“Robots and cognitive technologies are making steady advances, particularly in jobs and tasks that follow set, standardised rules and logic.”²⁶

—Deloitte, Global Human Capital Trends (2017)

Organisations are already reconsidering the shape and composition of their workforce. According to Deloitte, 41% of surveyed companies have already implemented aspects of cognitive or AI technologies in their workforce, while 37% are carrying out pilot programmes. Only 17% of surveyed executives, though, stated a readiness to manage a collaborative workforce of people, robots and AI.

The area with the greatest scope for change is manufacturing, in the automation of repetitive tasks. In Germany, for example, it is estimated that up to 80% of jobs for people with low-level education are at risk from automation, compared to only 18% for people with a doctorate degree. It’s a similar story when we look at income levels: in the lowest 10% income group, 61% of

jobs are projected to be at risk, while only 20% are under threat at the upper end.

As companies redesign jobs and workforces, questions arise around the eventual limits of automation. Could essential human skills, such as empathy, communication, persuasion, personal service, problem-solving, and strategic decision-making become even more valuable?

In moving towards greater automation, companies will have to rethink the role of people and provide training to prepare their employees for this new work environment. At Ford’s Cologne plant, robots and people are working side-by-side, complementing each other’s skills (simple and heavy vs creative). Businesses might soon start dividing skills and reframing jobs according to, on one hand, essential human skills and, on the other, nonessential tasks that could be carried out by machines.^{27,28,29}

Figure 1. Robotics, cognitive computing and AI: percentage respondents rating this of trend “important” or “very important”

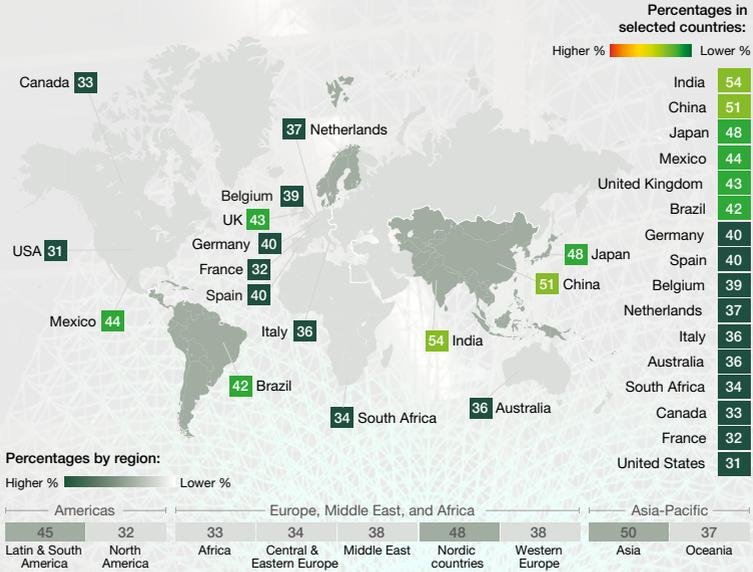
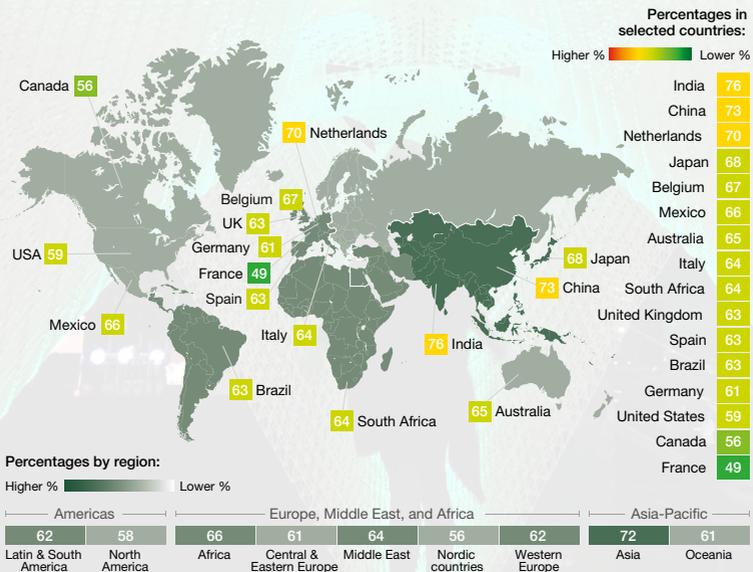


Figure 2. Augmented workforce: percentage of respondents rating this trend “important” or “very important”



(Source: Deloitte University Press)³⁰



Digital construction and project complexity

In construction, where projects are continually growing in scale and complexity, digital technologies offer huge potential for improving productivity. It is estimated that the typical large project across all asset types overruns its schedule by an average of 20% and exceeds its budget by 80%. The application of digital technologies has been shown to reduce cost and schedule overruns by at least 10-15%, and by even more on complex projects.

While digital technologies can make organisations more efficient and provide tools for better managing change and uncertainties, the challenge remains of developing teams that hold the necessary digital skills.

Overall, construction is seen as lagging behind other industries in the adoption of new digital technologies. The industry's

spending on R&D of under 1% of turnover lies way behind other industries such as automotive (3.5%) and aerospace (4.5%). Its investment in information technology is also below the 1% figure.

The benefits of digitised workflows can be observed widely. On a US tunnelling project, for example, the development of a single digital platform for the stages from bidding to contract management led to time savings of 75% for the production of reports and 90% for document transmittals. Similarly, the use of automated workflows for reviews and approvals on a \$5bn US rail project increased productivity and saved over \$110m.

The deployment of sensors and advanced analytics in construction projects offers further opportunities to improve efficiency and time and risk management.^{31,32,33,34}



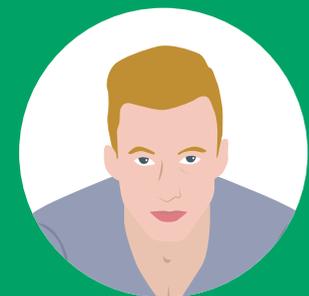
Meet the Future Project Managers



It's 2040. Small is beautiful. Collaboration networks of individuals and groups of specialists dominate the global economy, connected as never before through technologies and social media on which the world now depends.



Project management has become known as 'the last profession'. In a world where increasingly capable systems have gradually replaced professionals across the world, project managers still provide an irreplaceably human combination of leadership, integration of specialists, and ethical behaviour.





Francesca Saxby

DOB: 24 October 1970

Age: 69

Title: Ms

Specialism: Human-Based Creative Interfaces Project Manager

Role Summary: An elite problem-solving professional, specialising in project tasks that cannot or ethically should not be automated

Traits: Emotional intelligence; adaptive communicator; management skills; intuitive; hard working; strong



José do Nascimento

DOB: 09 February 2008

Age: 32

Title: Mx

Specialism: Sensors and Analytics Installation Project Manager

Role Summary: Integrator of technologies into residential and collaboration buildings, with enhanced installation, diagnostic and repair skills

Traits: Results orientation, customer focus; flexibility; enthusiastic innovator; kind; calm; loyal; intelligent



Manjinder Devi

DOB: 07 November 2012

Age: 27

Specialism: Meta-Data Accountability
Project Manager

Role Summary: An audit and verification professional, checking machine algorithms have been applied properly

Traits: Analytical skills; strategic perspective; key trend communicator; quick learner; confident; excitable



Fred Joveski

DOB: 09 December 2002

Age: 38

Title: Mr

Specialism: Design+Digital+Business
Process Project Manager

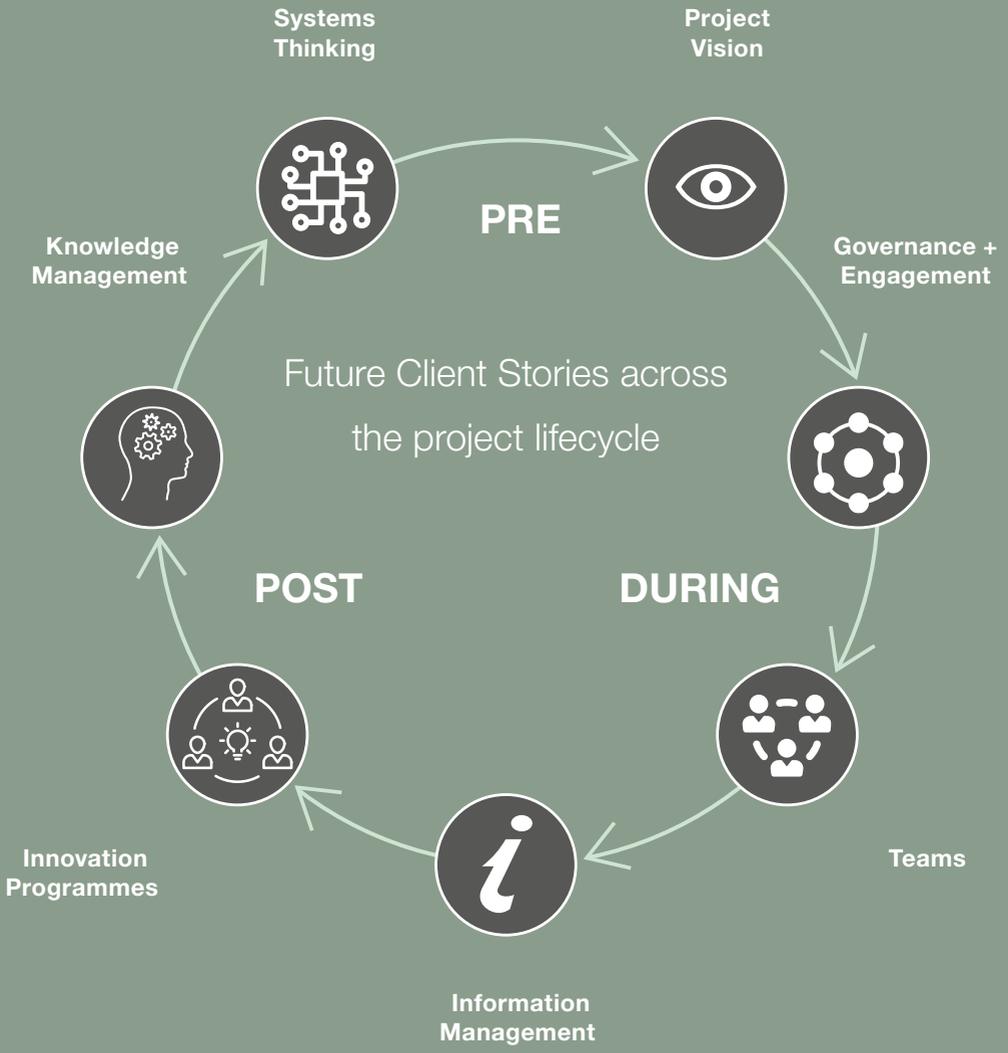
Role Summary: A creative professional, unlocking potential and improving the efficiency of water providers - the planet's only scarce resource

Traits: Character; people skills; business savvy; problem solver; loyal; forgiving; shy; emotional

Future Client Stories

Even in a future where professionals across the world have been gradually replaced by increasingly capable systems, core elements of project management will still provide an irreplaceably human combination of leadership, integration of specialists, and ethical behaviour.

These Future Client Stories look at seven ‘future proof’ project management themes across the project lifecycle, supported by best practice project case studies from around the world. These creative future stories are designed to enrich and illustrate the differences and qualitative shifts we expect to see in the future. Each one creates a coherent, plausible future scenario from the complex socio-economic and technological ingredients that make up every project.





Nuno Tavares | 39 Project Sponsor



Much of the credit for Mexico's recent period of sustained growth and national collectivism must go to Nuno Tavares. As leader of the country's National Energy Transition Programme (NETP), Tavares devised the blueprint for an independently sustainable and resilient energy sector, and the vision for getting there.

A graduate in Sustainable Energy Futures from Monterrey Institute of Technology in 2022, he quickly made a name as a project manager and technical authority in the field, delivering a series of eye-catching infrastructure projects supporting solar, wind, tidal power, and geothermal energy in Mexico and North America. Today, he's one of his country's most influential and popular figures, not just in energy but nationally.

In the 2020s, the large-scale job losses felt globally as professional work was automated hit Mexico especially hard.

Tavares experienced the social costs firsthand: his own father, an accountant for 30 years, found his expertise and judgement replicated and surpassed by smart algorithms. As the redundancies rose and pressure on the government intensified, Tavares, an accomplished project manager, looked for a new opening, a part to play in the rebuilding. It came in the invitation to lead the NETP.

He faced the challenge of growing Mexico's renationalised solar energy business, sharply aware that every taxpayer's peso had to be justified against the growing demand for state aid, cyber security, and housing. He didn't hold back, though. Despite his original mandate, he outlined a far broader vision for a long-term programme to make the country Resilient, Agile, Independently Sustainable, and Empowered through sustainable energy. His RAISE Mexico vision captured the imagination of a nation that has enjoyed a proud sense of community and environmentalism since becoming the first to ban all offshore and onshore drilling, following the 2010 Gulf of Mexico oil spill. But Tavares knew it was going to be a long, tough road, and that RAISE Mexico would need to stand the test of time.

He also knew that people wanted some flesh on the bones. At the foundation of the programme Tavares put educational re-skilling, focused on growing the creative skillsets that would be needed alongside the growing capabilities and efficiencies of artificial intelligence. Priority investments would be made in material science technologies, and project management became part of the secondary school national curriculum.

In the past, high import taxes had held back Mexico's good intentions. Tavares' plan for local manufacturing hubs for solar panels not only made them considerably cheaper than imports, it swiftly led to Mexico leading the world in solar nano materials. Jobs quickly grew in manufacturing, production, assembly, maintenance work, research and project integration throughout the supply chain required to relay clean energy to the public. By 2030, renewable energy made up 90% of the total energy used in Mexico, and Tavares has been determined to transition to 100% by 2040 — the pledge at the heart of his NETP vision that has remained a source of national pride.

The up-skilling programme has fed a wave of entrepreneurialism and small-scale business formation in areas such as wearable technologies. Its benefits have been tracked widely by the Mexican public, with commuters monitoring air pollution through their bags, and swimmers recording the ever-improving water quality through their costumes and goggles. This real-time transparency and ownership has driven a virtuous cycle in which individual and local behaviours have fostered the right collective and corporate policies.

Step by step, Tavares has built up a team of the country's most promising project managers, trusting and empowering them to execute his vision and build resilience for longer-term leadership succession. He's been far from the traditional disconnected project sponsor who secures project funds and then hopes to come in for the victory lap when it is all over — the kind that has affected virtually every mega-project on earth. Tavares has been a fully engaged executive sponsor, with a vested personal interest — along with the rest of Mexico — in the programme from kick-off to close. Having put in place a powerful vision for a better future for the people, his mandate for change has held firm, despite unrelenting economic and political pressure.



The binding thread in the success of the Beijing National Aquatic Centre was a crystal clear 'hill-to-hill' vision that wove itself into every aspect of project life. At the heart of this vision was the simple poetry of the Water Cube — a building full of water in the form of a 'box of bubbles'.

The vision had multiple benefits. Initially, it provided the design team with clarity and autonomy, empowering different work streams to progress in parallel, trusting that they would converge in synch to achieve a high-quality, integrated outcome in a very short period of time. It was also invaluable in discussions with external stakeholders and local approval authorities, who were able to buy into the overall vision and contribute to achieving it.

For example, at one point during the design process the price of glass in China fell significantly. Our project management team reacted immediately by submitting an option paper comparing the relative costs and benefits

of an ETFE 'bubble' roof and a glass alternative. The response from the Beijing Municipal Government was definitive: 'The Mayor has approved a box of bubbles, so we will have an ETFE bubble roof!'

Almost unique to this building is the correlation between the model produced for the international design competition in just three weeks, and the actual Water Cube when it opened five years later. The perfect alignment of vision and reality offers a powerful lesson in the value of capturing and communicating a clear direction at the start of the project.



In 2007, Zoos South Australia committed to its biggest redevelopment since its original opening in 1883. The main impetus for this came from the ten-year loan of a pair of giant pandas from the People's Republic of China (PRC). Sustainability and innovation formed the twin focus for the redevelopment.

In the creation of a new Giant Panda Forest, Zoos SA's core vision came to the fore: 'We exist to save animals from extinction.'

To develop the project vision, Arup led workshops to establish rapidly a positive culture and ensure an environment to deliver success, with all involved understanding the project, its objectives, and their role or roles within the project. These workshops were enormously valuable, providing clear direction and illumination on many levels.

Sets of team values and behaviours were also developed to be incorporated into the PEOPLE (Perimeter, Entrance, Orientation, Pandas,

Learning, Exit) project. Seventeen core values, for all project team members to apply throughout the building delivery and in their personal interactions, were identified and agreed, as well as a further set of 12 core personal behaviours.

This team charter won the buy-in from the entire team, including the contractor, who was inducted via another facilitated workshop that utilised the concept of 'a day in the life' of team members to stimulate discussion and participation. Arup's approach helped ensure that the project vision remained a focus for all throughout delivery of this complex project.

Attendance at the zoo rose dramatically following the project and the recruitment rate of Zoos SA membership saw a six-fold increase, delivering a solid platform for Zoos SA to continue pursuing its core mission of conservation, education, research and environment.



Jan Khosla | 32
Project Champion



Few projects have stirred public opinion and feeling more in recent years than the conversion of Buckingham Palace — the former London home of the British royal family — into the Community Institute of Digital Culture.

And few have harnessed that opinion and feeling to such powerful effect. At the centre of the CIDC's ground-breaking engagement campaign has been Jan Khosla, artist, entrepreneur and pioneer of full-immersion virtual reality — merging the human brain with computer intelligence — and now one of the UK's most recognisable faces.

Born and raised in the capital, Khosla has always wanted to give something back to his hometown. But the creation of the CIDC represents much more than that; it's his dream project. The youngest of a proud family of artists, Khosla has been alarmed to witness the loss of status of arts and culture in everyday British life. He believes passionately in the need to give young and

old equal access to a rich cultural education and the opportunity to live a creative life. Having consistently lobbied government to criticise what he calls 'the slow death of Britain's cultural ecosystem' he was handed the chance to take matters into his own hands.

The idea of renovating Buckingham Palace predictably provoked the full range of public opinion and lit up social media, despite the building having stood empty for nearly five years. The reuse of such a high-profile and emotionally charged public asset meant immediate public accountability. As soon as he was appointed, Khosla identified the almost unprecedented level of stakeholder consultation and engagement required as a major potential benefit. There was widespread scepticism about what a 'celebrity' could bring to a major project, but Khosla has never intended to emulate his predecessors. The best, most inclusive outcomes, he believes, are always the result of open communication and a diverse set of views and perspectives, especially when this invites creative tension.

Once upon a time, progressing a project even of this significance would have been a reasonably straightforward combination of political support and planning process. But that was before the age of engagement

professionals and social media. Today, even though decision-makers in local and national government have the benefit of emotion filters to spot genuine trends and messages in their feeds, the rules of public engagement demand a completely honest, open and transparent conversation with no preconceived ending. This was just the way Khosla wanted it. At the outset, he grasped the potential for the repurposing of the palace to become ‘the people’s project’ — but only when the people themselves had decided what they really needed and wanted to invest in. There were gateways Khosla knew the project had to go through, and he did his homework, particularly in the long-undervalued area of ‘governance of change’, the fastest-growing topic of business e-books and digital learning platforms — second only in demand to project management.

The business case and options analysis for what became the CIDC avoided the narrow historic perspectives of project time, cost and quality. Instead they focused on lifetime investment, social contribution and value for money. Khosla deployed free online full immersion virtual reality to allow the community to fully explore, understand, and make their own minds up about the early options and proposals. All senses

were utilised — sight, touch, hearing and smell — to make the virtual, actual. All of the users’ feelings — joy, fear, anticipation, trust — were automatically collected and fed back into the governance process.

Khosla has insisted that every decision — warts and all — be subject to a public debate and vote. Every aspect of the project has been democratically chosen: final proposals, location, design, team members, key features and costs. The ‘gamification’ of the design and planning consultation process, which grabbed headlines last year, has been an overwhelming success in encouraging broader positive engagement, collaboration and community consensus. For six months running, ‘Shape Your World’ was the most downloaded app in the UK as ‘players’ competed against friends and family to find the perfect and most popular balance between the sometimes conflicting demands of design, materials, budgets, construction impact, community benefits and long-term social and economic growth.



Case study

The Government Wireless Network

© Queensland Government

The Government Wireless Network will provide an integrated and secure radio communications network for Queensland's public safety agencies. The governance of the GWN programme is exemplary because of the important principle it broke, rather than the principles with which it abided.

One of the core principles of effective programme and project governance is that the business should own the project. They, after all, are making the investment to achieve an outcome and benefits. It follows that a senior executive from the business should be the nominated 'senior responsible owner' (SRO).

In the case of the GWN, though, each of the public safety agencies had their own particular needs. The GWN solution had to meet individual needs as well as joint needs if it was to ensure the agencies could work together and collaborate. The concern was that should the SRO be drawn from the largest agency, the others may have felt disempowered and their particular needs not

fully addressed since the SRO might be inclined to focus on the particular needs of their home agency.

It was decided that the government's ICT delivery agency should own the project and be accountable for its success. The vital principle of business ownership wasn't ignored — it was assessed and a conscious decision made that it was not in the best interests of the programme to follow it.

The CEOs of each agency were fully involved on the project board, ensuring stakeholder management started at the very top. The business case not only justified the investment but provided an effective governance tool, against which any changes to benefits, scope and value could be evaluated.



Case study

Visual and acoustic simulations, High Speed 2, UK

The comprehensive range of visualisation materials delivered by Arup for HS2, the UK's planned high-speed railway, has helped to communicate complex data as part of the route option studies, consultation process, and eventually the hybrid bill presented to the government. The work has de-risked and enabled major decision-making throughout the approvals process, in select committee, in the Houses of Commons and Lords. Our approach has set new standards in communicating major infrastructure proposals.

A three-dimensional, route-wide model was created for the production of the visualisations. Photomontages from along the route could be viewed easily on a map-based interactive portal and, using an intuitive interface, cycled through different stages of construction and operation, and different years and seasons, to allow the route's impact to be assessed.

The team also developed Arup SoundLab and SoundLab lite (for community consultation road

shows), which the client was able to use to show audiences HS2's actual acoustic impact when complete, using simulations of trains passing key points on the route. The team was able to consolidate both the visual and acoustic impact into a single, tangible experience. Giving stakeholders and cabinet ministers the means to easily envisage the visual and acoustic impact of proposed features along the HS2 route significantly helped to accelerate the parliamentary process.

Our environmental simulation approach to visualisation allows design proposals to be experienced within their existing context, in order that they can be discussed, iterated and improved. This approach creates the best outcomes for projects, people and places.



Rita Silvano | 40
Project Convener and Creativity
Support Manager



Rita Silvano is a creativity and relationship enabler or, in her words, ‘a mixture of magician, raconteur, holder of space and curator of ideas to action’. She uses her understanding of personality difference and empathic communication to build teams of diverse skills that are able to engage in deep dialogue and generate breakthrough solutions to everyday problems.

Currently working on a multi-partner, multi-school construction project in Cape Town as part of a major inner city rejuvenation programme, she wakes up every day wondering how she will bring people together to collaboratively ‘build generative physical and psychological spaces for life’.

‘On my work-seeking profile I have a non-negotiable condition that I can cycle to my place of work in under half an hour. And it

took me just 15 minutes to cycle to the site today. The consultancy I work through has honed the art of matching people to jobs that fit their values and contributions profile.

‘For this role, they were looking for a project manager who was, day to day, really a creativity and relationship enabler. That fitted me perfectly. In my professional training, I was one of a pioneering cohort of “passioneers”, studying drama and psychology as well as traditional engineering disciplines. Skillsets like mine have become more and more sought-after as elements such as project controls and deliverables tracking, have been automated.

‘My day starts with a HoloFX+ meeting with suppliers working out of Rio, Johannesburg and London, where we can use holographic projections and virtual interactive touch technology to discuss design and build issues.

‘The team mostly work from their different home bases, around the world. At the start of the project, I made sure that members they came together for a month in a co-located office on-site. I wanted the technical discipline leads to gain a deep feeling for the neighbourhoods where the schools are being built, so they went to talk directly with

local people, sometimes staying overnight in their homesteads, or shadowing them through the day. We spent a lot of time collectively debriefing their insights in guided exercises, using embodied exercises and dramatic recreation, so that we could internalise the needs and moods of the areas they will be designing and building for.

‘It was quite a challenge, bringing this supply chain together: a global engineering firm, a loose collective of gig-working natural building specialists and the larger delivery team, mainly sourced from the local area and many of whom had very little experience in this type of work.

‘It’s been a real pleasure watching the interaction between the “elder statesmen”, working mostly from their studies at home, and the younger generation. We made sure they all received training in the first few months on how to hold virtual meetings, tap into the tone of a conversation and listen beyond facts. When human met human, the generational distance disappeared.

‘The contribution across all generations has been crucial to this work, as has the concept of learning on-the-job. The schools we’re designing and building are mixed-

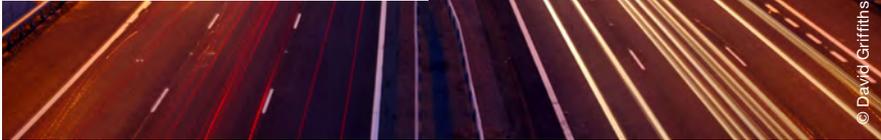
use, so alongside high school facilities we have recreation activities for the elderly and adult re-education facilities, too.

‘Formal institutionalised professional training is a thing of the past. Many of the younger people on the project, and especially those new to the design-and-build world, have formed self-organised and managed study hubs. They tune into live open online course sessions, and learn through experimentation and practice on-the-job, guided by our “elder statesmen”. Their organisations treat this time as formal training time, and make allowance for it in the working day — they give it the same recognition as old-fashioned university training.

‘I’m getting an alert: I’ve got a sensing journey, then a stakeholder debrief and an ideas harvesting session. Got to go!’

Case study

Highways England Smart Motorways Programme



Highways England (formerly the Highways Agency) introduced the Collaborative Delivery Framework (CDF) in 2014. At the time, it was the largest ever framework for the improvement of England's motorways and major A-roads. The intention behind it was to bring Highways England, designers and contractors together into one large, collaborative team.

The Smart Motorways Programme is an example of work awarded under the framework. The CDF design and reporting metrics require suppliers, many of them joint ventures, to not only demonstrate tangible evidence of collaboration within their joint ventures and with the client, but also with their extended supply chain and across projects and even schemes.

The Smart Motorways Programme has seen many new CDF initiatives gain traction, including peer-to-peer working groups with traditional competitors across the scheme, behavioural inductions and charters, ongoing collaboration behaviours maturity measurement, and people

development as part of programme and project delivery. The programme has also encouraged accessible communication for behavioural development and knowledge-sharing activities. This included using Yammer®, ProjectWise®, team events, co-location and videoconferencing to include staff working remotely or part-time.

The new methods have led to a dramatic increase in proactive, open and honest sharing of lessons learnt, ideas, information and knowledge between projects and team members. By improving relationships and collaboration between teams, potential bottlenecks have been proactively identified, and the pooling of knowledge and insight has led to issues and opportunities being managed more efficiently.



Case study

Mumbai Airport Terminal 2

Designed to handle 40 million passengers a year and thrill each one of them with its breathtaking design, the new Terminal 2 (T2) at Mumbai's GVK Chhatrapati Shivaji International Airport (CSIA) is a cornerstone of India's airport revolution and vital to the further growth of its largest city. The nightmare was that it would open late or in disarray, and cause red faces for both CSIA and the city.

On 12th February 2014, T2 opened as planned, with no suspension of operations or flights. Forty airlines transferred their operations from the old terminal, not over a period of weeks or months, but in a matter of hours.

This unique achievement was engineered by an experienced operational readiness activation and transition (ORAT) team from Arup, coordinating more than 100 stakeholders in the training of 2,000 key staff and the familiarisation of 14,500 terminal employees, as well as 96 proving trials of systems and processes, involving several thousand volunteers.

Learnings from successful and unsuccessful terminal openings of the past led to key strategies that included a flexible 'soft date' opening and the phased migration of all stakeholders' offices, equipment, people and systems in advance of the opening day.

T2 officially opened with service and flight schedules undisturbed. Press attention was focused entirely on the achievement of the terminal's construction, its breathtaking architecture and the realisation of GVK's dream to celebrate the ambition, creativity and resilience of Mumbai.



Hinata Nakamura | 35
Digital Buildings Manager



Hinata Nakamura commands a sizable property empire: ten office buildings, four shopping malls, a couple of mixed-use developments in Kyoto, and the majority of the training complexes used by clubs in the J-League. Yet it all fits comfortably into the home office in her Tokyo apartment. In fact, she regularly picks it up and carries it around the city with her.

‘A decade or so ago, I was what was known as a BIM specialist — now I’m a freelance “digital buildings manager”. Which means I supervise the construction and management of my clients’ buildings in a purely virtual environment.

‘This morning I’m helping the owner of a brand new office complex look into the future. I load the digital model of the completed building with all of the relevant

asset management information from my client, and I’m able to show him how the building will age, a year per minute. I feed in climatic trends, likely earthquake frequencies, different usage patterns and energy profiles, and build a picture of likely lifetime costs, risks and opportunities, so he can plan and invest wisely.

‘Not everything in my “empire” is built yet, though. In fact, most of it isn’t. I’m often asked to run scenarios and cost profiles of different build sequences for clients and contractors, which helps them make informed decisions about how to proceed. Only yesterday, I took a gym complex from detailed design right through to operational use in the same time it took to field a video call from my mother.

‘Sometimes the brief is more creative. More and more I’m being asked to work with wider economic trend data to find the optimum mix of human and robot labour for a development — balancing a build cost against the economic benefits for the area in which it’s being built. It’s very satisfying to know my efforts are helping to maintain a reasonable level of prosperity for my compatriots.

‘When I entered the profession, the industry was just taking its first faltering steps toward federated models and BIM. When I look back, it’s amazing to think how far things have come. For a while it seemed as if the old problems of storage and transmission would stop this kind of alchemic transformation of data into wisdom from ever being possible. But it is, and what it means is that I can have a flourishing career in construction without ever interacting with a physical building!

‘That doesn’t mean I can stand still and simply rely on my assets as a professional, the code I use and the analytical algorithms contained in it. To remain competitive, you have to innovate and invest wisely in the market for raw data — which is as big now as the market for steel and more traditional building components.

‘For every minute I spend utilising my models I spend two refining them, tweaking them to make them more accurate and provide a more valuable service to my clients.

‘It’s a lot of work maintaining the models. But they help me unwind sometimes, too. My friends will tell you, I’m a huge Grampus 8 fan. And you can have lots of fun subjecting Jubilo Iwata’s stadium to earthquakes and freak weather events...’



Case study

Programme Delivery Dashboard, Croydon

The regeneration programme that London Borough of Croydon is embarking on promises nothing less than a completely new town centre. Over a period of just five years, more than 160 construction projects will transform Croydon as a place to live, learn, work and visit, delivering 3000 new homes, 2.8 million sq.ft of new office space, 2 million sq.ft of new retail and leisure facilities, and 28 new public spaces.

It's an Olympic-scale programme of development, with one major difference: it's not on a blank canvas of land and Croydon's vibrant town centre cannot grind to a halt. Croydon set Arup the challenge of planning how to deliver the programme while keeping Croydon moving. Instead of a report or timeline, Arup gave Croydon an information management tool: a tailor-made, web-based dashboard that defines the programme, allows the cumulative effects of projects to be easily understood and balanced, and their progressive delivery to be tracked and managed, all in real time. The dashboard provides

an intelligent 'single point of truth' in an interactive format that allows users to navigate central Croydon, filtering into different project types, time periods and geographies, and drilling down on individual projects.

The Programme Delivery Dashboard gave Croydon a vital information management tool, but it has done much more than that. It has engaged and reassured stakeholders, allowed them to bring forward projects and grasp new opportunities, identified areas of infrastructure requiring investment, helped secure funding commitments from the mayor and Treasury, and promises to radically transform how city-centre regeneration schemes are coordinated and delivered in years to come.

"The council and Arup's work is hugely innovative. This will pioneer how major urban regeneration schemes are planned and delivered in future."
—Jo Negrini, CEO Croydon Council



Case study

Factory in a Box, GlaxoSmithKline

What's the best way to deliver vital medications to remote and underdeveloped communities, in the quantities they need them? GSK's Factory in a Box solves the firm's need to develop drug production and packaging facilities to a global standard, locally, for communities that need them.

Working with prefab specialists Bryden Wood, GSK developed a set of building components that can be delivered around the world from Europe or procured locally, and reassembled safely, quickly on-site as a small production facility. The factory is designed with all the technology needed for drug production and packaging. This modular, flat-packed approach is estimated by GSK to cut the cost of construction by 30% and the construction programme from one year to 15 weeks. The digital environment is essential in removing the current artisan work processes of the built environment so that the factory components are consistent and repeatable products.

The company's long-term programme requires ambitious construction in difficult, varied and often underdeveloped markets. GSK wants to bring best practice to all new facilities to minimise cost and delivery in an unprecedented time frame, and has set a challenge of 'zero incident, zero defect, zero waste' for the delivery of the new facilities. A prototype building, developed and constructed in Europe, allowed for lessons to be learned for the first time in a controlled setting rather than in the higher-risk African context.

The Factory in a Box is driven by the concept of construction as a mechanism for distributing drugs. This approach is made possible by technology, with advanced manufacturing techniques enabling the creation of the building.



Rafael Aksoy | 38
Head of Procurement



Rafael Aksoy lives and works in a large European megacity. He's an experienced smart city engineer, and has just been promoted to head of procurement for the city authority.

His task is to improve the resilience of the city's social infrastructure so that it's in better shape to meet the challenges of increasing population growth, an ageing workforce and new health concerns. To do that, he's bringing in new measures to boost the quality of innovation among tenderers for city contracts.

Innovation has become a non-negotiable performance indicator of the city authority, on a par with sustainability, value for money and health and safety. Innovation programmes are an intrinsic element of all projects. As Aksoy devises the framework approaches for the authority's next portfolio of projects and programmes — which includes social care, schools and parks infrastructure, and the associated neural networks that coordinate the city's social system — his challenge is to make the framework world-class.

In the past, the city's innovation programme has been lacklustre as individuals struggled to understand what innovation is, but three years ago the authority took the decision to define and explain what innovation meant to them. This has now cascaded down to employees, enabling them to define what they will do to make the authority innovative. In performance appraisals, they are asked to state what activities they have carried out to achieve innovation, rather than outline pie-in-the-sky future activities that they would never be held accountable for.

As a result, Aksoy is now treating the portfolio as an investment and asking tendering suppliers to not only demonstrate what innovation means to them but also submit innovative ideas to the frameworks for maximising the city authority's return on investment. For greater returns, a higher tendering score is awarded. They will also be required to submit open book responses detailing profit margins, costs and assets required.

To encourage tenderers to innovate, Aksoy has been permitted by the leader of the city authority to trial a number of new approaches. The first involves the surrender of all

intellectual property — all innovation submissions are to be freely revealed. The intention is to develop an appetite for working with individuals who enjoy producing and implementing innovation ideas, and move tenderers away from purely monetary motivations.

Secondly, the winning tenderer will receive copies of all the innovation submissions submitted and can make use of them as they please. This is to encourage the tenderers to invest in innovation.

Finally, all tenderers are to be reimbursed a notional sum of money — not enough, maybe, to cover the full tendering costs but that is not Aksoy's intention. He wants tenderers to see winning as more than just a commercial prize and to value the access they'll gain to new, innovative ideas.

A recent pilot project revealed some novel bid approaches. Incumbent market-leading organisations were partnering with smaller groups and individuals offering diametrically opposed services, such as newly formed start-ups and university research departments. What's driving these relationships is the need to develop innovative approaches in interrogating the data from the city's social

infrastructure neural networks in order to meet the project critical success criteria and realise better return on investment.

Aksoy also saw tenderers embracing the circular economy and considering the reuse of assets within the framework. This led to one tenderer forming a network with several dozen charities so that assets are reused appropriately, with the involvement of city residents. This kind of approach has the potential of helping businesses shift their social responsibilities and build connections to the communities they operate in — exactly the kind of change that will strengthen the resilience of the city's social infrastructure.



Case study

Crossrail Innovate18

Crossrail is delivering new railway for London and south-east of England. It will transform travel into and through the capital, and it is the first megaproject in the United Kingdom's construction industry to introduce a formal innovation programme — Innovate18.

Innovate18, developed in conjunction with Imperial College London, has put in place specific organisational arrangements for encouraging, funding, and implementing innovations in each of the projects that are part of the Crossrail development.

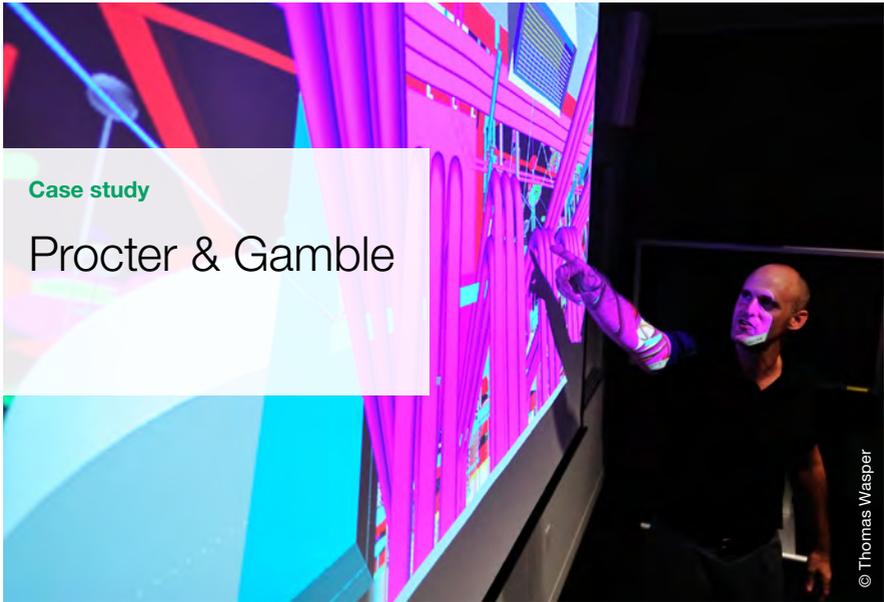
As the largest construction project in Europe, Crossrail is uniquely positioned to lead innovation in the construction industry. At the heart of Innovate18 is a commitment to deliver capability, collaboration and culture. Where collaboration, in particular, is strong, Crossrail has demonstrated that there is a direct correlation between performance and innovation. The programme encourages ideas from across its supply chain,

and has incentivised the generation of innovative ideas within each project, as well as the implementation of ideas proposed by other projects.

There are four themes to guide innovators and help generate ideas: health and safety, delivering efficiencies, digital-physical integration, and sustainable solutions. To date, Crossrail has invested over £350,000 to deliver innovation projects across these themes.

Innovate18 is recognising the vision of bringing the Crossrail community together to deliver value. Although the full benefits have yet to be realised, the achievements so far are impressive and have the set the bar for other infrastructure projects by signifying and validating the potential of an innovation programme.

Crossrail's award-winning programme will help leave a legacy that inspires and motivates innovation in future infrastructure projects around the world.



Case study

Procter & Gamble

© Thomas Wasper

At Arup we work across the world, with many leading global companies in sectors such as advanced manufacturing, consumer goods, bio-pharma, financial services and technology. And we are engaged in developing true innovation and best practice across industry, in areas such as the development of digital systems and technology, WELL building standards, sustainability and modular construction.

For our successful long-term client relationships, we use connected Arup leaders in our regions to drive a common global vision for each client. Through this collaborative network, we adopt the principle that best practice and innovation are freely shared for the benefit of Arup and our clients.

We've captured this activity over the past five years in a 'Rolling Innovation List' containing headlines of more than 50 recent topics, and developed a series of 'Innovation Bursts', short meetings that allow a focused sharing of these with our clients for mutual benefit.

An Innovation Burst approach with Procter & Gamble led to a five-year global programme of value-driven sustainability improvements. The benefits were significant: carbon, water and energy savings across their global capital projects, and the certainty that capital was being spent on improvements driven by cost and value.

It's a popular approach that clients appreciate because our innovations are commonly driven by metrics including costs or key performance indicators which drive business improvements. The experience has confirmed our view that continual, shared innovation is a key element in successful long-term client global relationship management, often leading to new opportunities for both Arup, our partners and collaborators, and our clients.



100 seconds with Anna Green, CEO and founder of Machine PM



In 2035, Anna Green's departure from Experiential Innovation's self-driving car programme sent shock waves through the tech world. She, after all, had done more than anyone to bring about the revolution in the car market that led to driverless models dominating new car sales.

Now she's back, ready to kick-start another kind of revolution. Following a few years of under-the-radar development, she last year launched Machine PM, a 'nearly humanless' project management firm already causing a stir across the construction industry.

Q: What made you leave the self-driving car industry?

AG: I'd spent nearly 10 years at Experiential Innovation, but once the technology was mature and globally accepted it felt like 'job done'. Plus, I found myself more and more interested in the positive social impacts being generated by declining vehicle ownership and the rise of shared

vehicle networks, and the massive potential changes in our cities' infrastructure.

Q: But why project management?

AG: Lots of reasons. My partner's a project manager, it's still the most influential role in choreographing the way projects are delivered, and there was a glaring opportunity for a step change to go beyond human-scale thinking and analysis. I was amazed and frustrated that major projects were still basically treated like prototypes, driven by the often outdated approach of senior project leaders based on 'what worked well last time', rather than a more evidence-based way of thinking based on getting the very best outcomes. Also, with the volumes of open source data constantly being collected on millions of government projects, there seemed to be an obvious opportunity for developing a totally automated machine-learning approach.

Q: We've heard so much about Machine PM. How has the company developed and what's your main business offer in this market?

AG: Project management has had automated 'supply side' features for years — think of integrated Building Information

Modelling, fully immersive simulations, 3-D swarm print fabrication. All of these still need human ‘demand side’ inputs so are limited by human ability and were never fully integrated. Machine PM has developed a fully automated demand side, so for the first time a near-humanless project team is possible — from cradle to grave, as my grandmother used to say.

The early algorithms we used were inspired by the pattern recognition used for driverless cars, and the open source data available provided the perfect basis for data-driven predictions and decisions that have always been the realm of the project manager.

Our business offering has grown in line with the regulatory breakthroughs — integrating steadily backwards through the project lifecycle from construction and logistics, through procurement, design and now all the way to initial project identification and creation. For the first time it now feels we can start delivering projects in the right way — quicker and cheaper without any waste — for the right reasons, and with total efficiency through the supply chain.

Q: So what are your plans for Machine PM?

AG: We have created an ever-evolving machine-generated model of knowledge that has proven to be many times more effective than relying on human experts. For the good of the economy, environment and society, I want to see that model being used globally. Machine PM is my baby, but it was always just a vehicle for finding a better, quicker, less wasteful way of delivering projects.

Our ultimate goal is to fully liberate the technology, expertise and knowledge. We’re finalising plans right now for providing our content and knowledge free of charge online. We just need to work through the regulatory issues of whether we can just transfer everything into a commons to be maintained by a contributor community, or whether for practical reasons Machine PM will need to remain a gatekeeper. We’ll be making a major announcement next month, so watch this space!



Case study

WikiHouse

WikiHouse is an open source project to reinvent the way homes are designed and constructed. It is being developed by architects, designers, engineers, inventors, manufacturers and builders, collaborating to develop the best, simplest, most sustainable, high-performance building technologies, which anyone can use and improve.

An online platform lets users download building plans and then 'print' jigsaw puzzle-like pieces out of materials, such as wood, using a computer-controlled cutting machine. The puzzle-like pieces avoid the need for special and bespoke pieces, and the frame of a Wikihouse can be assembled within one day without any need for formal construction qualifications and training, at a cost of less than £50,000.

An aim of the project is for these technologies to become new industry standards; the bricks and mortar of the digital age. Arup partnered with Architecture 00 and The Building Centre to create an installation designed to demonstrate the Wikihouse concept and coincide with the launch of London Design Festival 2014.

The Wikihouse mission is:

1. To put the design solutions for building low-cost, low-energy, high-performance homes into the hands of every citizen and business on earth.
2. To use digitisation to make it easier for existing industries to design, invest in, manufacture and assemble better, more sustainable, more affordable homes for more people.
3. To grow a new, distributed-housing industry, comprising many citizens, communities and small businesses developing homes and neighbourhoods for themselves, reducing our dependence on top-down, debt-heavy mass housing systems.

Wikihouse is an example of how — in a technology-based internet society — knowledge can be digitised, shifting expertise from 'craft' to 'commons'.



MTR Corporation's merger with the Kowloon-Canton Railway Corporation in December 2007 marked a step change in the company's scale, operations and structure. To support the corporation's Project Division with the dramatic expansion programme of its rail network, Arup proposed a Knowledge and Information Management infrastructure (K&IM), and to put in place the supporting processes, change management and appointment and training of an in-house K&IM team.

Within 12 months, a cost-effective solution was up and running that included a branded information portal, 'iShare', which used collaborative knowledge-sharing technology to help deliver complex capital projects efficiently and effectively. A collaborative working culture was developed across the multi-project organisation, connecting people and sharing lessons learnt, and the K&IM quickly became part of normal activities. Return on investment was achieved within two years. Key measures of success of any knowledge management system are faster, more accurate

access to project information and archives, and greater sharing of knowledge and insights between projects. Both have been achieved within the merged MTR Corporation and its multitude of projects. Of even greater value, though, are the less tangible cultural benefits. There's a strong, shared understanding of the merged corporation's combined heritage, and a mind-set of continuous learning has been established, systematically feeding lessons learned from one project into the next. Support networks encourage an enquiring attitude, an openness to learning, and a shared hunger to reach the best solutions to each challenge.

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Marina Alilek | 49
Head of Systems Data Integration



As the head of systems integration for her national water and wastewater provider, Marina Alilek has been rethinking how capital projects are planned and carried out.

To manage the zero carbon emissions construction and operation of wastewater facilities, she's developed a new approach that weaves together the physical and digital aspects of systems, and allows complex webs of interfacing tasks to be coordinated and carried out with a minimum of disruption.

The management of water and wastewater utilities is a vastly complex business. Services are in constant demand, yet systems need maintenance, update and replacement. Juggling those demands, and the numerous potentially costly interdependencies involved in any kind of capital project, has long been the biggest headache for any major water utility.

Alilek may have the answer. Her approach brings together the principles of project management systems engineering to

coordinate the work of both the contractors carrying out work on-site and the remote, self-employed freelancers hired to undertake the digital control aspects. This means the physical and the digital aspects of systems are able to work seamlessly together as a whole. Interdependencies and the associated interfacing tasks can be tracked on an interactive digital dashboard fed with real-time project data.

Five years ago, the water industry regulator was replaced with a digital crowd-sourcing entity that harnesses the knowledge of subject experts and users. Alilek's approach allows armchair data enthusiasts at home to interpret the metrics and even 'hack' the data to identify anomalies and inefficiencies. Some of these hacks have even spawned social media viral trends and become hot topics among teenage children of millennials, leading them to engage with capital project initiatives.

The digital controls that Alilek is responsible for are central to achieving the provider's zero carbon emissions targets. Systems are able to connect and 'talk' to each other in power needs, harnessing excess renewable energy available on the power transmission network and detecting inefficient assets that have encountered faults.

The connectivity between systems has even helped Alilek in devising the current form of contract to be used. Suppliers are now required to maintain a set level of service as part of their contract. This means that, with technology rapidly improving, suppliers are expected to upgrade the infrastructure they put in place at no additional cost to the utility, if that is what is required to maintain the standard of service.

Pairing the procurement of the infrastructure with its maintenance promises the best possible outcome. The responsibility for keeping each piece of infrastructure reliable and fully up to standard rests with a single entity — the company that provided it. Which means Alilek can manage the infrastructure being delivered through a managed service arrangement, with payments staged over the life of the contract, maximising affordability and enabling forward planning for future budgets.

Thanks to Alilek, changes to the way the water industry renews itself are flowing in the right direction.



Case study

Rolls-Royce Outcome-Based Contracts

Outcome-based contracts are an excellent example of organisations moving from goods-dominant logic to service-dominant logic. This kind of contract changes the dynamics of the delivery, bringing complex issues such as customer behaviours and involvement to the forefront, and focusing both customer and firm on value co-creation and co-production, rather than each party's contractual obligation. Rolls-Royce pioneered the concept as far back as 1962, when it transformed business aviation with its trademark Power-by-the-Hour (PbtH) service, to support the Viper engine. PbtH introduced an approach to engine management that aligned the interests of the original equipment manufacturer (OEM) fully with those of the aircraft operator, so that the engine manufacturer was rewarded only for engines that performed.

What made PbtH so distinctive was that it offered a complete engine and accessory replacement service on a fixed-cost-per-flying-hour basis, which allowed the operator to forecast costs with

pinpoint accuracy, reducing maintenance cost risk and avoiding the need to invest in stockpiles of engines and accessories. The current rapid growth in market share of Long-Term Service Agreements (LTSA) is testament to this outcome-based approach.

Suppliers of products as diverse as IT systems, trains and telecom systems have achieved success with this systems approach by designing and integrating innovative combinations of systems and services as high-value unified responses to their business customers' needs. Both parties recognise the property 'service' that emerges from the design of a single service system instead of two separate supplier and customer systems.



Case study

Queensferry Crossing, Scotland

© Paul Barrios / Atup

In 2007, the condition of the strategically important Forth Road Bridge in Scotland was discovered to be deteriorating so fast that the bridge would have to close to all traffic by 2017.

A new crossing would be needed within ten years, although infrastructure projects of this scale and complexity are rarely delivered in such a timescale. It takes time to secure the funding, statutory approvals, define an attractive procurement approach and deliver the construction strategy.

Large projects are normally delivered by a linear set of processes; there is wisdom in this approach since the interface between each is relatively easily defined and minimises uncertainty. The deadline of 2017 made such an approach unfeasible.

The response was to rationalise, accelerate and overlap processes wherever possible whilst mitigating risk, initially to cost and latterly to the schedule — in other words,

to integrate the systems. This called for a radical assessment of every aspect of the project, including: streamlining the governance structure; honing the project scope; carrying out extensive research projects to anticipate and mitigate risks in later construction; opting for a parliamentary bill because of the time certainty it provided, despite its greater demand on resources; overlapping statutory approvals with construction procurement; a wide dialogue with the construction industry to arrive at a mutually acceptable procurement and construction strategy; and continuity of leadership in the integrated client team.

Individually, these measures are not entirely unique. But taken together under the direction of a single team the outcomes have been acknowledged as remarkable. The crossing will be delivered by 2017 at a cost of £1.35bn — less than half the initial estimated cost of £3.5–4bn. The client, the Scottish government and the community are delighted with the outcome.



Daniel Nicholls
Research Manager
Association for Project Management

As Peter Drucker said, ‘The best way to predict the future is to create it’. Over the next twelve months the Association for Project Management will develop the new chartered standard to underpin the profession’s new status and prepare the necessary guidance, training and infrastructure required to deliver it.

We hope to use this as an opportunity to raise awareness, standards and the status for the project profession while focusing on key issues for project management and developing the skills required for the future. Future of Project Management is an important part in rethinking how we can support the profession. The project profession faces many challenges, drivers and trends as FoPM has set out. Project management and its role within management and organisational strategy has gained traction with increasing numbers of organisations seeing project management as a core competency. Increasingly, we have seen the

importance placed upon research as a means of enhancing individual and organisational practice. APM believes that underpinning all of this is the requirement to provide the right skillsets to meet these future requirements, as well as addressing existing skills gaps.

FoPM describes the growth of virtual project teams and timeless environments as ever larger projects work across national boundaries. Should this continue the importance of connecting and networking with project team members and fellow professionals will keep growing. Traditionally, project management competence and technical skills have been used in the recruitment of project professionals. Increasingly, behavioural characteristics and emotional and social intelligence are being sought. The project profession’s relationship with technology will only increase in importance with the onset of automation and artificial intelligence, which may bring about improved efficiencies and collaboration.

What is the future role of project professionals? There is the wider debate about whether project management will remain a profession in its own right or whether it will merge within the wider management practice. Project management

supporters argue that its importance and contribution can be demonstrated through ever-increasing numbers of certification, the growth and standing of project professionals, increasing reliance on the treatment of work as ‘projects’, and growing accountability for projects within organisations. This is further cemented by the attainment of chartered status within a single generation.

As a profession we face many challenges over the next 20 years. However, APM’s core purpose of meeting the needs of members and the wider public, facilitating networking and employment opportunities, developing and providing qualifications and skills required by industry will continue to be important, even though the definition of project management may change. Gazing into the future, the role of research and collaborating with like-minded individuals and organisations will only increase in importance to APM. With this in mind, we seek to work with academia and industry to identify knowledge gaps and emergent themes that will add to our knowledge. FoPM is an example of this vision in action.

Daniel Nicholls



Andrew Davies
Professor of the Management
of Projects
The Bartlett School of Construction
and Project Management, UCL

At the end of the 20th century, project management had spread from its origins in the US aerospace and defence industries to many organisations and industries around the world.

It was an execution-oriented approach based on detailed planning, hierarchical management and centralised control, designed to achieve a project's goal within budget, on time and to the required specifications. It worked well in a world when technologies and markets were considered to be stable and unchanging.

Today, a new generation that has grown up with the internet, social media and mobile communications are uncomfortable with the traditional project management approach. They are more at ease with the future of project management described here, based on collaborative teams, decentralised control and flat and responsive management structures.

The future of project management means that projects have to adapt and innovate to keep pace with increasingly complex, fast-changing and uncertain conditions that cannot

be accounted for in front-end plans. The best innovation programmes are being adopted around the world to complete megaprojects more efficiently. Many innovative projects — smart cities, carbon capture and storage, and tidal energy for example — have to achieve outcomes that balance the need for sustainability and economic efficiency. Modularity, offsite manufacturing and new forms of automation are relied upon to increase the safety, precision and efficiency with which complex projects can be designed, coordinated and assembled on site.

What role can UCL, APM and Arup play in this future? Some of the FoPM trends are already known to individuals and organisations. What is surprising is the gap between what they know they should do and what they actually do. Working closely with Arup and APM, UCL's students and researchers will be fully engaged with all types of projects and project-based organisations in government and industry. They will be able to identify the causes of the 'knowing-doing gap', and know how to close it.

We have identified five specific activities that UCL, Arup and APM will undertake to promote FoPM:

- An FoPM forum will provide support to develop research and engaged scholarship that addresses key project management challenges
- In a virtuous cycle of problem identification and solution, the research findings and insights will develop and improve FoPM
- FoPM will be a living lab with partners continuously building on it, honing and improving project management knowledge
- FoPM will provide UCL with the resources and thought leadership to pioneer new ways of teaching project management in collaboration with public and private partners
- FoPM is a catalyst for growing, deepening and strengthening the relationship between UCL, Arup and APM.

FoPM will help the discipline of project management to assume its rightful position as a strategic, innovative and transformative activity. It will provide the research, teaching and strategic solutions that governments, firms and individuals will rely upon to deal with an increasingly complex, often messy and uncertain future.

Andrew Davies



Julie Wood
Director,
Global PPM Skills Leader
APM Honorary Fellow
Arup

Working within a firm where innovation is at the very core of our DNA, we have always demanded from ourselves that programme and project management achieve high levels of excellence and be at the very forefront of the new and the next.

To me, as global skills leader, the inspiring thing about Future of Project Management, beyond reflecting on the influential projects we have already helped deliver globally, is the unbounded opportunity we have as project managers to proactively influence the future.

I'm a big believer in being explicit about what you want and expect from people, and so within our project management teams we have an operational stream specifically focussed on excellence and innovation. It is designed to challenge our thinking and to add as much value as possible to our clients and their businesses. Thinking about 'the future' is a big and potentially overwhelming pastime, but having this focus





has provided clarity and encouraged our people to think differently and experiment.

With FoPM we have already achieved more than we'd planned for. Along with deepening our partnership with The Bartlett at UCL and with APM as 'The chartered body for the project profession', it has already begun challenging our assumptions about many aspects of the way we work. It's good to be made uncomfortable at times — often this is when we know we are really learning and developing. FoPM has helped us define what our own 'future' will look like and communicate that to our staff and clients. We must empower our staff to iterate and adapt, embrace risk and failure, looking at what works and what doesn't, and to be curious in all they do. Testing, experimenting and improving.

Of course, someone needs to keep driving these efforts, which is part of our commitment to continue in this work with The Bartlett and APM to ensure the evolution and continual improvement of FoPM. We already have a growing programme of events planned with both APM and the Bartlett for the year ahead. The process of innovation and planning for the future needs to be continuous, and we will continue to use FoPM to question how work gets done. I strongly believe this will keep us in a strong position when it comes to the exciting and inevitable need to adapt and prepare for and embrace the future.

Finally, congratulations and many thanks to Rob, Thomas and everyone involved with this initiative. I know you will enjoy reading and engaging with it, so please give us your ideas and feedback. Whatever path project management follows, it's going to look very different to today and it will be an exciting ride. The future doesn't happen to you, or your organisation, or your projects — it happens because of you! So be part of it.

Julie Wood

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Future of Project Management is a partnership and collaboration between Arup, The Bartlett Faculty of the Built Environment at UCL, and the Association for Project Management, with crowd-sourced inputs from the global project management community. FoPM is presented in three sections that set the context through emerging trends and drivers, imagine plausible futures through the eyes of our future clients, and finally outline plans and priorities for future action and research.

FoPM is a living initiative, a showcase for thought-leadership and an interactive platform for future research and debate about change in the project management profession. Please join the conversation and share your ideas.

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