



Arts and  
Humanities  
Research Council

# Living with Machines



# Living with Machines: at a glance

- Living with Machines is an ambitious interdisciplinary research initiative, advancing the frontiers of the humanities, AI and data science.
- Living with Machines brings together researchers from the British Library, the Alan Turing Institute and a range of universities to study the human impact of what is commonly termed the 'Industrial Revolution'.
- UK archives and libraries contain a vast amount of information about this period, but researchers have lacked the technology to fully explore the millions of collected newspapers, census records and other sources.
- The project team are developing new methods in data science and AI to allow researchers to study these collections on a massive scale.
- An exhibition, articles and books, and a programme of press and broadcast pieces will share new discoveries from the research and the innovative means by which they were reached. The project will leave a legacy of tools and open source software for use in future archival research.
- The Arts and Humanities Research Council (AHRC) administers the programme with funding from UK Research and Innovation's Strategic Priorities Fund.

All photography courtesy of the National Library of Scotland.



# A richer picture of our past uncovering our relationship with AI and automation

**Professor Christopher Smith**

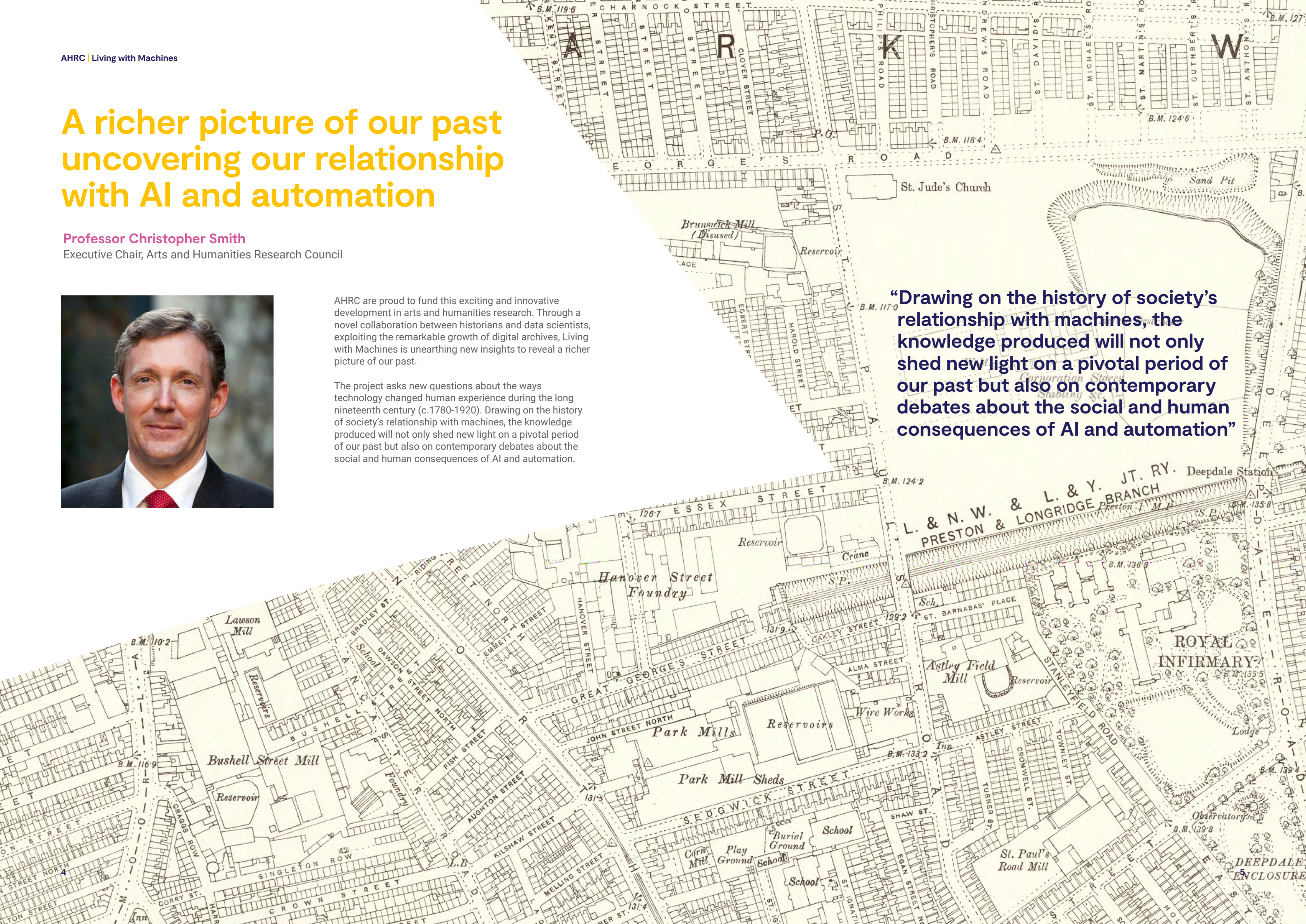
Executive Chair, Arts and Humanities Research Council



AHRC are proud to fund this exciting and innovative development in arts and humanities research. Through a novel collaboration between historians and data scientists, exploiting the remarkable growth of digital archives, Living with Machines is unearthing new insights to reveal a richer picture of our past.

The project asks new questions about the ways technology changed human experience during the long nineteenth century (c.1780-1920). Drawing on the history of society's relationship with machines, the knowledge produced will not only shed new light on a pivotal period of our past but also on contemporary debates about the social and human consequences of AI and automation.

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# Driving multidisciplinary collaboration

**Ruth Ahnert**

Principal Investigator, Living with Machines

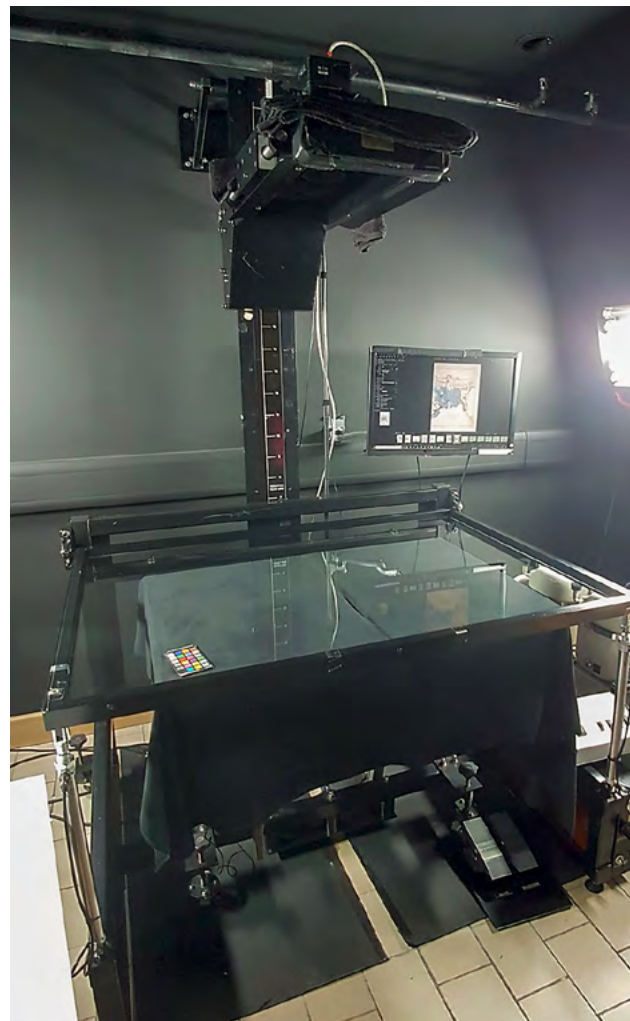


The most important thing we have achieved on the project so far is the development of genuinely cross-disciplinary collaboration – people from widely different research backgrounds coming together to solve a common problem. This leads to fresh insights.

Our act of collaboration is not just between researchers, but also with machines themselves. Across the project we are developing annotated data that can help train machine learning algorithms to help us identify at scale the features we are looking for – in texts, in tabular data like census returns, and in maps. For me, that is the new frontier in research in the humanities and in the cultural heritage sector.

Central to the Living with Machines project is a commitment to sharing methods so that they can be reproduced and developed by other researchers and cultural heritage organisations.

**“This group is using image analysis and computer vision – methods that allow computers to ‘read’ maps on their own – to compare nearly 9,000 different Ordnance Survey maps covering three time periods”**



The project is currently sharing methods to be reused or developed by others including:

- Publishing papers about the novel research methods we are developing
- Developing open source ‘notebooks’ that include code, explanatory text and other information to encourage others to reuse and adapt our work
- Developing tutorials, which will be published and delivered through hands-on training sessions with our colleagues in the Galleries, Libraries, Archives and Museums sector and in Higher Education.

## The project at work: mining data from Ordnance Survey Maps

One group of Living with Machines researchers are focusing on historical maps, using these to understand life during the nineteenth century and developing new tools for ‘map mining’, which refers to using automated or semi-automated techniques to identify and extract data from maps. This group is using image analysis and computer vision – methods that allow computers to ‘read’ maps on their own – to compare nearly 9,000 different Ordnance Survey maps covering three time periods. This work relies on the data generously shared with the project by The National Library of Scotland, which hosts the largest digitised and online map collection in the world, as well as map data from project partners the British Library. Using this data the project team are examining the locations of industrial buildings as they begin to appear on Ordnance Survey Maps, measuring how close people lived to specific services in different regions, and looking at many other aspects of the built environment over time.



# ‘Unlocking’ never-before-seen stories

**Dr Katherine McDonough**

Senior Research Associate, Living with Machines



Trains, tracks and all the associated machinery and infrastructure related to rail pose an interesting case in point: train schedules and freight business documents help us understand the impact that rail had on commute times and on the transport of goods, but we know very little about the effects of rail on local communities at a more granular level in the nineteenth century. With this map analysis method alone, we can capture visual patterns of residential and industrial development shaped by the arrival of rail.

**“Collaboration with data scientists and heritage professionals means that we have collected expertise spanning curation, digitisation, analysis, interpretation and preservation”**

One of the important lessons this research has taught us is that machines were everywhere in the nineteenth century. They were inside homes, filling factories, travelling down streets and tracks. Many of these machines, such as trams and power looms, do not appear on maps and are invisible in the historical record. But the maps have content that acts like a proxy for the presence of those machines. Buildings labelled as ‘mills’ or areas that are identifiable as residential mean that we can ‘search’ for the places where different kinds of machine were in operation. Understanding where these places were requires the eye of a historian, someone who can interpret the landscape of the past based on knowledge about what happens where.

By documenting ‘machine geography’ across different maps printed throughout the nineteenth century we can then learn more about the choices that individuals, communities and the state made during industrialisation, and how these changed over time. Furthermore, where other sources exist that can add context to machine geography, we can tie these changes to real people, their homes, and their businesses.

While studying these changes in the nineteenth century does not translate into simple lessons for today, it does point to the long-standing effects that rail has had on British lives and could inspire studies with new, remote sensing data that explore whether historical patterns hold true or have evolved because of other cultural, economic, and environmental factors.

Our method indexes the British landscape according to historically-significant elements: for example, buildings, rail infrastructure and industrial sites. In tune with the affordances of maps at different scales, we prepare browsable datasets that act as a guide to general patterns in the natural and built environments. One of the main features of our pipeline is that it connects granular information to national patterns. This can lead to finding local or national-level stories that could never be found examining more than 100,000 maps one at a time.



Collaboration with data scientists and heritage professionals means that we have collected expertise spanning curation, digitisation, analysis, interpretation and preservation: open access to collections and research outcomes is essential to interdisciplinary research. The National Library of Scotland’s online map collection provides a model of what such access can enable. Their georeferencing of these maps has fundamentally allowed many new ways of using and understanding them, and the technologies they employ allow dynamic ways of accessing the maps.

Our method seeks to add an extra layer of access to maps like this, as well as collections that haven’t received the same attention or resources, making them visually searchable. For museums, archives, state agencies and even businesses this could have a substantial impact. Uncatalogued collections could be ‘unlocked’ with our data-driven method – making them more accessible to anyone who might be interested in identifying visual patterns in those materials.



“In computer vision, the chance to work with nineteenth century maps allows us to identify open challenges in the field”

# Developing data-driven methods for working with heritage materials

Kasra Hosseini

Research Data Scientist, Living with Machines



As a research data scientist I contribute to the development and implementation of machine learning methods to extract information from large historical datasets. The design of these algorithms cannot be done without close collaboration with our historians and humanities researchers.

A machine learning method is only useful if it helps to answer historical questions by supporting or rejecting a hypothesis and by taking into account systemic biases in large-scale historical sources. Our collaboration combines the insights of historical thinking and applicability of machine learning algorithms at the level of experiment design. The real payoff of this is that together we develop data-driven methods for working with heritage materials.

There are a lot of unknowns about the relationship – in the past and in the future – between humans, machines, and the ways they are organised in the landscape. In Living with Machines, we have an opportunity to provide clearer information about that organisation – examining maps as snapshots of the industrialising landscape just as others would look at remote sensing imagery to understand that landscape today. In computer vision, the chance to work with nineteenth century maps allows us to identify open challenges in the field where detection, classification or segmentation tasks will differ from those methods developed for contemporary data (for example, satellite imagery). This multidisciplinary perspective has also guided the design of our tools and software libraries – from ways to access and explore the datasets, to interactive annotation tools and methods to assess the results.

This method has the potential to be applied to any geo-referenced visual material that is so large that it defies analysis. It can also be applied to modern data (for example, satellite imagery) to monitor the changes in regional morphology caused by human activities. The data about the British landscape that we create using this method will be of value to public and private entities who wish to compare such present-day data with the past.



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