

Generation ‘R’

Why our Grandchildren will grow up as the first Generation of “Robotic Natives”

Dipl. Inf. (Univ.) Dominik B. O. Boesl, MBA,
Technische Universität München, KUKA AG
Munich/Augsburg, Germany
e-mail: boesl@tum.de

B.A. Martina Bode
KUKA AG
Augsburg, Germany

Abstract — Robotics, automation, smart machines and artificial intelligence are currently in the center of public perception. We are facing a disruptive megatrend that will have at least as much impact on the next half a century as the internet had on the last five decades. As robotics is steadily starting to penetrate and enrich all domains of human society, our grandchildren will grow up as a Generation ‘R’ of Robotic Natives. This paper explains the basic concept of the already broadly adopted concept of Generation ‘R’.

Keywords — Generation ‘R’; Generation Robotics; Robotic Natives; Robotic Immigrants; Future of Robotics;

I. INTRODUCTION

Some technological innovations had disruptive impact on humankind and societies all over the world in the last few hundred years. Some of the last, undisputed ones are the invention of the car and the shift from agricultural to industrial and then to today’s information society. We are currently at the edge of another disruption that will at least have as much impact as the invention of the transistor and the internet: robotics and automation in combination with artificial intelligence will have unprecedented impact on the way we will be perceiving machines, technology and even the essence of human labor itself. As smart machines will steadily infuse, augment and enrich our living environment, future generations will have a different perception and attitude towards these technologies, then we have today. This paper will explain, how the generation of our grandchildren will be affected and why we have to accept responsibility today and help shaping their future. It lies in our hands, to pave the way for a world, in which technology is enabling and not replacing people and jobs; in which we feel delighted working with machines and not put aback.

Today, the public perception of artificial intelligence and smart machines is influenced on one hand by the glossy pictures we see in the Hollywood blockbusters: Robots and A.I. threatening, endangering mankind. And on the other side, statements from today’s “wise men” like Steven Hawking, Bill Gates or Elon Musk, who stoke fear in the general public by painting doomsday scenarios of artificial intelligence and robotics enslaving and destroying humanity. In this paper we are explaining, why we do not have to be afraid of these developments, what the concepts of Generation ‘R’, Robotic Natives and Robotic Immigrants are all about and how we can

still shape a desirable future for the generations to come. In short: How do we shape a future full ‘Rosies’ – the Jetsons’ benevolent robotic housekeeper – and why we have not to be afraid of Skynet and the Terminator. Although the terms “Robotic Natives” and “Robotic Immigrants” are becoming more common, not only in the academic community, there is still little research on the topic. This paper intends to define a general outline of them as a foundation for future research work.

II. PREDICTIONS ON THE FUTURE OF SOCIETY AND HUMANITY

For sure, it is nearly impossible to predict the future. Although, there exist some scientific methods and approaches on how to forecast certain future developments and transformations. These enable us, to provide a pretty sophisticated picture of society and its interaction with modern technologies, like automation, robotics and artificial intelligence.

One of these concepts to predict technological and societal change is the theory of the so-called Megatrends [1]. The futurist John Naisbitt describes in his book trends like the change from yesterday’s industrial society to today’s information-centric society or the trends of globalization and he accredits them with the potential for especially disruptive, profound impact on humanity. These two examples are perfect to illustrate how capable this method is to identify drivers of global, disruptive change but also how it puts emphasis on the resulting issues and challenges these disruptions might impose on society. Already in the year 1982, Naisbitt predicted for example the challenges that the rising flood of information would cause in the coming decades. Nearly 30 years later, we know he was more than accurate with his assumptions.

Since then, the list of Megatrends has consequently been updated, following Naisbitt’s scheme. One of the most recent summaries was published by the German Institute of Future Studies and Assessment of Technologies (Deutsches Institut für Zukunftsstudien und Technologiebewertung – IZT) [2]. They consist of the following trends:

- Scientific & Technological Innovations
- Environmental Pollution & Global Warming
- Demographic Change & Overaging Society
- Change towards a Services- & Science-Focused Society

- Globalization of Economy, Employment
- Technological, Economic & Social Disparity between First- & Third-World plus Extremism and Terrorism
- Individualization of Living and Working Realm
- Rising Personal Mobility and in Logistics worldwide
- Reduced Quality of Living (compared to UN- and World Bank indices)
- Fission of Society by unequal Distribution of Education

The selection of these trends and their “promotion” to Megatrends were based on three criteria: Firstly, a trend has to be fundamental in the sense of directly impacting the fabric of society and/or its natural environment. Secondly, its repercussions must be serious, transformational and disruptive in either a mid-term (five to 20 years) or a long term (more than 20 years) timeframe and, thirdly, the consequences have to be global. It has to be mentioned, that above-named list only presents the most commonly agreed subset of Megatrends. There exists a multitude of studies, that deal with the topic (e.g., compare [3] and [4] as instance for some newer publications) and which are mostly congruent, but not all mention for example Urbanization as a Megatrend. Hence, it can be stated, that the basic elements of these lists coincide, but there is still ongoing debate about some of the fewer mentioned Megatrends.

Another study, analyzing the changes in society is the Shell Youth Study. This empirical research study analyses the values, habits and attitudes of adolescents in Germany [5]. It categorizes young people in generations. The “Generation Y”, born between 1980 and 1999, is usually characterized as pragmatic generation. The following “Generation Z” describes the famous “Digital Natives”, which have grown up in daily contact with the Internet and Digitalization. These young people are said to be less afraid and anxious of the future as their predecessors from “Generation Y” and put emphasis on work-life-balance, personal fulfilment and family, although the desire to have children is decreasing. If considered in context with the megatrend of demographic change, this clearly hints to an increasing shortage of skilled labor.

In Germany, for example, an increased need for skilled workers is expected by 2020 – mainly in the area of public and private services [6]. At the same time, half of the German population will be over 50 years old [7] and by 2030, we will be lacking 30.000 from 200.000 workers in automotive manufacturing because they will have retired by then. Subsequently, 170.000 people will have to do the work of 200.000 – this can only be achieved using automatization solutions and robotics. Assumptions, that these were just “first world problems” applying to Germany, Europe and maybe the U.S. are clearly contradicted by the recent numbers issued by the United Nations: shortage in skilled labor will become a crucial global problem over the next 50 years [8].

In addition, the known “Limit of Growth” study on demographic developments by Randers (2012) emphasizes a tendency towards population growth and urbanization. Living in an urban environment usually provides access to better

medical care and better chances of proper school education which makes a higher number of children per family unnecessary and thus less attractive or even undesirable. Recent calculations hint towards a stagnation of population growth around the year 2040 and even predict the possibility of a slowly declining world population. Combined with growing disparity and social inequity, migration movements like the streams of refugees heading towards Europe that can already be observed, become more likely [9].

III. PROGNoses FOR THE FUTURE OF ROBOTICS

Robotics is steadily growing and conquering new markets as well as permeating new domains of the living realm. The number of used robots in manufacturing in China for example has been growing by over 200% since 2011. This development is especially interesting, as China still is one of the countries with the lowest cost for human labor. Obviously, companies can not only be driven by the thrive for reducing expenses of time and labor. The concern, that rising levels of automation in production would imply job losses has not really become reality [10]. Hence, forecasts hint, that the demand for industrial robots will still rise drastically [11]. Taking into consideration the demographic changes from chapter II, this does not come as a surprise. The increasing shortage of skilled workers, which is resulting from a decreasing working population, can mostly be compensated by automation solutions – at least in the domain of industrial manufacturing.

According to the theory of “4 Robotic Revolutions” [12], robotics and automation will face several disruptive paradigm changes and evolve in these four waves:

- First Robotic Revolution: Robot-based Automation Solutions (‘classic industrial automatization, like it has been carried out for more than 50 years: how to weld, bolt and glue a car together as fast as possible; huge, dangerous robots and machines fenced off from workers in safety cages)
- Second Robotic Revolution: Sensitive and Safe Robot-based Automation Solutions (enabled by new technologies in the field of low-cost sensorics, robotic systems that can feel and thus detect and avoid collisions; first step towards human machine collaboration – the robots are now ‘uncaged’)
- Third Robotic Revolution: Mobile, Sensitive and Safe Robot-based Automation Solutions (autonomously navigating systems permeating the working space as first step towards professional service robotics)
- Fourth Robotic Revolution: Cognitive, Mobile, Sensitive and Safe Robot-based Automation Solutions (automatization and robotics meets perception, cognition and one day maybe intelligence; robotics on the way towards intelligent assistive systems, that ‘understand’ their human co-workers)

Technological progress in the domain of human robot collaboration will enable robotics technologies to permeate other areas outside of industrial manufacturing. New markets will be developed in the field of (professional) service robotics

and consumer robotics, which will transform robotics and automatization into one of the most impactful technologies of the next half a century and thus carrying huge global economic potential.

This is also covered and underlined by many studies and research efforts. A recent McKinsey study states, that robotics is one of the most disruptive technologies, which global economic impact will dramatically grow and expand by 2025 [13]. Defining and developing a lead market will be one of the biggest challenges. It can be expected, that the big industrial and economic powers - first of all Europe, China and USA – will invest huge amounts of money in order to achieve even small strategic advantages. Apart from that, the study also cites IoT (Internet of Things), Cloud Technologies and Autonomous Driving as possible disruptive technologies [13].

The concept of ‘disruptive technologies’ originates in Christensen (1997) who coined the notion at Harvard Business School. He defines a disruptive innovation as one, that is able to (albeit) completely supersede an existing, established technology from one or more markets [14]. The invention of the automobile, which fully revolutionized the domains of transportation may serve as one obvious example. For their above mentioned study, McKinsey only chose technologies that are evolving at a rapid velocity and that are supposed to produce a disruption or breakthrough within a very short timeframe. Their possible reach and impact will be extremely high. In the field of Robotics and Automation, some areas and aspects will still have to be further developed (i.e., price, capabilities of artificial intelligence, flexibility, adaptability and safety) until the full potential can be unleashed [13]. The possible scenarios and areas for the application of robotics will nearly be unlimited, if these challenges can be overcome. Robotics will no longer be associated with industrial production or assembly, but will be found in rehabilitation, in medical applications or at home. First tendency towards this development can already be observed today: In New Zealand, fast-food chain Domino’s started a pilot-project delivering pizza to households with self-driving robots [15] and gigantic electronics company Sanyo launched a full-body washing automation for care recipients more than ten years ago [16]. This and other indicators lead to forecasts predicting a huge ascent of Consumer Robotics over the next few years [17].

Today, still many people carry objections against using robotics and automation systems in these domains [16], but continuous improvement and contact with these technologies will change the general perception and grant robotics a trivial integration into our daily life. Robotics will slowly but steadily start to permeate and enrich all areas of the human living realm and lose its nimbus of threat. In this context, it fully satisfies the above mentioned requirements for characterization as a Megatrend.

IV. A GENERATION ‘R’ OF ROBOTIC NATIVES

If seen as disruptive innovation and megatrend, robotics and automatization will have a staggering and overwhelming impact on society and humankind. It is safe to assume that a new generation will grow up in daily contact with these technologies that will perceive them as completely ordinary

and taken for granted – a part of their daily lives, intelligent tools enriching their living realm.

This Generation ‘R’ (abbreviated for Generation Robotics) will be the first generation of Robotic Natives. The parallels to today’s Digital Natives are self-evident: Today’s society is characterized by the daily use of the internet, smartphones, computers, tablets and other communication devices and technologies [18]. Hence, the concept of Digital Natives [12] – a whole generation growing up with iPads on their fingertips – can be transferred onto robotics. Robotic Natives are characterized as people that grow up as part of Generation ‘R’ in a world that is through and through enriched and augmented by automatization, robotics and smart machines. They will be used to the interaction and collaboration with robots as a normal part of their everyday life.

The notion ‘Robotic Immigrant’ can be used antonymously to describe a person that was or is introduced to this new world dominated by automation at older age (i.e., as an adult) and has not been growing up surrounded by these technologies. Although the first Robotic Natives have not been born, yet, we are already moving towards our lives as Robotic Immigrants. Extrapolating the current technological developments and based on other research, we can safely assume that at latest our grandchildren, however, will be the first Generation ‘R’.

The first documented use of the terms Generation ‘R’ and Robotic Natives dates back to a presentation of D. Boesl on the future of robotics at the Gartner CIO Summit 2013. Since then it has been used in many other industrial presentations by different speakers, e.g. by Dr. Bernd Liepert, President of euRobotics aisbl in his Plenary Keynote at IEEE IROS 2016 in Hamburg. It was also cited in a dissertation project initiated in 2012 dealing with the impact of robotics on society and Robotic Governance [19] and other papers. At the Hannover Messe Industry (HMI) tradeshow 2016, one of the internationally most renowned tradeshows on automation technologies, it became obvious that the terms have entered general linguistic use. Amongst others e.g., Prof. Dr.-Ing. Sami Haddadin from Leibniz University Hannover used the term “Robotic Native” at the Hannover Messe to describe the goals of a concept called “Robotfactory” [20].

The notion of “native” in combination with modern technologies was firstly used in the “Declaration of Independence of Cyberspace” in 1996 [21]. John Perry Barlow states in this paper: „You are terrified of your own children, since they are natives in a world where you will always be immigrants.“ It is well documented, that Digital Immigrants were (and some still are) deeply concerned and afraid of the newly rising technologies like computers, smartphones or the Internet. In parallel, it is and will be completely normal for our Generation of Robotic Immigrants to initially perceive the same concerns and objections (e.g., [22]) – as we can already experience in the actual publications or in statements like from Bill Gates, Elon Musk or Steven Hawking. But as with the evolution of Digital Natives, these misgivings will be solved by time and become obsolete.

Robotics, automatization and artificial intelligence – especially in combination – have the potential to fundamentally disrupt our society, communal life and our way how to interact

with other people. They have the potential to revolutionize our working environment and to establish completely new concepts in this area altering our basic ideas of human labor. If robots will be adopting more and more physical labor and other lower qualified tasks (driven by the increasing lack of skilled human labor resulting from demographic change), e.g. in the field of elderly care or other services, we will need to think about a new orientation of our educational system. The fear, that all human labor will be replaced by smart machines is pointless and unfounded – the shift from an agricultural society to today's industrial society did not eliminate all jobs in agriculture. It solely led to a change and evolution of professional careers and a shift in emphasis [1].

V. CONCLUSIONS

This paper describes the evolution of society and the disruptive impact robotics, automation and smart machines will have on humankind. It deduces from the analysis of technological triggers, other research and in analogy to the development of a generation of Digital Natives that over the next five decades a Generation 'R' of Robotic Natives will grow up. As this publication just explains the basic concept of Robotic Natives, it is evident that there will be need for a lot of future research in this field, e.g. about future domains of use for robotics and smart machines, about automatization and robotics as megatrend or the sociological analysis of Generation 'R'. Furthermore, the interdependencies between other disruptive innovations and megatrends and this generation of Robotic Natives has not been researched, yet.

Even, if the fear of robots and artificial intelligence will no longer be considered an impediment for the evolution of automation, disruptive change induced by one or more megatrends always brings about new issues and challenges. New fields of discussion and social defiance will have to be addressed [1] [23]. The research field of Roboethics deals with the social and moral implications arising from the use of robots in different domains. The maturity and stage of development of the robotic system is of crucial importance in this case. A mere machine fundamentally differs from a robot that might have perception, cognition or maybe even consciousness through the use of artificial intelligence and thus has to be treated in another way in an ethical discussion than the "tool" [24].

In addition to that, efforts have been launched, to ignite an interdisciplinary dialogue about Robotic Governance, that helps addressing these issues by voluntarily self-regulation – besides the establishment of legal frameworks [25]. If this concept of a dynamically, self-adapting frameworks proves to be valid and usable even in the context of steadily changing circumstances and framework conditions, problems could be addressed and issues solved even before they manifest in reality.

As we are clearly seeing the signs for the rise of a Generation 'R', it is our responsibility to our grandchildren and further generations to anticipate the disruptive changes of the next half a century and start discussing and addressing the possibly emerging issues today.

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