

WHO IS THE
ENGINEER
OF THE
FUTURE?



ENGINEERS OF THE FUTURE

What will an engineering job look like in 2030 and how should the workplace change to support this? What new business practices and partnerships will be needed?

Meet the Materials Oracle, Engagement Ecologist, Project Signaler and Planetary Infrastructure Lead. They work within a streamlined business architecture that focusses on connected working and transdisciplinary exploration.

This project report presents a snapshot of future engineers in the year 2030. It outlines key trends that will impact the development of new talent pools, and transform workplace cultures.

Based on research across sectors, these scenarios offer strategies for understanding the networked impacts of global technological and environmental developments on business recruitment and training models. Our proposed future offers recommendations for turning emerging skills and ways of working into levers for business development.

By constructing a future world and bringing to life the people within it, we are able to illustrate interactions between future skills and technologies at a human level.

Contents:

01 BUSINESS ARCHITECTURE

Structuring a new engineering organisation

02 PERSONAE

Showcasing the engineers of the future

03 SIGNALS

Key trends shaping the future

04 RECOMMENDATIONS

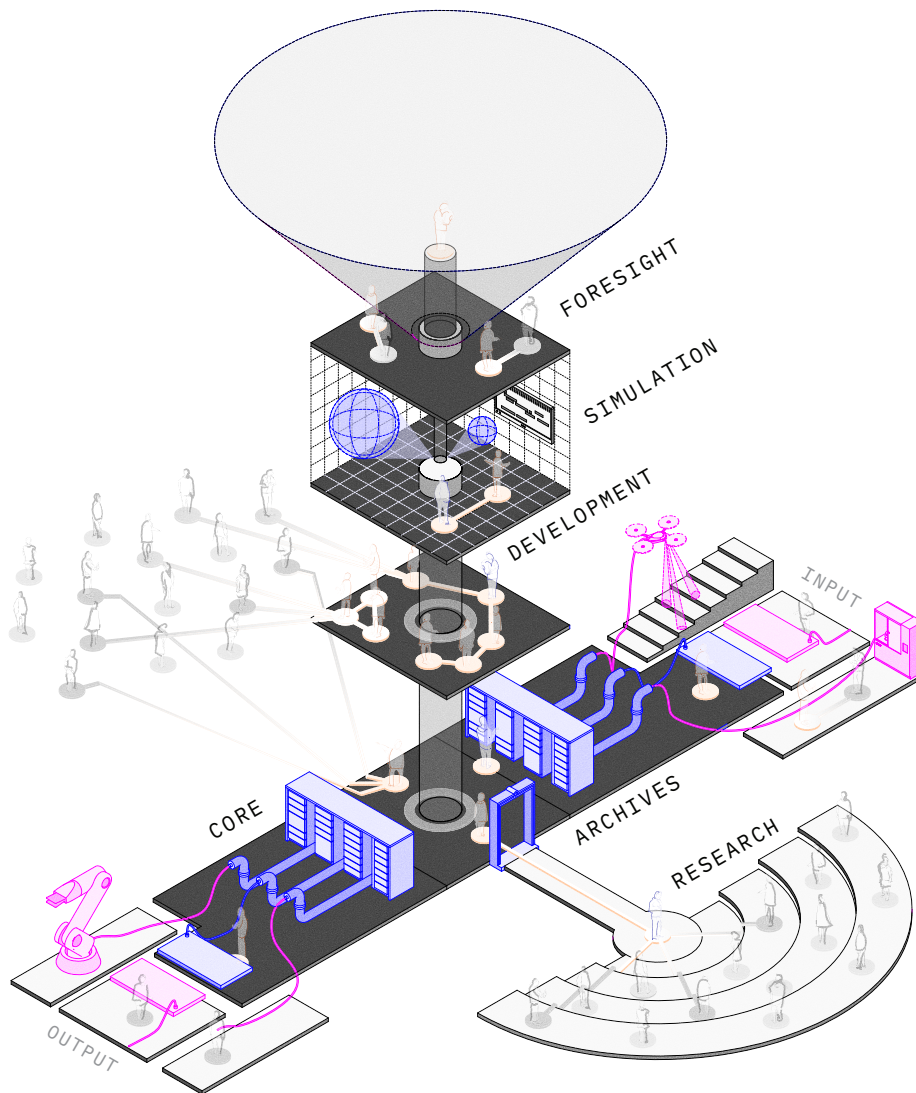
Strategies towards future working

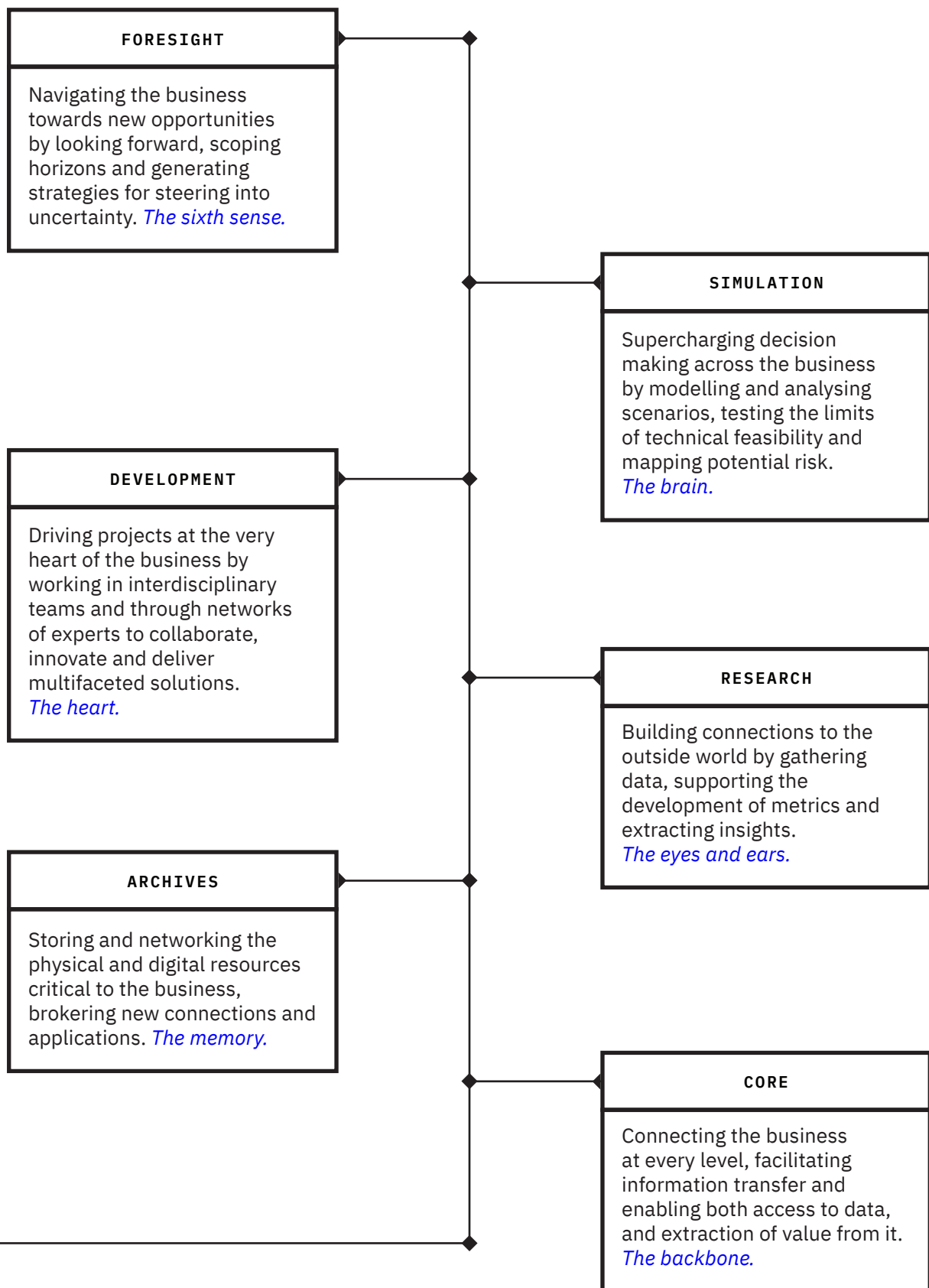
01 BUSINESS ARCHITECTURE

The future engineering business is structured through an organisational **core built for information sharing** and access. In this world, the flow of information and the flow of people are equally key to success and realised through flexible collaboration and partnerships.

World Building offers a blueprint for a potential future and a framework within which to contextualise the future workforce and explores how they operate and communicate.

This section visualises the signals identified in the research as the external environment within which the company operates, informing its structure and network design. The signals are anthropomorphised by analogy with the body – the future human that will connect the business at every level and navigate it through this new world.



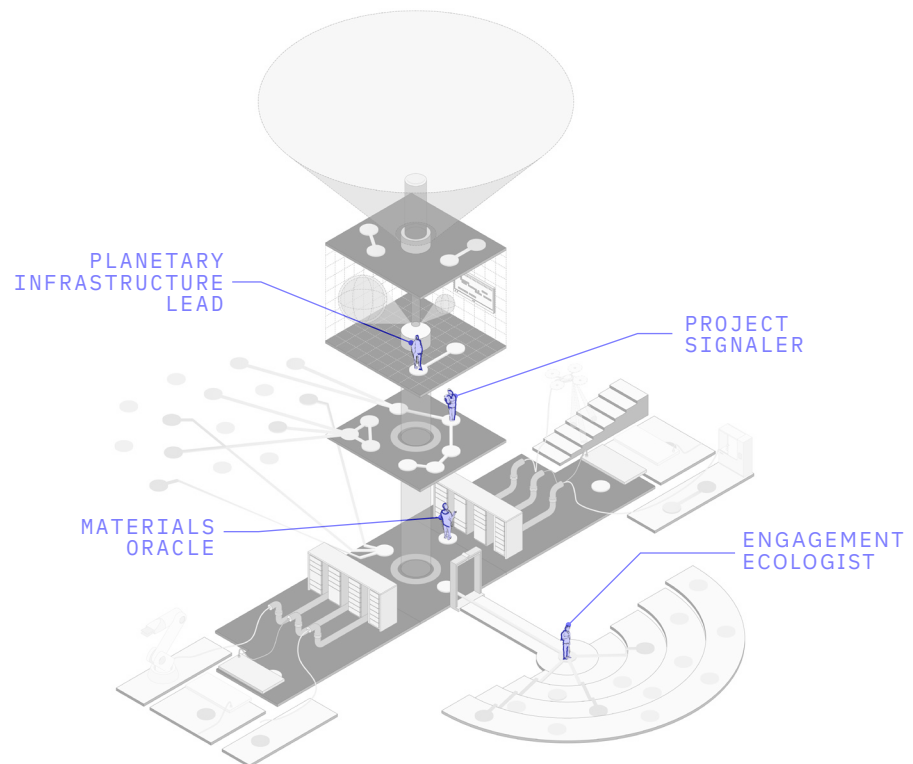


02 PERSONAE

Within the business architecture, the personae demonstrate various models of connected working. **Critical thinking and collaboration** are core to each role. The ability to deal with rapid technological change and to share expertise across the business (and beyond) are crucial.

We selected our four personae from the new talent pools that will transform the workplace culture in 2030. Detailed profiles of the Materials Oracle, Engagement Ecologist, Project Signaler and the Planetary Infrastructure Lead allow us to explore key trends for a hyper-networked and mobile global workforce.

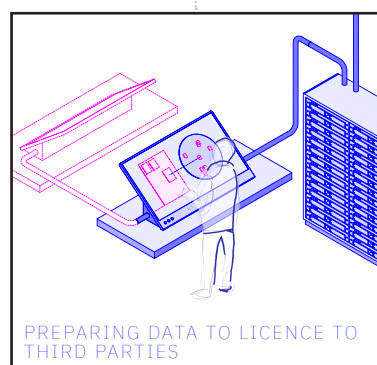
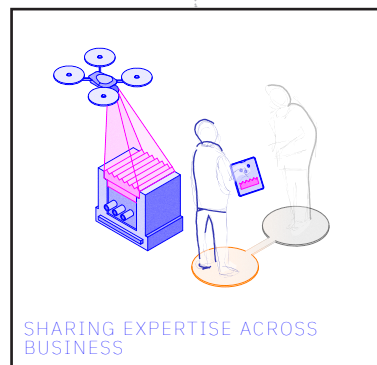
Defined in terms of their key attributes and interactions, the personae are shown at work within the new business architecture. Changing relationships between companies, collaborators and their workforces lead both to extended business scope and to new kinds of liability beyond established borders.



MATERIALS ORACLE

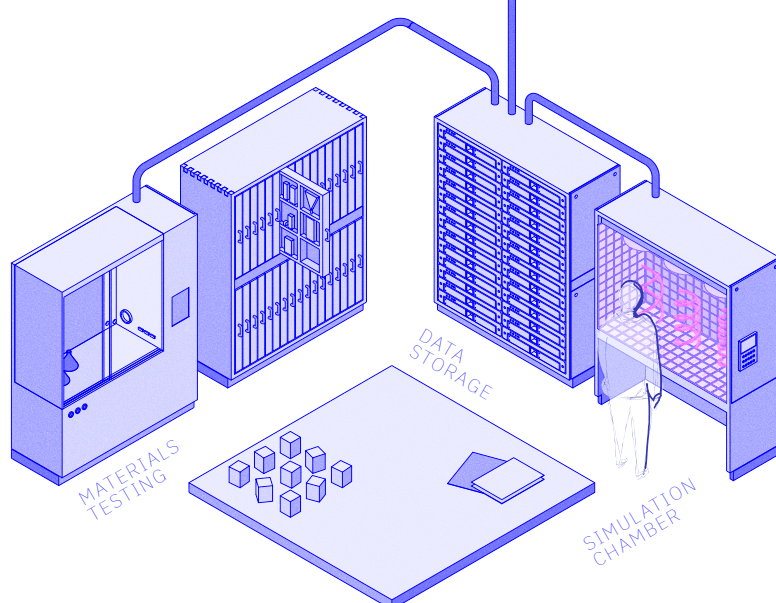
Curates and archives material samples and data, building a critical collection of resources that form the very foundation of the business.

- Collaborates to test material samples (in both the lab and the field) and gather further data.
- Curates and extracts value from existing company materials data and IP.
- Provides expertise to project teams.
- Prepares data for licensing to third party projects.



ATTRIBUTES:

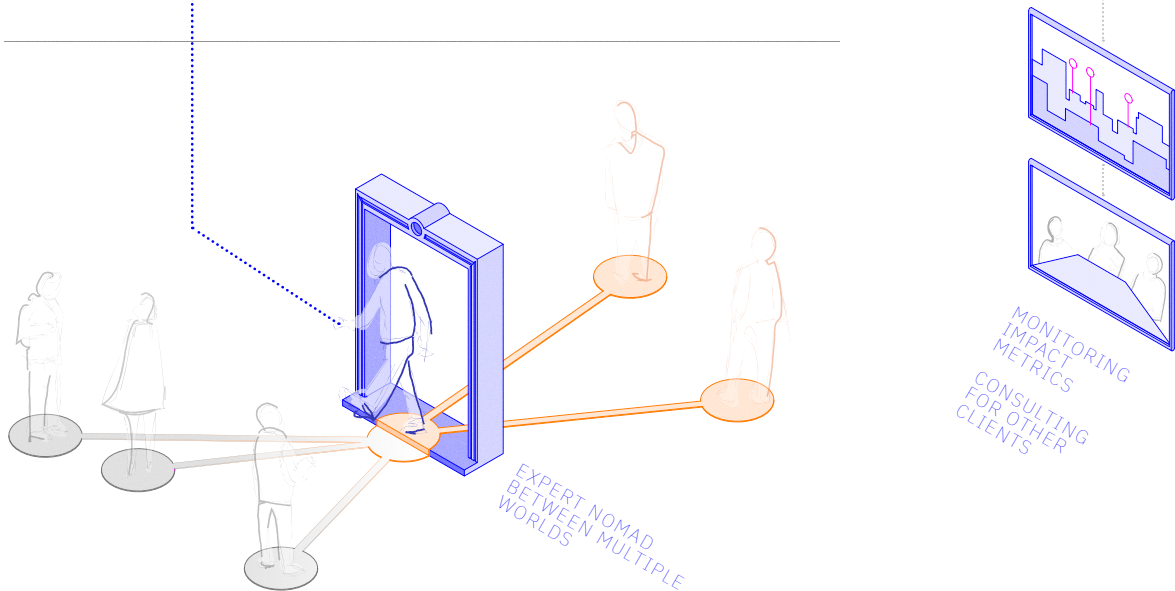
- PHYSICAL TO DIGITAL TRANSLATION
- GENERATING FOUNDATIONAL INTELLECTUAL PROPERTY



ENGAGEMENT ECOLOGIST

Incorporates socio-cultural impacts throughout project life cycles, ensuring the business sees better, does better, and connects with people and planet.

- Works on site with user groups to gather qualitative data, synthesising this for later use.
- Develops metrics and monitors evolving system dynamics and socio-cultural/actor-network/impact systems.
- Undertakes longitudinal studies, gathering impact metrics for use across the company.
- Communicates insights to design teams within the company for real time competitive edge.



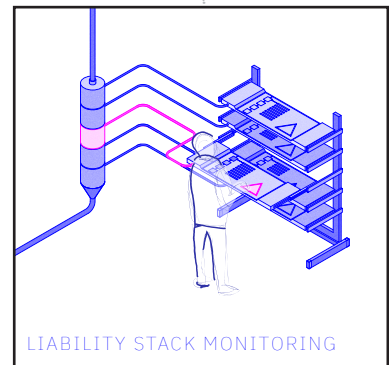
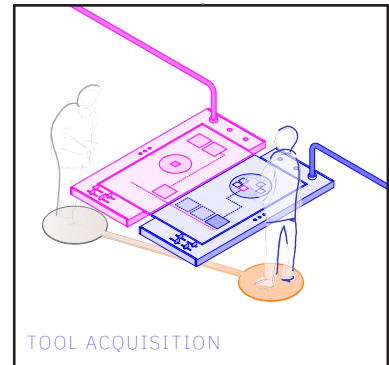
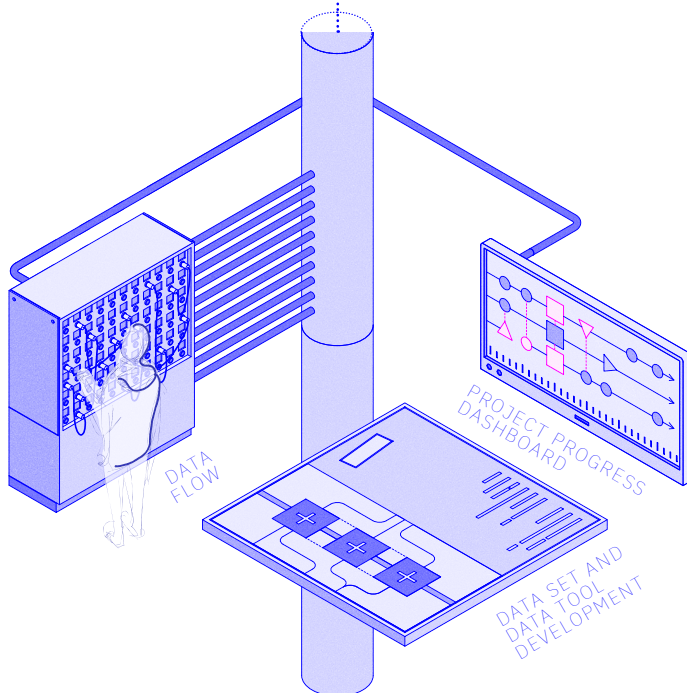
ATTRIBUTES:

- LINK TO THE FOREFRONT OF ETHICS MONITORING
- INJECTION OF PRACTITIONER EXPERTISE IN IMPACT RESEARCH

PROJECT SIGNALER

Oversees and synthesises data across projects, preempting issues and ensuring the development teams are always ahead of the game

- Manages data flow into, within and out of projects, and throughout project progression.
- Analyses gathered data sets used and their past, present and future applications.
- Acquires and validates third party datasets and tools to enhance digital initiatives.
- Monitors risk and the boundaries of liability stacking.



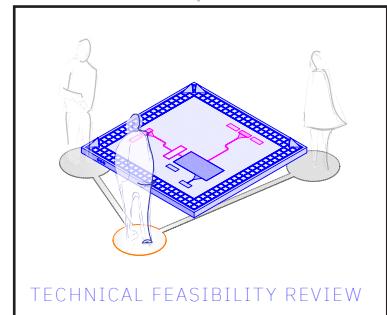
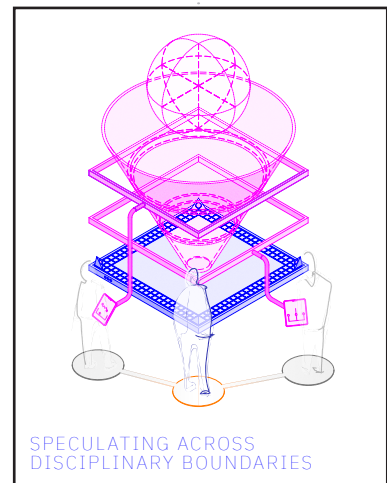
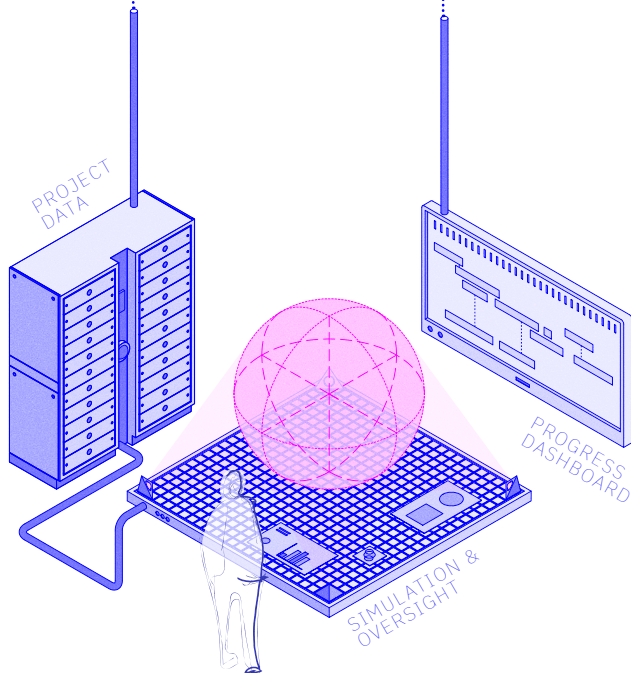
ATTRIBUTES:

- CHAMPIONING OPTIMAL DATA UTILISATION AND DEPLOYMENT
- PROTECTING PROJECTS FROM LIABILITY CLASHES

PLANETARY INFRASTRUCTURE LEAD

Heads up deep earth and extra-terrestrial infrastructure projects that extend the reach of the business by harnessing space and time.

- Directs large-scale and long-term initiatives exploring geo-engineering and extra-terrestrial mining.
- Collaborates with a range of experts across sectors to synthesise future strategies for the company.
- Uses advanced simulation facilities to model complex scenarios for feasibility review and to quantify risk.
- Ensures there will still be a business in the next millennium.



ATTRIBUTES:

- CATALYSING NEW TECHNOLOGY PARTNERSHIPS
- DEVELOPING ROBUST APPROACHES TOWARDS LONGER BUSINESS HORIZONS

UBIQUITOUS
METRICS

EXTENDED
RESPONSIBILITY

FLEXIBLE
AUTONOMY

IMPACT
ECOLOGY

UNCHARTED
TERRITORY

The signals provide a snapshot of the research conducted during this project. They inform the development of the new business architecture and the four ‘Engineers of the Future’.

The research conducted in this project sought to explore the emergence of core issues such as new talent pools and workplace cultures, as well as the impact of emerging technology, socio-political issues, environmental challenges.

The resulting signals identified show that companies will need to operate globally, and incorporate consideration of issues such as ethics, social impacts and environmental stewardship into their core business strategies and operations. The shape of career structures and trajectories will modulate towards portability as the individual working life will span roles, workplaces and sectors. The wider impacts on cultural, social and environmental issues, locally and globally, will become part of core business strategy.

UBIQUITOUS METRICS

Sensor based technology enables increased monitoring across all business activities.

The proliferation of affordable technology will bring with it advances in sensing, remote communication and processing big (and small) data. As data becomes an ubiquitous business tool, these technologies will enable increased monitoring of every activity - from supply chains to social impacts, leading to enhanced metrics informing that inform decision making across the entire business.

Data will increasingly function as:

- a tool for employees to react in real time, filter key information, collaborate better, and be more strategic
- a resource for novel valuable insight into new business arenas, extending beyond the straightforwardly operational to include areas such as longitudinal studies and social metrics
- a means of staying ahead of the game and of unlocking new revenue streams

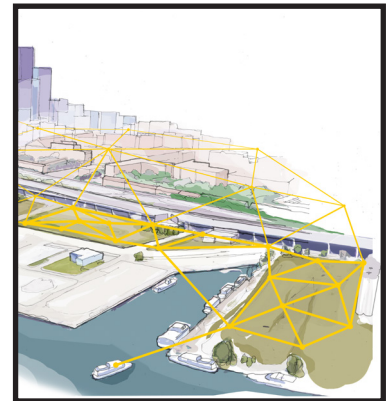


01^

New material science opens the door to increasingly responsive infrastructure and architectures

02>

The Instrumentation of the city - Sidewalk Labs neighborhood in Toronto, designed 'from the internet up'.



03v

Asset management and real-time analysis enabled by increasing access to satellites and UAV's

"...there are growing R&D investments in remote sensing research and increased interest in satellite remote sensing"

01 Living Architecture. Hylozoic Ground, Professor Philip Beesley, U. of Waterloo

<http://livingarchitecturesystems.com>

02 Internet First City. Sidewalk Toronto,

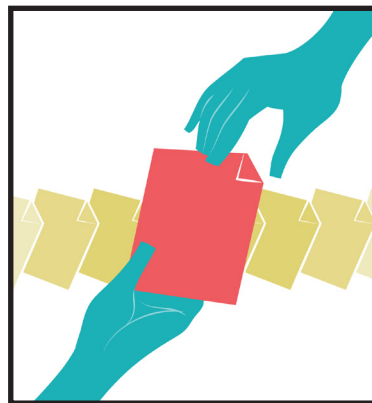
Alphabet Inc <https://www.citylab.com/design/2018/01/when-a-tech-giant-plays-waterfront-developer/549590/>

03 Satellite Applications Catapult <https://sa.catapult.org.uk/services/market-reports/route-market-reports/>

EXTENDED RESPONSIBILITY

Changing relationships between companies, collaborators and their workforces lead both to extended business scope and to new kinds of liability beyond established borders.

The nature of the relationship between companies and their workforces will change dramatically as people become more mobile in their jobs, and increasingly work across projects and businesses. New technologies will lead to changes in the protection of intellectual property and proprietary data. At the same time, as borders between companies, employees and automated systems become more porous, businesses will be faced with new risks and liabilities. They will also need to consider enhanced responsibility towards their workforce to ensure safety and sustainability.



As a result, companies will need to:

- ensure all workers are adequately qualified for the roles they undertake through more diverse and enhanced investment in training and development resources for the wider talent pool
- accept increased liabilities due to a number of factors, including reliance on intelligent 3rd party software and 'big' data
- accommodate new business interactions, complex and novel models of liability risk sharing and loss mitigation created by automated administration processes and innovations

01>

Automated processes give rise to new liability structures and redefined ideas of trust and responsibility for the engineer



03<

Simpler and increased numbers of partnerships facilitated by technology driven change in business administration

"We will need to demand engineers who will craft the code that determines all the million material ways in which the networked city interacts with the people who live in it, and give it shape and meaning, are able to consciously articulate the things they believe"

02^

Decisions made by automated systems can have extended ramifications beyond the engineering project life-cycle

01 SAM, bricklaying robot. MIT Technology Review <https://www.technologyreview.com/s/540916/robots-lay-three-times-as-many-bricks-as-construction-workers/>

02 The ideology behind technology. Adam Greenfield, Verso Books <https://www.versobooks.com/blogs/3333-the-ideology-behind-technology>

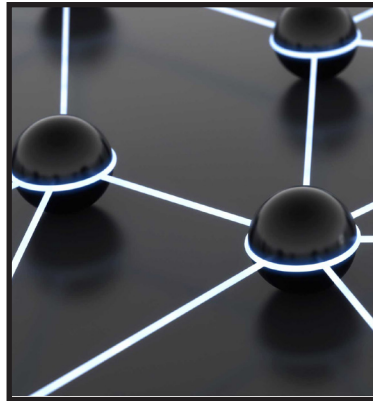
03 The Internet of Agreements. World Government Summit, 2017 <http://internetofagreements.com/files/WorldGovernmentSummit-Dubai2017.pdf>

FLEXIBLE AUTONOMY

Portability of skills and people leads to a breakdown of traditional roles, workplaces, career structures and sectors.

The shape of career structures and trajectories will modulate towards portability as the individual working life will span roles, workplaces and sectors. New modes of collaboration will emerge as companies become more agile, and employees work within flatter project based teams. This will require improved networks and transferable skills across sectors. As a result, **realignment of top-down management** and organisation structures within companies will include:

- flexible contracts and working environments which accommodate life/work boundaries and provide off-site connection with access to technology
- core and soft skills become transferable assets, portable across sectors and built through on-demand technical upskilling
- flatter, project driven team structures that are responsive to opportunities and supportive, with space to fail built into project scope
- developing new ways to attract and retain talent in increasingly competitive environments by providing inspirational stances on impact and thought leadership



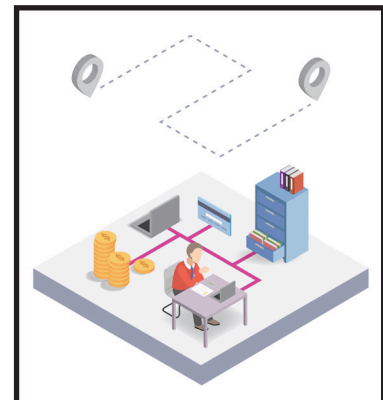
01^

Flatter project-based collaborative teams and virtual, informal organisations enabled by technology and mobile workforce

02v

Short technical skill half-life in the face of increasing rate of technological change.

“...the half life of engineering knowledge is 3-5 years”



03>

Understanding exponential growth of service delivery platforms as a formalisation of the informal economy.

01 Organisation 3.0. Future Agenda
<https://www.futureagenda.org/insight/organisation-3-0>

02 Professor James Plummer, Stanford IEEE Summit 2017 <https://spectrum.ieee.org/view-from-the-valley/at-work/education/the-engineers-of-the-future-will-not-resemble-the-engineers-of-the-past>

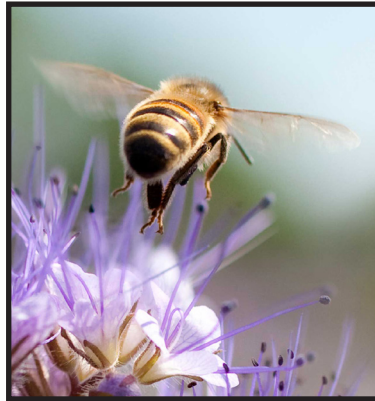
03 Work, Interrupted. The New Labour Economics of Platforms. Report by Institute for the Future http://www.iftf.org/fileadmin/user_upload/downloads/wfi/IFTF_Work-Interrupted_FullReport.pdf

IMPACT ECOLOGY

The wider impacts on cultural, social and environmental issues, locally and globally, will be part of core business strategy.

Organisations will need to operate globally, and incorporate consideration of issues such as ethics, social impacts and environmental stewardship into their core business strategies and operations. As new technologies improve traceability and communication, projects will become more transparent in relation to costs and impacts. Novel impact evaluation methodologies will enable embedded consideration of cultural-social heritage. As a result, **companies will need to develop:**

- new metrics for measuring success beyond the economic in response to increasing demand for true cost transparency
- extended time-prints as part of project briefs and routine impact evaluation rating for far future projects
- engagement methodologies and structures for working with users, communities and environments
- strategies for thinking beyond borders, and beyond traditional remits to consider the balance between local and global impact.



01^

Full cost and transparency on ecological impact requires businesses to move towards 'Net Positive' position workforce

03>

Millennial employees insist their companies are "good corporate citizens, environmentally green and ethical."

02v

Intensifying scrutiny of an organisation's impact on society and it's wider business ecology

"When we look in the mirror held up by society, do we like what we see?"



01 Full Cost. Future Agenda <https://www.futureagenda.org/insight/full-cost>

02 Human Capital Trends 2018. Deloitte <https://www2.deloitte.com/insights/us/en/focus/human-capital-trends/2018/corporate-citizenship-social-impact>

03 Why Millenials are great for engineering. FMI <https://www.fminet.com/fmi-quarterly/article/2018/06/why-millennials-are-great-for-engineering-and-construction/>

UNCHARTED TERRITORY

Uncharted territories will fall within reach as new technologies support collaboration and speculation.

Businesses will need to harness the opportunities of, and operate within, an increasingly uncharted world. As technological advance and extra planetary exploration facilitate new ways to simulate and speculate on possibilities, businesses will gain access to emerging markets and benefit from modes of operation. Dedication of more time and resources to high risk projects with larger ambitions and longer payback periods will require harnessing the opportunities of:

- scientific advances – for example, from sectors such as synthetic biology, geo-engineering and astrophysics leading to planetary infrastructure projects
- technological advances which will release new value streams and sectors of cooperation, for example, the leasing of data
- advanced simulation which will power up the possibilities of high fidelity risk analysis of previously unfeasible activities, leveraging the potential for advanced feasibility scoping.

01v

Materials and scientific advancement create opportunities for new relationships between digital and biological fabrication



01 Silk Pavilion. Professor Neri Oxman, MIT <http://matter.media.mit.edu/environments/details/silk-pavillion>

02 Ellen Stofan, Director, Smithsonian Air and Space Museum, for World Economic Forum <https://www.weforum.org/agenda/2016/11/by-the-2030s-we'll-be-ready-to-start-sending-people-to-mars>

03 Creating a successful Internet of Things Data Marketplace. McKinsey Insights <https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/creating-a-successful-internet-of-things-data-marketplace>

02v

Engineering and design for extra-terrestrial activities intensifies as entrepreneurial efforts drive cost to access space down

“By the 2030s, we’ll be ready to start sending people to mars...private sector partnerships are critical to enable us as a global society to explore mars”



03^

Aggregating and validating data in the course of business maximises value for lease and sale to industry marketplaces

04 RECOMMENDATIONS

“Adaptability - Agility - Automation” are a blueprint for attracting the new talent and changing workplaces culture to enter this world.

Our scenarios for ‘Engineers of the Future’ encompass near future worlds of advanced technologies, shifting global and local demographics, and key social, environmental and economic trends. New business architectures will embrace change from all sides - people, skills, technologies. It will require a bold ethical and strategic ethos and radical new practices for communication and collaboration. This project showcases how a business can adapt to this new future, and proposes companies should:

ADAPTABILITY

- understand the benefits of **engaged business conduct** and citizenship by becoming conscious of the true cost of business strategies as part of an ethical practice.
- focus on **research and development** as an integral component of all project work and part of core business identity
- build **stronger collaborations** and new revenue streams across business borders, including data, emerging technologies and scientific research
- prioritise **foresight driven**, nimble business practices to innovate in new sectors, at new scales and across uncharted boundaries

AGILITY

- reorganise the workforce around **project focused bottom-up teams**, built to deliver optimal project output with active design and engineering at their core
- **break down traditional career boundaries** and attract employees from fields beyond engineering
- share training, learning, and **continuous development** across the industry creating a rich talent pool which operates on demand for targeted projects
- offer **flexible working conditions** and contracts to create an extended network of on-demand, plug-n-play workforce, facilitated by smart administration tools

AUTOMATION

- develop creative and informed **decision-making driven by data** analytics, on-demand feasibility simulation, digital curation and validation
- curate creative and informed decision-making capabilities, driven by data analytics, **on-demand feasibility simulation** and research led validation
- understand increasing digital liabilities and have **risk models** and mitigation systems in place to ameliorate this
- develop a hyper-networked and **mobile global workforce** supporting on and off site collaboration and automated system validation
- provide enhanced mechanisms for **information capture** and flow to maximise the potential value of data and tacit knowledge that can be extracted from the business

BIBLIOGRAPHY

UBIQUITOUS METRICS

Bliss, L. (2018) **Toronto's 'Smart City' Could Be a Blueprint for Developers.** [Online]. CityLab. Available from: <https://www.citylab.com/design/2018/01/when-a-tech-giant-plays-waterfront-developer/549590/> [Accessed: 21 September 2018].

Chen, J. (2017) **The New Moats.** [Online]. 24 April 2017. Greylock Perspectives. Available from: <https://news.greylock.com/the-new-moats-53f61aeac2d9> [Accessed: 21 September 2018].

Dellot, B. (2018) **Good Work in an Age of Radical Technologies.** RSA. [Online]. Available from: <https://medium.com/@thersa/good-work-in-an-age-of-radical-technologies-52c7bc6b8cc2> [Accessed: 21 September 2018].

Hill, D. (2018) Arup Digital Studio. **Dark Matter and Trojan Horses.** [Online]. Available from: <https://medium.com/dark-matter-and-trojan-horses/arup-digital-studio-7467a61d5fd2> [Accessed: 21 September 2018].

EXTENDED RESPONSIBILITY

Greenfield, A. (2017) **The Ideology Behind Technology.** [Online]. Versobooks.com. Available from: <https://www.versobooks.com/blogs/3333-the-ideology-behind-technology> [Accessed: 21 September 2018].

Gupta, V. (2017) **The Promise of Blockchain Is a World Without Middlemen.** Medium. [Online]. Available from: <https://medium.com/humanizing-the-singularity/the-promise-of-blockchain-is-a-world-without-middlemen-bea499b4a20e> [Accessed: 21 September 2018].

Gupta, V. & ConsenSys LLC (2017) **Building the Hyperconnected Future on Blockchains. The Internet of Agreements.** [Online]. Available from: <http://internetofagreements.com/files/WorldGovernmentSummit-Dubai2017.pdf> [Accessed: 21 September 2018].

ProPublica (n.d.) **Machine Bias.** [Online]. Available from: <https://www.propublica.org/series/machine-bias> [Accessed: 21 September 2018].

Greenfield, A. (2017) **Radical technologies: the design of everyday life.** London; New York, Verso.

Sklar, J. (2015) **New Robot Helps with Masonry on Large Construction Sites.** [Online]. MIT Technology Review. Available from: <https://www.technologyreview.com/s/540916/robots-lay-three-times-as-many-bricks-as-construction-workers/> [Accessed: 21 September 2018].

Woyke, E. (2018) **AI can now tell your boss what skills you lack—and how you can get them.** [Online]. MIT Technology Review. Available from: <https://www.technologyreview.com/s/611790/coursera-ai-skills/> [Accessed: 21 September 2018].

FLEXIBLE AUTONOMY

Fidler, D. Institute for The Future (2016) **Work, Interrupted.** [Online]. Available from: http://www.iftf.org/fileadmin/user_upload/downloads/wfi/ITF_Work-Interrupted_FullReport.pdf [Accessed: 21 September 2018].

Future Agenda (n.d.). **Organisation 3.0.** [Online]. Available from: <https://www.futureagenda.org/insight/organisation-3-0> [Accessed: 21 September 2018].

Perry, T.S. (2017) **The Engineers of the Future Will Not Resemble the Engineers of the Past.** [Online]. 30 May 2017. IEEE Spectrum: Technology, Engineering, and Science News. Available from: <https://spectrum.ieee.org/view-from-the-valley/at-work/education/the-engineers-of-the-future-will-not-resemble-the-engineers-of-the-past> [Accessed: 21 September 2018].

Störmer, E. & UK Commission for Employment and Skills (2014) **The Future of Work: Jobs and Skills in 2030**. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/303335/the_future_of_work_key_findings_edit.pdf [Accessed: 21 September 2018].

Taylor, M. (2017) **Good Work. The Taylor Review of Modern Working Practices**. [Online]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/627671/good-work-taylor-review-modern-working-practices-rg.pdf [Accessed: 21 September 2018].

IMPACT ECOLOGY

Deloitte Insights (2018) **The rise of the social enterprise**. Deloitte Global Human Capital Trends. [Online]. Available from: https://www2.deloitte.com/content/dam/insights/us/articles/HCTrends2018/2018-HCTrends_Rise-of-the-social-enterprise.pdf [Accessed: 21 September 2018].

Future Agenda (n.d.) **Full Cost**. [Online]. Available from: <https://www.futureagenda.org/insight/full-cost> [Accessed: 21 September 2018b].

Kulchisky, M. (2018) **Why Millennials Are Great for Engineering and Construction**. [Online]. FMI. Available from: <https://www.fminet.com/fmi-quarterly/article/2018/06/why-millennials-are-great-for-engineering-and-construction/> [Accessed: 21 September 2018].

Smith, R. C. (ed.) (2016) **Design anthropological futures: exploring emergence, intervention and formation**. London, Bloomsbury Academic, an imprint of Bloomsbury Publishing, Plc.

University of East London School of Architecture, Computing & Engineering. (2018) **Tangible – Intangible Heritage(s) – Design, Social and Cultural Critiques on the Past, the Present and the Future**. [Online]. 15 June 2018. Available from: <http://architecturemps.com/london-2018/> [Accessed: 21 September 2018].

UNCHARTED TERRITORY

Brouet, A.-M. (2018) **Scientists sketch out the foundations of a colony on Mars**. [Online] Available from: <https://actu.epfl.ch/news/scientists-sketch-out-the-foundations-of-a-colony-/> [Accessed: 21 September 2018].

Living Architecture Systems Group (n.d.). **Can architecture integrate living functions?** [Online]. Available from: <http://livingarchitecturesystems.com/> [Accessed: 21 September 2018].

Oxman, N. (n.d.) **Silk Pavilion**. [Online]. MIT Media Lab. Available from: <https://www.media.mit.edu/projects/silk-pavilion/overview/> [Accessed: 21 September 2018].

Rüede, A.-M., Ivanov, A., Leonardi, C. & Volkova, T. (2018) **Systems engineering and design of a Mars Polar Research Base with a human crew**. Acta Astronautica. [Online] Available from: doi:<https://doi.org/10.1016/j.actaastro.2018.06.051>.

Temple, J. (2017) **As climate dangers grow, it might be time to begin limited geoengineering experiments**. [Online]. MIT Technology Review. Available from: <https://www.technologyreview.com/s/604081/the-growing-case-for-geoengineering/> [Accessed: 21 September 2018].

U.S. Global Change Research Program (2017) **National Global Change Research Plan 2012–2021: A Triennial Update**. [Online]. Available from: <https://downloads.globalchange.gov/strategic-plan/2016/usgcrp-strategic-plan-2016.pdf> [Accessed: 21 September 2018].



ENGINEER OF THE FUTURE, 2018

Authored for Atkins & SNC-Lavalin by:

IMPERIAL COLLEGE LONDON

Dr Leila Sheldrick

Prof Sandra Kemp

ID PROJECT OFFICE

Andrew Slack

Bentley Farrington