LUISS Guido Carli
LIBERA UNIVERSITA' INTERNAZIONALE DEGLI STUDI SOCIALI

DEPARTMENT OF MANAGEMENT

Chair of Competition and High-Tech Markets

Disruptive Technologies and their Impact on the Labor Market

SUPERVISOR

Prof. Andrea Renda

CANDITATE

Giuseppe Menicocci

ID. Number 656011

ASSISTANT SUPERVISOR

Prof. Giuseppe Colangelo

ACADEMIC YEAR 2014/2015

Disruptive Technologies and their Impact on the Labor Market

Executive Summary

Disruptive Technologies and their Impact on the Labor Market

The impact of Technology has been, in the mere definition of the human being, always more present. The focus on research and innovation of technology, as well as the enthusiasm and the worries that it causes, often lead to distract attention from a careful consideration of the entire context as a whole. In the limits of any biological metaphor, it can be argued that between human being and Technology there is a tight relationship of coexistence and mutual advantage. It can be said that there is a sort of "symbiosis": our species blended with all the new innovation and instruments that creates and produces. It is quite impossible not proving the easiness that technology generates in different realities, such as social's and professional's, through, *ex plurimis*, the transfer of activities, competences, and even decisions, which in the past were belonging to humans, to machines and artificial intelligence robots. All of these concepts bring to another consideration: the technology advancement entails a minor material compliant in the form of an increasing dependency of human to technology itself.

If, on one hand, history tells us that the rhythm of technology progress is constantly increasing over time, due to the fact that a set of new discoveries serve as basic ground for others, newer and larger, on the other hand, it is required to notice that the consequences, of the technology evolution itself, cannot be confined to its immediate effects. There are (and there will be) always unexpected, unpredictable, and undesired effects. Moreover, technology evolution is marked from very fast changes, fastened to actualization mechanisms, thanks to which the immediate adjustments to innovation tend to take the root into the profound society structure, by chaining together the "*homo technologicus*" with the permanent presence of such innovations and evolution[1].

[1] "L'avvento di Homo Technologicus", Giuseppe O. Longo, Scienzainrete.it, 18.03.2015

Can the impact of technology being predicted with absolute certainty?

Today, the present scenarios and the hypothesis of the future are, often, built through conjectures filled with high degrees of predicting and diagnostic competences. Nevertheless, one thing is sure: the asymptotic evolution of new technologies requires, as *conditio sine qua non*, a corresponding and updated education, which would be able to allow a fair adaptation to the continuous changes.

What impact these things just said had and will have on the labor market?

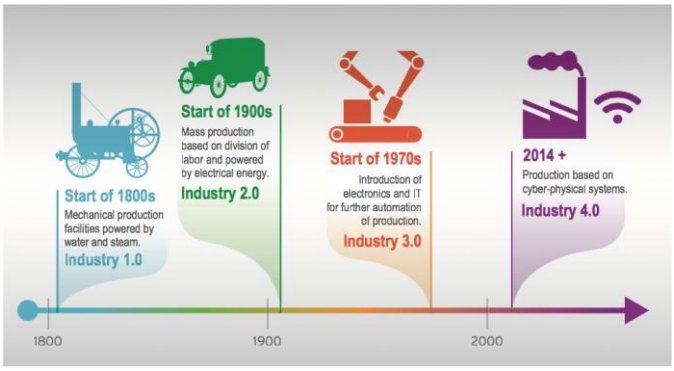
The advent of new technologies, the emerging of new professional opportunities, new markets, new sectors, and the continual quantitative and qualitative modification of human-machine interaction, have brought radical changes in work's structure and essence. These work's transformations can be read either under an optimistic, than a pessimistic lens. From one perspective, technology advance will definitely bring a bunch of new opportunities in almost every field of applicability: smart cities, wearable devices, interconnected sensors and items, smart manufacturing organizations, and a quite all customization of every individual need thanks to huge amount of available data. From the other perspective, instead, several academic studies, as well as other reliable sources, have shown that the increasing automation of some tasks, mostly related to routine and ruled-based tasks, is laying on the line a very big portion of the labor market.

My study, with obvious humility, will attempt to illustrate possible scenarios and feasible applications that the evolution of technology will necessarily imply.

The thesis will be structured as follow: the first part, from chapter 1 to 3, will regard the different Industrial era, from the first Industrial revolution to the futuristic concept of Industry 4.0 and Internet of Everything. In order to give a reliable interpretation of the abovementioned contents, it is correct to make an initial distinction between the meaning of Industrial revolution and the term Machine age, used as title for each chapter.

Figure 1 represents the different time frames associated with the four stages of the Industrial Revolution.

Figure 1: The fourth stage of the Industrial Revolution



Source: Cognizant (2014), from Industry 4.0, or Zukunftsprojekt Indstrie 4.0.

The Industrial Revolution kicked off with the invention of the steam power engine and the first mechanization of manual work at the beginning of the 1800s. The second Industrial Revolution has been associated with the beginning of the mass production techniques implemented by Henry Ford and its first concept of "smart factory" in the early 1900s. Going ahead, over the past thirty years, with the advent of electronics and IT revolution, the entire world assisted to a radical transformation in terms of living and working attitudes. Then, the third Industrial revolution employed electronics and information technology to achieve increased automation of manufacturing processes, which have brought to a machine take over of a substantial proportion of manual and cognitive jobs. The last Industrial revolution refers to the evolution of PCs into smart devices that has also been accompanied by other trends that combine miniaturization and the unstoppable growth pace of the Internet. These results in the convergence of the physical world and the virtual world in the form of Cyber-Physical Systems, as well as the rise of the Internet of Everything, the concept of Industry 4.0 and the new future of smart factories.

In this thesis work the different stages of the Industrial revolution are represented under the term of Machine Age, following and adapting, to some extent, the categorization made by Brynjolfsson and McAfee (2014). Thus, within the First Machine age, presented in the first chapter, are grouped the first and the second industrial revolution, covering the period from the 1800s to the information revolution; following, the Second Machine age is going to represent the third industrial revolution, and the rise of a social and economic problem called the "hollowing-out" of the labor market; finally, will be presented, as the Third

Machine age, the last industrial revolution, which involves the technical integration of CPS into manufacturing and the use of the Internet of Everything in almost every sector and industrial processes.

The second part, instead, will stress the accent on the possible implication of technology progress, through a cross comparison analysis of several scenarios based on different methodologies. The final goal would be drawing a future action plan, strong enough to face the challenges that technology advancements will definitely bring, thus understanding if the employment is suffering or benefiting from it.

Going into details, in the first part, the entire focus was on travelling through again the different stages of the "Machine Ages".

The combination of several innovations, linked by a common denominator, which was the industrialization, created significant changes by revolutionizing both industrial production and socio-economic context of each country. A first milestone could be considered the creation of the steam engine, which laid the foundation for the implementation of new machines that revolutionized the UK industries in terms of higher production and few workers needed to perform a single task. This brought to the first protests and the rising of the concept of technological unemployment.

With the beginning of the second Industrial Revolution, new discoveries brought to a huge expansion of markets boundaries that led to a sort of limitless technology advancements potential.

From a study conducted by Katz and Margo, (2013) over the period 1850 to 1880, it was shown that the introduction of purpose-built machinery (e.g. assembly line) and the rise of large factories resulted in the shift from farm laborers to machine operatives. In manufacturing, for instance, there was an increased demand for clerks, supervisors and managerial, technical and professional occupations. In services, increased demand for unskilled service workers (e.g. travel), medium-skilled services (e.g. sales) and skilled services (e.g. managers). However, the same analysis showed that the manufacturing distributions exhibit hollowing out between 1850 and 1910 with a declining share of skilled artisans, and rising shares of operatives and white collar workers.

The first two stage of the Industrial Revolution were just the beginning of a process of polarization of the labor market, which Keynes defined as "technological unemployment" (Keynes, 1930) and that will continue to grow in the following stages.

Indeed, in the second Machine age several studies (Acemoglu, 2011) (Autor and Dorn, 2013) (Autor *et al*, 2003) (Osborne and Frey, 2013) have analyzed the effects of technology advancements, especially regarding the obsolescence of some skills and the rise of new ones, as a percentage of employment share loss. The results have shown that the labor market of different countries, both in Europe and US, is experienced an economic phenomenon called the "hollowing out", or the job polarization, of the labor market by which, dividing the total share of employment in three ranks of jobs, low, middle and high ranked jobs, according to the level of skills sets necessary to perform a specific task, it is possible to identify an expansion of high-ranked and low-ranked jobs over the middle ones. What the scholars have tried to demonstrate, was that one of the main causes of such a phenomenon has to be connected with the technology advancements and the simultaneous changing of the skills-set workers are required to have in order to be successfully competitive in the labor market, against the race of machines.

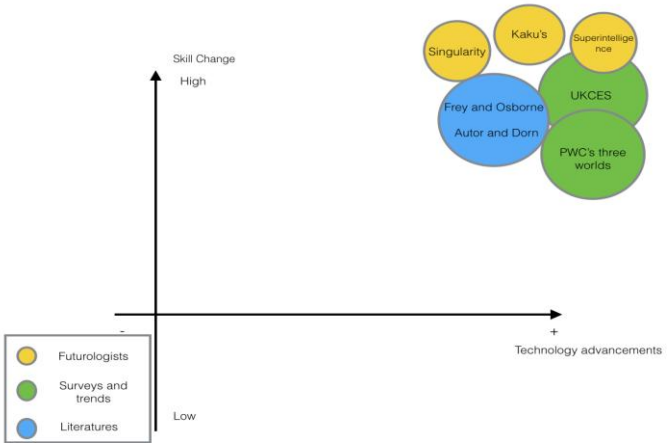
In the third Machine age, however, the evolution of technology practices has opened new opportunities in different sectors, and has broadened the field of applicability of artificial intelligence and advanced machines. Thanks to the always larger number of interconnected devices and the availability of huge amount of data, gathered from sensors and actuators installed almost everywhere, organizations are implementing new strategies to unlock the value of the so-called Internet of Everything. Furthermore, the important topic in the third machine age is the concept of Industry 4.0 and advanced manufacturing. Advanced manufacturing is an envisioned state of operations in which all relevant and synthesized information are made available when, where and in the form in which it is needed across manufacturing supply chain, and to all the stakeholders. In this way, inside a smart factory, all the machines will be connected to each other and to the plant itself through several platforms that will grab all the information available from sensors and actuators. The interaction between machine-to-

machine and machine-to-human will be extremely enhanced, and thanks to the power of the Internet of things and the huge world of interconnected devices, the manufacturing industry will shift from the concept of mass production, to the one of mass customization. In this scenario it will be hard to say if the technology advancements would disrupt more jobs than it would create; however, what is, once again, certain is that workers have to modify or to upgrade their skills-set, by focusing more on communicational and interpersonal skills, as well as in advanced engineering and mathematics fields.

In the second part, in order to identify a good pattern of results, it was drafted a methodology comparison regarding different future scenarios and technology applicability. There were selected three different scenario's methodologies based on: surveys and trends, futurologists' visions, and literatures' analysis.

From a cross comparison analysis, it was shown that technology advancement is, actually, reducing the employment share, especially, of the middle-skilled workers and all the kinds of works related to manual and repetitive tasks, mostly due to a simultaneous change in the skills sets required by employers. Indeed, technology progress is strictly correlated to an updating of skills for all the workers, either for low- and middle- skilled, and either for high-skilled ones.

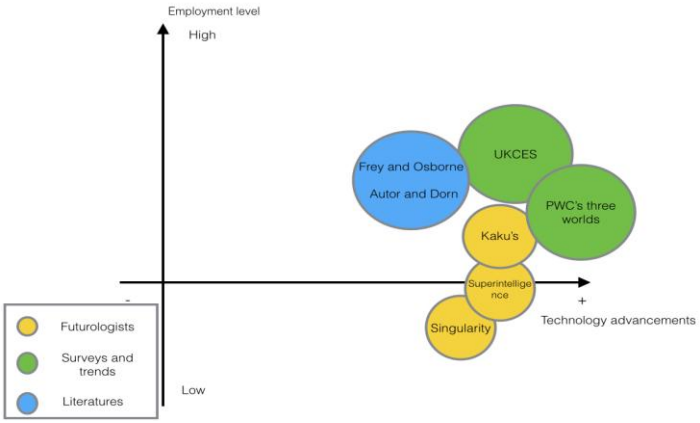
Figure 11: Scenario's comparison I[2]



Source: Internal calculations

[2] Even though both UKCES and PWC provide four and three, respectively, different scenarios, the differences between each other are not relevant in the understanding of the positioning map.

Figure 12: Scenario's comparison II



Source: Internal calculation

That said, technology can be considered as a source of economic and employment growth if, and only if, institutions and governments will implement several reforms that aim to create a sort of bridge between the level of education, the skills sets that workers are requiring to have, and the technology progress. Education challenge, policies that would have the goal to enhance technology progress with incentives, funds, and R&D improvements, and, finally, guaranteeing a secured and trusted cyberspace in which data and information can flow freely, are all possible action plans for ensure a better future cohabitation between human and machines.

Concluding, it would not be correct to deny the role that technologies have had, and have on the global economic and social structure, but it is also required to consider that "when a machine is created to do the work of a Man, something is taken away from the Man!"[3]

[3] Quote from the movie "Start Trek: The Insurrection", 1998

References

Acatech. (2013). Recommendations for implementing the strategic initiative INDUSTRIE 4.0. Acatech National Academy of Science and Engineering, Industrie 4.0. Federal Ministry of Education and Research.

Accenture. (2015). Winning with the Industrial Internet of Things: how to accelerate the journey to productivity and growth. Accenture.

Acemoglu, D. a. (2011). Skills, tasks and technologies: Implications for employment and earnings. Handbook of labor economics. , vol. 4, 1043- 1171.

Acemoglu, D. (1999). Changes in unemployment and wage inequality: An alternative theory and some evidence. American Economic Review 89(5) , 1259-1278.

Ackerman, E. a. (2011, March 31). 5 Technologies that will shape the Web. Spectrum, IEEE.

Akcomak, S. K.-R. (2013, February). The effects of technology and offshoring on changes in employment and task-content of occupations. CPB Discussion Paper No. 233 .

Akyildiz, I. S. (2002). Wireless sensor networks: a survey. Computer Network , 38, 393-422.

Alberti, A. a. (n.d.). Interent of Things: Perspectives, Challenges and Opportunities.

Al-Qutayri, M. a. (2010). Integrated Wireless Technologies for Smart Homes Applications. In M. a. Al-Qutayri, Smart Home Systems (pp. 18-42). InTech.

Andermon, A. a. (2011). Job Polarization and Task-Biased Technological Change: Sweden, 1975-2005. Uppsala University, Department of Economics Working Paper 2011:15.

Antonczyk, D. D. (2010, March). Polarization and Rising Wage Inequality: Comparing the U.S. and Germany. Discussion Paper No. 4842 .

APEC. (2014). White Paper of Internet of Vehicles (IoV). 0th Telecommunications and Information Working Group Meeting .

Autor, D. a. (2013). The growth of low skill service jobs and the polarization of the US labor market. American Economic Review .

Autor, D. a. (2009). This job is "getting old": Measuring changes in hob opportunities using occupational age structure. American Economic Review: Papers and Proceedings , 99 (2), 45-51.

Autor, D. D. (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States. American Economic Review. , 103 (6), 2121-2168.

Autor, D. D. (2013, April). Untangling Trade and Technology: Evidence from Local Labor Market. IZA Discussion Paper NO. 7329 .

Autor, D. K. (2006). The polarization of the U.S. labor market. American Economic Review , 96 (2), 189-194.

Autor, D. L. (2003). The skill content of recent technological change: An empirical exlporation. The Quarterly Journal of Economics , 118 (4), 1279- 1333.

Autor, D. (2010, April). The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings. Center for American Progress and The Hamilton Project.

BDI initiative Internet of Energy. (2010). The Energy Industry on the Way to the Internet Age. Internet of Energy ICT for Energy Markets of the Future .

Bloom, N. D. (2011). Trade induced technical change? The impact of Chinese imports on technology, jobs and plant survival. CEP Discussion Paper 1000 .

Bloss, R. (2011). Mobile hospital robots cure numerous logistic needs. Industrial Robots: An International Journal , 38 (6), 567- 571.

Boden, M. (2003). The creative mind: Myths and mechanism. Routledge.

Bosch. (2014). Capitalizing on the Internet of Things - how to succeed in a connected world. Bosch Connected World - Software Innovations, White paper Series. Bosch.

Bostrom, N. (2014). Superintelligence: Paths, Dangers, Strategies. UK: Oxford University Press.

Bradley, J. B. (2013). Embracing the Internet of Everything to Capture Your Share of $14.4 Trillion. Cisco, White Paper.

Bradley, J. L. (2013). Internet of Everything (IoE) Value Index: How Much Value Are Private-Sector Firms Capturing from IoE in 2013? CISCO, White Paper.

Breazeal, C. (2003). Social Interaction in HRI: The robot View. IEEE Transaction on Man, Cybernetics and Systems , XX (Y).

Brown, D. (2014). Working Futures 2012 - 2022: Introduction and Commentary. Briefing Paper, UKCES UK Commision for Employment and Skills.

Brynjolfsson, E. a. (2011). Race Against the Machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy. Digital Frontier Press Lexington.

Brynjolfsson, E. a. (2014). The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. W.W. Norton & Co Inc.

Campbell, T., & Ivanova, O. (2013). Additive manufacturing as a Disruptive Technology: Implications of three-dimension Printing. Technology and Innovation , 15, 67-79.

Campbell-Kelly, M. (2009). Origin of computing. Scientific American Magazine , 301 (3), 62-69.

CapGemini. (2014). The Internet of Things: Are Organizations Ready for a Multi-Trillion Dollar Prize? CapGemini.

Chase, J. (2013, September). The Evolution of the Internet of Things. Texas Instruments .

Chen, Y. K. (2010). Challenges and Opportunities of Internet of Things. Intel Labs , S7-1.

Chopra, S. (2005, February). Seven-Eleven Japan Co. Kellogg School of Management.

Clinckx, N. B. (2013). Smart Home: Hope or hype? Greenwich Consulting , Thoughts, reflection and analysis for the telecom, media and utilities industries.

Cognizant. (2012). Exploring the Connected Car. Cognizant 20-20 Insight.

Cognizant. (2014). Informed Manufacturing: The Next Industrial Revolution. Report, Cognizant.

Cognizant. (2014). Reaping the Benefits of the Internet of Things. Cognizant Reports.

Cohn, J. (2013, February 20). The robot will see you. The Atlantic.

Computing Community Consortium. (2011). Smart Health and Wellbeing: The role of Basic Computing Research . Computing Research Association, Washington.

Danekas, C. R. (2011). "Future Energy Grid" – Migration Paths into the Internet of Energy. eChallenges e-2011 Conference Proceedings .

Deloitte. (2014). The Internet of Things Ecosystem: Unlocking the Business Value of Connected Devices. Deloitte Report.

Deutsche Bank. (2013). Europe's re-industrialisation: The gulf between aspiration and reality. EU monitor. Deutsche Bank Research.

Deutsche Bank. (2014). Industry 4.0, Upgrading of Germany's Industrial capabilities on the horizion. Deutsche Bank, Current Issues, Sector research. Lars Slomka.

DHL Trend Research. (2014). LOGISTICS TREND RADAR. DHL. DHL Customer Solutions & Innovation.

Drucker, P. F. (1966). The First Technological Revolution and Its Lessons. Technology and Culture , 7, 143-151.

European Commision. (2014). Advancing Manufacturing - Advancing Europe - Report of the Task Force on Advanced Manufacturing for Clean Production. Working Document, European Commision, Commision Staff Working Document, Brussels.

European Commision. (2010). Europe 2020 - A strategy for smart, sustainable and inclusive growth. Report, European Commision, COMMUNICATION FROM THE COMMISSION, Brussels.

European Commision. (2013). Factories of the Future - Multi- annual roadmap for the contractual PPP under Horizon 2020. EFFRA , Manufuture Initiative, Luxemburg.

European Digital Rights. Net Neutrality. EDR. The EDRi papers & Digital Courage.

Evans, D. (2012). The Internet of Everything: How More Relevant and Valuable Connections Will Change the World. CISCO IBSG.

Feil-Seifer, D. a. (n.d.). Human-Robot Interaction. Robotics Research Lab .

Frey, C., & Osborne, M. (2015). Technology at Work. Oxford University & Citi Group. Citi Research.

Gemalto. Securing Healthcare. Gemalto .

Gerla, M. L. (n.d.). Internet of Vehicles: From Intelligent Grid to Autonomous Cars and Vehicular Clouds.

German Federal Governement . (2014). The new High-Tech Strategy - Innovations for Germany. Report, Federal Ministry of Education and Research.

German Federal Ministry of Education and Research. (2007). ICT 2020 - Research for Innovation. BMBF, High-Tech Strategy. Bonn, Berlin: BMBF.

Germany Trade & Invest. (2014). Industrie 4.0, Smart Manufacturing for the Future. Germany Trade & Invest, Future Markets. Berlin: Federal Ministry for Economic Affairs and Energy.

Girloy, A. (2015). Access to Broadband Networks: The Net Neutrality Debate. Congressional Research Service. CRS Report.

Gockley, R. e. (2005). Designing Robots for Long-Term Social Interaction. IEEE/RSJ International Conference on Intelligent Robots and Systems .

Goldman Sachs. (2014). The Internet of Things: Making sense of the next mega-trend. Goldman Sachs, Equity Research.

Goos, M. A. (2009). Job polarization in europe. American Economic Review: Papers & Proceedings 99(2) , 58-63.

Goos, M. a. (2007). Lousy and Lovely jobs: The rising polarization of work in britain. Review of Economics and Statistics 89(1) , 118-133.

Goos, M. M. (2011). Explaining Job Polarisation: the Roles of Technology, Offshoring and Institutions. Center for Economic Studies Discussion Paper 11.34, University of Leuven.

GSMA. (2011). Vision of Smart Home The Role of Mobile in the Home of the Future. GSMA.

Gubbi, J. B. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. Future Generation Computer System , 29, 1645-1660.

Hobsbawm, E. (2011). How To Change the World: Reflections on Marx and Marxism.

Holmes, C. a. (2010). Are UK markets polarising? SKOPE Research Paper No. 97 .

Holmes, C. a. (2013, January). Occupational Mobility and Career Paths in the ‘Hourglass’ Labour Market. Economic and Social Research Center .

Holmes, C. a. (2012). The Changing Shape of the UK Job Market and its Implications for the Bottom Half of Earners. Resolution Foundation Report.

Holmes, C. (2010). Job Polarisation in the UK: An Assessment Using Longitudianl Data. SKOPE Research Paper (90).

Holmes, C. M. (2011). Mobility and the Cahnging Structure of Occupations: a Cross-Cohort Comparison. SKOPE mimeo .

Holmes, C. (2011). The Route out of the Routine: Where do the Displaced Routine Workers Go? SKOPE Research Paper No.100 .

Hoos, H. (2012). Programming by optimization. Communication of the ACM , 55 (2), pp. 70-80.

IEEE. (2014). IEEE Internet of Things Journal Special Issue on Internet of Vehicles (IoV). IEEE INTERNET OF THINGS JOURNAL .

ING. (2014). The German Technology industry - Opportunities in a more open supply chain. ING - Dutch Technology. ING.

Innovation Unit. (2012). 10 ideas for 21st century education. Innovation Unit lab, London.

Institute for the Future. (2011). Future Work Skills 2020. University of Phoenix Research Institute.

Institute, M. G. (2011). Big Data: The Next Frontier for innovation, competition, and productivity. McKinsey & Company.

Institute, McKinsey Global. (2013). Disruptive technologies: Advances that will transform life, business, and the global economy.

International Education Advisory Board. (2008). Learning in the 21st Century: Teaching today's students on their terms. IEAB.

Jurich, S. (2000). The Information Revolution and the Digital Divide A Review of Literature . Knowledge Enterprise, Inc., TechKnowLogia.

Kaku, M. (2011). Physics of the Future: How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100. (Penguin, Ed.) Penguin.

Karnouskos, S. (2010, June). The cooperative Internet of Things enabled Smart Grid. SAP Research .

Katz, L., & Margo, R. (2013). Technical Change and the Relative Demand for Skilled Labor: The United States in Historical Perspective . (C. M. "Human Capital and History: The American Record" Conference, Ed.)

Keynes, J. M. (1930). Economic Possibilities of our Granchildren.

Kim, S. W. (2008). Classifying software changes: Clean or buggy? Spftware Engineering, IEEE Transaction on , 34 (2), pp. 181-196.

Kurzweil, R. (2006). The Singularity is Near: When Humans Trascend Biology. Gerald Duckworth & Co Ltd.

Levy, F. M. (2005, August). How Computerized Work and Globalization Shape Human Skill Demand. Massachusetts Institute of Technology IPC Working Paper Series .

Machin, S. (2009). Changing Wage Structures: Trends and Explanations. Department of Economics, University College London and Centre for Economic Performance, London School of Economics .

Markoff, J. (2011, March 4). Armies of expensive lawyers replaced by cheaper software. The New York Times .

Markoff, J. (2012, August 18). Skilled work, without the worker. (T. N. Times, Ed.)

McIntosh, S. (2013, October). Hollowing out and the future of the labour market. BIS Research Paper Number 134 .

Meyer, H. (December 2014). Inequality and Work in the Second Machine Age. The Worker Institute, SE Journal, number 4. Friedrich Ebert Stiftung.

Michaels, G. N. (2010). Has ICT Polarized Skill Demand? Evidence from Eleven Countries over 25 Years. National Bureau of Econmic Research Working Paper 16138 .

Mieske, K. (2009). Low-Skill Service Jobs and Technical Change. Unpublished MSc dissertation, University College London .

Mims, C. (2010, June). AI that picks stocks better than pros. MIT Technology review.

Mishel, L. S. (2013). Assessing the Job Polarization Explenation of Growing Wage Inequality.

Misra, P. P. (2014). Unlocking the Value of the Internet of Things (IoT) - A Platform Approach. TATA Consultancy Services, White Paper - Innovation Labs. TATA.

Mokyr, J. (1990). The lever of riches: Technological creativity and economic progress. Oxford University Press.

Murnane, F. L. (2013). Dancing with Robots: Human Skills for Computerized Work. NEXT Report. http://www.thirdway.org/publications/714.

Namdev, S. P. (2014). Artificial Intelligence Robotics: Services and Future roadmap . International Journal of Innovation and Scientific Research , 6 (1), 71-74.

OECD. (2012). Cybersecurity Policy Making at a Turning Point: Analysing a New Generation of National Cybersecurity Strategies for the Internet Economy . OECD.

OECD. (2013). PISA 2012 Assessment and Analytical Framework. OECD, Programme for International Student Assessment. OECD Publishing.

Oesch, D. a. (2011). Upgrading or polarization? Occupational change in Britain, Germany, Spain and Switzerland, 1990-2008. Socio-Economic Review , 9, pp. 503-531.

Osborne, C. B. (2013, September). The Future of Employment: How Susceptible are Jobs to Computerisation? Oxford University.

Partnership for 21st Century Skills. (2008). Learning for the 21st Century Skills. Washington.

Perspectives. (2014). Investing in smart logistics. 21st Century Themes.

Pew Research Center. (2014). AI, Robotics, and the Future of Jobs. Pew Research Center, Digital life in 2025.

PriceWaterhouseCoooper. (2014). The future of work - A journey to 2022. PWC, Human capital.

Rifkin, J. (1966). The End of Work: The Decline of the Global labor Force and the Dawn of the Post-Market Era. (Tarcher, Ed.)

Rifkin, J. (2004). The European Dream: How Europe's Vision Of The Future Is Quietly Eclipsing The American Dream. J.P. Tarcher.

Robotics-VO. (2013). A Roadmap for US Robotics. From Internet to Robotics 2013 Edition. Robotics in the United States.

Roland Berger. (2014). Industry 4.0: The new industrial revolution - How Europe will succeed. Roland Berger Strategy Consultants, Think Act - Beyond Mainstream.

Schumpeter, J. (1962). Capitalism, socialism and democracy. New York: Harper & Row.

Simmons, P. (2011). The Hourglass and the Escalator Labour market change and mobility. Thw Work Foundation.

Smart Card Alliance. (2012). Smart Card Technology in U.S. Healthcare: Frequently Asked Questions. Smart Card Aliiance.

Smart Manufacturing Leadership Coalition. (2011). Implementing 21th Century Smart Manufacturing . SMLC, Workshop Summary Report.

Spitz-Oener, A. (2006). Technical Change, job tasks and rising educational demands: looking outside the wage structure. Journal of Labour Economics , 24 (2), 235-270.

Suzuki, T. a. (2014, July 30). Modeling and Evaluating the Process of Creating Paintings with Evolutionary Computing. School of Information and Sciences, Nagoya University .

Swezey, D., & McConaghy, R. (2011). Manufacturing Growth - Advanced Manufacturing and the Future of the American Economy. BreackThrough Institute, The Schwartz Initiative on American Economic Policy. Third Way.

The Boston Consulting Group. (2015). Industry 4.0, The Future of Productivity and Growth in Manufacturing. Report, BCG.

The Economist. (2008). The future of higher education: How technology will shape learning.

zemen, D. a. (2013). The Vanishing Middle: Job Polarization and Workers' Response to the Decline in Middle-Skill Jobs. Economic Review .

UKCES. (2014). The future of work - Job and Skills in 2030. Report, UKCES, University of South Wales.

Vermesan, O. a. (2014). Internet of Things – From Research and Innovation to Market Deployment . River Publishers Series in Communication . River Publishers.

Vermesan, O. a. (2013). Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems . River Publishers series in Communication. River Publishers.

Vermesan, O. B. (2011). Internet of Energy – Connecting Energy Anywhere Anytime. In O. B. Vermesan, & Springer (Ed.), Advanced Microsystems for Automotive Applications 2011 (pp. 33-48). Springer.

Verzijl, D. a. (2015). Smart Health. Business Innovation Observatory, Internet of Things. EU: European Commission.

Wagner, C. (2011). Emerging careers and How to Create Them. 70 Jobs for 2030 .

Welbourne, E. B. (2009). Building the Internet of Things using RFID: The RFID ecosystem experience. IEEE Internet Computing , 13, 48-55.

Wilson, R. a. (2012). Working Futures 2010-2020. UKCES Evidence Report 41.

Zebra Technologies and Forrester Consulting. (2012). Building Value from Visibility: 2012 Enterprise Internet of Things Adoption Outlook. Zebra Technologies.