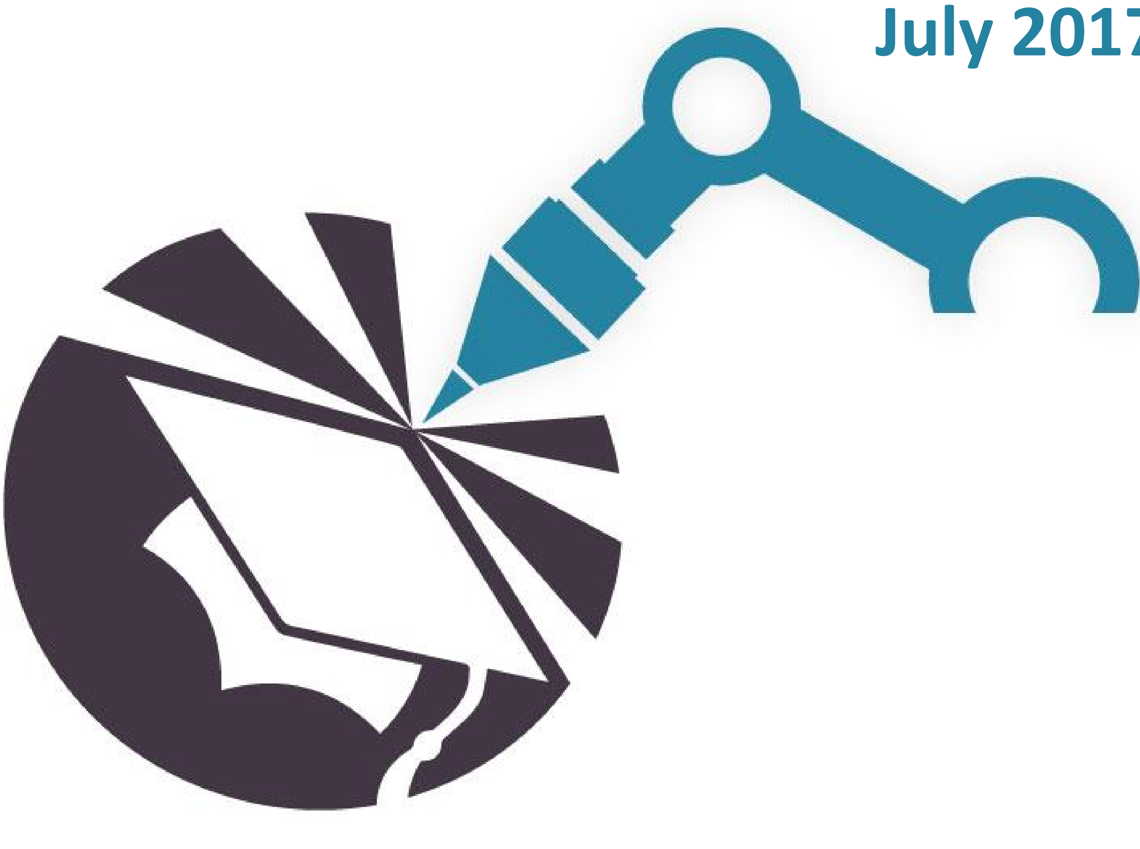
Robotics – Training for the New Age

European Survey Report
Robotics/AI and 3D printing
(Executive Summary)

July 2017



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In memory of Dr Tony Pustovrh (1979-2017) both a colleague and friend to us all.

July 2017

The Full Survey Report can be downloaded at www.rotena.eu

1. INTRODUCTION

The ERASMUS + project ROTENA: Robotics for the New Age aims to use the motivational effects of robotics and 3D printing to excite students and learners about science and to develop programmes to enable them to productively engage in the "New Age Technology" revolution. The development of an entry-level general robotics/3D printing curriculum should enable learners to acquire skills and competencies to understand the principles of robotics and 3D printing and their widespread application in industry in order for them to access jobs in these new-age industrial sectors.

Robotics is a fast developing market increasingly driven by the development of novel and improved products in areas as diverse as manufacturing, search and rescue and retrieval, inspection and monitoring, surgery and healthcare, homes and cars, transport and logistics, agriculture, and many more. The rapid increase in the use of robots in our homes and at work, in hospitals and industrial environments provides an inspiring vision about how they can benefit society as a whole and how priorities to stimulate robotics should be defined at this point in their evolution, to best develop the potential for growth, jobs and innovation in Europe.

Similarly, 3D printing offers many novel opportunities in architecture, construction, industrial design, automotive, aerospace, military, engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewellery, eyewear, education, geographic information systems, food, and many other fields. Transformative changes and new opportunities are expected in industrial and entrepreneurial ecosystems.

In order to build on a solid empirical foundation, the first part of the ROTENA project was dedicated to an extensive analytical exercise. The analysis was intended to take into account the current socio-technological context in which new technologies are opening new opportunities for industry, entrepreneurship and jobs, with a specific view to robotics and 3D printing. This includes new opportunities for both education and employment in these fields, as well as the skills that will be needed by prospective workers. As informatization and automation are expected to produce changes and even make some jobs obsolete while opening up new workplaces, it is important to motivate and engage people now so that labor market shortages for new age technology jobs will be minimal.

Ensuring a sufficient number of skilled workers is also crucial to boost entrepreneurship and innovation opportunities in the fields. In this regard, existing workers should also be provided with opportunities to learn about robotics and 3D printing in order to help companies secure new markets and opportunities.

2. MODERN SOCIETY AND TECHNOLOGY

Technological development over the past two decades has been progressing extremely rapidly in several domains, especially in Nanotechnology, Biotechnology, Information-communication technology and Cognitive science (NBIC).[1] New technologies, especially those that are emerging at

[1] Roco, C., W.S. Bainbridge (Eds.). 2003. Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science. Dordrecht: Springer.
Bainbridge, William Sims in Mihail C. Roco, ur. 2005. Managing Nano-Bio-Info-Cogno innovations: Converging Technologies in Society. Dordrecht: Springer.

the intersections of the NBIC domains, are now permeating practically all levels and spheres of societies in the developed countries. Technological applications thus increasingly condition and mediate how we do things, that is, how we interact, how we think, how we produce and also how we learn and how we work.

Many workplaces are now becoming **digital workplaces**. Automation means that a number of tasks in the workplaces, and in some instances entire work processes, can be carried out by smart machines, with little or no human supervision and input. This can relate either to industrial manufacturing, to warehouse robots, or to data acquisition, analysis and management. Robotization refers to physical manipulators, at least partially controlled by some form of information technology, that carry out various work tasks or processes by manipulating objects in the physical environment, either semi-autonomously or completely autonomously. Thus, increasingly smart machines are able to carry out not just predictable physical activities but also more demanding cognitive activities.

Some experts postulate that we are currently located in the midst of a new industrial revolution, what Brynjolfsson and McAfee term as The Second Machine Age[2] or what others have called The Fourth Industrial Revolution or Industry 4.0.[3] While the First Machine Age was marked by the automation of physical tasks through mechanization, the second is characterized by the automation of cognitive tasks through digital technologies. The progress in the development of the underlying enabling technologies is exponential, the technologies are mostly digital and are driving the digitalization of previously solely physical objects and processes, and they are capable of combinatorial reinforcement, meaning that robots can be directed through cloud-based algorithms, that tasks and needs can be automatically communicated through networks without human intervention, that digital objects can be printed remotely using 3D printers, and that big-data driven analytics can be used to optimize drug discovery or disease prediction. Similarly, in Industry 4.0, various technologies are combining and blurring the boundaries between the physical, the digital and the biological.

The third industrial revolution made use of electronics and information technology, in the forms of computer and automation, to achieve further automation, while the fourth industrial revolution is based on cyber-physical systems that are increasingly connected and smart. Their distinctive features are that the speed of their progress is exponential, that their scope is widening, as they are being disruptive in a growing number of industries globally, and that they are having a systemic impact, for example on production (workplaces), on management (organizations, companies) and on public policies (economy, employment, education).

3. DEFINITION OF ROBOTICS AND 3D PRINTING

3.1 Robotics

A condensed definition for the purposes of the ROTENA project:

> *Robotics is a multidisciplinary technoscience that combines mainly mechanics, electronics and computer science. Its goal is the research, design, development and building of robotic systems controlled by integrated circuits. ROTENA Partners see the learning and use of Robotics as a*

[2] Brynjolfsson, Erik and Andrew McAfee. 2014. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. W. W. Norton & Company.

[3] Schwab, Klaus. 2016. *The Fourth Industrial Revolution: what it means, how to respond*. World Economic Forum. https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

way to develop the skills that will allow people to build autonomous projects that will contribute not only for personal and professional development, but also for innovation and entrepreneurship. The knowledge acquired in this field will make the users technologically adaptable in a fast changing society.

What is robotics?[4]

In general, we can think of **robotics** as a multidisciplinary science and technology field or approach, where the goal is to research, design, develop and build various **robotics systems and robots**, including their programming, operation, usage and maintenance. As with many new technologies that are experiencing rapid growth, it is not easy to strictly define and separate different concepts, objects and fields. **Robotics** can be conceptualized as an expanding research and technology field that combines various disciplines, including mechanical and electronic engineering and computer science as the core disciplines, but there is increasing cross-fertilization and convergence with various other fields such as biology, materials science, cognitive neuroscience, etc. The rapid development, cutting edge technology, multidisciplinary and its converging nature make robotics education quite challenging.

Both robotics and robots are closely connected with the concepts and fields of **automation** and **artificial intelligence**. **Automation** focuses on systems that can operate autonomously, without constant human supervision, and emphasizes efficiency, productivity and reliability with minimal human intervention (e.g. factory production and assembly lines). **Artificial intelligence (AI)** is both a scientific and technology field, and in this context can be seen as the software necessary to control the robot's responses and increasingly enable the capacity to emulate aspects of biological cognition, such as perception, sensorimotor navigation, memory, etc. Although some AI can exhibit specialized intelligence in narrow domains (search engines, playing games, big data informatics, medical diagnosis, etc.), the goal of artificial general intelligence that would equal or surpass human intelligence is still a distant effort. Greater (specialized) cognitive and physical autonomy can be seen as a general goal of AI. Ultimately advances in both AI and robotics hardware are necessary to increase the **autonomy**, as the capability for unsupervised operation, and range of capabilities of future robots.

[4] A Roadmap for US Robotics: From Internet to Robotics. 2016 Edition.
Gerhard Schweitzer, ETH Zurich, HUT, 8092 Zurich, Switzerland, 17th International Congress of Mechanical Engineering (COBEM 2003), São Paulo, Brasil, November 10-14, 2003 (Invited Paper)
Benjamin Wittes and Gabriella Blum. 2015. The Future of Violence: Robots and Germs, Hackers and Drones—Confronting A New Age of Threat. New York: Basic Books.
Peter Sinčák, Pitoyo Hartono, Mária Virčíková, Ján Vaščák and. Rudolf Jakša. 2014. Emergent Trends in Robotics and Intelligent Systems: Where Is the Role of Intelligent Technologies in the Next Generation of Robots? Cham Heidelberg New York Dordrecht London: Springer.
Encyclopædia Britannica. 2016. Robotics. Available at: https://www.britannica.com/technology/robotics.
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LEO - Center for Service Robotics. 2016. Defining robots and robotics. Available at: http://www.leorobotics.nl/definition-robots-and-robotics
NASA – National Aeronautics and Space Administration. 2016. What Is Robotics? Available at: http://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-robonaut-k4.html.
Maja J Matarič. 2007. The Robotics Primer. Cambridge, Massachusetts London, England: The MIT Press.
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http://www.revereschools.org/cms/lib02/OH01001097/Centricity/Domain/64/VEX%20Robotics%20Unit%202-Intro%20to%20Robotics.pdf
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Stefano Nolfi and Dario Floreano. 2004. Evolutionary Robotics: The Biology, Intelligence, and Technology of Self-Organizing Machines. Cambridge: MIT Press.
www.directrecruiters.com/wp-content/uploads/.../Robotics_4-16.pdf

Ultimately, a robot should be capable of autonomous and purposeful sensing and acting and achieving goals in the physical world. Whether or not we would consider a drone, a roomba floor cleaner or a self-driving car a robot depends on what degree of autonomy, decision-making and adaptability, but on the other hand also body shape, we consider to be essential robot characteristics.

3.2 3D printing

A condensed definition for the purposes of the ROTENA project

3D printing refers to the process of additively building a three-dimensional physical object from a digital model data (Computer Aided Design or scanned object) file by depositing and forming successive layers of material under computer control.

What is 3D printing?[5]

In a nutshell, a 3D printer is a machine that can turn a blueprint into a physical object by applying material layer by layer without the need to adjust the production tooling. 3D printing refers to the process of additively building a three-dimensional physical object from a digital model data (Computer Aided Design or scanned object) file by depositing and forming successive layers of material under computer control. This additive manufacturing process is the reason why 3D printing is also referred to as "additive manufacturing", and while technically more accurate, the term 3D printing has been more enthusiastically adopted due to mainstream media diffusion. The analogy with document printing also plastically presents the basic underlying concept of depositing material with a printing head in order to bring a specified object into existence. However, there are many underlying additive manufacturing technologies that can be used (e.g. stereolithography, laser sintering, fused deposition modeling), which allow various degrees of precision and sophistication. While in principle the printed objects can be of almost any shape or geometry, their characteristics depend on the underlying printing technology and the materials that can be employed. With advanced 3D printers it is also possible to create assembled objects with internal, movable parts. The time it takes to print a full object however increases with the level of detail and complexity of the object.

The technology is significant because it offers direct manufacturing, meaning a design goes directly from designer to physical product through a computer and a 3D printer. It brings a revolutionary approach to manufacturing through three key advantages - shorter lead time, design freedom, and lower costs. It thus enables rapid and low-cost prototyping, manufacturing end-use products (direct digital manufacturing) and producing tooling that allows the manufacture of other components and products using different methods.

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[5] http://3dprinting.com/what-is-3d-printing/
https://www.stratasysdirect.com/resources/what-is-3d-printing/
Bandyopadhyay, Amit and Susmita Bose (Eds.). 2016. Additive Manufacturing. Boca Raton, London, New York: CRC Press Taylor and Francis Group.
van den Berg, Bibi, Simone van der Hof and Eleni Kosta (Eds.). 2016. 3D Printing Legal, Philosophical and Economic Dimensions. The Hague: TMC Asser Press.đ
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Gibson, Ian, David ¬Rosen and Brent ¬Stucker (Eds.). 2015. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing 2nd Ed. New York Heidelberg Dordrecht London: Springer.
Muthu, Subramanian Senthilkannan and Monica Mahesh Savalani (Eds.). 2016. Handbook of Sustainability in Additive Manufacturing, Volume 1. Singapore: Springer Science+Business Media.
Birtchnell, Thomas, and William Hoyle. 2014. 3D Printing for Development in the Global South The 3D4D Challenge. Palgrave Macmillan UK.

There are also enabling interconnections between the fields of robotics and 3D printing, for example printing robot parts with 3D printers, such as engineers would be unable to construct otherwise. Such an example is a soft legged robot that can navigate difficult terrain and could be used in search and rescue operations.[6]

4. IMPACT OF ROBOTICS AND 3D PRINTING ON INDUSTRY, WORK, EDUCATION AND SOCIETAL NEEDS

Usage and applications of robotics

There are many predictions regarding how the trends in robotics and 3D printing will continue to develop and impact specific industries, workplaces and practices, as well as education and societal needs and structures. Most existing robots are currently used in industrial manufacturing. The total worldwide stock of operational industrial robots at the end of 2015 was about 1.6 million units and the value of the global industrial robotics market was US$11 billion in 2016, while the robotics systems market (including software, systems engineering, etc) is estimated at US$35 billion. [7] Of the existing industrial units, 272,000 were in America (259.200 in North America), 914.000 are in Asia and Australia (262.900 in China, 297,200 in Japan 201,000 in South Korea). Europe had 433,000 (183,000 in Germany). Africa had 4,500. In 2016, 290,000 new robots were installed globally.

The majority of such robots are used in the automotive and the electrical/electronic industries, followed by metal, chemical and food industries. The average global robot density is about 69 industrial robots installed per 10,000 employees in the manufacturing industry in 2015. The most automated markets are South Korea, Singapore, Japan and Germany. The US, one of the biggest robot markets has a robot density of 176 units in 2015, and China, the biggest robot market since 2013, reached 49 units in 2015, showing huge potential for robot installations. In 2015, about 5.4 million service robots for personal and domestic use were sold, 16% more than in 2014. The value of sales increased by 4% to US$2.2 billion.[8]

Projections for new installations in 2019 are 50,700 for America (46,000) North America, 285,700 for Asia and Australia (160,000 in China, 43,000 in Japan, 46,000 in South Korea). For Europe, the projections are 433,000 (25,000 in Germany), and for Africa 800. The global robot market between 2016 and 2019 projections are that 1,4 million new industrial robots will be installed in factories, 333,000 will be sold to both the industrial and non-industrial sector and 42 million service robots for personal and domestic use (consumer robots) will be used privately. While the sale of robot companions/assistants/humanoids has been quite low until now, it is projected that between 2016 and 2019 some 8,100 units of these robots will be sold. This clearly shows that there will be future labor demand for people who design, produce, maintain, program and operate robots.

Today we are seeing robots of various forms performing many different tasks, although most remain in the domain of industrial manufacturing, usually performing repetitive, predictable, difficult and highly specialized tasks. Nevertheless, we are seeing automated and semi-automated robotics systems used in surgery (e.g. the da Vinci surgery system),[9] for telepresence in hazardous environment (the

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[6] http://www.bbc.com/news/av/technology-40296297/the-soft-3d-printed-robot-that-could-come-to-the-rescue

[7] International Federation of Robotics 2016

[8] World Robotics Service Robots 2016 https://ifr.org/free-downloads/

[9] http://allaboutroboticsurgery.com/surgicalrobots.html

huge explosion of commercial drones, probes on other planets, in the sea), and we now have robots available for domestic consumer use, for example vacuum cleaners and washers, lawn movers (e.g. Roomba). We are also seeing the first automated robotics systems preparing food in fast food restaurants,[10] or performing the work of receptionists in hotels, and the first self-driving cars have successfully completed various routes, along with an Uber self-driving 18-wheeler truck delivering a cargo of Budweiser beer.[11] A parallel research goal is however still to develop robots that can perform a wider range of human-like capabilities.

Usage and applications of 3D printing

Similarly, 3D printing or additive manufacturing is a technology that has been in the making since the latter part of the 20th Century, but has only now reached a point of technological development where it is becoming accessible to

Commercially, these technologies are predominantly used in high value-added industries and applications including those involved with aerospace, automotive, and biomedical (prosthetics and implants) products which require highly complex and customized designs at low volumes. Still, improvements in terms of speed, accuracy, material properties, machine reliability, and development of low-cost machines has widened the accessibility and user base, and thus holds great potential. Currently, just one in a thousand products is fabricated using 3D printing. Global manufacturing was worth $10.5 trillion in 2011 and is predicted to be worth $15.9 trillion in 2025. The 3D printing economy was worth $1.7 billion in 2011 and is estimated to be worth $10+ billion by 2025.

The concept and technology of 3D printing also presents new business opportunities as well as new (including social) entrepreneurial models based on transforming digital data into physical objects in remote locations, independent of centralized production and industrial areas by using "printing hubs". In addition to enabling the creation of a greater range of products than would be possible with conventional manufacturing, it presents the possibility to democratize design and empower communities by decentralizing production, and promoting innovation and creativity. Making product conceptualization, creation and propagation possible in any (relatively speaking) geographical location or community, makes 3D printing businesses and jobs potentially less vulnerable to off-shoring. All this of course also raises issues of intellectual property rights and environmental impacts resulting from possibly increased consumption and production in vulnerable, remote locations, etc.

Impacts of robotics and 3D printing

In general, robots offer considerable economic benefits to companies and employers, also in terms of lower labour costs, as robots do not require healthcare, annual leave, health and pension security or other social benefits. Regarding production and work, they enable increased productivity, faster speeds, greater precision, lower costs and an expansion of work beyond the current range of human capabilities. As robotic systems become more sophisticated and their price begins to drop, this would also mean that they present an increased scope of innovative activities achievable by SMEs. As robotics systems become more sophisticated, we can expect that more businesses will have to adopt robotic systems in order to stay competitive and innovative in the increasingly interconnected global market.

[10] https://singularityhub.com/2017/03/08/new-burger-robot-will-take-command-of-the-grill-in-50-fast-food-restaurants/
[11] https://www.wired.com/2016/10/ubers-self-driving-truck-makes-first-delivery-50000-beers/

The introduction of new machines that automate tasks previously performed by humans or animals has also been accompanied by the fear and actual loss of work and jobs since at least the industrial revolution and the now famous Luddite struggles against work loss due to industrial looms introduced in 19th Century England. Thus the positive impacts of increasing automation and robotization, especially in the industrial and commercial sectors, are always accompanied by the societal side-effect of the reduced need for human workers, whose occupations are often made obsolete. Although there are always new jobs that are created because of the introduction of new machines and technologies, usually more skill-intensive, the question of how to retrain the now unemployed and whether enough and what kind of jobs will always be created to replace even white-collar workers and experts, remains open.

Some recent studies from prestigious institutions, for example the one conducted by Oxford University and Deloitte predict a high probability that 47% of 700 jobs in the USA will be automated within the next 10 to 20 years[12]. In the UK, about 35% of current jobs are at high risk of automation by 2030.[13] Further studies have predicted that about 57% of jobs in the OECD will likely be automated, with probably 69% in India and 77% in China[14]. The McKinsey Global Institute predicts the potential automation of half of the 2,000 current work activities in 800 jobs by 2055 on a global scale. This means that there will be changes in a majority of jobs, which will require new skills and knowledge, but that there will not be complete automation of most jobs. The jobs that are however most likely to be automated are those involving predictable physical activities (81%), data processing (69%) and data collection (64%). Thus it is not only low skill and low wage jobs that are vulnerable to full automation, but an approximately equal number of the lowest and the highest paying jobs.

The analyst Stuart Elliot, who posited in 2014 that about 80 percent of current jobs could be automated in the future, also writes that employment in the remaining 20 percent of jobs could be expanded to absorb the entire labor force.[15] Robots ultimately (still) need to be designed and created by humans.

The jobs that are emerging and opening up with the development of 3D printing are in the areas of 3D design, 3D computer-aided design (CAD) modeling, research and development (R&D), biological and scientific modeling, architecture/construction modeling, education, law and legal professions, new business opportunities, 3D-Printing-as-a-Service franchises and operations and administrative positions. [16] Jobs for designers who can translate a product idea into 3D printed objects will be opening up in 3D printing firms, as part of 3D design teams in companies and as freelancers.

Regarding the skills that will be needed by workers in new age technology fields, there are three basic skill fields[17]. First, there are **cognitive skills**, which include digital literacy, as well as advanced problem-solving and creative and critical thinking skills. Second, there are **social and behavioral skills** like

[12] Frey and Osborne 2013

[13] http://www.bbc.com/news/business-39377353

[14] Citibank, Frey, Osborne 2016

[15] http://issues.org/30-3/stuart/

[16] http://www.businessnewsdaily.com/5125-3d-printing-jobs.html

[17] https://www.brookings.edu/blog/future-development/2016/03/01/preparing-for-the-robots-which-skills-for-21st-century-jobs/

conscientiousness, grit, and openness to experience. Third, there are job- or occupation-specific **technical skills**, in this case related to robotics systems and 3D printing.

Conclusion

A global survey of 100 largest employers showed that they expect a total of 7.1 million jobs to be lost due to automation from 2015 to 2020. [18] Of these, two thirds will be lost in routine office and administrative tasks. On the upside, they expect a total of 2 million new jobs to be generated, predominantly in the areas of computers, mathematics, architecture and engineering.

Whether robotics and other technologies will in the end create more or less jobs than they make obsolete remains an open question, but it is clear that workers whose jobs are taken over by technology or transformed, will need to learn new skills and knowledge and also become familiar and adept at working together with robots. The same holds true for first-time employment seekers and young people who are still deciding on a career path.

5. ROTENA EUROPEAN SURVEY RESULTS

In order to determine what the needs, expectations and the conditions among the actual providers, users, and the ROTENA project conducted an extensive web-based European survey. The survey questionnaire was of a structured type, consisting of 20 questions, divided into two sets, one focusing on robotics (15 questions) and the other on 3D printing (5 questions). We focused on three key groups of stakeholders - on providers of vocational education and training, on SMEs as potential users of robotics and 3D printing and employers of individuals with the necessary skills, and the individuals who could be interested in pursuing such knowledge, skills and careers in the future.

The questionnaire was developed in English and then translated into all partner languages (Portuguese, German, Swedish, Slovenian). All language versions were installed in the online web survey system 1KA, and data collection took place from February 2017 to April 2017. Invitations were sent out when the survey was opened as well as throughout the duration of the survey. Several channels were used, from partner networks to personal invitation and posts on social networks and websites.

When the survey was closed, we had received valid 150 replies. Of these, 28 (19%) were from representatives of an SME, 36 (24%) were from representative of a course/training provider institution, and 86 (57%) were from individuals.

Main Results

- 36% or respondents had no knowledge of automation and robotics in an industrial setting.
- 83% thought that the use of robots in a company can be beneficial.
- 38% or respondents were already using robotic devices in their company, 38%.
- 79% of respondents could identify tasks in their company that could be automated or carried out by a robot.
- 63% of respondents said that their company is considering using robotic devices in the future.

[18] WEF 2016

- 58% of SMEs indicated that their employees would benefit from more knowledge/training about the use of robotics.
- 96% of respondents thought schools and educational institutions should provide more robotics skills/knowledge training.
- 36% of respondents knew how to use a 3D printer. The answers show that there are needs for additional education and training opportunities in 3D printing that are easily accessible to SMEs.
- 45% of respondents already uses 3D printing in their company.
- 82% of SMEs thought that their employees would benefit from more knowledge/training about the use of 3D printing.
- 67% of SMEs thought that the use of 3D printing would improve their competitiveness and/or reduce costs.
- 86% of respondents thought that schools and educational institutions should provide more 3D printing skills/knowledge training.
- 90% of respondents thought that in the future, knowledge of robotics could give them a professional advantage in job seeking or their work.
- 83% of respondents would consider taking a course/module about robotics if it were available for free.
- 58% of respondents were interested in building and programming robots with 42% wanting introductory and basic knowledge of robotics.
- 54% or respondents could envisage their work being carried out by a robot.
- 23% of the institutions responded said they offer any stand-alone robotics courses. There is a need for additional stand-alone courses on the topic of robotics that can be adapted by institutions to suit their own curricula and needs.
- 9% of the institutions responded said they offer any stand-alone 3D printing courses. However, 33% offered some kind of module.

Survey Conclusions

- Given that more than two thirds of the surveyed SMEs are considering to use robotics devices in the future, this further confirms a growing need for employees skilled in the production, maintenance and operation of such devices.
- This overall datum shows that the demand for robotics devices and robots will further increase in the future, and that the demand for employees who have knowledge and skills in handling such devices will equally increase.
- The two thirds of affirmative responses show that there is a need not only for new students and trainees in robotics, but also for online courses that would help existing employees gain additional knowledge and skills in the field.
- The majority in favor of more such training in schools and educational institutions also confirms the need for online courses and materials that can be used and adapted to suit specific curricula and training.
- As with robotics, the answers indicate that not only future workers, but also existing employees could have an interest in gaining additional training and skills.
- As with robotics, the majority in favor of more such training in schools and educational institutions also confirms the need for online courses and materials that can be used and adapted to suit specific curricula and training.

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