Introduction

In the short time that is left before entering the third decade of the new millennium, it can already be seen the tendency towards invisibility of the technology in a myriad devices of daily life, within and without the home. It suffices to watch and thin, the possibilities that are offered by certain new hardware devices of a very low cost such as the Raspberry Pi computer (www.raspberrypi.org), whose only or simple plate hailing from the UK, has as its main goal the fostering of computer science teaching in high and primary school. These plates used in the glasses and mirrors give us the option of unfolding interactive menus, opaque and/or transparent, with information related to meteorology, the month calendar, the time, news headlines, etc. (Figure 1). Besides, it can be programmed to manage several devices in the domotic or intelligent house, for instance. The computer is an open software and its operative system is already compatible with a version of the Windows 10.

That is, technologically we are in a metamorphosis which will drives us from miniaturization towards the invisibility of the current computer and/or telematic devices keeping or increasing the communicability between the human beings and computers. In other words, the new technological devices, with small size, with a minimalist device and empathic towards interaction will tend to merge, exponentially increasing their functions. In this context, quanta computer science and the expansion of communicability will take a very important role, the same as artificial intelligence and all its derivations. It is a

Figure 1. A cheap computer for intelligent glasses and mirrors

vertiginous process which entails quickly widening the horizon of new neutral scientific research, that is, noncommercial, for a myriad of potential new users. In this sense, new and interesting horizons are opening for the human-computer interaction (HCI), especially that which is aimed at the seriousness and universality of the obtained results.

Since the late 20th century the human-computer interaction as an area of scientific knowledge has passed from being an intersection of professional disciplines of the formal and factual sciences to a chaotic gathering of said sciences in the new millennium, where the partial fields of studies from engineering usability of the 90s (Nielsen, 1992) are nowadays total or global contexts under the label of user experience (UX). Oddly enough in this boundless expansion of the human-computer interaction among the human beings and the new technologies different dynamic and/or static media of interactive communication are still being used. It is there where communication and, very specially, the quality of communication, that is, communicability, is one of the vital focuses of the research for the new decade and especially not only with the horizon of 2020, but rather with the look set on 2050, in the educational and scientific field, for instance.

This endless inclusion inside the human-computer interaction in other areas of knowledge under expressive formulas such as interdisciplinarity, transdisciplinarity, multidisciplinarity, transversality, etc. indicate the presence of the wild mercantilism of the sciences and all its derivations, starting by teaching, whether it is secular or not, and the training of professionals and/or experts of this sector. It is a disorderly widening of new horizons, stemming from a variegated range of professions. Some examples may be nuclear engineering, industrial engineering, fine arts graduates, anthropology, mathematicians, physicists, among many others. Professionals who are geographically located and mostly in the societies with theoretically developed economies, but which have found in the human-computer interaction a kind of panacea for daily survival, and turn this scientific sector a space of study without rules. That is, everything goes, applying the pecking order. In few words, it is the eternal dilemma of the lack of balance between the formal and the factual sciences (Bunge, 1981; Ander-egg, 1986), where the former try to take a place of supremacy with regard to the latter. One of the genesis of that phenomenon has been the expansion in the use of the computers, which leads us to review previously and briefly the notions of sciences, mathematics, physics and engineering.

Mathematics is regarded as the "godmother of the sciences", because of the generality of the results that are obtained from it. That is, a priori it has no bounds in its applications, whether it is in the study of the numbers and the calculations as well as the space and the structures. To such extent that in our days each one of the technical or scientific disciplines which range from physics to engineering, or from descriptive statistics to computer sciences, resort constantly to the calculation, analysis and modelling stemming from mathematics. However, in the field of the social sciences (Kincaid, 2012), sometimes that exaggerated quantification applied to the elaboration of design models of interactive systems, the partial and generalized conclusions of heuristic analysis, the quick extrapolation of non-verified results of research-in-progress etc., all of them aimed at the learning processes, creative or original contents for the teaching of children, the elderly, the disabled, etc., may seriously damage the communicability among the potential users and the new interactive technological devices. Quantifying and quantification are not synonymous of quality and qualification, in two essential pillars of the societies such as education and healthcare, even if mathematics, has a long tradition in the whole history of the evolution of the civilizations and alphabets (Veltman, 2014) in our planet. It has been the first discipline in having available rigorous methods, which have allowed it to increase its field of action with the computers. In this regard it is worth mentioning the equations that have changed the world, according to Ian Stewart: The

Pythagorean Theorem, Logarithms, Calculus, Law of Gravity, The square root of -1, Euler's Polyhedra Formula, Normal distribution, Wave Equation, Fourier Transform, Navier-Stokes Equations, Maxwell's Equations, Second Law of Thermodynamics, Relativity, Schrodinger's Equation, Information Theory, Chaos Theory and Black-Scholes Equation (Stewart, 2012).

Physics is one of the earliest academic disciplines, perhaps the oldest, since astronomy is one of its branches of knowledge. Most ancient civilizations in each one of the continents have been looking for explanations of the functioning of their environment. In that sense they started by analyzing the nightly and daily sky, that is, the stars, the comets, the moon, the sun, etc., and associated phenomena such as the sun and moon eclipses. This led to many interpretations of a more philosophical that physical nature. Consequently, in those moments physics was called natural philosophy. Many philosophers can be found in the genesis of physics, such as Aristotle or Thales of Miletus (Moledo & Olszevicki, 2015), among others, because they were the first to try to find some kind of explanation to the phenomena that surrounded them. During these two latter millennia, physics was regarded as part of what is currently called philosophy, chemistry and certain branches of biology and mathematics. In the 17th century, with the scientific revolution it became a modern science. However, in some spheres such as mathematical physics and quantum chemistry, the boundaries of physics are still hard to distinguish. Here is a field where the boundaries are very elastic, temporally and professionally speaking, apart from the fact that physics can be defined synthetically as a natural sciences which devotes itself to the study of energy, matter, time and space as well as the interaction of these four notions with each other.

Historically physics precedes electric engineering. Electric engineering applies knowledge of sciences such as physics and mathematics. Given its evolution in time, now it encompasses a series of disciplines which include telecommunications, electronics, control systems and the processing of signals, electrical engineering . It is necessary to remember that in relation of the spatial or contextual variable that is used, the term electric engineering may or not encompass electronic engineering, which arises as one subdivision of it and has had an important evolution since the invention of the tube or thermo-ion valve and the radio. That is, primary technology for the birth and development of the Global Village, in the 20th century (McLuhan & Powers, 1989).

In its beginnings engineering was related almost exclusively to military, government and religious activities. It suffices to mention the fortresses and their embankments, the roads and the bridges, the ports and the lighthouses, etc. A genius of Renaissance such as Leonardo Da Vinci, interrelated exceptionally art with engineering, as it can be seen in the wide collection of his masterpieces. In peace time engineering, theoretically, has to be at the service of the wellbeing of mankind, excluding the bellicose framework. Hence that when the early universities started to offer this career they called it civil engineering to distinguish it from that carried out by the warriors, that is, military engineering.

Etymologically the term sciences stems from the Latin "scire" which means to know. However, the Latin verb "scire" refers to a form of knowledge and accumulation of knowledge. Mario Bunge claims that science grows from common knowledge and surpasses it with its growth (Bunge, 1981). Scientific research starts in the same place where experience and knowledge stop solving problems or even approach them. In other terms, it is the social practice when the human being faces a series of problems which can't be solved with the daily knowledge, nor through common sense. This is a very common mistake by using indiscriminately the notion of empathy in interactive design, in myriad situations more related to social communication that with the actual experience of the users. That is, cyclically the same mistakes are repeated which at the end of the first millennium, when they were used as synonymous, on the banks of the European Mediterranean, the notion of usability and a quality attribute for an interactive

system, whether it is online or offline, such as accessibility, what Leggett and Schnase, calls hyperbase (Leggett & Schnase, 1994), that is, the data base.

Simultaneously, Aristotle claimed that to the human being eager to know and widen his knowledge external grasp of events and observation isn't enough, nor common sense, since there are phenomena which can't be grasped solely at the perceptive level (Moledo & Olszevicki, 2015). That is, it is necessary to overcome the immediacy of the sensorial certainty of the spontaneous knowledge of daily life. Precisely it is this qualitative leap which leads us to scientific knowledge. Undeniably this does not mean an extreme discontinuity as far as nature is concerned, but yes concerning method. Between both types of knowledge the differentiator isn't given by the nature of the object of study, but because of the form or procedure of acquisition of knowledge, particularly in the social sciences. In contrast, in the sciences of physics, for instance, there is a total break between both kinds of knowledge. Here is another essential difference between formal and factual sciences. A short historical review of the evolution of science allows us to complete a first state-of-the-art to better understand certain causes and effects of some human and social factors in the framework of the new technologies which will be approached in the handbook.

The greeks considered two dimensions of sciences: one theoretical and the other practical, but they focused on the first one. It was the Arabs who leaning on Greek knowledge concerned themselves with the application of sciences in its practical function and its utilitarian character. Precisely the practical accessibility contains the notion of utility, and it is one of the branches from which derives the term "usability, with its five classical principles for the use of the early hypertextual systems at the end of the 80s and early 90s, which were enunciated by Nielsen: easy to learn, efficient to use, few errors, easy to remember, and subjectively pleasing (Nielsen, 1990). However, those principles lacked attributes and quality metrics (Nielsen, 1990; Nielsen, 1992), as well as a procedure for their evaluation, starting by the design, where the equation quickness of evaluation, high quality of the obtained results and low costs were present. In this sense, several "classical" disciplines of the factual sciences, for instance, have been very useful to fill that measurement void, resorting to notions of semiotics, design models of the interactive systems, the human-computer interaction and software engineering among others.

With Francis Bacon starts a tradition of accumulation of data, observations and formulation of hypothesis (Ander-egg, 1986; Moledo & Olszevicki, 2015). This process peaks at the end of the Renaissance with Galileo and Newton, in the 16th century, and science appears in its modern sense of notion, with a common denominator such as its rationalistic and empirical character. The Renaissance and Humanism create the right climate for the irruption and development of science by overcoming the tendencies to abstract speculation and dogmatism typical of the Middle Ages. The humanists were heirs of a general paradigm in dissolution and they didn't have a new paradigm with which to replace it. However, they were contributing to draw its general lines, having got rid of the theological issues, aside from the scholastic discussions between realists and nominalists.

The humanist, the scientist, the artist and the Renaissance technician, many times rolled into one (nowadays, we can find this tendency in some pseudo experts in humanistic computer science, for instance). However, they at that time started the union between experimental science and mathematics, between empirical practice and theory, established a new way to perceive time, space and the world which gave its foundations to the mechanical philosophy of the 17th century and the scientific revolution. In short, it isn't any longer about making speculations, but directly watching the facts. The sources of science aren't given by arguments of authority, but by principles and laws which are deduced from reality.

From the 17th century onwards science and technique will be joined in a increasingly narrower reciprocity of functions. Science ceases to be a 100% intellectual activity in itself and for itself, a knowledge

of things, to acquire every time more a clear motivation aimed at "doing things". The techniques, that is, the instruments of the practical activities, start to be used for the advance of science. Francis Bacon points out the importance of statistics for the progress of the sciences and the need for empirical verification.

The empiricism of Bacon will influence the new ways of approaching reality, that is, the observation and experimentation will constitute the main sources of knowledge. Kant will stress the importance of reason as a source of knowledge. In our days, sometimes, the empirical verification may not exist when the results obtained with the new college study plans of the new millennium are examined, such as the reduction of the time to obtain university diplomas with the simple purpose of increasing the statistic number of the population with college degrees.

Taking this short historical route to the surface of a compass, it is possible to establish the cardinal points over which the needle passes at the moment of getting orientation not only in the strategic sectors of the new technologies of information and communication, but also in knowing the motivations and reason for which certain human and social factors related to the human-computer interaction, to mention two examples last with the passing of time (Salvendy, 2012). Therefore, a diachronic view is always necessary. Besides, it is one of the main strategies to escape the last fashions in issues of research and development (R&D), generally fostered from public, private or hybrid financial bodies for the sale of their services and/or products, related directly and/or indirectly to the latest technologies. The research that doesn't belong to the set of the "latest fashions" is where the scientific principles are usually respected in almost 100% of the studied cases. Besides, these are centres where is fostered the creation of solid, dynamic and avant-garde structure, since the mercantilist factor practically doesn't exist.

This mercantilist factor, aimed at obtaining the greatest profits in the least possible time in our days is gnawing at not only the scientific system but also at its structure. A structure that entails a long time in being set up and seeing it work correctly. For instance, in the transition from the old to the new millennium and with the democratization of the internet (Carr, 2010), many made a heavy bet on the virtual firms, ecommerce, etc. thus generating a bubble that burst in the first decade of the 21st century. The motives were several ranging from the speed of the networks to the issue of security in the transactions, going also through the reliability of the potential users in the face of the technological novelty as well as the different speed in which the hardware moves in relation to the software (the former is faster than the latter).

Currently, and in this sense, some applications of the social networks, such as YouTube may be of great use to detect at mere sight the quality of experiments carried out in the context of the user experience (UX), HCI, usability engineering, etc., with users at the moment of interacting with the computers, tablet, PC, iPhone, etc. For instance, in the Figures 2, 3 and 4 we see an experiment with real users in a Barcelona association which has ceded a classroom with computers to carry out an experiment related to the videogames for the elderly (positive ageing or zero ageing, financed by foundations, banks, government bodies, universities, etc., local and/or European). However, the results obtained to not adjust at all to previously described scientific and experimental principles. In said images it can be seen at mere sight that not only the computers aren't equal among themselves, whether it is from the point of view of the hardware and the software (keyboards, mouse, monitors, etc.) preventing the standardization of the time of access to the applications, since they are different from each other. Besides, there are users who do not really belong to the third age as well as you can see participants who interact with the PC individually, between two or more, as it can be seen in the several frames that make up the video. This is a small example of how it is necessary to eradicate the fads in the educational-experimental field.

Figure 2. Experiments that do not abide by the epistemological principles of the factual sciences

Figure 3. Not all the users belong to the third age

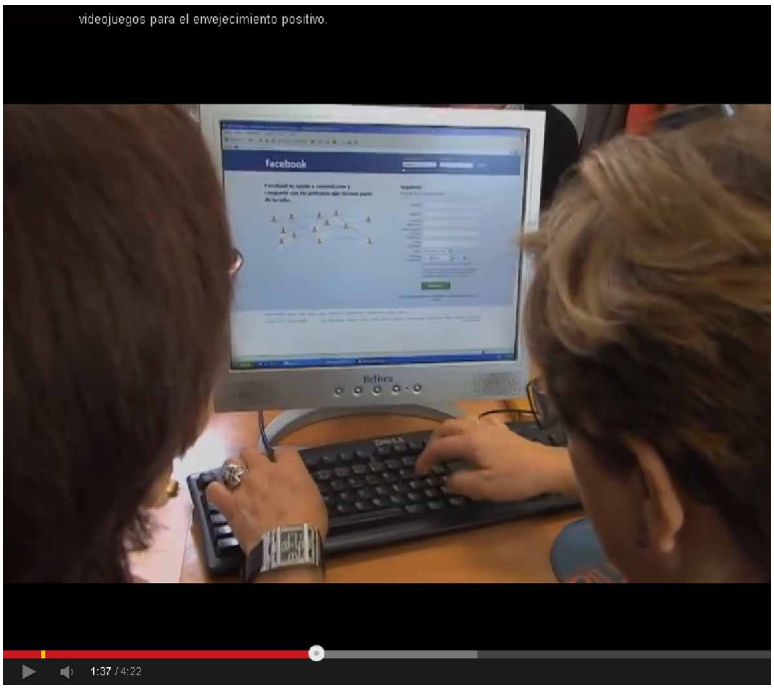

Figure 4. Non-homogeneous use of software and hardware

Now inside the current context of the latest novelties of the NICTs (New Information and Communication Technology), two rhetorical questions are elementary: How to prevent the fashions or rather pseudo fashion, essentially in the training stage of the would-be professionals? A priori, what new technologies can escape the fleeting phenomenon of the fashions or of access only to a given elite of the population with the look set on the future in the middle and long term?

The first question finds a very brief and simple answer derived from the data bases where the scientific works are indexed. In them it can quickly be detected the ability, the competence, the knowledge and the scientific profile of the professors of graduate programs, engineering courses, masters, specialization courses, doctorates, post-doctorates, etc. There it is easy to check whether in their student period those professors have monographic publications, that is, with a single author, the main author, or in all their publications there are several authors. If all their publications have several authors, it means that the degree of scientific production is shared in a stage which should be autonomous or monographic to show their ability of researching self-sufficiency. In both cases it is also important to determine the total of international publications of that period.

A valid parameter of a "PhD Professor" is to have had at least five (minimun) or seven/ten (ideal) monographic or autonomous publications irrespective of the data base where those international scientific publications have been indexed. This parameter may sound to many heads of the current training courses in the EU as something old or of the past century. However, it is the vital key to determine the quality of teaching. Besides, it is the way to prevent that the students and/or their parents fall into the trap of the educational mercantilism, attracted by the mermaid song of advertising or propaganda, manifest or latent, in the traditional mainstream media (radio, tv, newspapers, etc.) and in the social networks. Mermaid songs for the local and global promotion which include even the possibility of publishing scientific articles since the first months when the student is taking subjects of a master, for instance.

It is also very important that all the promoted courses have a free access to the detailed information of each one of the programmes of their subjects, with their matching bibliographical references: the listing of tenured professors, assistants, aids, with their matching curricula; the equipment (software and the hardware, for instance) in the labs for the experiments or practices; the dedication of the head of department and his/her collaborators to teaching and research, that is, if they are part-time or full-time,

among many other variables, belonging to the transparency and free access to online information. When there are no international publications or they are mostly shared, the faculty of the training/university centre will tend to not train the students to face in an autonomous and efficient way the challenges at the workplace once they have finished their studies. To such an extent that nowadays many computer science technicians in the south of Europe, who carry out outsourcing tasks for the maintenance, installation, etc., of printers, computers, servers, etc., do not know how to solve in an independent and professional way the problems posed to them without previously contacting their colleagues from their headquarters through the cell phone or the internet.

With regard to the second question sometimes it is necessary to give time to time when we are in the face of certain discoveries and/or inventions in the technological framework. However, our compass allows us already to anticipate some roads to be followed (Ross, 2016). In the first place, everything concerning artificial intelligence and especially domestic robotics will generate a new market of products and services, particularly in the Asian countries, where certain cultures accept the robot as yet another member of the family. In this regard it can be stressed the role of the androids with a human face, as it can be seen in Figure 5. Here also an interesting field of study is opening up between realism and the artificiality of the human movements, at the moment of simulating or emulating that reality. In America, Europe and Oceania industrial robotics and everything concerning automatism will keep on growing in an exponential way.

The social networks will keep on having their ups and downs for reasons of differentiation between freedom and debauchery. This will lead to a further control of the access to the internet until doing it in a nominative way, like that who accesses a bank account, from the home. So that everything concerning cyber security, cyber behaviour, rights and obligations of the users, etc., will tend to expand. The digital natives will not oppose the loss of freedoms, because without the devices of the multimedia mobile phones and all their applications they would have difficulties to carry out arithmetic operations, such as divisions and multiplications and they will increasingly lose their skills for the reading of texts, digital or not, as well indicates abc in his work abc. Therefore, the architecture of information and data analysis is another sector which will tend to grow to the extent to which the access to the information will remain free and

Figure 5. Android with a human face (kodomoroid)

without cost. In this field specialists will be needed because the user of the interactive systems of the next decades will tend to lose skills for learning, memorization, the ability to establish associations, etc.

A human being who will undergo great environmental and technological changes through the smart cities. Where the drones will not simply be devices for the transportation of books or other objects, but also a means of air transportation for people, whether it is in a car or a bike as it can be seen in the Figures 6 and 7. At the home the wireless networks and the automatic devices are opening service sectors starting from the interactive communications such as domotics since the start of the new millennium.

Everything concerning medicine and the use of the new technologies will keep opening the gap between the great scientific breakthroughs whether it is in the framework of genomics the interactive systems and the brain handled devices, scientific visualization, three-dimensional, etc. with those users and patients who have access not to the latest technological breakthroughs but to the simplest of the healthcare systems. Public or private health systems where the patient and the environment of close relatives are central and not peripheral, such as simple numerical or alphanumeric codes of a health system. They have to keep on being informed constantly about the evolution of the disease and the options about the different methods and techniques to advance in the best possible way in the healing of the diseases or the improvement of health, in a safe and controlled way. This is a field where the breakthroughs in the matter of ecommerce should be more applied, especially when information is given to the patients and their close relatives.

Figure 6. Prototype of a bike
Source: Scorpion-3, hoverbike (www.hoversurf.com)

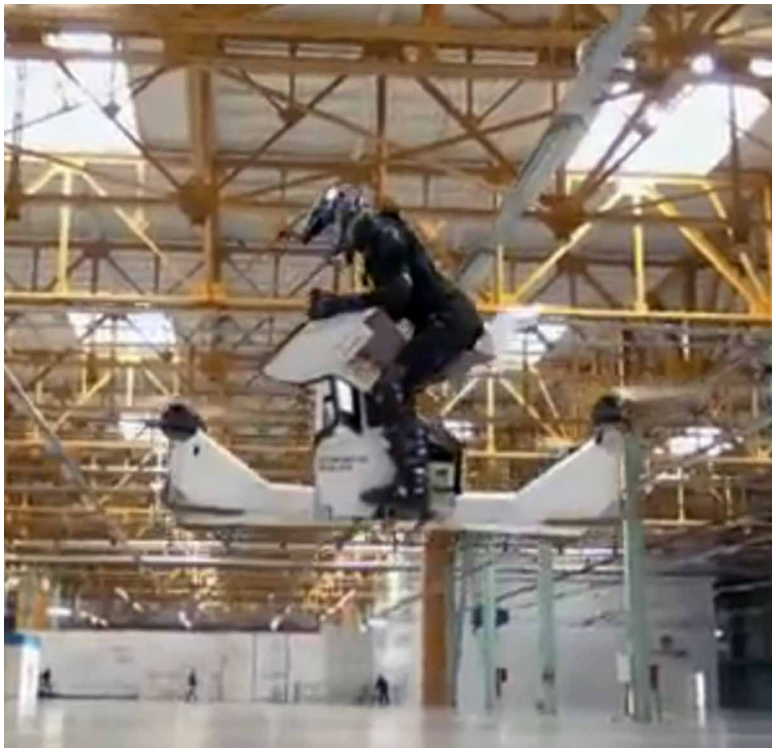

Figure 7. Experimental transportation of people in cars
Source: EHang 184 (www.ehang.com).

From all the sectors enumerated the latest is the most important, because the real heritage of the human being will keep on being invisible and will be called health. Besides, healthcare and education are the real cornerstones of any community that calls itself developed. Therefore, yesterday, today and tomorrow the new technologies of communication and information must be at the service of the human being and not the other way around.

Lastly each one of the diverse research works compiled in the current handbook generates a kind of strategic links, indispensable and dynamic, of theoretical and practical knowledge, which will not only help to analyze and better understand the current situation of the sciences and some of its disciplines, but also go ahead of the future areas of scientific interest and daily coexistence for millions of users of the new technologies, professors, students, researchers, businessmen, industrialists, designers, among so many others.

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