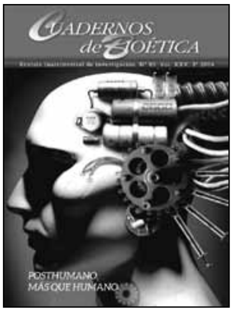

POST-HUMAN AND SCIENTIFIC RESEARCH: HOW ENGINEERING CARRIED OUT THE PROJECT

EL POSTHUMANO Y LA INVESTIGACIÓN CIENTÍFICA: COMO LA INGENIERÍA LLEVA A CABO EL PROYECTO

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ABSTRACT:

We start with a definition of robot in order to understand which are legitimate robotics' objectives. Then it is provided an outline of new robot generations and their industrial and biomedical applications. We consider the consequences of this new kind of technology on the notion of intelligence, stressing how the exteroceptive sensor systems provide a new bottom up approach to the AI debate. We consider three challenges Robotics have to face nowadays. First materials and components, which are built with technologies top-down, set huge limits in terms of weight, speed, safety and cost, not to mention reliability and durability. Second the metholdological aspects: the challenge concerns the management of complexity. How to achieve intelligent and adaptive behaviors out of the control system of the robot, which must remain intrisically simple? A third issue we address is the cultural one: the unreasonable expectations of the general public often provoked by a misunderstanding of the notion of intelligence itself. We consider then what makes human specifically human from a broader philosophic point of view, pointing out how the will is strangely absent in the AI debate. We show three advantages connected with this different perspective instead of the classical one intellect centered. First, while intellect is not used only by man, will is. Second, desire involves intellect while the reciprocal is not necessarily true. Third, looking at robotics and more specifically to cybernetics the key concept of these fields are control and govenrance, whereas both of them are specifically relate to the domain of will rather than intellect. We look then into the concept of participation as essential to the understanding of the notion of will, to overcome some roboethics' issues related to the adoption of the still dominant rationalitsic paradigm.

Keywords:
Robotics, roboethics, embodied intelligence, free will, ontological participation.

RESUMEN:

Después de haber propuesto una definición del concepto de robot, pasamos a considerar cuáles son los objetivos legítimos de una robótica epistemológicamente coherente. Se analizan las nuevas y emergentes tecnologías robóticas y las consecuencias que han tenido en campo biomédico e industrial, con particular atención a los efectos que tienen estas novedades en relación con el concepto de inteligencia. En particular, como la nueva sensoristica, permitiendo la construcción de extero-ceptive systems, ha promovido nuevamente el acercamiento bottom up en el debate sobre la AI. Se consideran tres problemas: el componente hardware, construido hasta hoy con tecnologías top down, poco eficaces para las necesidades bio-médicas; los aspectos metodológicos, concretamente, cómo obtener comportamientos inteligentes y adaptativos,

Palabras clave:
robótica, roboética, *inteligencia encarnada,* libre albedrío, *participación* ontológica.

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manteniendo el control simple; la cuestión cultural, es decir, cómo responder a las expectativas crecientes y muy frecuentemente inadecuadas que el público espera de la robótica. Atendiendo a algunas razones, se prefiere plantear la cuestión de la especificidad humana apuntando no al tema de la inteligencia sino al de la voluntad: porque es mayormente específica; porque el querer implica el comprender, mientras que no es siempre verdadero lo contrario; porque la robótica nos enseña que el gobierno y el control son problemas reales de los que es necesario hacerse cargo. Profundizaremos, por tanto, la noción de participación como instrumento conceptual útil para la comprensión de la voluntad, que permite, además, superar los nudos irresueltos de la robótica, fundada hasta hoy en acercamientos racionalistas.

1. The Challenges of robotics

Robotics is one of the few areas of technology, together with spatial, nano- and biotechnology, which enjoy that deadly privilege of being in the spotlight of the mass media. It does not help that, robotics and in particular its shadiest potential implications, were prefigured in a work of fiction, the dystopian drama "Rossum's Universal Robots" by the Czech Karel Čapek (1922)[1]. Later, it entered the collective imagination by means of the great narrative successes of Asimov, well before becoming reality, even if only as a prototype in some research laboratory. Robotics, so dangerously resonant with the many traditions of artificial beings, object or subject of popular myths ever since ancient times (think only of the story of Pygmalion and Galatea narrated by Ovid[2] or Golem[3] of Jewish tradition), is still affected by this hovering between reality and expectations.

While popularity may serve as a useful catalyst, on the other hand it can raise unreasonable expectations which flow from visions of the future that are more or less of a Hollywood nature. The challenges to be solved are those that dot the road that lead to the achievement of the objectives of robotics. But what are the objectives of robotics? To answer this, it is appropriate to define the concept of *robot* in the light of the state of the art.

From an engineering point of view, a robot is a machine able to perform displacements and apply forces following a pre-set program. So a robot is equipped with a control system which is an integral part that acquires information from the proprio-ceptive sensors (e.g., position, speed, force / torque), so as to adjust the sizes controlled (e.g. joint angles or force to the end-effector) as required by the running program. Typical examples are industrial robots used in automatic assembling lines. In some use scenarios, the reference values of the control system are provided by the user in real time via interfaces. This category includes *tele-operated* robotic systems (e.g. surgical robots, such as the much used Da Vinci Intuitive Surgical Inc. of California, robots for remote handling of explosive material, welding robots on submerged pillars, manipulators mounted on shuttles and space stations, etc.). Both in the industrial and tele-manipulation field, the *intelligence* of the robot consists in its programmability and flexibility of use.

Much more interesting are the robots with exteroceptive sensors, i.e. able to perceive information about the environment in order to adapt to it. In this case, the intelligence of the robot is little more than a synonym of *adaptability*. One famous example is the robot - vacuum cleaner "Roomba" of I- Robot, which in fact is the most successful service robot in the history of robotics.

Research on non-industrial robotics is mainly interested in this type of robot, capable of sensing information about the state of the environment by addressing all the aspects, ranging from the control paradigm and artificial intelligence to the structural, electronic and sensor related aspects. The challenges in this context arise from the specific function of the robot, which can be highly

1 Čapek, K *R.U.R.*, Paperback Thrift Editions, Dover, 2001. First ed. 1920.

2 On this subject see Galvagno, R. *Frayages du fantasme dans les Métamorphoses d'Ovide*, Panormitis, Paris, 1995. Pp. 31-45.

3 On this myth is worth reading what the father of cybernetics wrote in Wiener, N *God and Golem, A Comment on Certain Points where Cybernetics Impinges on Religion*, The MIT Press, Cambridge Mass, 1966.

varied and which range from home assistance for people with disabilities, administrating protocols for physical or neurological rehabilitation, restoration of motor functions compromised by disease or trauma (robotic prostheses or orthoses), cooperation with human personnel in non-structural environments (e.g. humanoid robots to be used in missions like search and rescue, interactive museum guides, robotic nurses, etc.) and the enhancement of human motor functions (robots for *human augmentation* for both civilian and military personnel).

Both the general public and work operators expect important developments in the field of technologies which enable effective cooperation between man and robot. We are dealing with a very varied and complex environment, ranging from issues of *dependability* in the broadest sense to matters of *sentience*, meaning the ability of the machine to become aware of the context in which it operates in order to optimize its behaviour.

The challenges are numerous and are arranged in (at least) three levels.

On a lower level, centred on the hardware, robotics suffers from the very limited availability of materials and components. The robots are built with technologies (top-down) and materials derived from traditional manufacturing sectors, and make use of electronic cards that are typically commercial. The hardware sets limits in terms of weight, speed, safety and cost. The actuators, except for a few incremental changes, are the same ones used for at least a century in industry (electric, hydraulic and pneumatic motors). If you compare a robotic actuator with a biological muscle, which merges on implementation capacity, sensing, adaptation, self-healing and energy storage, we understand how rudimentary our construction technologies are, and the machines that use them.

Micro technology and nanotechnology have taken a number of routes, through bottom-up technologies, that promise to make available multifunctional and intelligent materials and devices, with properties similar to those of biological tissues and organs. But the road is still long and the performances achieved until now are far from expectations, not only in terms of nominal performance but also, and especially, of reliability and durability.

On a higher level, which is centred on methodological aspects, the challenge concerns the *management of complexity*. In fact, today's robots are designed using the same design approaches of other mechatronic devices. The sum of hardware limits as mentioned, being human limits of the designers in terms of ability to integrate numerous and diverse functions into systems architecturally simple and low hardware complexity, are required by the need to increase the economy of construction, of exercise, energy independence and reliability. In a sense, if you want to construct a robot that behaves as a simple biological organism, there would be the need to evolve a design method whose effectiveness is comparable to that of nature in the act of synthesizing a biological organism optimized for a specific environmental niche. The challenge in terms of methodology then consists in identifying these design methods and the easiest way, but the most promising does not necessarily seem to be the one based on techniques of artificial evolution of robotic structures using physics-based environment simulation inclusive of all components characterizing the operative niche of the robot. The challenges are manifold, in computational and modelling terms. In the case in which the operative niche of the robot includes man, as happens in the case of the wearable robot (exoskeletons, active prostheses and orthoses), the challenges then widen to include the problem of modelling the human component, in its biomechanical and neuro-cognitive dimension. Only by working on methods of project, can you expect to make machines in which aspects of artificial intelligence are harmoniously integrated with the structural aspects, creating an optimized *unicum,* as is the case for biological organisms. In this regard, it may be interesting to mention the revaluation that is happening in robotics for the theme of artificial intelligence. Recent studies have shown that the computation which underlies every possible aspect of artificial intelligence cannot be a mere logical process, entrusted solely to the execution of an algorithm on a calculator. Rather, it can also arise from the interaction between a robot (properly designed) and the environment in which it operates. This concept, which goes under the name of *morphological computation*, belongs to the broader framework of *embodied intelligence*, intelligence *embodied* into the structure (hardware) of the robot, which can lead to the emergence of behaviours, often dynamic in nature and non-linear, describable by appropriate limit cycles, even complex, although the control of the robot remains intrinsically simple.

Embodied Intelligence is a deeply bio-inspired concept that promises to enable the development of simple but performing machines with low computational requirements. Putting it into practice, however, is still far from standard procedure and assumes, as anticipated, a change in paradigm design: the robot is no longer seen as a machine that generates movements in a determining way, but as a system whose dynamic aspects have a weight that is no less than that of cinematics. Given that the desired movement is known, that a dynamic system has been identified that tends to a limit cycle that corresponds to that movement, and furthermore that we can write a Hamiltonian function of this dynamic system, how can we synthesize a machine that is associated with that specific dynamic equation?

To conclude this section, it is useful to mention also the third type of challenges, which we might call *cultural,* as not being related to technical problems or technology, but to unreasonable expectations of the general public, sometimes provoked by simplistic statements made for the use and consumption of the media personnel or articulated by journalists in search of headline news. A robot is not an artificial being, let alone an artificial *human* being. In fact, the study of humanoid robots is only a niche of robotics. A robot is not intelligent. In fact, it is still uncertain what the exact definition of intelligence is, being the discernment of philosophers, anthropologists, epistemologists, cognitive scientists, psychologists, and with much less virulence, engineers. The operational definition in vogue, although dated, is that the Turing, inventor of the eponymous test which is nothing more than a ploy by focusing on the comparison of performance between a machine and a human, to get around the problem of defining intelligence.

After all, what would be the motive be to create intelligent beings? One could argue that such research would be useful to understand the human mind. But would it be the best route, in the sense of the most effective and scientifically solid?

An engineer by means of intellectual property, he must meet human needs: the systems that he builds should be considered useful insofar as they help to overcome a limitation of human beings. Just as an electronic calculator is faster than the human brain in making calculations, it is useful for this reason, as is a tractor indicated more clearly than the muscles of a farmer in order to operate a plow, and it is useful for this reason. Similarly, an industrial robot is faster, more tireless, more repetitive and more accurate than a machine operator. You could go on with examples, but the sense is clear: where there is a human limit, there is room for technology in general and robotics in particular. Creating false needs, which do not arise from man's true limits, is more about marketing and not technology. For example: is it truly necessary to work on the development of artificial domestic assistants who know how to iron, cook, pour a drink, perhaps learn the habits of their "master", possibly interact with him verbally, being able to handle emergency situations or simple ones not taken into account at the project stage, or exhibit a versatility of the human kind, when today's dynamic global demography has made accessible human labour (unfortunately) so cheap?

Although technology is most often fascinating in itself, it would be appropriate to reflect on what are the real needs to be met, in order to avoid running into the error of creating false expectations that stimulate the research lines of fragile motivation lines but dotted with challenges that are almost insurmountable.

2. Human, all too human

The interest that the proponents of post-human engineering show in general and robotics in particular has emerged for a number of reasons. Among these, perhaps the best known is the debate on the possibility of the design of artificial intelligence (AI).

Here we do not want to delve into the age-old and probably over-emphasized debate on the subject of A.I, but rather to consider the human, and thus the post-human debate, in the light not only of intelligence but of the will. It is the other faculty strangely absent in this kind of debate. Among the various definitions of will, we deliberately choose the most extensive and most generic possible which is described as: a particular sort of capacity of rational agents to choose a course of action among various alternatives.

Why move the centre of gravity of the issue onto the will rather than the intellect? For at least three reasons. The first: intellect, although different in shape and size, is used not only by man, so it cannot be said to be perfectly specific to the human race, unless there is agreement in advance on a specific definition of intellect, but it is precisely what is lacking today in the current debate. When in classical philosophy, an individual person is defined as existentia rationalis naturae (Richard of St. Victor), reference is made to a rational nature, not only to the intellect, which is certainly a component but without exhausting this nature.

The second: the desire involves the intellect, while the reciprocal is not necessarily true, but especially the exercise of the will is a specifically human act that constitutively takes advantage of intellect and passions (which are the other illustrious factors excluded from the current debate) and thus allows to focus on the anthropological aspect in its most relevant point.

The third reason as to why it is a useful argument for a change of perspective in favour of the will comes directly from robotics, furthermore by its foster mother: cybernetics, which was born to resolve the problem of the control of machines and complex systems. Control and governance (let us not forget the Greek root of the word: κυβερνάω (kybernaw), which means to govern) are therefore key concepts in robotics and in engineering of contemporary systems and relate more to the will than the intellect.

In fact, both the intellect and will are actually analogous. Being so, there cannot be one without the other: there is no intellective act that is not, in some way, voluntary. While just as there is no will that is not enlightened by the intellect, according to the classical Thomistic adagio "nihil est volitum nisi precognitum". While you may not want what you do not know by intellect, on the other hand, you cannot know the thing towards which you have not directed your attention, by way of an act of the will.

The debate on the possibilities of artificial intelligence, both digital and biological[4] , not only focuses attention solely on the intellectual aspect, but this gives a partial picture, almost like a caricature. In fact, the intelligence which is dealt with in these contexts is almost always calculative, a deductive logic in the narrower sense of the term. One of the merits of the new generation of robotics is to have liberated the field from the rationalistic prejudice with which the matter was dealt with in favour of a broader approach, the so called bottom-up, of which embodied intelligence can be considered as avant-garde.

The will however, understood in quite a minimal sense as that of a capacity of choice, as a selection between different options, becomes a frequent theme from engineering and internal epistemology to robotics when you begin to design machines with the ambition of autonomy. Moreover, machines which are able to "decide" which behavioural options to put in place in the face of certain scenarios. The decision that the machine is called to follow is only in an analogical and figurative sense. In fact, the options it has available are limited, and scenario analysis of action brings the variety of configurations to some schemes previously studied. That which we therefore call decision is in fact still an algorithm calculation where the input data is placed in relation with the output data. Thus, nothing is different from the classical computational logic, except that the acquisition of data through a sensor of new conception introduces an element of variability greater than the previous computer strategies, thus allowing greater adaptability of the machine.

4 We refer here to the philosophical trend that advocates a sort of imminent evolutionary leap in the level of intellectual ability, a sort of homo sapiens 2.0 or a form of collective intelligence in the network, such as to a configure a specific singularity. See for example Walker, MA [on line publication] «Prolegomena to any future philosophy», Journal of Evolution and Technology, 10 March 2002. http://www.jetpress.org/volume10/prolegomena.html [Consulted 15-10-2013]

So, again, it is a specific issue of the faculties of the will by means of a calculation technique of their intellectual faculty. Though it seems that, despite repeated attempts, we are unable to get out of the doldrums of a certain rationalism.

What is the underlying reason for this inability to reason on the will in terms that are not intellectually compromising? We believe that the answer is at once both simple and complex: the will is a faculty that works for participation and as such may not be reproduced. For this reason, it is not susceptible to "interest" on the part of science that has, as among its prime purposes, reproducibility.

This response was defined as simple and complex since as you can see, it indicates straight away the fundamental concept that is entrusted to the argument: participation, but it remains to be understood the profound meaning and this is by no means simple.

Firstly, there is the participation; who or what, with whom or with what? Then: what kind of participation, who has the initiative: the proposer or the participant? These are just the first of a series of questions that look legitimate to our mind when we cross the notion of participation.

Let us try to clarify. The question of human freedom and morality is the question of the participation of will to reason. This participation involves the submission and obedience that the will lend to the empire of reason, to which the will is called "rationalis" for participation[5]. With these words, the philosopher who, more than any other in the last century has investigated the concept of applied participation in intellect and will, Cornelio Fabro, explains the participatory dynamics that run between the human faculties, illustrating the will as an intermediate point from which reason's own light irradiates into each human district. Mindfully, if the will is said to be rationalis by participation, it is not to reintroduce a veiled form of rationalism, but to explain what the relationship between reason and will is, and moreover for the latter that is not an autonomous faculty and detached from reason, but on the contrary it shares the essential features, being participation, in fact. It is far from any voluntarism, being those positions that emphasize the separation between reason and will, as if to say the will does not act in accordance with reason, the classical position explains this delicate relationship in terms of the participation of the will to reason. Even more, the frame of classical medieval thought went further and presented the same reason as participatory of the creative Intellect, to the point that if the knowledge of reality occurs for approximations, on the other hand, however, reason is capable of grasping elements of intelligibility, which are technically the formal causes, belonging to the angelic sphere or the spiritual world, of which the human being is a candidate for such knowledge.

Participation in the sphere of intelligibility allows human knowledge to overcome, though not entirely, the bonds of sensitive knowledge, related to what is to become of the material world. This overcoming allows us to read the reality from the perspective of the reasons that determined it, almost as if we could throw a glance at the ideas that govern the creation of nature and in this sense the knowledge that we get is not extrinsic but internal. With engineering vocabulary we could say that tapping into the intelligible sphere, the founding project of creation can be known.

This is specifically the nature of human knowledge brought about through acts of will conformed to reason. This *excursus* into classical philosophy allows us to appreciate the difference and specificity of knowledge and human activities that reach, even if imperfectly, the reality at its root. Paraphrasing the Apostle, we could say "per speculum et in aenigmate" [6].

Having clarified this aspect, it should now be clear about the difference between participatory and productive knowledge. It must first be recognized as a formal analogy between the two forms of knowledge: that is to say, just as the producer is aware of the project and thus the intimate reasons of his own products, with access to

5 Cfr. Fabro, C *La nozione metafisica di partecipazione*. (The metaphysical notion of participation) EDIVI, Roma, 2005, pp. 278-281.

6 *Corinthians1* , Chap.12, Ver.12.

them being possible only if the craftsman shares his own schemes. In the same way, the knowledge for participation is a kind of sharing of these schemes. On the other hand this sharing has limits, moreover, our understanding of the schemes that are located at the founding of nature, that remain within the design metaphor. While the producer will be able to be understood by his own kind, the Creator, which by definition consists of an infinite Intellect and Will, can only analogically share "reasons". Nevertheless, this sharing, in fact this participation, is precisely what enables the intimate knowledge of reality, as well as the perfect realization of human nature, which tends, according to his own purpose, towards this goal: the knowledge and enjoyment of Truth.

Another element that deserves to be emphasized is this still valid theoretical and epistemological model is as follows: participation by man to the reasons of nature implies the free availability of these very same reasons for his investigation. Therefore a participation exists since there is accessibility to the reasons of creation which, depending on the metaphysical and theological background that is embraced, is guaranteed by God the Creator , rather than nature or otherwise by Him/or Whatever is the source of reality. It is important to emphasize the aspect of gratuity of participation because it is a discriminating factor in the on-going debate. Indeed, on the horizon of techno-scientific reductionism, dominated by poor conception and tight reason, in fact limited to the calculative dimension, the productive approach prevails, so you know what is produced and therefore knowledge becomes a manipulative action. In the metaphysical participatory approach, we know and want that which is given to know and want for to share. It may seem like a subtle difference but it's capital and is at the head of two antithetical philosophies.

The arguments that are read around the post-human debate and its technological variations often fall within an environment of rationality of the first type, that is, manipulative productive where man is the product of himself and has the right and duty, written in his own nature, of becoming/improving according to what he sees worth pursuing. The error of this perspective, one of the errors, is to ignore the participatory aspect of human knowledge and will. It is that aspect that allows man a fruitful progress and further improving of himself, following his own nature, which, however, asks not to be exceeded in terms of production/quantitative[7] but to know intimately the reality that is given to us and that certainly consists of quantifiable aspects, but more radically a logical-metaphysical foundation, unattainable with tools of calculation only.

In this ability to participate, there is also the irrepressible difference between man and machine, as well as the reason for the failure of all the interpretative models that seek to understand the man starting from mechanical schemes. The will, again, is the key element. Not so much because the machines do not possess one, but because it is made abundantly clear in the purpose that animates the human action, which differs substantially from the "purpose" imposed on the machines via software. The objectives pursued by machines are always extrinsic to themselves, in the sense that there are installed by man. Unlike the ability to have a purpose, this distinguishes the human being in an eminent way in respect to any other artefact. Furthermore, this ability, if analysed according to the model of participation considered previously, allows to see how it is not random, that is to say that the presence of a purpose in humans is a trace of finalized project. In other words: man has been fashioned for finalization, or according to a more classical vocabulary was created to participate in creation.

Robotic engineering being more aware and recognizing these issues, does not lend itself to being used improperly by ideological perspectives that, by virtue of an arbitrary conception of human nature, claim to shoulder the burden of designing Sapiens 2.0.

Paradigmatic in this regard is the internal debate in the new discipline that goes by the name of roboethics.

In this context, we discuss how to reconcile the needs and challenges of robotics with the emerging ethical issues that the adoption of the new robots raises. It discusses, among other topics, whether it is possible to

7 It is not that required by human nature to increase the volume of the brain mass, or exacerbate the sensory-perceptual faculties.

implement ethical software into the machines that need to be operated in problematic contexts such as war scenarios rather than in emergency medical situations. It speaks explicitly of moral machines[8], as well as slave morality[9], or there is the Kantian matrix of the laws of Asimov[10], but the prospect that seems the most appropriate and which brings together everything said so far is that which is expressed under the name of value principle[11], in which it is made explicit that the ethical evaluation aspect could not be anywhere else than in the mind of the engineer, and not in the software of the machine.

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10 Asimov, I *I, Robot,* Doubleday & Company, New York, 1950.

11 Pfeifer et al., *How the body Shapes the Way we Think*, a *new view of intelligence*, the MIT press, London, 2007.