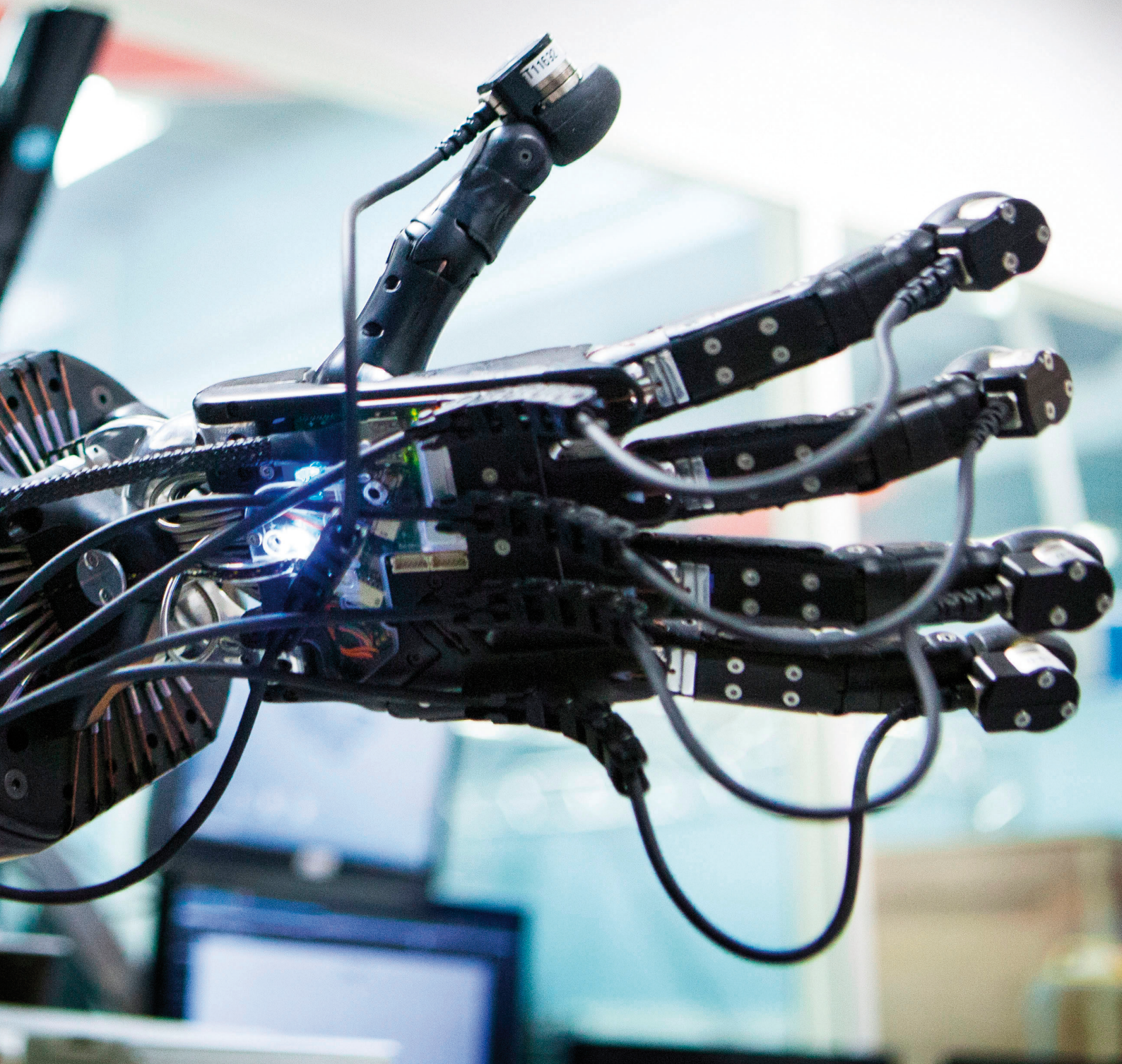


**Deloitte.**

From brawn to brains

The impact of technology  
on jobs in the UK



# Contents

---

Foreword	1
Introduction	2
A shift in the workforce	3
A £140 billion boost to the regions	4
Skill-biased changes in the workforce	5
Views of British businesses	8
Outlook and recommendations	11
Endnotes	12
Contacts	13

---

## Acknowledgement

We would like to acknowledge the significant contribution to the data analysis and authoring of this report provided by Jemma Insall and Ankur Borthakur from Deloitte Insight.

In this publication, references to Deloitte are references to Deloitte LLP, the UK member firm of DTL.

# Foreword

---

Deloitte is committed to contributing to the important debates about the future of business in the UK. One such debate, which has far reaching consequences for our clients, our people and the economy, is the impact of automation and robotics on work and employment.

Last year, Deloitte collaborated with Carl Benedikt Frey and Michael Osborne of Oxford University on *Agiletown: The relentless march of technology and London's response*. In that report, we suggested that 35 per cent of jobs in the UK were at high risk of automation in the next 10 to 20 years. In recent months, we have conducted a new and in-depth study of the UK's labour force to understand how these hypothetical models compare with actual changes in employment over the last 15 years. This new work paints a positive picture: while technology has potentially contributed to the loss of over 800,000 lower-skilled jobs, there is equally strong evidence to suggest that it has helped to create nearly 3.5 million new higher-skilled ones in their place. Each one of these new jobs pays, on average, just under, £10,000 more per annum than the one lost. Crucially, every nation and region of the UK has benefitted, and we estimate that this technology-driven change has added £140 billion to the UK's economy in new wages.

A strong pattern through time is that tasks that are repetitive and routine for humans are increasingly performed by machines. The data shows that jobs are indeed being lost in lower-skilled clerical, administrative and manual occupations. Meanwhile, thousands of new jobs are being created every year in technology and creative occupations, business and professional services, and caring professions. These growth jobs require a high degree of manual dexterity or higher cognitive skills, such as those that depend on management or human social interaction – a shift from brawn to brains.

Looking to the future, technology can only continue to play a bigger role in the workplace. Some commentators worry that this presents us with a binary choice: human or robot jobs. But the reality is more nuanced. While technology can indeed wholly automate certain routine manual tasks, other occupations benefit most from the partial integration of technology. The resulting human-machine combination augments total intelligence and can significantly raise both productivity and quality. However, achieving the optimum mix of human and machine labour across the workforce will depend on overcoming several challenges. Not least among these are the technical difficulties associated with many facets of automation and robotics, their cost, and social or political resistance.

Ensuring that the workforce of the future has the right skills and education is also vital. The survey of British businesses we conducted last year suggests that while three-quarters of businesses expect to grow their overall workforce in the coming years, they also feel that the skills required are changing. The highest priority skills are digital know-how, creativity, management and leadership, entrepreneurship and complex problem solving.

The lessons of history around technology are extremely positive for the country. The UK also has the right foundations for the future: a highly educated workforce, some of the best universities and research teams in the world, entrepreneurial leadership in many of its high-skill, high-tech industries and a relatively flexible labour environment. Businesses, policymakers and educators all have a key role to play in ensuring that technology continues to benefit the country in the coming decades.

We hope that you find this report useful and look forward to your feedback.



Angus Knowles-Cutler  
Vice Chairman and London Senior Partner



# Introduction

Concerns about the impact of technology on jobs may seem to be a relatively modern problem. But as far back as 1589, the inventor William Lee applied to Queen Elizabeth I for a patent on a new type of knitting machine that could produce far higher quality stockings than weavers could by hand. The Queen denied him his patent, saying “consider thou what the invention could do to my poor subjects. It would assuredly bring to them ruin by depriving them of employment, thus making them beggars.”<sup>1</sup> In spite of Mr Lee’s setback, over the next three centuries the UK became the world leader in textile manufacturing.

The same debate is rolling on in the second Elizabethan age. How technology impacts our jobs is ‘front of mind’ for businesses, policymakers, the media and the general public. This will no doubt continue long into the future.

As part of Deloitte’s ongoing work on the impact of technology, robotics and automation on the UK’s economy, we are pleased to present the results of our latest research in this short paper. The goal of this research was to create a better understanding of the actual effects of technology on the UK’s workforce compared to the hypothetical ones. We therefore build on the analysis, published last year in Deloitte’s *Agiletown: The relentless march of technology and London’s response*, and examine the changes that have occurred in the UK’s labour force over the last 15 years.<sup>2</sup>

Key points from this research include:

- Over the last 15 years, the UK has benefitted from a technology-driven shift from low skill, routine jobs to higher-skill, non-routine occupations.
- Over 800,000 jobs have been lost but nearly 3.5 million new ones have been created.
- On average, each job created is paid approximately £10,000 per annum more than the lower-skilled, routine jobs they replace, resulting in a £140 billion net boost to the economy.
- Every region has benefitted from employment growth in higher-skilled occupations.
- Almost three-quarters of UK businesses surveyed say that they will employ more people (net) in future and most think that technology will have a significant or very significant impact on their businesses.
- In the future, businesses will need more skills, including: digital know-how, management capability, creativity, entrepreneurship and complex problem solving.
- The UK’s continued success will rest on the ability of businesses and organisations, educators and government to anticipate correctly future skills requirements and provide the right training and education.

# A shift in the workforce

As well as considering the impact of technology on the UK's capital city, *Agiletown* predicted that 35 per cent of all jobs in the UK have a high probability of being 'computerised' within the next 10 to 20 years.<sup>3</sup> This figure was derived by Carl Benedikt Frey and Michael Osborne after they applied the same methodology described in *The future of employment*, their seminal paper on the impact of automation on the US labour market.<sup>4</sup>

Frey and Osborne postulated that the majority of jobs where automation was a low probability (less than 33 per cent chance) were within professional and vocational occupations where tasks were non-routine in nature. These occupations typically require higher-level cognitive or social skills, significant manual dexterity or some combination of both. In contrast, medium-probability jobs (between 33 and 66 per cent chance of computerisation) were dominated by caring and leisure occupations requiring a mix of routine and non-routine tasks. High-probability occupations, with greater than 66 per cent chance of being automated, were largely administrative in nature or involved routine manual activities, such as operating machinery.

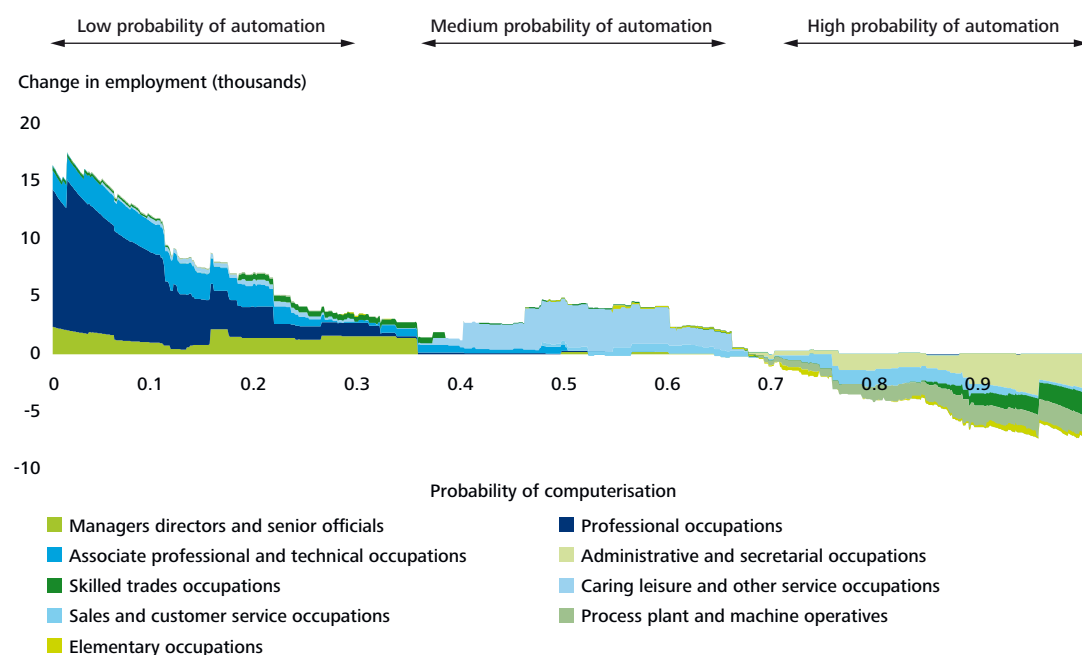
Although these and other predictions have been the subject of considerable debate during the past year, relatively little evidence has been presented of the actual effects of technology on the UK's workforce and economy.<sup>5</sup> Future public policy and business strategy will depend on being able to answer the question, to what extent are automation and robotics technologies replacing jobs?

Through a detailed analysis of the last 15 years of official labour force survey data from the Office for National Statistics (ONS), our research has shown that not only has the impact been broadly in line with the predictions of *Agiletown*, but also – and, perhaps, surprisingly – that the UK has benefitted considerably from a technology-driven shift from low-skill, routine jobs to jobs within higher-skill, non-routine occupations.

This shift is illustrated in Figure 1, which supports Frey and Osborne's hypotheses regarding the drivers of job creation and loss across occupations. Figure 1 shows significant net job growth has occurred in professional and management occupations, as well as in skilled trades and other associate professional and technical occupations, all considered to be at low risk of automation. At the other end of the spectrum, job losses have occurred in elementary occupations and factory work – exactly as predicted. In caring, leisure and other service occupations, where the degree of computerisation is by no means certain, the UK has seen considerable jobs growth.

The conclusion is that over the last 15 years, automation has created approximately four times as many jobs as it has lost.

**Figure 1. Change in employment by occupation from 2001 to 2015**



Note: The area under all curves (sum of employment in each probability bin) is equal to the total change in employment.  
Source: Frey and Osborne, ONS, Deloitte analysis 2015

# A £140 billion boost to the regions

Deloitte’s research demonstrates that every nation and region of the UK has benefitted from the application of technology to work. While some regions have seen a decline in jobs in high-risk, routine occupations, this has been outweighed by the creation of new jobs in higher-skilled, non-routine occupations, which have, collectively, added a net £140 billion in value to the economy in new wages.

**Figure 2. Summary of regional impact (2001-2015)**

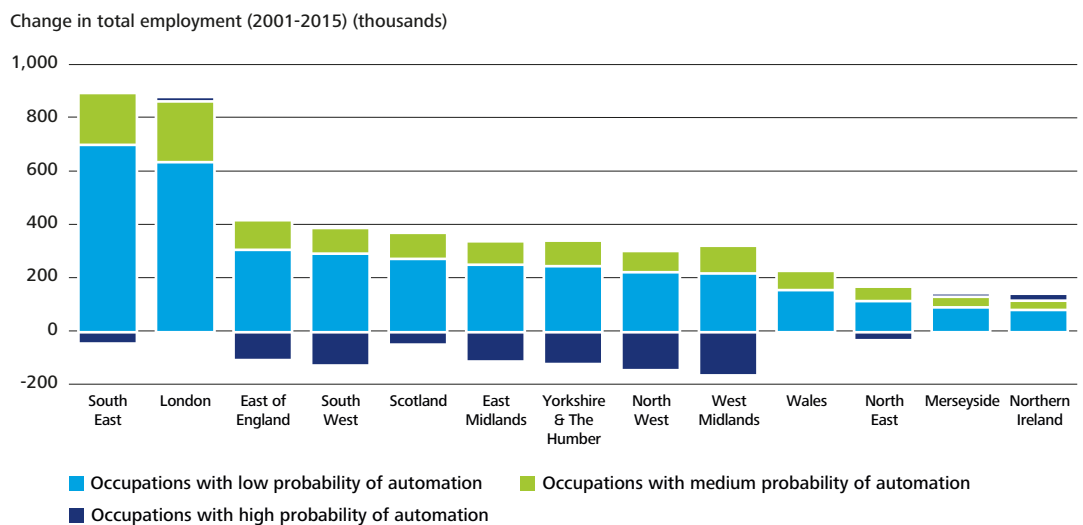


Source: Frey and Osborne, ONS, Deloitte analysis 2015

However, regional employment profiles vary considerably, so the constituent parts of the UK are each affected in different ways. In London, for example, just over half of jobs are considered to be at low risk of automation. This is because a large proportion of the capital’s workforce is already employed in highly-skilled roles that are not yet easily replaced by technology. As connectivity increases and broadband speeds continue to rise, jobs that do not need to be done in London, or can ultimately be replaced by technology, may start to leave the city.

Figure 3 shows how total employment has changed in each region since 2001. It also shows that London and the South-East have seen substantial increases in employment during the last 15 years, principally from growth in high-skilled, non-routine jobs at low risk of automation. However, all regions have seen equivalent proportional increases in employment for these kinds of occupations. In contrast, the South West, North West and the West Midlands, in particular, have experienced greater than average job losses in low-skilled, routine occupations more at risk of automation.

**Figure 3. Change in total employment (2001-2015) by skills category**



Source: Frey and Osborne, ONS, Deloitte analysis 2015

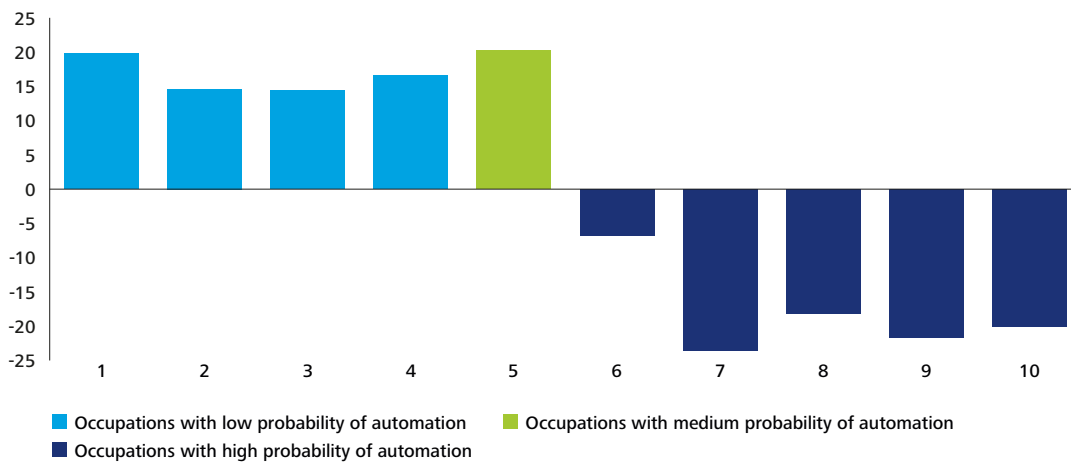
When aggregated to the national level, Deloitte’s research finds that technology is likely to have displaced over 800,000 jobs since 2001 but has created nearly 3.5 million new ones.

# Skill-biased changes in the workforce

Figure 4 presents the workforce data in another way – the percentage change in the share of overall UK employment for groups of occupations at increasing risk of automation. The result is even starker: high-skilled, non-routine jobs represent – almost exclusively – the increase in share of total UK employment since 2001, while exclusively low-skilled, routine jobs have diminished in share. Frey and Osborne’s estimates of high and low risk are being borne out in the employment data.

**Figure 4. Change in employment by probability of computerisation**

Percentage change in employment share (2001-2015)

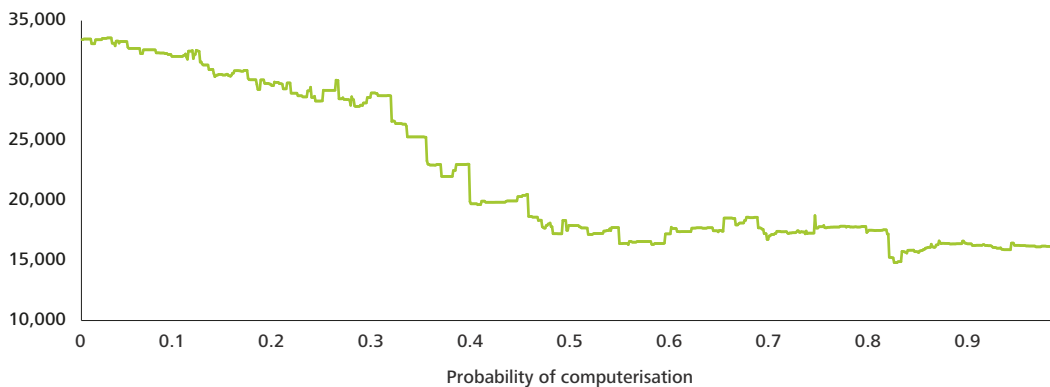


Note: Each decile represents approximately ten per cent of the UK’s workforce, with jobs ordered by probability of computerisation. Source: Frey and Osborne, Deloitte analysis 2015

There are broader economic effects, too. Based on 2013 earnings data, each new job, on average, pays approximately £10,000 per annum more than the job it replaces. This is good news for the UK’s skilled workforce, especially as Frey and Osborne found that jobs paying £30,000 or less are five times more at risk of computerisation than jobs paying £100,000 or more. The impact of automation on median earnings is shown in Figure 5.

**Figure 5. Probability of computerisation and median earnings**

Median income – UK (GBP)

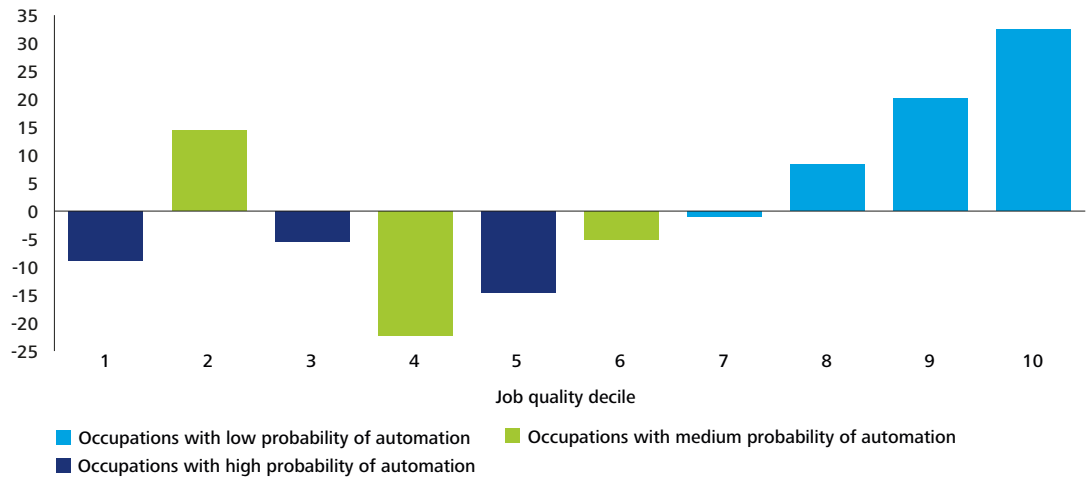


Source: Frey and Osborne, Deloitte 2015

But this rise in average earnings is also contributing to the so-called ‘hollowing-out’ effect, as illustrated in Figure 6, in which technology impacts primarily middle-income jobs.

**Figure 6. Change in employment by job quality: The hollowing-out effect**

Percentage change in employment share (2001-2015)



Note: Each decile represents approximately ten per cent of the UK’s workforce, with jobs ordered by median earnings.  
Source: Frey and Osborne, Deloitte analysis 2015

Economists Maarten Goos and Alan Manning developed a hypothesis for this hollowing-out, which suggests that routine cognitive jobs that require precision, such as bookkeeping, are not typically performed by the lowest-skilled members of the workforce.<sup>6</sup> But they are increasingly automatable, in particular through rapid advances in technologies such as ‘big data’ and machine learning.

Despite these shifts, the UK’s economy has shown remarkable resilience – primarily through the strength of consumer spending and the services sector. As technology drives down the cost of production, prices for typical basket goods will fall, leaving a greater proportion of disposable incomes to be spent on a range of personal and leisure services. Demand for these occupations, as we have seen in Figure 1, continues to rise and helps to mitigate some of the effects of hollowing-out.

In addition, the original predictions of *Agiletown* assumed that all of the barriers to the development and adoption of technology would be overcome.<sup>7</sup> For service occupations, it may well be that the demand for labour – needed to cope with a bigger, wealthier and ageing population – cannot be met by what is currently immature and expensive technology. It could also be that recipients of such services prefer to be served by humans rather than robots.



Overall, the main areas of job creation are in creative, caring and complex occupations such as care workers and chefs, and the financial services sector. The highly non-routine nature of these occupations supports the concept of the three ‘bottlenecks’ to automation, identified by Frey and Osborne as perception and manipulation, creativity and social intelligence.<sup>8</sup> This is reflected in the growth occupations in Figure 7, below.

**Figure 7. Occupations with the largest growth or decline since 2001**

Occupations with largest fall in employment	Probability of automation (%)	Change in jobs by occupation ('000s)	Occupations with the greatest rise in employment	Probability of automation (%)	Change in jobs by occupation ('000s)
Personal assistants and other secretaries	85	-204	Care workers and home carers	50	271
Typists and related keyboard occupations	99	-108	Teaching assistants	56	235
Bank and post office clerks	98	-83	Nurses	1	186
Retail cashiers and check-out operators	97	-72	Secondary education teaching professionals	1	131
Shopkeepers and proprietors, wholesale and retail	16	-69	Sales accounts and business development managers	16	122
Postal workers, mail sorters, messengers and couriers	80	-65	Business and financial project management professionals	11	115
Assemblers (electrical and electronic products)	94	-60	Teaching and other educational professionals n.e.c.	1	113
Business sales executives	60	-58	Primary and nursery education teaching professionals	56	110
Metal machining setters and setter-operators	79	-51	Chefs	57	103
Sewing machinists	89	-47	Property, housing and estate managers	25	101

Source: Frey and Osborne, Deloitte analysis 2015

Ian Stewart, Deloitte’s Chief Economist, and his team recently looked at the impact of technology on jobs over the last 140 years in their report *Technology and People: The great job creating machine*.<sup>9</sup> This research demonstrated that while automation has replaced many dangerous, unpleasant, boring and unrewarding tasks, it has also created capacity and demand for higher-skilled cognitive and socially interactive jobs.

Moreover, technology has the greatest impact at the task level. Technology can therefore change the nature of an occupation, rather than replace it. A significant evolution of cognitive occupations over the last 15 years has been driven by humans and machines working together. This augmentation of human intelligence can deliver enhanced productivity because both humans and machines are matched to those tasks each performs best. Medical, legal, financial and other knowledge-rich occupations are beginning to experience this shift, as technologies like natural language processing and other forms of cognitive analytics assist with knowledge recall and decision-making.

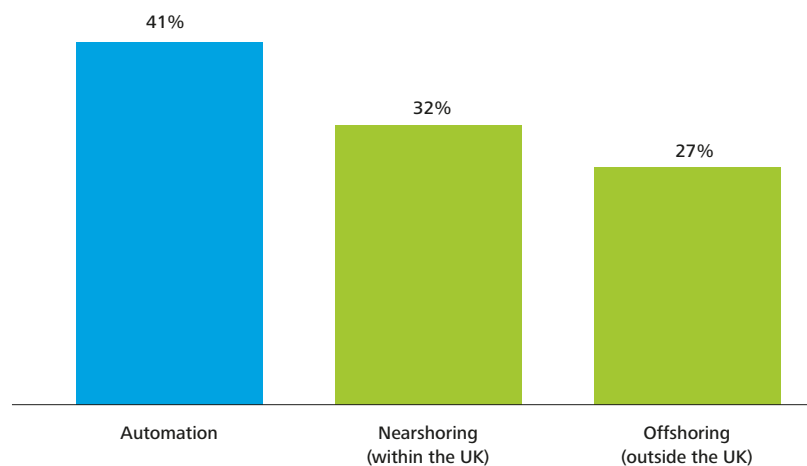
# Views of British businesses

Deloitte surveyed 100 leaders of British businesses in 2014. Their views give a useful insight into how they see technology impacting their organisations to 2019.

In the next 10 to 20 years, 35 per cent of today's jobs in the UK are at risk of automation. Thus, it is not surprising that automation is considered by businesses to be the most likely cause of job losses in the future, as seen in Figure 8.

**Figure 8. Factors leading to headcount reduction (responses have been weighted)**

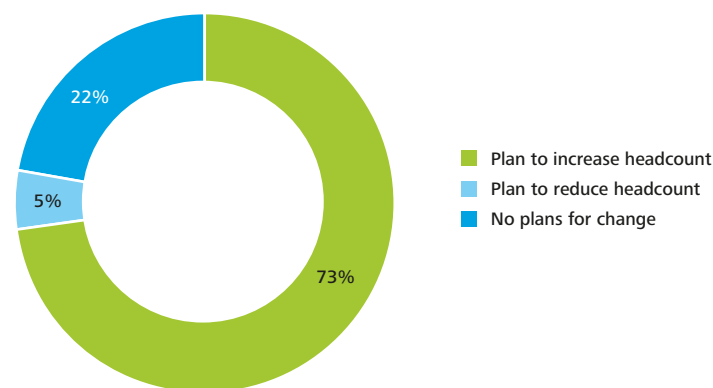
Job rationalisation



Source: Deloitte survey of 100 businesses, 2014

However, businesses are also optimistic. For example, 73 per cent of British businesses surveyed say that overall they intend to grow their UK headcount in the coming years.

**Figure 9. Plans to increase or reduce headcount to 2019 (businesses)**



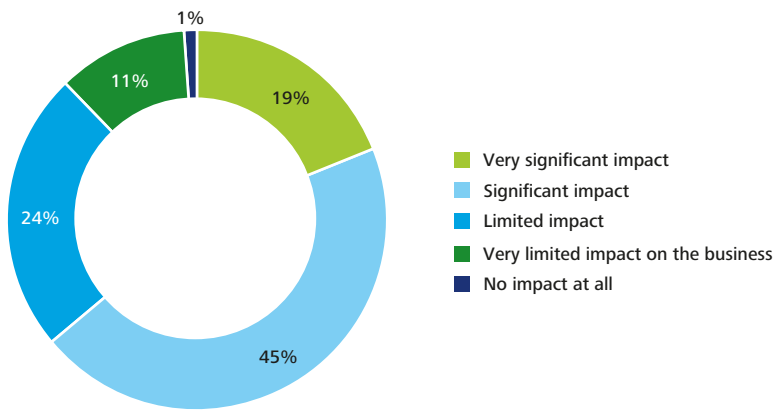
Source: Deloitte survey of 100 businesses, 2014

There is likely to be a strong correlation between graduate level skills in the workforce and a healthy knowledge-based future economy. The UK has the highest graduate participation in Europe.<sup>10</sup> It also has the strongest research universities and centres.<sup>11</sup> Together, this will help the country to remain well positioned for continued technology-driven shifts in the labour market. Other advantages for the UK are that predicted growth is likely to be in the sectors where UK institutions already lead the world, such as high-tech manufacturing, legal, financial and professional services, and higher education. The UK also stands to benefit from having a relatively flexible workforce and labour laws that reduce friction in the labour market.

A key to the UK’s continued prosperity will be the way that businesses and organisations, educators and policymakers correctly anticipate future skills requirements and provide the right training and education for the workforce – both prior to starting work and throughout working lives.

Another reason for optimism is that the majority of businesses Deloitte surveyed recognise that technology will have a significant or very significant impact on their businesses within the next ten years. Almost three-quarters of respondents said that they intend to grow their UK headcount in the years to 2019.

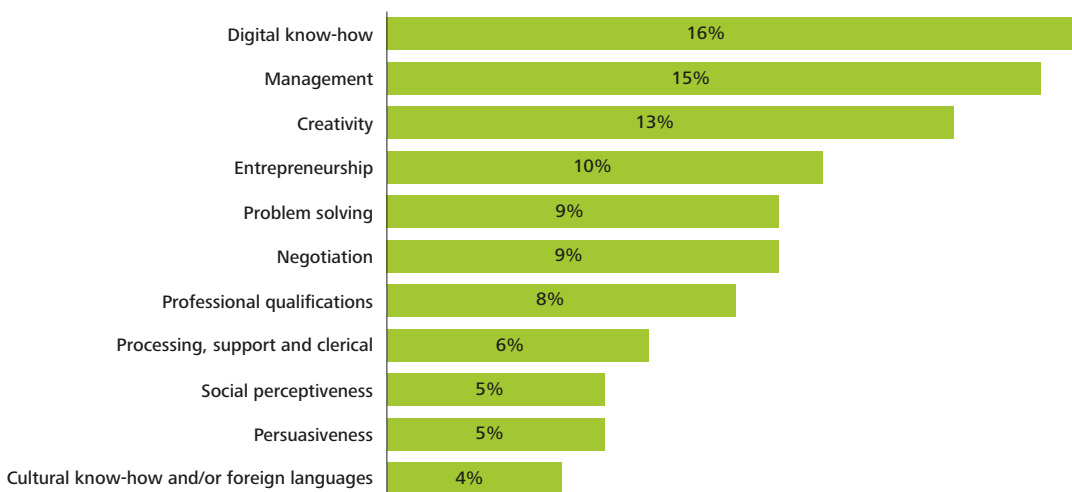
**Figure 10. Predicted impact of technology on business**



Source: Deloitte survey of 100 businesses, 2014

Business leaders also believe that the skills their businesses will require are going to change. Across the community that Deloitte surveyed, most stated that they would need more digital know-how, new management and leadership skills, creativity, entrepreneurship and the ability to solve complex problems.

**Figure 11. Skills required by businesses and public sector organisations**



Source: Deloitte survey of 100 businesses, 2014

Agility in the workforce will thus be essential to allow workers to successfully adapt, innovate and exploit new technology-driven opportunities that emerge. This will be easier in areas with a relatively highly skilled labour force, such as London. The Association of Graduate Recruiters 2015 survey reinforces the buoyancy of UK high-skill sectors.<sup>12</sup> They report a 13.2 per cent increase over 2014 on vacancies being offered by graduate recruiters. The study indicates that employers in the accountancy or professional services sector continue to offer the highest proportion of graduate vacancies. The public sector offers the second highest proportion (15 per cent) followed by engineering or industrial companies (12 per cent).

Given the important relationship between graduate level skills and the continued strength of the UK's knowledge-based economy, the view that education is crucial to optimise the benefits of automation and minimise technology-driven inequality is shared by many. For example, Professor John Van Reenen of the London School of Economics believes that inequality tends to worsen when skills do not keep up with demand.<sup>13</sup> Therefore, the UK's leading position in the tables of graduate participation in Europe, as well as the number of its world-class research universities, really matters.

# Outlook and recommendations

This new study has shown that technology is having a profound effect on the UK's workforce. Lower-skilled, routine jobs are progressively being replaced by higher-skilled, non-routine jobs that require dexterity, creativity, digital know-how and other 'softer' people skills. This technology-driven shift has already created nearly four times more jobs than have been lost, and it has brought considerable additional value to the UK's economy. It also accentuates the importance of generating and retaining the right skills in the workforce.

While the predictions made by Frey and Osborne in *Agiletown* depend upon the speed at which technology matures, its cost and the strength of social and political resistance to change, one thing is certain: occupations are already evolving. Right now jobs are being created and destroyed as a result of technology.

Therefore, automation needs to be high on the agenda of every business leader, policymaker and educator. Inevitably, though, there is some uncertainty about the future. Expert opinion is almost evenly divided between those who think that technology will continue to be a benign force if well understood and managed, and others who see it as leading to greater unemployment, increasing inequality and social tension.

The pace of change is also unclear. This new study suggests that the adoption of technology over the last 15 years has been both productive and positive. However, if the rate of technological innovation continues to accelerate, this may present new challenges that the UK's economy has not yet seen.

There is no question that skills are crucial to success in the future. Businesses need to be clear about what skills and competencies they need – not just today, but in the next five to ten years. Educators need to adapt what they teach – and how – to ensure that the young people entering the workforce as well as existing workers always have the skills they need to work effectively alongside machines. Government needs to ensure that policy is coordinated with business and education strategies. And finally, individuals will need to plan their careers acknowledging that theirs will be a longer working life in which they will need to remain agile in attitude, aptitude and skill – but the rewards will be more interesting, more challenging and more lucrative employment overall.

History tells us that the debates around the impact of technology on jobs will persist. But while the debates rage on, the changes, inexorably, will continue to take place – and will potentially accelerate. Deloitte's work shows that the UK is benefitting from these changes for the time being, not losing out. But we cannot be complacent. The march of technological progress affects everyone. We must work together and plan now for how we, collectively and individually, must adapt to the new future of work.

# Endnotes

1. "Why nations fail: the origins of power, prosperity, and poverty." Darron Acemoglu and James A. Robinson. See also: [http://www.lse.ac.uk/assets/richmedia/channels/publicLecturesAndEvents/slides/20110608\\_1830\\_whyNationsFail\\_sl.pdf](http://www.lse.ac.uk/assets/richmedia/channels/publicLecturesAndEvents/slides/20110608_1830_whyNationsFail_sl.pdf)
2. Agiletown: the relentless march of technology and London's response, Deloitte LLP, 2014.
3. Ibid.
4. "The Future of Employment: How susceptible are Jobs to Computerisation?" Carl Benedikt Frey and Michael A. Osborne. See also: [www.oxfordmartin.ox.ac.uk/publications/view/1314](http://www.oxfordmartin.ox.ac.uk/publications/view/1314)
5. Technology and people: the great job creating machine, Deloitte LLP, 2015.
6. "Lousy and Lovely Jobs: the Rising Polarization of Work in Britain" Maarten Goos and Alan Manning. See also: <http://core.ac.uk/download/pdf/94495.pdf>
7. Agiletown: the relentless march of technology and London's response, Deloitte LLP, 2014.
8. Ibid.
9. Technology and People: the great job creating machine, Deloitte LLP, 2015.
10. "Over-qualification and skills mismatch in the graduate labour market" CIPD, 2015. See also: <http://www.cipd.co.uk/binaries/over-qualification-and-skills-mismatch-graduate-labour-market.pdf>
11. "QS World University Rankings 2014/15" Top 20. See also [http://www.topuniversities.com/university-rankings/world-university-rankings/2014#sorting=rank+region="+country="+faculty="+stars=false+search=](http://www.topuniversities.com/university-rankings/world-university-rankings/2014#sorting=rank+region=)
12. "AGR Annual Survey: Gender diversity a challenge in a growing graduate market." The Association of Graduate Recruiters 2015.
13. "Inequality in the UK" John Van Reenen. See also: <http://eprints.lse.ac.uk/62878/>

# Contacts

## **David Sproul**

Senior Partner and Chief Executive, Deloitte LLP

+44 (0) 20 7303 6641

[dsproul@deloitte.co.uk](mailto:dsproul@deloitte.co.uk)

## **Angus Knowles-Cutler**

Vice Chairman and London Senior Partner, Deloitte LLP

+44 (0) 20 7007 2946

[aknowlescutler@deloitte.co.uk](mailto:aknowlescutler@deloitte.co.uk)

## **Harvey Lewis**

Director and Acting Head of Deloitte Insight

+44 (0) 20 7303 6805

[harveylewis@deloitte.co.uk](mailto:harveylewis@deloitte.co.uk)

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited (“DTTL”), a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see [www.deloitte.co.uk/about](http://www.deloitte.co.uk/about) for a detailed description of the legal structure of DTTL and its member firms.

Deloitte LLP is the United Kingdom member firm of DTTL.

This publication has been written in general terms and therefore cannot be relied on to cover specific situations; application of the principles set out will depend upon the particular circumstances involved and we recommend that you obtain professional advice before acting or refraining from acting on any of the contents of this publication. Deloitte LLP would be pleased to advise readers on how to apply the principles set out in this publication to their specific circumstances. Deloitte LLP accepts no duty of care or liability for any loss occasioned to any person acting or refraining from action as a result of any material in this publication.

© 2015 Deloitte LLP. All rights reserved.

Deloitte LLP is a limited liability partnership registered in England and Wales with registered number OC303675 and its registered office at 2 New Street Square, London EC4A 3BZ, United Kingdom. Tel: +44 (0) 20 7936 3000 Fax: +44 (0) 20 7583 1198.

Designed and produced by The Creative Studio at Deloitte, London. J1051