

A person is sitting on a rocky ledge, looking at a smartphone. The background is a landscape with trees and hills. A large blue circle is overlaid on the image, and a smaller yellow circle is overlaid on the person's phone.

Self-Repairing Cities

Impact Story

Gary Dymski, Arpita Bhattacharjee,
Andrew Brown, Gary Graham



“By far the greatest danger of Artificial Intelligence is that people conclude too early that they understand it.”

[Eliezer Yudkowsky](#)

What we hope to achieve

- Build resilient and sustainable infrastructure systems
- Knowledge creation to build inclusive cities
- Understand disruptive technologies and how they can serve as catalysts towards a higher productivity frontier
- Empower individuals and communities towards political participation and engaging in critical decision-making processes.
- Paradigm shifts in education geared towards specific skills training complementary to technological advances

PREPARE

The questions we seek to answer

“Will I lose my job?”

Scoping out the level of work displacement when robots and AI replace human labour. Identifying the jobs and tasks most at risk, and hence the sections of the work force that face a high probability of unemployment.

“How do we make this a fair game”

Safeguard interest of vulnerable sections through creation of safety nets. Restructure education systems so as to impart knowledge and skills complementary to advances in Robotics and AI systems. Identifying new tasks and re-training opportunities. Shift focus towards capabilities and how to build a workforce able to keep up with rapid technological advances

Drill down (in time), then push out (through time)

- Worker job displacement: Leads to UK
- Analytical approaches to employment threat and gain
- Our next analytical steps
- The children of infrastructure workers
- From the Self-Repairing Cities project to the creation of new industries and jobs
- Putting humans and communities into the robotic/future landscape

Worker job displacement: Leeds to UK

Immediate impacts:

Asphalt maintenance and repair / Road construction / Telephone / Cable maintenance / Water pipes, storage / Electric system / More ...

Further impacts:

Workers living in Leeds, in similar categories to those above
Households with labor-force members in places where those in the above categories live

Workers in cities "like" Leeds – maybe "Northern powerhouse" places
Workers in towns surrounding these NP cities, and in the countryside

Still more general impacts:

Workers in occupations that are vulnerable to being taken over by Robotics / AI – where, and in what numbers?

Which places are especially vulnerable?

Analytical approaches to employment threat and gain

Shift-share analysis of employment data: a decomposition of why jobs have been lost or gained, focusing on technological impacts, industry shifts

Mechanical/behavioral approach: what machines can do better than people, what jobs are at risk, where are they concentrated geographically?

- Frey and Osborne, "The Future of Employment: How Susceptible are Jobs to Computerisation?," Oxford, Sept 17, 2013 - Using a "Gaussian process classifier" based on O*NET data, 47% of US jobs are at risk.
- Arntz et al. (2017, *Economics Letters*) use detailed task data and show that the automation risk of US jobs drops to 9 %.

Different modelling approaches

- Acemoglu and Restrepo (2018, NBER Working papers): A task-based framework that emphasizes the *displacement effect* (machines replacing labour) and a counteracting *productivity effect* (labour saving increases labour demand for non-automated tasks).
- Kim et al. (2017, Futures): Track jobs that are susceptible to future computerization using a model based on Markov chains. Simulations *demonstrate the importance of intervention policies (including improved technical education) in these transitions.*
- DeCanio (2016, Journal of Macroeconomics): Estimate the impact of AI technologies on aggregate wages by focusing on the *elasticity of substitution between human and robotic labour.*

Our next analytical steps

- **Combine**, under one ambit these approaches to the implications of the advent of AI and robotics.
- **Replicate** estimates for these models using UK datasets. This will yield publications and generate more robust results, helping us draw out policy & industry implications.
- **Develop overall** lessons from the different models, develop and put to test a theory of value and distribution as the fourth industrial revolution looms large.

The children of infrastructure workers

The availability of training/education to prepare young people for future roles in society

- The evolution of the 'digital divide'
- Review studies of education & work-preparation, focusing on 'future fit' knowledge and skills
- Review school programs with innovative approaches to 'future fit' work- and university-preparedness, focusing on STEM and on areas with lower socio-economic status
- Co-production, sharing sessions in city & town neighborhoods

From the Self-Repairing Cities project to the creation of new industries and jobs

- The reimagination/reinvention of manufacturing
 - First-order vs second-order breakthroughs
- More circular economies: from cost to 'output'
- Systems of provision ('care economy'), infrastructure, energy, as sources of both demand stimulus and renewed supply innovation (build on iBUILD)
- Physical and social infrastructure systems thinking as pathways to innovation and new engineering vistas, living within the boundaries of a resource-limited, human-centred world

From the Self-Repairing Cities project to the creation of new industries and jobs

Some challenges have already surfaced in our project:

- Open-source vs proprietary knowledge advance
- Off-the-shelf vs custom-built hardware choices
- Hierarchically-controlled vs. decentralized, 'worm' systems with dispersed decision-making
- Visible vs invisible systems of repair and rehabilitation

Citizen acceptance of new system introduction

Experimental systems vs fully-implemented solutions ..

- Link to UK Industrial Strategy White Paper (& beyond)
- Link to ESRC Productivity Insights Network (May 2018)

Joining the Productivity Insights Network



If you have a stake in the productivity debate then we want to engage with you. The Productivity Insights Network is all about building capacity, developing new insights and sharing good practice. Whether you want to join our mailing list or pioneering new directions in productivity research, in order to change the tone of the debate in theory and practice the Productivity Insights Network is all about bringing partners together to identify the key questions and develop new insights together.



Productivityinsightsnetwork.co.uk

Our team

The core Productivity Insights Network team is led by Professor Philip McCann and Professor Tim Vorley at the University of Sheffield. All of the co-investigators are contributing to the programme of work through their thought leadership, by championing interdisciplinary research as well as promoting stakeholder engagement.

Professor Varia Sena
University of Essex

Professor Gary Dymski
University of Leeds

Professor Kirsty Newsome
University of Sheffield

Professor Robert Huggins
Cardiff University

Mr Benjamin Gardiner
Cambridge Econometrics

Dr Katerina Lisenkova
University of Strathclyde

Dr Maria Abreu
University of Cambridge

Professor Andrew Henley
Cardiff University

Dr Leasa McSorley
Glasgow Caledonian University

Professor Richard Harris
Durham University

Professor Colin Mason
University of Glasgow

Kate Penney
University of Sheffield

Professor Iain Docherty
University of Glasgow

Mr Jonathan Cook
SQW Ltd

Phil Wallace
University of Sheffield

Changing the tone of the debate

Please contact any of our network partners or email productivity@sheffield.ac.uk for further information of queries about the Productivity Insights Network

Putting humans and communities into the robotic/future landscape

What are the opportunities and obstacles to:

- sharing knowledge, and creating knowledge-rich societies, and
- Sharing resources, and enjoying widespread prosperity?

How to engage all people/citizens/residents – in efforts to be better, make a better world?

- The role of engagement as an organizing principle for economic life
- The need for emotional intelligence in systems design and operation



“As more and more artificial intelligence is entering into the world, more and more emotional intelligence must enter into leadership.”

[Amit Ray](#)