STEM FOUNDATION

SHAPING THE FUTURE OF STEM SKILLS

By Professor Sa'ad Sam Medhat

CONTENT

Researchers & Contributors
Prof Sa'ad Sam Medhat
Dr Nick Jagger
Michelle Medhat
Andrew Thomson

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The Research Study

Supported by the European Union's Social Fund (ESF), this research study has been undertaken by the STEM Foundation in partnership with the Greater Cambridge and Greater Peterborough (GCGP) Enterprise Partnership and the Association of Colleges in the Eastern Region (ACER), to highlight the changing needs of STEM skills that are often shaped by technology disruption and sector/region economic priorities and thus, informing education and training providers on areas for curriculum development.

Acknowledgment

We are most grateful to all those who have completed the surveys and participated in the various interviews and discussions.

INTRODUCTION

Technological innovation and its convergence are changing the conventional wisdom as we know it. New and emerging technologies such as Autonomy, the Internet of Things, Artificial Intelligence, Augmented and Virtual reality, and Cloud Computing are reformatting customer and market expectations. Businesses are, and will continue to restructure their operating models and redefine their core competencies, particularly in areas of STEM-related skills, where the supply is intermittent and of varying currency and quality. Digital centricity is the common theme that ties together technology trends, interconnectedness and the need to be responsive. Such a theme presents an expectation that makes digital a ubiquitous presence in today's talent world. Every sector in the economy from manufacturing to professional services and retail – can now be classified as a technology company. This has changed forever the way talent acquisition experts do their jobs, and what candidates have come to expect. Digital transformation in business means that organisations of all types are fighting over digital talent resulting in many hard to fill vacancies. This is particularly evident in such roles as data scientists, Customer Experience(CX) professionals, experience designers, digital business leaders, software developers, bioelectronics, analysts skilled at statistical and predictive analytics, cybersecurity professionals, content professionals skilled at storytelling, and augmented and virtual reality designers.

Balancing the skills development of what the economy needs today and in the future, calls for a systematic approach and a shared responsibility by all the key stakeholders in a region to raise productivity and improve the level of regional GVA (Gross Value Added).

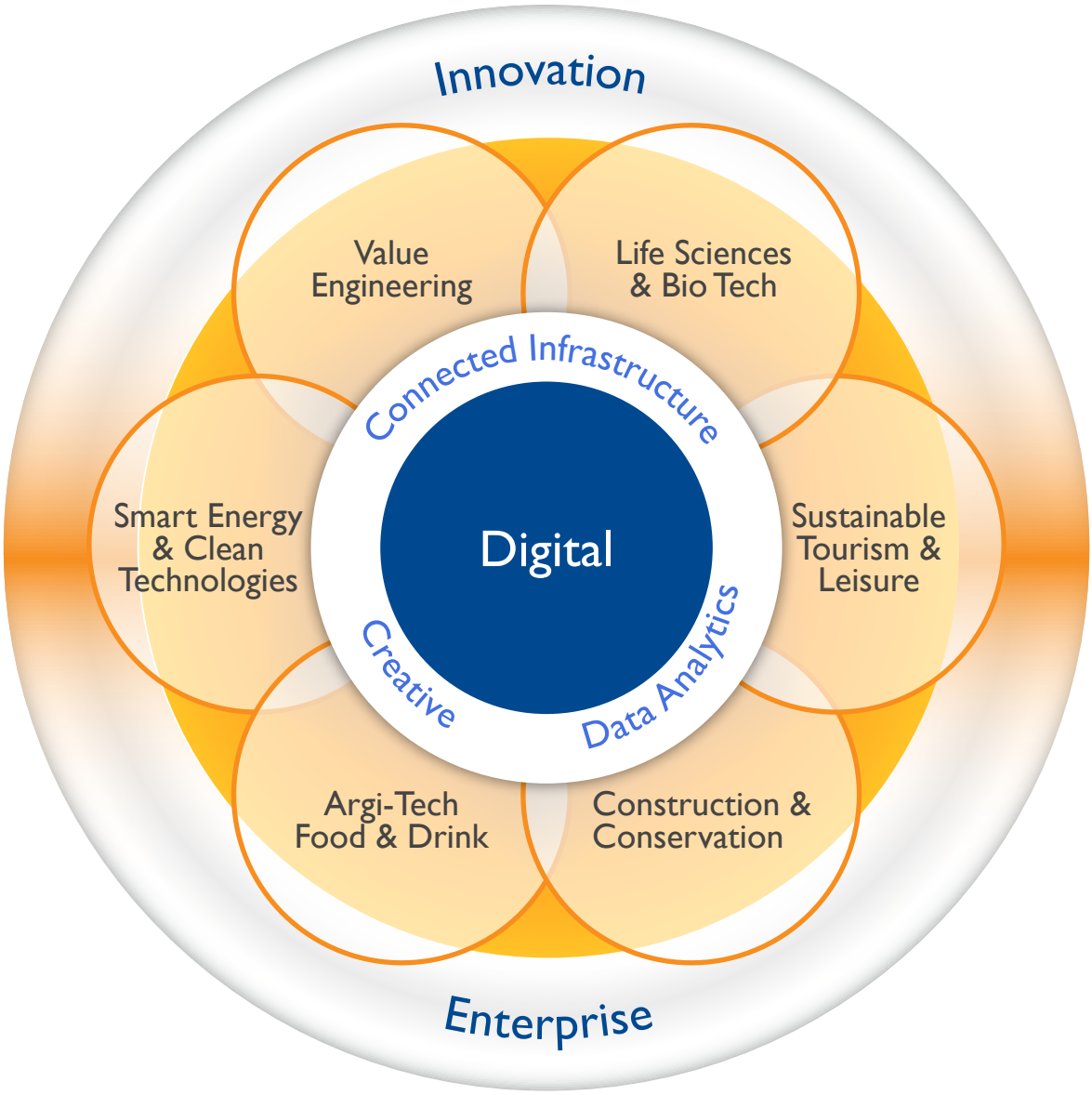


Figure 1: STEM Clusters of focus

STEM CLUSTERS OF FOCUS

This study has identified seven key clusters as areas of potential growth that the educational providers and related stakeholders will need to focus their efforts on, in order to create the required baseline capability to drive and sustain growth in STEM related industries within the GCGP LEP region specifically, and in the UK more generally.

WHAT IS NEEDED

As the need for companies to compete with ever more sophisticated smart technology grows, a new collaborative model that predicts talent shortages in STEM-related fields is required to overcome the talent shortage that has been creeping up for some time. This collaborative approach requires the participation of several stakeholders at a regional level including amongst others the following:

- those providers teaching STEM subjects (schools, colleges, training providers and universities)
- those employing people with STEM skills
- those funding the STEM provision

Such a predictive model will need to be shaped by technological disruptions, business model changes, societal trends and economic priorities.

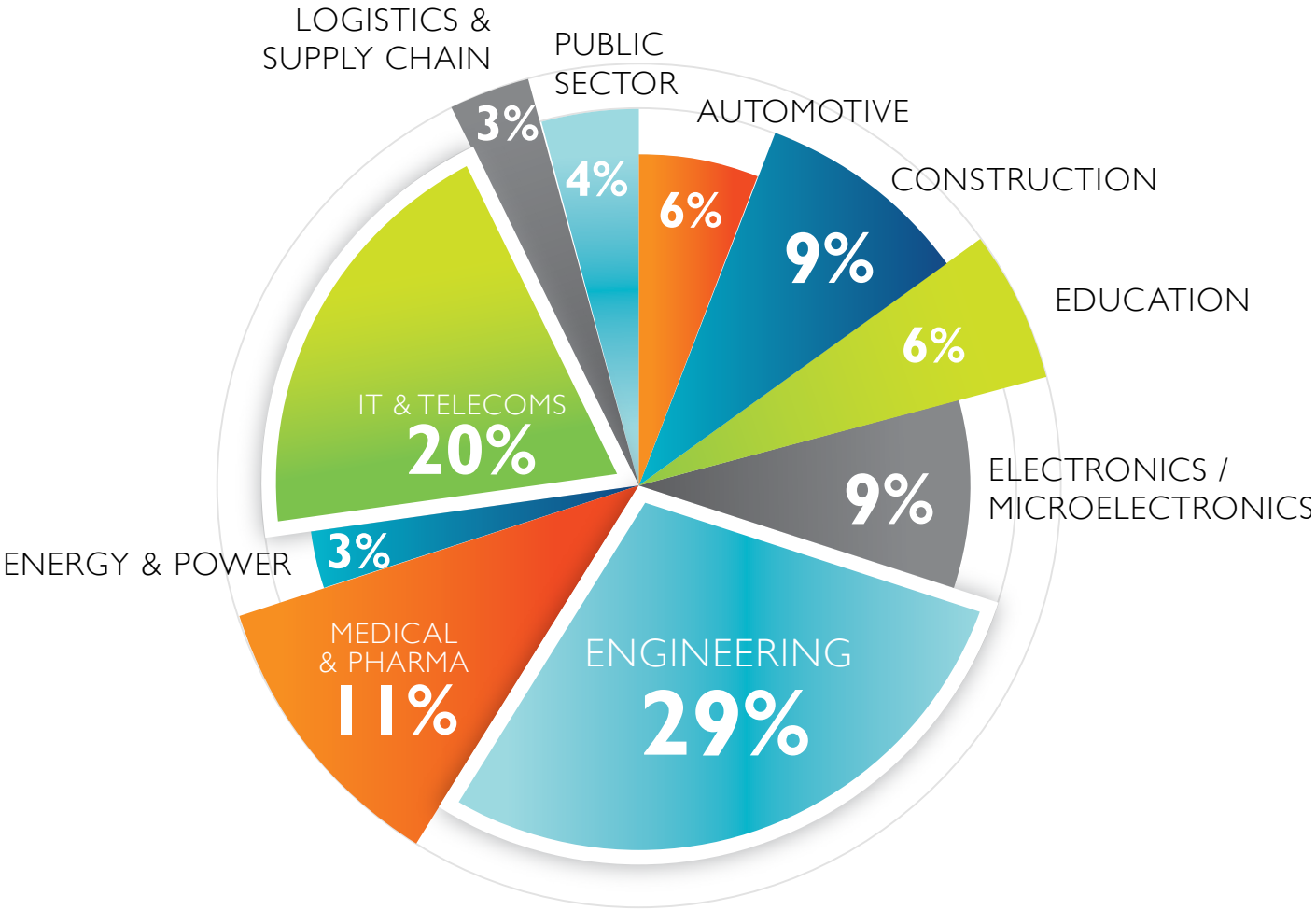


Figure 2: Sector Participation

THE RESEARCH METHODOLOGY

A quantitative-based industry impact survey was initially conducted. Respondents were principally senior technical managers in science, technology and engineering companies across the GCGP LEP area. These senior managers were selected due to their leadership role in determining their company's technology roadmaps, and thus the skills and training requirements that would be needed over the next five years. Although local companies within the GCGP LEP catchment area were the main focus for this study, respondents from multi-national companies that have a regional GCGP footprint or are part of the supply chain, also participated. Engagement in the survey was by invitation and the survey was created and distributed online. Participants in the survey included representatives from the following industry sectors as shown in Figure 2:

The survey's primary focus was centred around the direction of technology development highlighting the principal technological drivers, and therefore, skills requirement over five years. Two areas that the questionnaire targeted were:

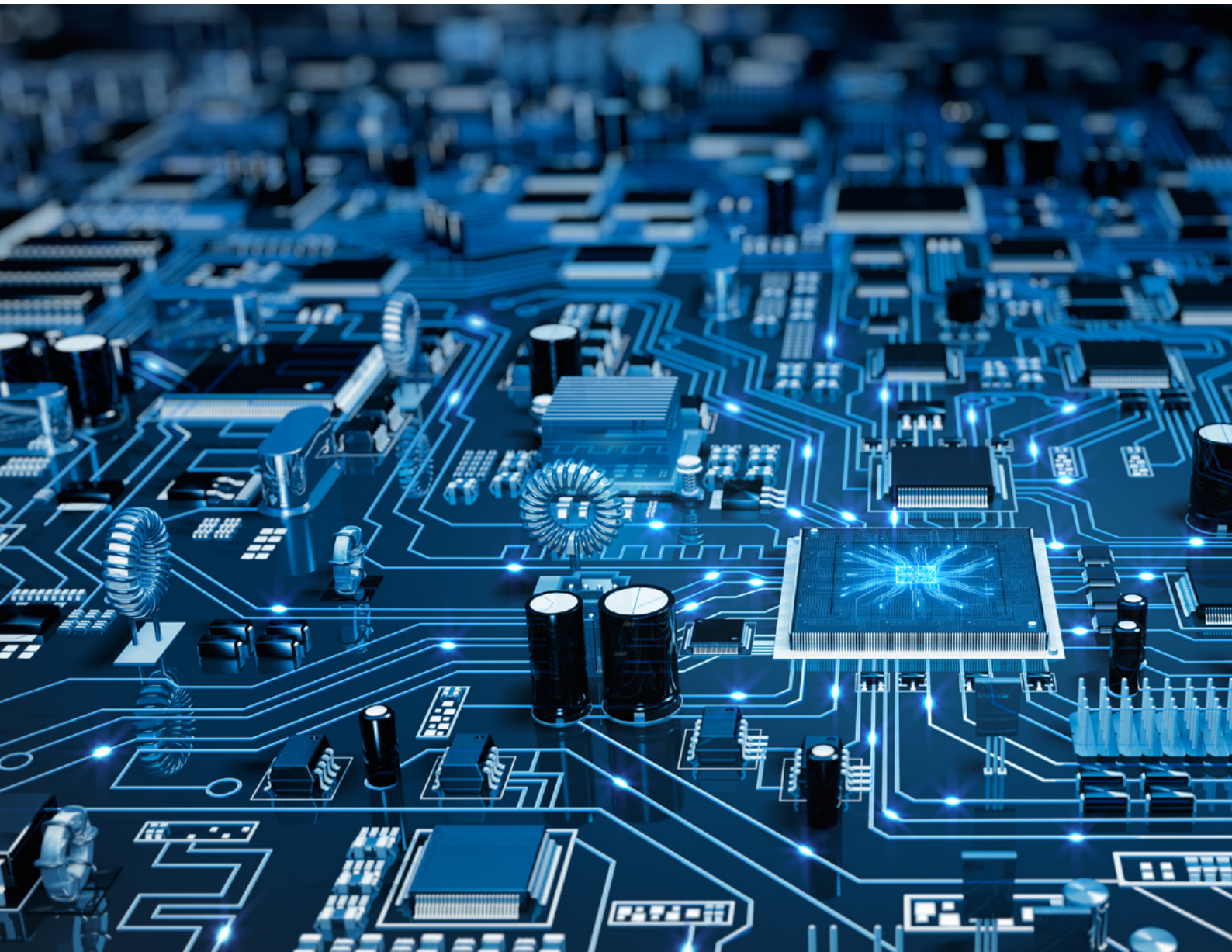
- The impact of technology disrupters on business
- The impact on business due to the lack of STEM skills needed in the disruptive technology domains

The first part of the questionnaire examined the impact that the technology disrupter would have on the respondent's business. Respondents were given a 30% to 100% impact-scale per technology disrupter. The technologies were identified through various consultations and trend assessments and where such a technology disrupter could have a cross-sectoral reach. It was also necessary to ensure that the technologies selected held a currency in today's business environment, but still had sufficient capacity to grow in terms of their level of technological maturity, dissemination and take-up.

Table 1: Technology Disrupter and Impact on Business

Robotics & Automation	Application of Sensors
Internet of Things	Near Field Communications
Industrial Internet (Industry 4.0)	Standards & Protocols in Communication between Smart Devices
Business Analytics	3D Printing (Multi-D)
Audiology, implants and Prosthetics	Design & Visualisation
Predictive Systems	Machine to Machine Learning
Telepresence, Virtual Reality, Augmented Reality, Remote control of machinery, Knowledge automation such as Telemedicine)	Radiology and Imaging

It was recognised that several other disruptive technologies such as artificial intelligence, nanotechnology and quantum computing have already created significant impact on business and industry. However, the research focused on the applications of these technologies as the rationale behind this study was to understand the future technician and technologist job roles, and therefore, the skills and educational requirements that will be needed to shape such new roles.



The second part of the questionnaire examined the impact that would be suffered by the business if they failed to have in place the STEM skills and competencies needed to support, use and drive the aforementioned disruptive technologies. The impact in this context was regarded as sales revenue, market growth and profitability.

The skills and competencies reflecting the disruptive technologies were broken down into eleven skill sets.

Technology convergence is driving the need for a new skills development approach that would prepare those individuals entering the workforce to demonstrate a range of new interoperable capabilities and skills that will enable them to operate across many different industry sectors.

Table 2: Technology Disruptor & Impact on Technical Skills & Competencies

1) Programming
Embedded Systems (e.g. Python, Ruby, C, C++)
Middleware (i.e. middleware is software that serves as an interface between components)
Front End (e.g. device interface) – HTML5, Java, Objective C, Java Script, Python, R
2) Construction related Skills
Design for Manufacture and Assembly
Supply Chain Management and Automation
Intelligent Building Design
Offsite Manufacture of Components (MMC)
3) Use of 3-D Design Packages
3-D Printing
Building Information Modelling (BIM)
4) Connectivity Skills
Surf and Stream (MIMO - Multiple Input/Multiple Output and 60 GHz Band)
Find and Navigate (Sensor Hub, GNSS/GPS, Bluetooth Smart & Wi-fi)
Pay and Pair (Near Field Communications & Mobile Payment Systems)
Control and Monitor (Wave 2 Wi-Fi – 802.11ac & Bluetooth Smart)
Charge and Go (Resonant wireless charging/ Bluetooth Smart)
5) Data Analytics
Data capture
Data interrogation
Profiling and predictive analysis
6) Nanotechnology & Bio-tech laboratory skills
Manufacture of materials
Development of applications
7) Unmanned Vehicle/ Drone Technology Skills
Design and Manufacture
Development of Applications
8) Material Sciences
Smart Materials (including Stealth)
Graphene and Super Materials
Composites & Polymers
9) Machine to Machine Communications & Learning
Cyber Security Awareness and Protection
Knowledge Automation
10) Installation, Operation and Fault Finding of Microelectronic & mechanical systems (MEMS)
Diagnostics and Fault Finding
Sensors
11) Battery Technology / Fuel Cell Skills
Design and Test of Battery (Chemical Based)
Manufacture of Fuel Cells
Development of Applications

In addition, five transferable skill areas were also identified:

Table 3: Technology Disruptor & Impact on Transferrable Skills

Transferrable Skills
• Cross Disciplinary Project Management
• Sustainability (e.g. Recycling & reduction of waste)
• Multi-way, multi-platform communications capability
• Technology and Ethics
• Mandarin as a Foreign Language

The demand for these transferable skills is expected to increase significantly over the five-year period.

References to future jobs indicate that the educational level will need to increase upwards so that there will be a natural expectation for people to have higher functioning skills in programming, dexterity, interaction, design, innovation and logic.

The growth in automation and robotics is expected to continue and will subsume many of the lower level, menial and repetitive job functions across all economic sectors as the economy shifts towards an integrated digital and human workforce.

ANALYSIS AND KEY FINDINGS

Any respondent stating that their business would be affected by a technology or a skill's deficiency by 70% or more, was confirmed to have demonstrated a high degree of intensity of demand. Such a position therefore, identified the need to develop provision to support the business change that the new technology disrupter would bring about. As the areas of technology impact, and the impact of skills deficiency, are two inextricably linked areas, the analysis and key findings examined them as one total component. This presentment thus offered a coherent and comprehensive view of the Technology-Skills need under scrutiny.

Industrial Internet of Things (IIOT)

> *Worldwide, a 1% increase in productivity could add $10 - $15 trillion to worldwide GDP over the next 15 years"*

Forbes, 2016.

> *The Industrial Internet [of Things] will transform many industries, including manufacturing, oil and gas, agriculture, mining, transportation and healthcare. Collectively, these sectors account for nearly two-thirds of the world economy."*

World Economic Forum, Industrial Internet of Things Report 2016.

The Internet of Things is about the proliferation of smart things, from appliances, running shoes, watches to cars that can connect through sensors to the Internet, passing and receiving data and connecting the physical world to the digital world. The Internet of Things is focused on human interaction with objects, delivering value in increased efficiency, improved health and safety or a better experience for the user.

The Industrial Internet of Things or as it's becoming widely known Industry 4.0, is everything the internet of things is, but is focused on industrial applications. Innovation and convergence of technology has led to the emergence of this new digital industrial revolution. Innovations in hardware mean that sensors are inexpensive, more powerful and provide longer battery life. Connectivity is cheaper, and through the cloud, it's easier to send data from sensors. And with big data analytics and machine learning, that data can provide invaluable insight into manufacturing processes. Such insights can provide productivity increases and cost reductions. The faster, better, cheaper doctrine of 21st Century (smart manufacturing) can be achieved through the IIOT.

The Industrial Internet although, still emergent, its ability to disrupt business models, reconfigure supply chains and force business innovation is evident. In our survey, over half of all respondents across ten business sectors claimed that the IIOT would have at least a 70% impact on their business,

with 40% claiming that the impact on their business would be 80% or higher. In just the Engineering sector, over 75% of all respondents claimed that the Industrial Internet would impact their business by at least 50% or higher. These indicators show that the IIOT will disrupt businesses and encourage a rapid change in how they operate.

> Skills in 3D Printing, Material Science, Connectivity and Design for Assembly Skills and are of high importance to Plessey.
>
> ***Michael LeGoff,*** CEO, Plessey

100% of Logistics advising of a 100% impact on their businesses, as well. In terms of connectivity skills, programming in Control and Monitoring using Bluetooth Smart and WIFI - which forms the heart of the connection flow in the Internet of Things - 38% of respondents claimed a 70% or higher impact on their business, if these crucial connectivity skills were not present.

The Industrial Internet will require greater analytical abilities and skills in the use of digital technology. Skills such as problem-solving, interaction and complex communications, large-frame pattern recognition, collaboration and the ability to adapt to unfamiliar situations, will increase in demand, in relation to the uptake of machines assuming routine tasks and jobs.

The Internet of Things, focused on the consumer side, was identified by 45% of all respondents as having 80% or higher impact on their businesses, with those respondents in Pharmaceutical and Medical, Logistics, Telecommunications & IT confirming a 100% impact on their business. This response illustrates that business models in these sectors will have to be radically transformed to accommodate and take positive advantage of the impact that the Internet of Things will bring.

> Skills in programming (e.g. SDN/ NFV / 5G all Carrier grade), Connectivity, Machine to Machine Learning, Radiology and Imaging are of high importance to Telefonica.
>
> ***Dr Mike Short,*** CBE, Vice President, Telefonica

Sensors are a key part of the Internet of Things and its industrial cousin. The application of sensors in relation to their operation with big data analytics are what gives the Industrial Internet of Things its strength. When it was asked of respondents the impact that sensors would have on their businesses, over half of all respondents claimed that the application of sensors would have a 70% or higher impact on their business. Specifically, 90% of all Construction companies and 95% of all Engineering companies claimed the application of sensors would have a predicted impact of 80% or higher on their businesses.

With sensors, comes skills in connectivity and communications technology. Standards and protocols are the backbone of the IIOT, enabling the data flows and analytics. Smart devices and wearable tech depends upon communication standards and protocols to operate, and any changes would disrupt a business. In our survey, over two thirds of respondents claimed changes in communications standards and protocols would have a 70% or higher impact on their businesses. The Telecom & IT sector confirmed a 100% impact, with 90% of Pharma and Medical respondents, 75% of all Construction and

Business Analytics is how value is driven from the Industrial Internet. It is also how value creation is derived from innovative new products and services. The business analytics and big data market was worth $130.1 billion in 2016, and is predicted to grow to more than $203 billion in 2020 – Compound Annual Growth Rate (CAGR) of 11.7% (Forbes Jan 2017). The use of the cloud and more favourable pricing plans will enable more businesses to use sophisticated analytical tools. Monetisation of data will be a new way to extract value from an asset that was previously passive. Deep learning - a sub-set of artificial intelligence - is already emerging in the high-tech domain as a vital tool for prescriptive, predictive and eventually, pre-emptive analysis of data. Over two thirds of respondents confirmed that business analytics will have a 70% or greater impact on their businesses, with almost half (48%) of respondents stating that there would be a 70% or higher impact from Predictive Systems. 90% of Medical and 70% of Engineering respondents confirmed an 80% or higher impact from the application of business analytics.

The market for **Machine Learning, Artificial Intelligence and Deep Learning** is accelerating, and it's predicted to reach $15.3 billion by 2019, with an average annual growth rate of 19.7% (BCC Research 2017). In relation to the Industrial Internet of Things, predictive analytics software could offer a strong market for machine learning applications. According to Transparency Market Research, the market is expected to reach $6.5 billion worldwide in 2019, up from $2 billion in 2012. Respondents in our survey also recognised that the Machine Learning and AI would change their businesses, with just over 40% of all respondent citing 70% or higher impact on their business. All respondents in the Construction sector stated a 100% impact on their business. 80% of all Engineering companies (with a focus on subsectors of aerospace and defence) claimed a 100% impact of Machine Learning and AI on their businesses. With automation and autonomy, devices need to tackle every situation placed their way, but pre-programming isn't always possible, and they need to learn, adapt, and resolve things on their own, often without explicit information being fed to them.

The role of the **Data Scientist** is critical to business analytics and is one which is growing fast. In the first half of 2016, the role of data scientist in companies grew by 32% (Computer Weekly, Aug 2016), and is predicted to grow by around 50% by the end of 2017 (Warwick Analytics, Mar 2017).

> Key Programming Skills in Unmanned Airborne Vehicle / Drone Technology together with Project Management (Agile & Scrum) Skills are of high importance to BAE Systems.
>
> ***Prof Nick Colosimo,*** Principal Technologist (Disruptors), Futurist, Strategic Planner and BAE Systems Global Engineering Fellow BAE Systems Plc

languages for data analytics are Python, R, Java, SAS, Kafka, Storm and C++. Scala is increasing in usage, particularly in natural language processing, and the use of SQL is still the most used language when used as part of a data science workflow to connect databases. Over 66% of respondents stated that their business would be impacted 70% or higher by a lack of Data Capture skills. 71% of respondents claimed a lack of skills in Data Interrogation would impact their business by 70% or greater, and 69% of respondents confirmed a higher than 70% impact if they did not have Predictive Analysis skills and competencies available.

Skills in Machine Learning, Artificial Intelligence and Deep Learning are mostly focused on programming in Python, R and Java for Machine Learning; C++ for Deep Learning; and LISP, Prolog, Python, R, C++ and Java for Artificial Intelligence. It is clear that a deficiency in programming skills in these languages would result in an impact on a business. From respondents in our survey, over half confirmed that a workforce that lacked the Machine Learning, AI or Deep Learning programming skills would result in an impact of 70% or more on the business. Given the intrinsic nature of these programming languages to support the Industrial Internet and Business Analytics, business impact could be a loss in efficiency, drop in productivity, and an inability to be competitive and profitable.

> Understanding of Industrial Internet / Industry 4.0 together and the Standards & Protocols in Communication between Smart Devices is essential for Syrinix.
>
> ***Justine Brain,*** Finance Director Syrinix Limited

For technologists, a new era dawns with the convergence of Analytics, the Internet of Things, Big Data and Machine Learning. This will bring about cross-functional learning, whereby Data Analysts improve capability with Big Data skills, Data Scientists are upskilling themselves with Machine Learning, and business analysts include Data Visualisation in their CVs.

The global market for **3D Printing** is driving a CAGR of 20%, and is predicted to reach $16.2bn by 2019 (Statista Report on 3D Printing 2017). The two main drivers of this growth are: the declining 3D printer prices (3D printer under $1000 account for 28.1% of all 3D printer sales) and the target market of spare parts and logistics, which has a potential growth value of $400bn by 2030 - particularly in transportation (planes, trucks, cars and trains). For example, GE is intending to print 40,000 jet-fuel nozzles for aircraft by 2020, and in automotive manufacturing, Mercedes-Benz Trucks enable customers to 3D print a range of spare parts for freight trucks, while BMW has recently invested in a 3D metal printing start-up company. In the rail industry, Deutsche Bahn, the German national rail company, confirmed that it will actively pursue 3D printing for train parts, and Siemens, a major rail equipment manufacturer, has already commenced 3D printing small-series custom train parts.

The additive manufacturing and 3D Print market is segmented thus: Metal and Polymer printing 29.2%, Polymer 51% and Metal 19.8% (Wohlers Report April 2017). Nearly half of all additive manufacturing undertaken includes a metal additive.

Over a third of respondents stated that 3D printing would have a 70% or greater impact on their business over the next five years, with those respondents from Engineering and Construction sectors stating a 100% impact on their businesses. This is unsurprising given the increase in rapid prototyping and the production of spare parts in engineering. The significant impact of 3D printing on the Construction sector is somewhat aligned to the rise in Building Information Modelling and Digital construction trends, and the need to produce physical models to reduce complexity and support integrated project management. Respondents from the Medical sector stating a 90% impact of 3D Printing on their businesses are cognisant of the surge in bioprinting. From teeth to organs, the global market for bioprinting reached $295 million in 2016 and is predicted to attain $1.8 billion by 2021, growing at a CAGR of 43.9% from 2016 to 2021.

46% of all respondents stated that a lack of skills in 3D printing technologies and software would have a 70% or higher impact on their business. Skills cited as part of a 3D printing capability are programming and coding and developing software programmes and routines for use in 3D printers; technical design; product design and competency in 3D and solid-works packages, together with technician skills in maintenance and repair of the 3D printing machines. At the higher-skills end, capability in material sciences and research and development in additive materials to find out how they could be used and made, is needed. Additive manufacturing and 3D printing jobs rose between 2010-2014 by 1,834% (Wanted Analytics 2016), and this demand for people with integrated hardware and software product design and marketing capabilities will rise as 3D printing heads further into the industrial mainstream. Over a third of all respondents in our survey identified that a lack of skills in additive manufacturing and material sciences applications would have a 70% or greater impact on their businesses.

Nanotechnology is an area facing maturity and emergence, as far the markets are concerned. Dry and wet nanotech production has been around for

many years and is regarded as a mature market. This global nanotechnology maturing market (applications and devices) should reach $90.5bn from $39.2bn at a CAGR of 18.2%, from 2016 to 2021 (BCC Research Nov 2016). The Global nanocomposite, nanoparticles, nanoclays and nanotubes market is expected to reach $5.3bn from $1.6bn in 2016 at a CAGR of 26.7%, from 2016 to 2021 (BCC Research Jan 2017). The global market for quantum dots (QDs) totalled $610.0M revenue in 2016. The market is expected to grow $3.4bn, increasing at a CAGR of 41.3% from 2016 to 2021 (BCC Research Report May 2016) . Current and future applications of QDs impact a broad range of industrial markets. These include, for example: biology and biomedicine; computing and memory; electronics and displays; optoelectronic devices such as LED lighting and lasers; optical components in telecommunications and image sensors; and security applications such as covert identification tagging or biowarfare detection sensors.

> The rail industry must meet the demand for more travel options and better value services from its customers by equipping its people with the skills required over the next decades. Theses skills include human machine interface operation; implementation and management of key data driven technologies, big data, cyber security and the physical internet; autonomous systems; and lifecycle, resilience, and value management.
>
> *James Lewis,* Conformance Manager, Network Rail

The key to all of the aforementioned growth is the right balance of skills. In our survey 21% of respondents claimed 70% or higher impact if skills were not in place. This smaller figure is reflective of some areas of market maturity in nanotech. However, when a longer timeframe (of 10 years) was suggested, 46% of respondents indicated a 70% or higher impact on not having current nanotech skills in their business, as those skills would be different from the ones envisaged by the initial 21% of respondents.

> BASF is also playing an important role in the digital transformation of agriculture. With data mining and new advanced sensor technologies, it is possible to extract useful knowledge from very large new and existing data sets both from the lab and the field. When it comes to the need for rapid advancements in new products or processes data mining can significantly accelerate the identification of promising candidates across the whole biological spectrum of our portfolio. In recent times, this has included searching for candidates with beneficial traits outside of the normal requirements for the required biological activity. This helps to identify products that precisely impact on the pest, weed or disease target whilst at the same time have no impact on non-target species giving the products a far stronger regulatory profile than in the past. Interdisciplinary skills that link for example physical chemistry to biology and mathematical modelling are important to us to enable us to bring new innovative solutions to the agricultural market, thus ensuring our role as a leading solution provider.
>
> *Dr Rosie Bryson*, Team Leader - Arable Crops Fungicides
> Technical Management Europe, Africa, Middle East and Central Asia, BASF The Chemical Company
> Chair of the Institute of Innovation & Knowledge Exchange

A subset of the **nanotech** market is **graphene**, the world's first 2D material. Graphene, as a super material is ultra-light and extremely tough. The honeycomb lattice structure of the material makes it 200 times stronger than steel and extremely flexible. The material is considered an

excellent conductor of electricity and has high level of heat resistance as well. Due to its unique physiochemical characteristics, the material has wide applications across different industries such as energy, electronics, composites, coatings, biomedical, sensors, automotive, defence and aerospace. Although hindered by production capabilities, due to handling and health issues, graphene is expected to reach a global market value of $278.47M by 2020, with a CAGR of 42.8% from 2015 to 2020 (Markets and Markets Report Oct 2015). The main applications that are driving this growth are sensors, super capacitors (fuel cell and energy storage tech) and super strength composites.

> Skills in Business Analytics, Design and Data Visualisation including Building Information Modelling are of high importance to Marshall Group.
>
> ***Rob Butler,*** Manager of Aero AcademyMarshall Aerospace and Defence Group

Design and Visualisation are two elements that are converging with **Virtual Reality (VR) and Augmented Reality (AR)** platforms. Aligned with the explosion in data analytics, the design/visualisation (VR and AR) market is expected to grow from $5.6bn in 2016 to $162bn by 2020 (IDC Report 2017). Data visualisation using VR has been shown to improve understanding of complex data into a meaningful visual way. Intel Survey 2017 found 63% of IT Managers surveyed expected data analytics to done in real time, and data visualisation, as a result, is increasing in importance as real-time data analytics is identified as a key to driving competitive advantage.

In our survey, almost half of all respondents recognised a potential 70% or higher impact on their business during the 5-year horizon. 80% of all Engineering, 90% of all Construction and 70% of all Medical companies stated that design and visualisation technologies would have an impact of 90% or higher on their sectors. When asked about telepresence, VR and AR technologies, almost half (48%) of all respondents stated an impact of 70% or higher on their business. 95% of all Construction, 100% of all Logistics and 70% of all Engineering companies stated that VR and AR would have an impact of 90% or higher on their business.

> Skills in programming of embed systems, sensor applications and Internet of Things (IoT) are of high importance to my company and the Healthcare sector.
>
> ***Jessica Auton,*** Director Aseptika Limited

With the rise in burgeoning amounts of data and insights, human intervention will eventually take a back seat to **Artificial Intelligence**. Skills in machine learning and advanced statistical algorithms will be needed to make sense of big data and respond to real-time analytics demands with data visualisations. The use of Natural Language Generation (NLG), a style of data visualisation that is increasing in use in data intensive industries such as finance, banking and construction. NLG takes many different data sources, identifies patterns and insights and displays such analysis in a visual but non-complex way, so to enable faster decision-making to take place. Skills in the use of NLG will be required to keep pace with the charging force of visualisation. The survey identified more than 60% all the respondents stated that a lack of skills in machine learning and data visualisation would negatively impact their businesses by 70% or greater over the next five years.

New Technologies in Construction, such as Building Information Modelling (BIM), unmanned systems (drones), robotics and automation and modern methods of construction (modular/off-site manufacture), design for manufacture and assembly, VR and AR are forcing a shift in how construction companies operate. Acceptance of new technologies is underlined in the JBK Construction Report Dec 2016, which showed 19.3% of building professionals are very confident with using new technologies. In the same report, it showed that 29% of companies were adopting the use of drones, with 360o scanners, VR and AR technologies all gaining traction in their usage. AR technologies are particularly being used in conjunction with BIM models to project buildings on to a table/surface for discussion and project management purposes.

> Skills will be needed in the technology and ethics of artificial intelligence, and how intelligence is embedded into devices and the Internet of Things, highly scalable, event driven cloud applications and data solutions. We will also need skills in 3D and mixed reality application development.
>
> ***Dr Rob Fraser***
> Senior Director, Commercial Software Engineering Microsoft UK

Globally **BIM** is expected to grow to $11.7bn by 2022, registering a CAGR of 21.6% during 2016 – 2022 (Allied Market Research May 2017). Across the world, governments are mandating the use of BIM in public sector buildings, national infrastructure projects and procurement, and this requirement is fuelling growth. However, skills in BIM, such as the management of data, production of high quality transfers 'data drops', and higher levels of numeracy and literacy, with ability in AR presentment – 'fly throughs' - and influencing people skills, are holding back the potential for the industry to grow at its expected rate. Two thirds of construction industry use BIM (according to NBS BIM Report 2017) however, 45% are still not confident that they have the sufficient knowledge and skills in BIM. In our survey, over 50% of all respondents stated that there

would be a 70% or greater impact on their business if BIM skills were not available, with 100% of all Construction and 90% of all Engineering sector companies confirming that BIM skills were crucial to their business.

> Skills in Building Information Modelling (BIM), Machine Learning, Offsite manufacture, Project Management and Mandarin are of high importance to us.
>
> *Euan Burns,* Chief Engineer, Carillion Plc

100% of all Construction respondents claimed a 90% or higher impact on their business if skills in **Drone and Unmanned Airborne Vehicle (UAV) technologies** were not available. The key skills known as drone mapping, include capabilities in GIS specialist areas such as ortho-mosaics, terrain modelling and NDVI (Normalised Difference Vegetation Index) analysis – all of which can be automated through drone mapping software applications, and can be learnt through specialist certification programmes. These capabilities dovetail with data analytics, visualisation and AR which are needed once the drone data has been captured. Across other business sectors, over two thirds of those respondents from Engineering and Logistics stated an 80% or higher impact on their business if they did not have drone skills, specifically in repair, maintenance and operations.

Autonomous systems, including autonomous mobile robots is currently valued at $9bn globally and is expected to reach $120bn by 2026 at a CAGR of approximately 14% (IDTechEx Mobile Robotics Report Jan 2016). The autonomous mobile robots market is segmented between: Autonomous Unmanned Ground Vehicles (UGVs), Unmanned Aerial Vehicles (UAVs) and Autonomous Underwater Vehicles (AUVs). Sectors for Autonomous UGVs application include Transport and Logistics, Mining, Oil and Gas, Defence, and Agriculture. UAVs are prevalent in a number of sectors including Engineering, Defence, Telecoms, Agriculture, Construction and Logistics, and AUVs have applications in Emergency Services and Defence, Mining, Oil and Gas, Transport and Logistics, amongst others.

> Telepresence (e.g. remote control of machinery, knowledge automation) and Programming Skills for supply chain management are of high importance to DHL and the Logistics industry.
>
> *Tim Bolam,* Vice President IT Project Delivery DHL Supply Chain Ltd

Although mobile robots are expected to be the biggest trend area, static robots continue to evolve. Use of surgical robots, for example, are emerging in some specific laparoscopic procedures, and more companies in development mode are seeking to bring more surgical robots to market to ride the growth trend. In our survey, 55% of all respondents claimed robotics and automation would affect their businesses by 70% or higher. 90% of Construction, 70% Medical and 85% Logistics claimed a 90% or higher impact of robotics and automation on their operations.

With the rise in **modular construction and off-site manufacture,** the skills in design for manufacture and assembly, 3D printing, supply chain automation and life-cycle asset management are growing in need. From PwC's 19th Annual Global CEO Survey focused on Engineering and Construction firms (January 2016), 74% of participants confirmed that 'Technological Advances' would be the ultimate differentiator, delivering value and competitive advantage. In our survey, almost half of all respondents, and all of those from Construction claimed a 70% or higher impact on their business if skills in Modern Modular Construction were not available to them. 62% of Engineering and 100% of Construction respondents confirmed an 80% or higher impact on their business if Design for Manufacture and Assembly skills were not available in their business.

Intelligent or smart building market is expected to grow from its $7bn value in 2014 $36.0bn in 2020 growing at a CAGR of just over 30% between 2015 and 2020 (Smart Building Magazine June 2016). This growth, underpinned by the technology from the Internet of Things, coupled with a drive to be more energy efficient, safe and secure has driven a need for selective skills. Alongside the Computer-Numerical Control and Programmable Logic Control technical skills, there is a need for skills in 5D CAD and BIM, design visualisation, sustainable construction and smart materials. At the heart of an intelligent building is its hub and thus, connectivity is key. Skills in Control and Monitor (Wave 2 Wi-Fi and Bluetooth Smart), and Find and Navigate, together with data analytics and asset management are vital to supporting the growth in the intelligent building market.

Aligned to the booming IoT and industrial internet markets, and their applications in smart factories, buildings and enterprise asset management/life cycle management, the market of **Micro-Electro-Mechanical Systems (MEMS)** including sensors is growing at a CAGR of 11% from $13.0bn in 2015 to an expected $26.8bn by 2022. In our survey, respondents from all sectors acknowledged the need to have people with skills to design, install and operate MEMS, with over a third claiming a 70% or higher impact on their business if these skills were not available. 70% of all engineering respondents identified a 90% or higher need to have MEMS focused skills together with a grounding in programming in data analytics languages (R and Python). Semicon West July 2017 stated that the fastest area of MEMS growth is the RF Filters (RF MEMS BAW filters) as they're needed to support the increasing complexities of communicating all the different data streams with high speed 4G/4G+ mobile technologies. This market will see a CAGR of 35% from 2017 – 2022, with the value of the market increasing from

$2.2bn in 2017 to $10.2bn by 2022. Skills needed to enable this growth to be achieved include electronic engineering design, microelectronics, transducers, communications, audio processing and Digital Signal Processing and data analytics.

In the light of the need to be more fuel efficient, the **Fuel Cell technology** market is expected to grow. Although it is segmented into type of fuel cells (proton exchange membrane, solid oxide or direct methanol), the biggest growth, spurred on by the transportation industry is the solid oxide market. At a global level, the solid oxide fuel cell (SOFC) market was valued at $2.6bn in 2015 with an expected CAGR of 9.4% to reach $4.9bn by 2022. Over half of the respondents in our survey, across all sectors, stated 70% or higher impact on their business if they did not have suitable skills in fuel cell technology, particularly SOFC. Aerospace, Automotive and Defence respondents identified an 80% or higher impact on their operations if these skills were not available in their businesses. Skills in demand to support the growth in fuel cell technology include physical chemistry: thermodynamics, kinetics and basic electrochemistry, electrochemical power sources (e.g. batteries and capacitors), reactor engineering, battery technology, supercapacitor technology, fuel cell including hydrogen fuel cell technology, together with battery design, monitoring and data analytics.

Medical imaging is experiencing a strong confluence with the IoT technologies, artificial intelligence and augmented reality, which will deliver new growth across the medical sector. The medical imaging market was valued at $30.05bn in 2015 and it is expected to reach $40.56bn in 2021, expanding at CAGR 5.1% between 2016 and 2021 (Infinium Global Research March 2017). Medical imaging equipment is mainly categorized as X-ray devices, computed tomography (CT) scanners, magnetic resonance imaging (MRI) scanners, ultrasound devices and nuclear imaging scanners. All those respondents from Medical sectors stated at least a 90% or higher impact if medical imaging skills, such as X-Ray, Angiography, Radiation therapy, Mammography, Computerised tomography, Magnetic resonance, Cardiovascular radiography, Interventional radiography, Nuclear medicine, Sonography/Ultrasound along with skills in data analytics and diagnostics, patient care and preparation, management and interpersonal communication were not accessible in the market.

> Thales believes that key skillsets include the ability to develop creative solutions across multiple STEM disciplines, as well as within specific domains of expertise like in Civil (e.g. Ground Vehicle Display) and Military Avionics to include Real Time Embedded Software Skills, Project Management and Delivery, Systems Engineering, Design Authorities and Communications Systems. Also within our simulation business the skills that will set us up for the future are cloud and virtualisation based architecture, distributed computing, big data analytics, WEB technologies and Cyber security.
>
> *Dr Ana Mirsayar*
> Integrated Modular Communication Research Manager, Thales

Aerial Imaging for other industries is also experiencing growth due to drone technology and AR/VR visualisation applications. The aerial imaging market is expected to grow by 12.9% CAGR to $2.8bn by 2022 (Allied Market Research Oct 2016). New applications in national security, environmental, construction, urban planning and disaster management are helping to achieve the growth levels. Skills in drone operation, 3D mapping, and data analytics will be needed. Specifically, skills in imaging were shown to have a demand with our respondents in Construction, Transportation and Defence, with the majority (90%) of the respondents citing a 70% or higher impact on their sector if the skills in Aerial Imaging were not prevalent.

MedImmune is the global biologics research and development arm of AstraZeneca; pioneering innovative research across key therapeutic areas including oncology; respiratory; and cardiovascular and metabolic diseases. We are driven to create life-saving medicines — a process that does not happen without people who fundamentally love science and love to innovate across STEM disciplines. That passion is something that we can nurture early on in students so that it thrives, and it is further enhanced when we encourage skills like working collaboratively – something that MedImmune believes is critical to creating new avenues for the exchange of innovative ideas.

Jacqui Hall
Vice President, MedImmune (AstraZeneca)

INTERVIEW WITH ARM HOLDINGS

ARM works with a diverse ecosystem of partners to build shared success across sectors and geographies, fostering continuous innovation in all areas where compute is possible. ARM's partners have shipped more than 86 billion ARM-based silicon chips in devices to date, reaching more than 80% of the global population to help shape the world in which we live.

The main business focus is chip design; ARM is a unique supplier to the world, selling over 19bn chips last year. ARM works as a business ecosystem model, designing versatile chips for all IT companies around the world.

ARM is a major employer, employing over 3000 postgraduates in Cambridge. Elsewhere, the employment is everywhere in supply chain: designers, sales, engineers. The highly qualified and capable technician is in strong demand. A critical need is for softer skills and capacity to be resilient and take the initiative.

ARM is uniquely placed to speculate about the future and what the future direction of the digital industries, given its role and place in the overall market. Many new applications are upon us in the IT industries: The Internet of Things is the key focus at present, quantum computing very much on its way.

INTERVIEW WITH THE WELDING INSTITUTE (TWI)

TWI provides advanced solutions for industry's needs. TWI is one of the world's most respected research and technology organisations, with industry-leading capabilities in a number of areas.

Specialising in joining techniques and technologies, structural integrity and material properties, TWI has been providing advice, information and engineering services to industry for almost 70 years, and our continued growth is testament to the consistent excellence of that provision.

Being a member of TWI today means being part of an organisation that brings together a staff of hundreds of expert engineers and scientists with tens of millions of pounds' worth of cutting-edge facilities and equipment. We conduct research that promotes the advancement of engineering technology and guides industry. Our work is depended upon by thousands of individuals and some of the largest and most successful companies in the world.

Seven decades of experience and expansion has equipped TWI with considerable engineering capacity, enabling us to set the standard in areas including welding engineering, failure investigation and non-destructive testing. The engineering capabilities of TWI can be grouped into three general categories, each containing multiple specialisms:

- Joining Technologies
- Integrity Management
- Materials

The company employs directly over 800 people in the UK, the focus of which is on science graduates, but there is a strong demand for well qualified and capable technicians. TWI's coverage in STEM is very broad: defence, automotive, oil and gas, nuclear and electronics.

TWI certainly has the means by which to speculate about the future. This is a core business capability – seeing the problems STEM industry faces and developing materials and processes that will help them make tomorrow's world work better. TWI gathers new knowledge via a Dual Use Technology Exploitation process, known as DUTE, which is an established process that harvests this knowledge at a highly-detailed level.

AT A GLANCE: SUMMARY OF TECHNOLOGY DISRUPTORS AND SKILLS NEEDED

Technology Disruptors

Industrial Internet

Over **half** of respondents claimed Industry 4.0 would have a **70%** or higher impact on their business.

75% of the Engineering companies surveyed confirmed that Industry 4.0 would have at least a **50%** impact on their business

Virtual Presence Technologies

55% of all respondents stated an impact of **70%** or higher on their business by telepresence, VR and AR technologies.

95% of all Construction, 100% of all Logistics and **70% of all Engineering** companies stated that telepresence, VAR & AR would have an **impact of 90% or higher** on their business.

Internet of Things

45% of all companies confirmed that the IoT would have an **80%** or higher impact on their business. With **all of the Medical, Logistics and ICT companies** confirming **100%** impact on their businesses.

Artificial Intelligence & Machine Learning

41% of all companies confirmed that AI would have a **70%** or greater impact on their businesses.

Application of Sensors

Over **half of all respondents** said that the application of sensors (aligned to IoT and data analytics) would have a **70% or higher impact** on their business.

With **90% of Construction** and **95% of Engineering** companies citing 80% or higher impact of sensor applications on their business.

Standards & Protocols

Over two thirds of all respondents claimed that with the rise in smart devices the changes in standards and protocols would disrupt their businesses, delivering a 70% or higher impact.

100% of Telecom and IT respondents confirmed a **100%** impact on their businesses.

90% of all Medical, 75% of all Construction and **100% of all Logistics respondents** stated a **100%** impact on their companies.

Radiology & Audiology Technologies

Despite the specialist nature of these technologies, respondents indicated a significant level of business impact by these tech disrupters, with **71% of all respondents** advising on a potential **impact of 70% or highe**r.

Design & Visualisation

An existing technology that saw **almost half of all respondents** recognised a potential of **70%** or higher impact on their business during the 5-year horizon.

80% of all Engineering, 90% of all Construction and **70% of all Medical companies** stated that D&V technologies would have an impact of **90% or higher** on their sectors.

Business Analytics

65% of all respondents stated 70% or higher impact on their businesses through data analytics. **48%** claimed that **Predictive Systems** would have a **70% or higher impact** on their operations over the next 5 years.

Robotics and Automation

55% of all respondents claimed robotics and automation would affect their businesses by **70% or higher. 90% of Construction, 70% Medical and 85% Logistics claimed a 90% or higher** impact of robotics and automation on their operations.

Skills Needed

Data Analytics Capture

Over two thirds of all respondents claimed an impact of **70%** or higher on their business if they couldn't secure data capture skills for data analytics.

Fuel Cell Technologies

Over 50% of all respondents stated an impact of **70%** or higher on their businesses if they didn't have fuel cell technology (especially Solid Oxide Fuel Cell).

90% of Automotive, Aerospace and Defence claimed an **80% or higher impact** on their businesses if these specialist fuel cell capabilities were not present in their companies.

Data Analytics Interrogation

71% of all respondents advised of an impact of **70%** or higher on their business if the requirement for data interrogation skills was not met.

Modular and Off-Site Manufacture in Construction

Almost half of all respondents and 100% of Construction respondents stated a business impact of **70%** or higher if modern modular construction skills were not available.

62% of Engineering and 100% of Construction respondents confirmed an **80% or higher impact** on their business if Design for Manufacture and Assembly skills were not in their businesses.

Micro-Electro Mechanical Machines MEMS

Over a third of all respondents claimed a **70% or higher** business impact by a lack of MEMS related skills.

70% of Engineering respondents identified a **90% or higher impact** if MEMS skills were not secured.

New Technologies in Construction

50% of all respondents claimed a 70% or greater business impact by a lack of Building Information Modelling (BIM) skills.

100% of Construction and 90% Engineering respondents confirmed a **90% or higher impact** if BIM skills were not available.

Predictive Analysis

69% of all respondents claimed an impact of **70%** or higher on their business if they couldn't secure people with skills in predictive analysis.

3D Printing Technologies

46% of respondents stated a 70% or higher business impact by a lack of 3D print skills.
33% of all respondents claimed a **70% or greater** business impact if skills in **material sciences** were not available.

Medical and Aerial Imaging

100% of Medical respondents stated a **90% or greater impact** if specialist imaging skills are not available.
90% of Construction, Transport and Defence companies cited a **70% or higher impact** on their businesses if skills in aerial imaging were not acquired.

Drone Technologies

30% of all respondents claimed a **70% or higher** business impact by a lack of drone design and manufacture skills.

Nearly 50% of all respondents identified a **70% or higher** business impact by a lack of drone application skills**.**

100% of Construction respondents advised an impact of **90% or higher** if drone tech (especially mapping) skills were not available.

66% of Engineering and Logistics respondents stated an **80% or greater impact** on their businesses if they couldn't secure drone mapping, maintenance and repair skills.

Machine Learning, Artificial Intelligence and Deep Learning Technologies

Over half of the respondents confirmed that a lack of Machine Learning, AI or Deep Learning programming skills would result in an **impact of 70% or more** on their businesses

Figure 2: Sector Participation

PREDICTING THE FUTURE IN STEM SKILLS

A roadmap approach to STEM skills development is needed to anticipate in a timely manner the skills shortages and future needs.

The proposed T2K (Trends to Knowledge) model envisages a collaborative approach that operates as an ecosystem, bringing together education and training providers with business and industry, to assess Technology and Social Trends in order to predict and guide the development of new knowledge and STEM-related skills provision as shown in Figure 3.

It presupposes the need to develop T-Shaped skills and competencies in students and learners in a balanced way that combines discipline-specific technical knowledge with professional and personal skills and attributes (T-Shaped Technologist report, STEM Foundation 2014). It also assumes a shared responsibility between education and training providers, and, business and industry to identify new and emerging trends to anticipate and thus, update the STEM education and training provision.

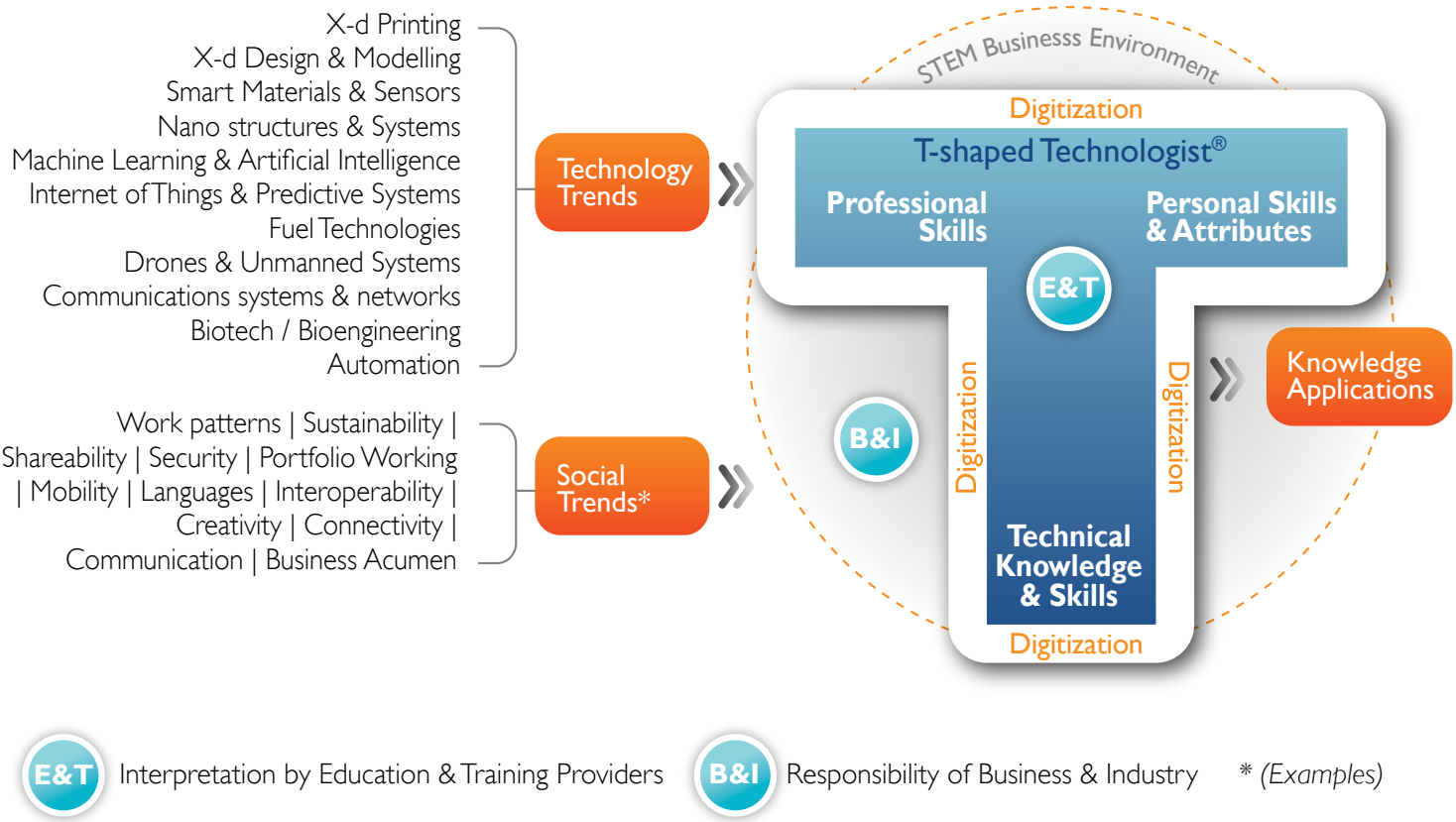


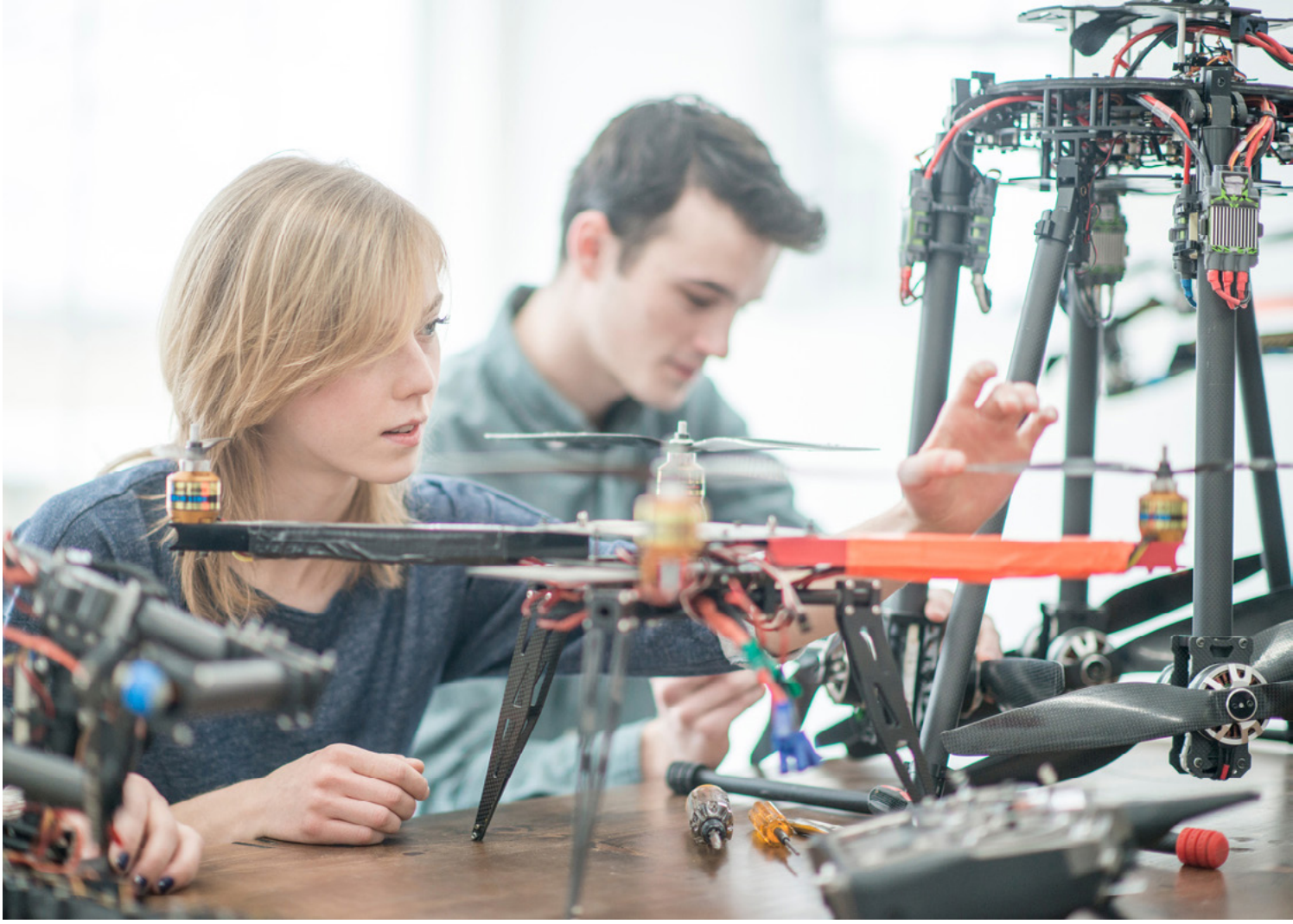
Figure 3 T2K: STEM Skills Road Mapping Model

The T2K model could operate as a digital platform that collects data with respect to technology and social trends, and act as an early warning system that will provide education and training providers with the requisite inputs to prepare the business case for introducing new offerings or changing and adapting existing ones.

** (Including Questionnaire & Direct Research Data Input)*

Figure 4: Predictive Analysis: Trends Frequency & Sources

T2K could run as an open source web-based application with a preloaded search function that assesses the intensity of technology and social trends as they appear on the internet, as shown in Figure 4. T2K will comprise of four-operational steps. It will be set to monitor the intensity of keywords as the appear on Internet searches and categorise those trends into technical and social clusters. These will then be cross-referenced against multiple sources, to ensure validity. A basic forecast analysis could then be conducted. Alternatively, deep-dive assessments and reporting could also be undertaken and made available online. These reports will carry a price tag against them to generate a baseline revenue to enable reinvestment in the development and housekeeping of the T2K system. The T2K system could be managed by an independent charity or association, and the beneficiaries (e.g. employers, education and training providers) could join in as subscribing members.



CONCLUDING REMARKS

- The pace of technology confluence (e.g. IoT, Data Analytics, Autonomy, Smart Materials) forces the need for multidisciplinary technical skills. The expansion of technology-based applications also necessitates the need for interdisciplinary transferrable skills.

- The job profiles and therefore job families are changing dramatically within a shorter horizon, driven principally by the need for skills in AI, Knowledge Automation, Autonomous Systems and Robotics, Bioelectronics, 3D and Mixed Reality applications development.

- Just-in-time education and training providers will need to factor in the level of 'Intensity of Demand' for skills in new and emerging technology areas, as developing just a sector-specific provision is likely to be volatile. Introduction of new provision will need to assess the characteristics of multi-sector/market readiness with respect to the level of maturity of new technologies and their applications.

- The high level of automation both in repetitive and algorithmic tasks is signalling the need for new types of Conversion Courses that enable individuals to interoperate in adjacent disciplines/sectors but still use their existing specialist technical skills and competencies to underpin their newly acquired knowledge.

- There appears to be a disconnect between the way in which STEM fundamentals are packaged and taught by providers against market expectation and the pace of technology. Such a disconnect requires a change in philosophy and attitude in how education and training providers prepare and equip individuals to achieve a high degree of competence in self-directed and continuous learning.

- Structured retraining is becoming the new recruitment mantra for many organisations. Digital transformation and the impact of technology proliferation such as AI is creating a scarcity in the labour market for digitally competent individuals. This in turn is pushing organisations to retrain their existing workforce to fill open technical roles faster.

APPENDIX: RESEARCH PARTICIPATION & VALIDATION

Participation in the research study included over 100 representatives drawn from the following:

- Members of the Institute of Innovation and Knowledge Exchange with a remit for new technology road mapping.
- A sample of STEM employers from the GCGP LEP region as well as multinationals who have a footprint in the region
- Attendance at events and conferences (e.g. CleanTech Cambridge)

The research included online surveys, depth interviews and discussions as well as review of many technology or sector specific research publications.

Key Assumption

Any respondent stating that their business is affected by a technology or a skill need of **70% or higher, demonstrates a degree of demand intensity** in the market place and therefore, a requirement that the provision should be developed and delivered within a maximum of 3 years' timeframe.

Participants

ARM	ELECTRONICS / IT	CEO
Aseptika Limited	MEDICAL	Director
BAE Systems	ENGINEERING	Strategy & Planning Manager, Global Engineering Fellow, Technologist
Bentley Motors	AUTOMOTIVE	Future Talent Manager
Carillion	CONSTRUCTION	Chief Engineer
Cobra products	ENGINEERING	Director
DHL Supply Chain	LOGISITICS	VP IT Project Delivery
Dialog semiconductor	ELECTRONICS	HR Director
Eminox	AUTOMOTIVE	Deputy MD
FARRANS	CONSTRUCTION	Strategic Marketing Manager
Fraunhofer IDM@NTU	ITC	Head of Business Development and Technology Transfer
Hyster-Yale Group	ENGINEERING	HR Manager
Johnson & Johnson Medical	MEDICAL	Engineering Manager
Marshall Aerospace and Defence Group	ENGINEERING	Manager of Aero Academy
MedImmune	MEDICAL	VP, Learning, Standards & Insights
Plessey Semiconductors	ELECTRONICS	CEO
Raytheon Systems Limited	ENGINEERING	STEM Lead
Raytheon UK	ENGINEERING	Technical Director
Reckitt Benckiser Group plc	MEDICAL	R&D Director - Innovation
Rolls-Royce plc	ENGINEERING	Head of Community Investment & Education Outreach
Rolls-Royce Submarines	ENGINEERING	Head of E&T Nuclear Skills Management
SGN	POWER	Head of Training & Development
Skanska	CONSTRUCTION	Director
South West College	EDUCATION	Deputy Chief Executive
Syrinix Limited	ENGINEERING	Finance Director
Telefonica	TELECOMS	Vice President
Thales	ENGINEERING	Technology & Innovation Manager
The Open University	EDUCATION	Associate Dean - Academic Excellence
The Skills & Growth Company	PUBLIC SECTOR	Skills & Employment Officer
The Welding Instit ute	RESEARCH & TECHNOLOGY	Director
UCAS	EDUCATION	CEO
West Dorset District council	PUBLIC SECTOR	Economic Development

Organisations Participated in the Survey

Amec Foster Wheeler	Engineering
AVX / Kyocera Group Company	Financial Services
Babcock International	Construction
BAE Systems	Defence
Balfourbeatty	Construction
Barclays	Finance Services
BASF	Chemicals Manufacturing
BBC	Broadcast Media
Bosch Thermotechnology	Industrial Manufacturing
Brush Group	Power
BT	Telecommunications
Bupa	Health Care
Bupa	Health Care
Cobham	Aerospace
Cobra Global	Aerospace
Contour / Zodiac Aerospace	Aerospace
Convatec	Medical Products & Technologies
Danone	Food Stuff
DELL EMC2	Information Technology
DHL	Logistics
Domino Printing Sciences	Printing Technology
Drax Power	Power
Dunhill	Design
EDF Energy	Power
Extrinsica Global	Information Technology
GE	Engineering
GSK	Pharmaceuticals
HS2	Infrastructure
Hyster-Yale Materials Handling	Equipment Manufacturer

Johnston Sweepers	Equipment Manufacturer
Lotus Cars	Car Manufacturing
Medimmune	Pharmaceuticals
Microsoft	Information Technology
Moog	Engineering
National Grid	Power
Network Rail	Transportation
NHS England	Health Care
Norgen	Engineering
Plessey Semiconductors	Semiconductors
Raytheon	Defence
Renishaw Plc	Engineering
RM	Educational Technologies
Rolls-Royce	Nuclear
Rolls-Royce	Aerospace
Rolls-Royce	Manufacturing
Rolls-Royce	Engineering
Seagate	ITC
Siemens	Industrial Manufacturing
Sunseeker	Yachts Manufacturer / Leisure Industry
Tate and Lyle	Food Stuff
Team Flo	Information Technology
Telefonica - O2	Telecommunications
Thales UK	Engineering
Thales UK (SIX)	Information Technology
Toyota	Car Manufacturing
TT Electronics	Engineering
UKPIA	Petroleum & Petrochemicals
Xyratex / Seagate PLC	ITC

IKE Institute supports our educational charity the STEM Foundation (www.STEMFoundation.org.uk) - an innovation-driven charity that supports improvements in STEM (Science, Technology, Engineering and Mathematics) education. It conducts STEM assurance, delivers CPD to lecturers in new and emerging technology areas, facilitates multidisciplinary collaboration and conducts action research that enables knowledge and technology exchange. Since 2004, we have supported over 250 colleges and benchmarked over 100 institutions. Our efforts so far, have positively impacted the lives over 600,000 STEM students in the UK.