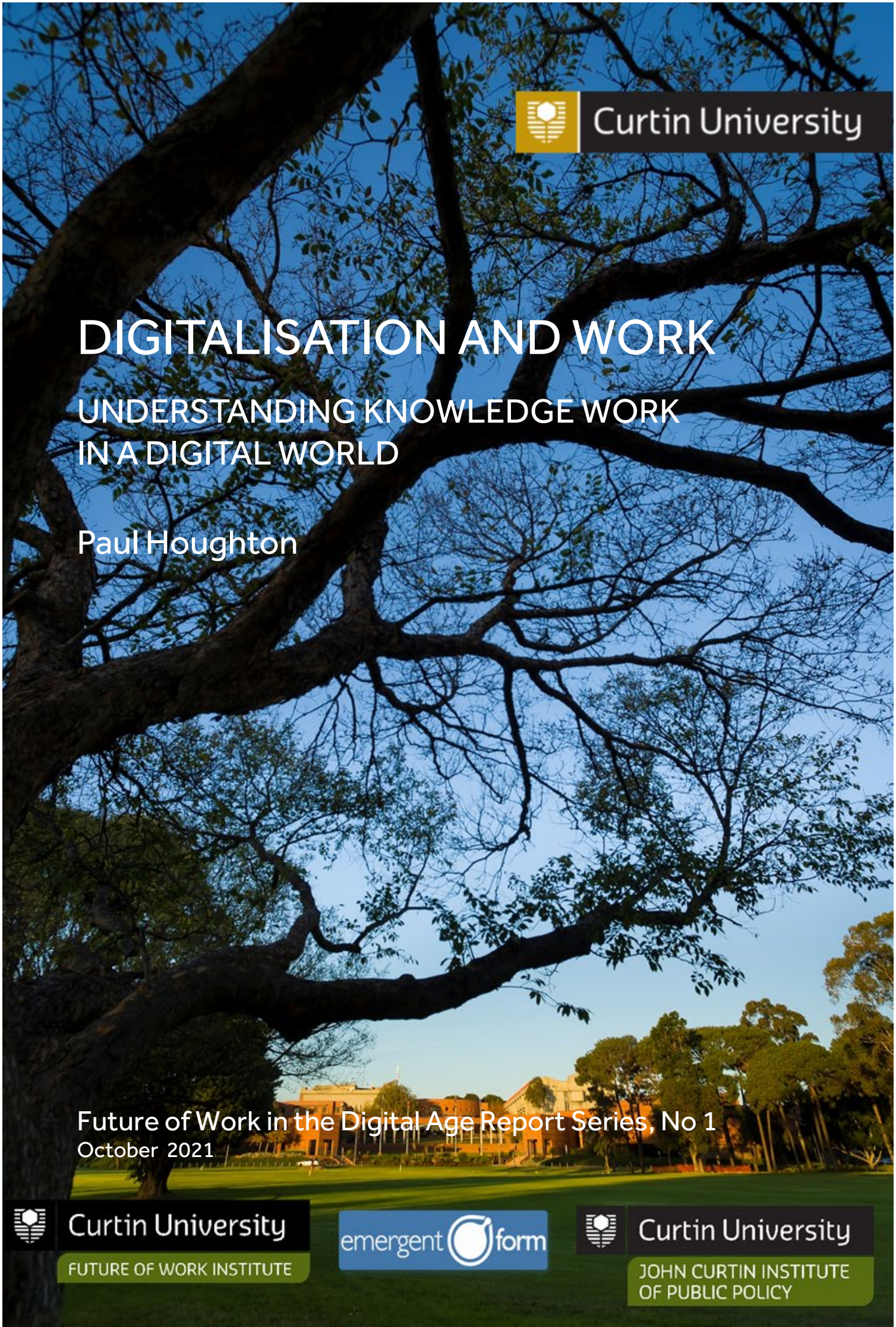
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DIGITALISATION AND WORK
UNDERSTANDING KNOWLEDGE WORK
IN A DIGITAL WORLD
Paul Houghton
Future of Work in the Digital Age Report Series, No 1
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ABOUT THE AUTHOR

Paul Houghton is the Managing Director of Emergent Form, a Perth-based consultancy focused on information and knowledge in a digital world. An early career in all aspects of information management at the Australian Bureau of Statistics led to a role as Principal Policy Analyst for information policy at the Department of the Premier and Cabinet and the Treasury in the Western Australian government, before becoming Director of Information Services at the Department of Transport. Later Paul became Director of KT Studio, which was established to research the use of technology in knowledge systems. Topics such as e-learning, e-commerce and creative communities were explored with the Western Australian government and others.

Bringing together this experience and an academic background in management, Paul has been able to undertake many projects through Emergent Form which give him a well-grounded understanding of the shifts and changes impacting our economy and society as the digitally enabled future becomes clear.

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FOREWORD

In two reports for the JCIPP's 'Future of Work in a Digital Age' series, Perth-based digital strategist Paul Houghton examines the nature and impacts of digitalisation and the associated acceleration of changes to work across various parts of the economy. In particular, the combination of digitalisation with knowledge and creative work is explored. It is this combination that is now driving growth and changes to industry, government and society – but it is a combination that is still not well understood. In particular, we are still struggling to know how to respond to digitalisation from a skills perspective.

This first report in the series clarifies the need to distinguish between digital technology, digitisation and digitalisation, and showed how digital transformation of companies and industries relies on all three. The second report builds on this understanding of digitalisation to identify the best way to tackle skills gaps in the light of the pace and complexity of change, with a particular focus on the relatively neglected area of up-skilling within jobs, as opposed to re-skilling as people change jobs. The reports are a starting point and will hopefully generate more research and discussion, policy analysis and strategic options.

An iterative methodology was adopted that brings together many of the current threads of causes, impacts and strategic options. The project was supported by initial meetings with FutureNow, the Western Australian skills advisory body for the creative, technology and leisure sectors. The project then involved initial desktop research across a number of industry sectors plus interviews with people from the design, freelancer, technology and creative fields like film and television.

The interviewees reinforced the view that they were responding to digitalisation and changing the way they worked, by both drawing on existing skills while continuing to rapidly develop new skills. In many ways they are ahead of the curve. We believe that the lessons to be learned from their experiences can be applied to a broader section of the economy.

To quote William Gibson: 'The future is already here – it's just not evenly distributed '.

Professor John Phillimore
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October 2021

INTRODUCTION

The adoption of digital processes and tools is now impacting the whole economy, something that has taken nearly half a century. It picked up pace through the widespread use of the internet, then via the interconnection of computer systems and now through the adoption of new technologies that support distributed applications, automation and intelligence. Along the way there have been successes and victims of these changes – but change has been relentless over a long period.

For example, the ongoing digital transformation of manufacturing is now considered the Fourth Industrial Revolution, which is "rapidly driving transformational disruption across every sector," according to The World Economic Forum.[1]

Terms such as digital disruption or transformation imply these changes are sudden or that they have come from nowhere, but this is not always the case. Interoperation of financial systems in the 1990s led to massive changes globally across that industry in the following decades. The same thing, with the addition of the internet, led to big changes in the transport, logistics and tourism industries – all played out over decades.

The growth of the services sector and of knowledge work (first identified in the 1950s) and creative work (identified in the 2000s), has also taken a long time to become accepted as business as usual across all industries. Yet some of the underlying ideas and practices in both forms of work are recognisably the same as in previous eras, except for the addition of digital technology. The speed of change and reach are different now though, which opens up new markets and the possibility of new products and services.

The impact of digitalisation has been and continues to be an evolution, not a discontinuity, for most industries. However, if these changes are not detected, industry participants can be blindsided. Not only that, the introduction of new digital technologies can also accelerate evolution in ways that will demand new processes and new skills which could be in short supply.

Digitalisation brings with it the lessening of a reliance on place-based activity where business was centred on a physical location. This is especially so for both knowledge and creative work. That means that a significant proportion of work across all industries can take advantage of digitalisation to disaggregate work and operate with more autonomy across networks of people as well as of technology. The very nature and organisation of work is changing as a result.

This means that the future of work is a part of this ongoing evolution that is driven by digitalisation and a recognition of the value and impact of knowledge and creative work. The principles that guided the previous century of work in large parts of the current economy are now being questioned and revised as a series of major shifts are occurring, driven by digitalisation. A major issue of addressing a skills gap around digitalisation has been identified across a range of literature and commentators, but the underlying rationale, nature of the changes that created these gaps, and the best

way to address them, is not clear.

In this report, I unpack the meaning of digitalisation and its application to work, organisations and industries, including a brief demonstration of how this applies to two industries. The second report looks in more detail at the implications of digitalisation for work and up-skilling.

Knowledge Work

The emergence of the knowledge economy and knowledge work was first discussed by Peter Drucker[2] as early as 1959. He established a focus on this (then) emerging type of work, well before the broad introduction of digital technology. It was when information technology meant paper ledgers, typing pools and mechanical calculators.

Along with Machlup[3] and Bell[4], Drucker went on to describe the form of work he called information-based work and what Bell described as post-industrial work. This work was increasingly symbolic and emphasised the importance of abstract ideas.[5]

Initially part of the primary and secondary sectors of the economy, recognition grew that this less tangible work was increasing in importance and economic impact. By the beginning of the 1970s the OECD estimated that 40% of the US workforce was engaged in such work.[6]

Traditional industries such as steelmaking transformed from mass production to custom production and services offering different steels for very specific purposes tailored to customer requirements at a premium. Similarly IBM was once classified as a manufacturer but by the 1990s the manufacturing cost of an IBM PC was only 10% of the purchase price; the rest was research, design, engineering, sales and service.

The most stunning example of this trend is Apple Inc, now the biggest company in the world by market capitalization. Its valuation is now based on less tangible ideas like design, engineering, marketing and logistics. It was not always so. Apple produced its own computers like the Macintosh in robot assembly lines in Fremont in the 1980s. This shift was made possible by a sophisticated network of suppliers worldwide who can tailor extremely specific raw materials, components and assembly services to meet Apple's requirements.

The growth of the service (tertiary) economy has also underlined the growing importance of information and knowledge leverage which was in turn made more effective across locations and organisations with digital technology. These changes have led to the recognition of knowledge workers as a valuable contribution to organisations in all industries, especially those involved in the service economy but increasingly those in entirely new forms of work that involved creativity, innovation and entrepreneurship.
This has led to both an increase in the percentage of work in any organisation that is considered to be knowledge work, and the creation of new organisations that only do knowledge work, sometimes on behalf of others.

However, before further exploring knowledge work now and into the future, we need to understand the nature and impact of digitalisation.

Dimensions of Digitalisation

While the broader economic impacts of digital technologies and information systems can be seen to be playing out over time, there is still some apprehension and lack of understanding over the impacts on organisations and business. This applies to both private and public sectors as these organisations adopt digital technologies and information systems which offer new possibilities. They also threaten existing systems, challenge workers' established skill sets and disrupt organisation culture – to better meet the changing needs of citizens, customers and business partners.

These are big changes and challenges. At the heart of them is the impact of new and emerging digital technologies on an organisation, its processes and its people. The time to impact for these technologies can range from decades, as is the case for virtual reality or artificial intelligence, through to almost 'overnight' as people working from home have to become rapidly familiar and reliant on video conferencing and tools like Zoom and Slack.

The impact on business processes, job tasks and skills is often at the shorter end of those time-scales. 'Digital technologies are electronic tools, systems, devices and resources that generate, store or process digital data. Examples include social media, online games, multimedia and mobile phones'.[7]

Selecting the right digital tool for the job requires almost complete knowledge of the work to be undertaken, the outcomes sought, the resources needed and how that work will evolve over time. A focus on the tools alone neglects the essential ingredients for their successful implementation, namely, having the right people and processes in place to take advantage of the potential of the technologies and to respond quickly to new opportunities they present.

It is here that the concepts become somewhat messy and intertwined. The difference between the different stages of implementing change as a result of digitalisation are quite distinct, but the terminology and the organisational response are not as clear cut.
Too often the response to a change that is driven by technology is handed to the IT branch whose primary job is to select, implement and maintain the technology.
In many cases this extends to the task of digitisation and management of information assets and data. Rarely does it include change management, business process change or skills development. These issues are directly related to broader management rather than a function specific response and can be considered to be part of a broader strategic approach.

In the following discussion, we unpack the different elements of digitalisation, in order to better understand its implications for industries, for companies, and for work.

Digital Technology

The core of the digital changes underway in organisations is driven by the development and deployment of new digital technologies as new ideas become reality through the rapid developments in processing power. Of course, many technologies are developed but not necessarily taken up. Those that are can make a big difference in a short space of time, like Zoom or Slack, but these are building on other technologies from the past.

Technologies like cryptocurrency are taking longer and are forming new interconnected technology ecosystems as many players develop overlapping variations on the theme. Some like Virtual Reality (VR) have taken decades, waiting for adequate processing power in lower end computers. Mass adoption takes time to come about sometimes.

Another example would be the introduction of the iPhone in 2007, shown as an 'iPod, a phone and an Internet communicator' in one device. It then made the internet and location data personal and mobile, which led to the development of entirely new service platforms such as Uber which in turn revolutionised on-demand transport.

One thing that is common is that the hardware, software and systems are being developed to achieve acceptance and impact. These do not operate in isolation. For any organisation or individual, the technology is a tool or enabler which allows new things to happen or old things to be done differently. This involves the use of data or information which has existed in analogue form in the past or increasingly exists in digital-only form now.

The worldwide spread of digital technology is as important as the implementation of other general purpose technologies (as economists call it), e.g. a technology like steam power or electricity which is so broadly useful that it re-orients the entire economy and tenor of life.[8]

Digitisation

Digitisation refers to taking analog information and encoding it into zeroes and ones so that computers can store, process, and transmit such information. According to the Gartner Group, it is 'the process of changing from analog to digital form'.[9] It is the conversion to digital form of the data or information, not the business processes which make use of the data or communicate the information. That is digitalisation.

Digitalisation

The broader context for the use of digital technologies and digital content is digitalisation. The Brookings Institute quotes Gartner again, saying 'Digitalisation is the process of employing digital technologies and information to transform business operations'.[10] They go further and focus on how digitalisation impacts people, stating 'Digitalisation is transforming the world of work. The acquisition of digital skills has

now become a prerequisite for individual, industry and regional success'.

This points to a range of issues beyond the digital information itself. Why is information needed, how is it used and what can it now be used for? While some organisations have been managing the broader context for decades (e.g. as long as computers have existed), work on business models, processes and people often gets neglected or at least gets a lower profile. This is about leveraging the digital content in order to achieve improved and new business models and processes with a specific goal in mind such as efficiency, growth etc. These improvements can apply to either the organisation as a whole or to specific parts such as the production process.

In some cases, digitalisation can apply outside the organisation to include the customer, as seen in digital health care or digital government. Digitalisation will occur at the project level in the main. This differs from digital transformation which is enterprise-wide and more broadly encompasses things like the customer experience, business model and operational process at a more strategic level.

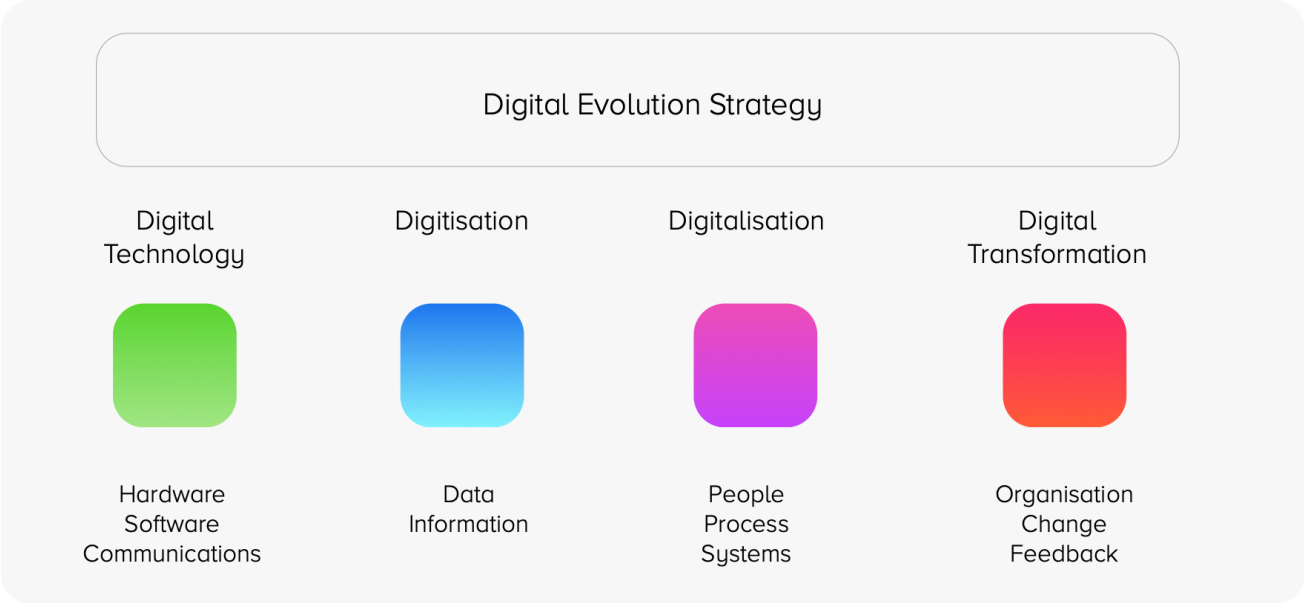
Digital Transformation

As an organisation moves towards becoming a digital business and builds upon the implementation of new technologies and digitised content, this needs to be accompanied by an appropriate business model, culture and skills profile. Digital transformation occurs at a strategic level to ensure an organisation meets and exceeds customer expectations. It is 'Customer-driven strategic business transformation that requires cross-cutting organisational change as well as the implementation of digital technologies'.[11]

Digital transformation requires the organisation to deal better with change overall, essentially making change a core competency as the enterprise becomes customer-driven end-to-end. Such agility will facilitate ongoing digitalisation initiatives but should not be confused with them.

Digital transformation is driven at the strategic level and involves leadership, staff at all levels and importantly, the customer. Rather than a focus on the processes and skills that relate to digital technology alone, digital transformation encompasses all aspects of the business and points to a broader skillset beyond digital skills – for example, analytical capability or design skills. The Figure below shows the evolution of digital

strategy.



In the final analysis, therefore, we digit*ise* in order to create or convert information into digital form; we digit*alise* processes and roles that make up the digital operations of a business; and we digitally *transform* the business and its strategy. Each one is necessary but not sufficient for the next, and most importantly, digitisation and digitalisation are essentially about technology, whereas digital transformation is not. Digital transformation is about the customer and the service mix to meet their needs, which are changing faster now than ever.

To develop a digital transformation strategy, the evolutionary nature of change, the pace of change and the multi-dimensional nature of digitalisation must be considered. It is not as simple as a technology choice. A Digital Evolution Strategy will consider each of these dimensions and also provide feedback loops as each informs and influences the other.

Two examples of very different industries that have undergone a digital evolution are that of the music industry, and shipbuilding. We describe each below.

Case study 1: the digital evolution of the music industry

The digitalisation of music has occurred over the last 20 years and has fundamentally driven the changes to and in some cases, the elimination of some of the main players in the music industry. The table below describes these changes in some detail, in particular the dimensions of digitalisation and the broader impacts that are sometimes overlooked.

Technology Phase	Digital Technology	Digitisation	Digitalisation	Digital Evolution	Work Evolution
CD (digital music)	CD standard, consumer players	Analog music converted to digital	Familiarisation and use of a new player	Re-purchase of existing music	Retail workflow largely unchanged
CD-R (Rip, Mix, Burn)	Writable CD	Digital music tracks copied	Curating, editing and recombining tracks	New 'albums' or playlists created	No involvement of record industry
MP3 (music compression), iPod	Compression standards & tools	Compressed music	1000 tracks in your pocket'	Custom digital music is mobile	Sales and production drop
Napster (music sharing)	File sharing standards and software.	Online catalogues and listings	Sharing music files across the internet	Networked digital music sharing	Focus shifts to legal blocking.
Spotify (music streaming)	Digital libraries and streaming server/clients	High quality music streams online via subscription.	No ownership of music, use of playlists.	Mass availability, royalties to artists	Subscription and delivery infrastructure

The shift to digital music occurred in the early 1990's with the broader introduction of recorded music on Compact Disc, a technology co-developed by Phillips and Sony and released in 1982. This offered an increase in quality and capacity on a single disc which was conveniently smaller than the existing LP record. The music industry utilised established processes for acquiring music and distributing it which was largely based on an industrial manufacturing model but the end product was released to retailers at nearly four times the price per album.

Personal computers at that time gained the ability to read the CD format which was used to distribute software and games and also play music. Later in the 1990's, these drives and a new writable format (CD-R) brought the ability to copy CD music and recompile music from a range of retail CD's onto a customised CD-R to cater for individual tastes. This was the era of 'rip, mix and burn' and the music industry's response was to continue with the existing industrial model while shipping more and more CD's. The parallel development of compression technology (MP3) by the Fraunhofer Institute in Germany meant that a CD-R could contain many more tracks.

Personal computers also became networked and gained tools for sharing information such as using a browser to access the World Wide Web. As bandwidth improved, sharing the smaller, compressed files became feasible - which is what happened. Now the music industry wasn't involved as music files were freely shared via Napster and other services. In 2001 a small computer called the iPod was sold as holding 1,000 tunes in your pocket which allowed compressed music to be enjoyed independently of the personal computer.

The music industry was changing, new entrants into the music business were now technology companies, not manufacturing and distribution companies. This occurred at a speed that didn't allow the incumbents to respond and led to a major shift in both the economics of music and the processes by which people enjoyed it. Now major technology companies stream music directly to devices all over the world for subscription to massive libraries. This is all a far cry from selling vinyl in a cardboard cover.

Case Study 2: Digitalisation in Shipbuilding[12]

The table below describes the way in which digitalisation has impacted what might be regarded as a 'traditional' industry – shipbuilding.

The key new driver for the bulk of the changes to the shipbuilding industry, in line with big changes in many other industries, is digitalisation. This is already underway in some aspects of the workflow of a ship build, predominantly beginning in the design office. Other industries such as automobile manufacturing and aerospace are considered to be years ahead.

Technology Phase	Digital Technology	Digitisation	Digitalisation	Digital Evolution	Work Evolution
3D modelling	Computer Aided Design (CAD)	Plans and asset information held in one 3D model	Change management process & 3D skills	Managing model changes	Accommodating complexity
Data Repositories	Product Lifecycle Management (PLM)	Project management, inventory and assets	Data management and change management	Distributed work, complex coordination	Linking business processes and data
Shared models	Digital Twin	Data in context	Shared models, continuous updates	Recording change over product lifecycle	Tracking change and accountability
Real time data	Internet of Things (IOT)	Operations data & predictive modelling	Operations and maintenance modelling	Iterative product tuning	Maintenance and depreciation optimised
3D Experiences	Virtual Reality	Human scale shared experience of models and data	Collaboration with shared 3D tools	Global teams in real-time spaces	Shared experiences across teams

The emergence of product lifecycle management (PLM) technologies that are tailored to the unique challenges of developing advanced ships has been partially responsible for Integrated Product Development Environments which allows for parallel production across different and diverse teams. This results in productivity gains, improved shipbuilding performance and ultimately reductions in the total cost of ownership of a ship.

The PLM combines tools for product modelling using 3D computer-aided design (CAD), project management and coordination tools, 'database features' to manage parts, suppliers, and production information in a completely integrated way. This approach scales across multiple teams and multiple shipyards.

Another idea across this new, integrated shipbuilding landscape is that of a digital twin or virtual twin. The concept here is that the digital model developed as part of concept design, carries through to detailed design and engineering, production and ultimately to the operation of the vessel. The design is developed as a 3D model, the same as with the engineering phase although not always in the same systems. Bringing the actual build data into a digital model is challenging but possible. Then the operational data and live data from sensors etc. can become part of this evolving digital twin model.

Sensor data for the operational ship is gathered from large numbers of sensors and analysed for anomalies which can be used to tune performance or predict possible failures. Currently this data is largely brought together in the form of data lakes but increasingly this data is analysed at the edges using machine learning on the sensors themselves.

A more recent addition to the suite of digital tools in shipbuilding is that of virtual reality. The digital models at concept or detailed design stage can finally be experienced by the non-expert as if they were real - allowing inspection, review and problem solving as if the ship were already built. Parts of the same model can provide the detail of compartments or blocks for production.

The addition of collaboration tools inside of VR now allows for multiple people to undertake these reviews which can occur across the world involving experts for issue resolution, annotation of models for change by designers and recording of joint decisions for contract variation.

From Knowledge Work to Creative and Invisible Work

The way we work and the very nature of work have shifted dramatically over the last decade and even more so in this current century when compared with the last. There are a number of important trends that stem from the impact of digitalisation that are important to understanding the factors impacting on work and organisations today and into the future.

Increasingly, the application of digital technology to knowledge work in all its forms changes the way this work is performed. It also extends the capacity of the knowledge worker to assimilate more data and information from a much wider range of sources and have an impact over a broad client group, faster than ever before. This opens up new possibilities very quickly, faster often than the capabilities of the existing workers.

It is critical to understand the scope and extent of knowledge work, particularly in the context of digitalisation. The democratisation of computing through the 1980's, combined with access to telecommunication networks in the 1990's, paved the way for the explosion in the last two decades of 'always on' access to data, information and the knowledge of other people. Knowledge work was straining at constraints imposed by industrial organisations and institutions.

In 1991, Robert Reich described three distinct groups of work[13]:

- Routine production services, including manual and physical work as well as routine information processing comprising around 25% of the US workforce and shrinking;
- In-person services, direct in-person service delivery such as sales, cashiers and secretaries, accounting for 30% of the US workforce; and
- Symbolic analytical services; entailing non-standardised tasks such as problem solving, problem-identifying and strategic brokering services comprising 20% of the US workforce and growing.

Each of these types of work can have a knowledge work component or dimension to them but there was an increasingly non-standard nature of work in each category. The need for the capacity to deal with non-standard situations indicate that the sort of worker required in the future will not be of the kind that suited Taylorism in the industrial-focused last century. Rather, workers who can exhibit innovation and entrepreneurship, deal with abstract ideas and collaborate with others in teams will come to be valued.

Later, the 1990s brought an aggregation of 'the arts' into what is now called the Creative Industries to validate the economic impact of their activities in total. Initially this included sales, exhibitions etc., but in the 2000s the role of creativity more generally in innovation became a broader focus of the composition of the workforce and the role of creative work was recognised across a broad range of industries.

The role of individual creativity has long been recognised as a component of knowledge work. 'The most important implication of the above views is that individual creativity and innovativeness comprise the scarcest and arguably the most valuable resource in an information society'.[14]

Most recently, the impact of knowledge work as it relates to information or data centric work, and creative work as it relates to ideas and innovation, have been described as 'Invisible Work 'by John Howkins.[15] Again, Howkins was not the first to do so, because as early as 1995, McDermott said 'Like craftwork, knowledge work in teams is largely individual, ad hoc and invisible'.[16]

Howkins brings a more complete model into focus by bringing knowledge work, creative work and digitalisation together into a conceptual framework for understanding the dynamics of today's knowledge work, which lays a foundation for the future of this form of work.

It is now the case that since most people work with computers of different forms, it is difficult to determine what people are doing in the office. The difference between an architectural practice, an accounting firm or a radio astronomy team is not immediately obvious because everyone is engaged with a screen to perform their work. Individuals and teams are increasingly dealing with complex and interconnected tasks and issues in ways that can be hidden until a result is achieved or the project is completed.

Digitalisation changes how work gets done and changes the mix of activities that make up tasks and jobs. Increasingly, more advanced digital technology like artificial intelligence changes who does the task. In the 20th Century, management theory leant towards analysis and planning, breaking down the plan into smaller processes and then selecting or training workers to execute the processes repeatedly.

This was fine when the environment was stable and few things changed in the multi-year planning cycle. In a digital economy, where volatility, complexity and ambiguity are the norm, such an approach is increasingly irrelevant as technology is driving change faster than a 'normal' planning or management horizon.

New ways of working and new processes become not only possible through the use of digital technology but necessary. As pressures on efficiency become greater, expectations of customers and partners change. Organisations, including government, are now required to deliver on expectations that are set by more nimble players informing customers instantly via social media and quickly adapting to changing demand in weeks not years. It is not just the technology that makes the difference though, as we have seen.

Customisation of services, platforms to support rapid adaptation, service-centric, not process-centric management – building on lower level services offerings to create higher value customer experiences are all features of this emerging environment.

Summary

To understand the changes in the economy and society that can result from the introduction of digital technology, it is necessary to trace the threads of innovation and change back, sometimes decades, to earlier changes such as the recognition of knowledge work. The growing importance of services and their evolution towards customer-driven services and the application of digital technology to improve productivity and impact existing industries such as manufacturing and agriculture is profound.

Digital technology is not an end in itself. Understanding the changes in work, how work is organised and recognising new modes of work are important. So too are the organisational processes and availability of talent. All are fundamental to the successful introduction of digital technology. A model of digital evolution has been suggested here as well as a recognition of new ways of working which includes a 21st century extrapolation of knowledge work and a recognition of creative work as key

organisational responses to digitalisation.

This poses the challenge of how to make the personal and organisational changes necessary to take advantage of digital technology at the job level and in particular, at the task level within jobs. People will need to rapidly develop new skills and attributes in response to the speed of change. Existing educational institutions don't respond that quickly and often their focus is not on the working person seeking to meet a small skills gap quickly but on more foundational skills for people entering the workforce or job/career changes.

A new learning model is needed that is more responsive to these emerging needs and enables the rapid development of new content and curation of available content from elsewhere. That is the subject of Report 2 in this series.

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