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Robots, genes and bytes: technology development and social changes towards the year 2020 ☆

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Abstract

Scientific and technological policy has become a key activity in contemporary societies. In this context we present different projections about the evolution of science and technology in the area of robotics and advanced automation, which in turn shapes the new possibilities and risks emerging in this area in the future. This goes hand-in-hand with an analysis of the interaction of such trajectories with the social context from which they emanate. This interaction reinforces the need for establishing the probable sequence of technological innovation; analysing the impacts on economy and society; and providing qualified information for decision-making, both in policy and business. In this article, we present the results of the prospective research carried out in the field of robotics and advanced automation, paying special attention to the transformation trends of organizations, and the integration of robots in daily life and leisure, and underscoring potential repercussions which may deserve more attention and further research.

1. Introduction

We are immersed in a non-stop scientific–technological revolution, which is changing our world, risking our survival [1], and opening new possibilities in the transformation of our species and post-

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human life, genetically modified, in which intelligence, genes and machines are merged, giving rise to what has been called NBIC convergence (Nano-Bio-Info-Cogno) [2]. The prospective analysis about evolution trends in XXI century technology, take as a starting point two fundamental features of present techno science: firstly, the quick growth of innovation processes and application of technologies; secondly, the convergence of technologies that give a higher speed to the technological change, and allow new developments and applications. Robotics is a good example of this process of quick growth, convergence and diffusion of new applications [3].

We can distinguish three orientations that allow us to classify the prospective studies:

– In the first place, there is research focusing on the internal dynamics of the technological development, and its consequences on human life from a perspective focused on the species identity. Here we can distinguish two different perspectives: first, those approaches that analyse the scientific–technological development as an exponential process, in line with Moore's Law; second, those approaches that focus on the radical innovation, assuming that, at a certain moment of the scientific–technological (S/T) development, a new revolutionary era will begin — an approach reminiscent of the kuhnian view of paradigmatic shifts in science.

  In both cases the convergence between biology, robotics and artificial intelligence gives rise to a choice among three possibilities: the genetic improvement of human beings, to the point of improving our biological potential, launching a new age in the species evolution; the development of artificial intelligence in its stronger variety towards eventually producing self-governing machines, robots with the possibility of self improvement and repair, creating beings more intelligent than humans; and a different future in which nano-robots and biological improvements in the human brain will coexist producing a mixture of human being *cum* robot, bringing in a sense the use of technology by human beings back to its primordial role: beyond a certain evolutionary stage human beings did not adapt biologically, but rather 'adapted' their environment to their needs/goals, by means of their intelligence and technology. By way of example, the Neolithic revolution, particularly in agriculture and stockbreeding, allowed a high increase in productivity of land and animals, and so made possible the growth of the human species [4].

  The projected challenges (e.g. climatological) life on earth may face (to a large extent due to anthropogenic activities), and the difficulties in reversing the trends exacerbating these challenges, give extra credibility to the hypothesis that we will 'adapt' not only by changing our environment but also ourselves. The ethical debate about how to face these radical changes in technology and in our own life is present in well-known recent analyses, from approaches that defend, from an optimistic point of view, the benefits for humanity that come from the convergence between genetics, nanotechnology and robotics [5], to those approaches that insist on the impossibility of controlling the technological change and its negative effects — e.g. will androids also assume/develop all the negative traits of human beings? [6].
– Secondly, there is research that takes as its starting point how societies build their technological trajectories in an interaction process between scientific innovation, citizens' demands, the intervention of relevant actors such as firms or government, and the adaptive and creative response of economical and legal institutions. In this approach, it is of great importance to understand the consequences of existing/emerging technological trajectories, because once these are established, their inertia limits our possibility of choice. It is also relevant to analyse the paradoxes caused in the innovation, design and application of new technological process, beyond the anthropologically pessimistic or optimistic discourse.