

Information and communications technology is merging data science and advanced artificial intelligence towards the core of knowledge based society

-Part 4-



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Abstract

The paper analyses the context of generating refined knowledge, when leveraged by the information and communication technology (ICT) evolution, as the main driving factor of the human society by the complex consequences of its services, products and applications and support for the Information Society (IS) on the way towards the Knowledge Based Society (KBS).

Because today it is more and more complicate and also difficult to maintain the exponential pace and the progressive increase of performances, the ICT actual research struggles reflect the necessity of innovative approaches, sometimes **beyond the usual technological paths and resources**, keeping alive the necessity to refine knowledge, **in order to achieve a sustainable progress not only for ICT but also for the whole World they are aiming and influencing, by all kinds of consequences**. It is crucial, from the actual stage of ICT progress, to consider that **beyond the usual** approaches could mean unlimited innovations, sometimes changing paradigm and generally using data/information/knowledge even from unexpected areas, i.e., using outmost results of the human or artificial intelligence. Such large and unusual approach of the research is, by our opinion, **the logical option for keeping the ICT pace and extend performances and features from the actual high levels and facing also unprecedented and complex challenges at Earth scale**, like climate changes, Earth resources fading or Covid 19 pandemic. In fact, the natural aim of optimizing ICT for **achieving a sustainable progress at Earth scale for IS/KBS**, considering all complex challenges and consequences, leads to **the logical approach of using human imagination and all resources, this way innovating and refining knowledge all the time**, i.e., just what we could witness today and tomorrow.

Considering the unlimited areas or issues which could be part of the innovative solutions for ICT advances, in this paper we point, by some examples, just **the tip of this iceberg, meaning at least the perception of this larger picture, from both ICT designer and user perspective, but clearly encouraging the perseverance in optimization, recognizing the crucial importance to this goal for Earth ecosystem and humankind evolution**. This global and holistic approach is inherently a very difficult and complex chain of processes, supposing a relative level of the multi-criteria optimization, as many of the performance parameters and features have no-metric and consequently are not measurable, while the whole picture is fast changing, just because of the ICT exponential development which induce its pace all over the Earth. Here, for example, beyond technical and economical parameters, we might think at informational, environmental, ethical or social criteria (to include just few) to comply.

Approaching the roots of knowledge, i.e., from experience and education, the above general approach is detailed by analysing some relevant examples, showing concrete trends of the actual state and vision of ICT development, as premises and context. **This way, considering the evolution of ICT engineering, a prominent conclusion is that the information/knowledge is now faster generated and it contain new challenges, including the increasing complexity of knowing.** Because, for most of people, Internet became a utility like water or electric power, its continue improvement is one of the prominent challenges of ICT, in spite of the impressing performances achieved, as speed, which support amazing applications like videoconferencing or home working. COVID-19 pandemic has generated, among other disturbances of life on Earth, changes which amplify some of the Internet existing challenges (the need for lower latency). This influence is **a prove of the above mentioned global/holistic approach we have proposed for ICT progress and more than this, it lays in a zone where only an excessive imagination could forecast the evolution.**

The **Internet** example (analysing a weather map for the Internet) is revealing how far the actual challenges (low latency expectations) could appear versus the past ones, i.e., the last became surpassed by just the consequences of our "progress" in more complex applications, incidentally affected now by pandemic. Here the conclusion is that it is a **logical option** to use our imagination beyond any actual apparent limits and especially simply reconsider (refine) knowledge and **ask one more time** if are they all (i.e., some complex applications, like online gaming) very necessary, as it is sure **they rise the costs of ICT development** (and beyond!) by many different ways and consequences. Analysing the deepness of these examples, we could wonder if other applications fields, like human and Earth health or people education, should be a priority versus gaming on line (for example), considering the Earth resources fading and the other mentioned challenges? Such optimization criteria do not mean to stop improving ITC performances or entertainment applications, but it is sure they will be useful to better manage Earth resources and even Internet improvement options.

An important result is that, under deep analyses and complex context and criteria, innovations could be enabled, even in the most difficult areas, like Internet actual performance improvement, using the power of other ICT advances, like AI, in order to globally optimize the network use. In addition, the struggle for adapting Internet to the actual and future challenges is a clear link between AI/ICT innovations and refining knowledge for the core of knowledge based society, as it is difficult to imagine the optimization of the huge network of networks at Earth scale, **on all possible paths**, without the expected progress of AI and other ICT advances like Big Data, using the leveraging support of DS.

Analysing the Quantum Computing example and presenting the advantage of Intel silicon spin qubits, we can notice the often-used ICT way of compensating complexity by exploiting some of the already achieved technological advances, even when, this way, a compromise must be supposed, but a step ahead is provided. Also, the essential of this example is the **iceberg tip** image we can observe about this revolution, called Quantum Computing, that is coming, step by step, along with other **emergent AI/ICT advances, which will leverage progress and the refined knowledge for the core of IS/KBS.**

These examples confirmed how important it is to timely watch the exponential evolutions of ICT, as their speed could generate or influence, along with well-known benefic consequences, other challenges for the Earth ecosystem and even for the ways the evolution of humankind is potentially affected, including climate changes, Earth resources fading, social unbalances, human health/education/behaviour, geopolitical security and so on. Some of these challenges, reflected above from relevant examples (**promoting wisdom** when approaching science and technology versus human values, like empathy or solidarity), are referring first to the human nature/behaviour, which we also consider crucial for the future of Earth ecosystem, as human is the main factor of innovation and decision and this way the fundamental role of the human nature and evolution is influencing all other challenges, starting from the ICT pression of time/speed (which determines the opportunity of reactions to changes) and ending with social unbalances. On the other side, the role of science and technology for the World progress is by far essential and constructive, but, in the complexity and dynamic of processes of development at Earth scale, all implied factors and consequences must be timely analysed.

This way we have just arrived to the most complex and difficult processes of decisions, where the refined knowledge, for the core of KBS, could be generated, but this does not happen always, mainly because of human nature. These processes are critical because **defining the appropriate "refined knowledge", in such multi-dimensional cases on Earth, meaning a generic model 3D+time+restrictions, is almost impossibility to manage, but this does not mean we have to ignore these challenges.** The necessity of **wisdom** (realistically including human values), versus simply having intelligence (expressed in only applying science and technology to the real problems), as we also expressed many times, is also confirmed by the analysed examples. Although almost everybody could agree with the necessity of wisdom, as refined knowledge, in the World development decisions, including AI/ICT/IS/KBS, sometimes the real problem is left at the old/last stage, mainly because it is too difficult to define and solve, which is mostly true. What we could not accept is to ignore the new potential consequences/problems, as we have to timely analyse the context of AI/ICT/IS/KBS and refine knowledge, even when the dynamic, the speed/time or the incumbents represent obstacles for achieving this goal.

As the humankind life on Earth is highly depending on science and technology and this dependence will naturally increase in the future, by our opinion, the actual realistic question is which are the level of dependence, in every case, where we have to worry and ask: what if this support of technology fails one moment? There are more and more fields and cases where we are depending too much on technology and this relative assertion is relevant for critical infrastructures, as power grid or even communications/Internet. In fact, the answer is aiming to prevent such events and provide the compensation solutions, i.e., just to refine the core knowledge for such context and contribute this way to the sustainable progress of AI/ICT/IS/KBS. More than these, many of the emergent projects, as autonomous cars and generally smart city/home, rely on complex systems and these premises determine high difficulties and challenges to design and optimize them. This way, a special branch, the complexity science (Engineering Resilient Complex Systems), is increasing in the actual context and is expected to improve the solutions for future complex systems. The main roots of actual systems complexity, as difficulty factors to analyse them, are given by their structures of systems of systems and the inherent interconnections, which rise major problems for finding the mathematical models and algorithms useful in the design approach.

As a final conclusion, **for the ICT/IS/KBS sustainable development it is necessary to combine the power of technology advances (first including AI) with new complexity science achievements, under the innovative approaches provided by human intelligence and imagination, in order to obtain the appropriate refined knowledge which should leverage solutions to the actual challenges of Earth ecosystem.**

Keywords: information and communication technology, knowledge generation, artificial intelligence, knowledge based society, Internet latency, democratizing the Internet, quantum computing, silicon spin qubits, complexity science

JEL Classification: L63; L86; M15; O31; O33

“The saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom.”

- Isaac Asimov

1. Advancing Information and Communications Technology everywhere with more intelligence

Sometimes we are marvelling about the performances of individuals in different sports, as often they seem quite impossible, but there are people that think that such trials are not for them, but in the same time there are few which imagine that they could reach similar performances, if there is a determination.

Such dilemmas **inspired** me for a larger view and analysis of the complex ways and mechanisms Information and Communications Technology (ICT) is so amazing advancing, due to the people’s determination.

It is sure that all these ICT advances, including artificial intelligence (AI), Big Data and Data science (DS), by the unprecedented spreading of ICT services, products and applications will be the main support, generating data, information and eventually knowledge, for the Information Society (IS) on the way towards the Knowledge Based Society (KBS) [11][13][16][17][18][20][21].

Just because this way is more and more complicate and also difficult to maintain the exponential pace and the progressive increase of performances, the actual ICT research struggles reflect the necessity of innovative approaches, sometimes **beyond the usual technological paths and resources**, keeping alive the necessity to refine knowledge – as we presented in [12], **in order to achieve a sustainable progress not only for ICT but also for the whole World they are aiming and influencing, by all kinds of consequences.**

We think that it is crucial, from the actual stage of ICT progress, to consider that **beyond the usual** approaches could mean unlimited innovations, sometimes changing paradigm and generally using data/information/knowledge even from unexpected areas, i.e., using outmost results of the human or ... artificial intelligence.

Such large and unusual approach of the research is, by our opinion, **the logical option for keeping the ICT pace and extend performances and features from the actual high levels and facing also unprecedented and complex challenges at Earth scale**, like climate changes, Earth resources fading or ... Covid 19 pandemic. Here it is worth to mention “**the iceberg**” we can actually see as the so called “*semiconductor crisis*” or just imagine scenarios that could follow other potential crises, like geopolitical ones (Ukraine/Russia, China etc).

If someone would say that linking the ICT development context with the above premises or incidents is too much, well one of the paper points is to reveal, by relevant examples, how the mentioned **logical option** is reasonable and why the human imagination is the main resource for extending the actual ICT limits.

In fact, the natural aim of optimizing ICT for **achieve a sustainable progress at Earth scale for IS/KBS**, considering all complex challenges and consequences, leads to **the logical approach of using human imagination and all resources, this way innovating and refining knowledge all the time**, i.e., just what we could witness today and tomorrow.

Considering the unlimited areas or issues which could be part of the innovative solutions for ICT advances, in this paper we just want to point, by some examples, **the tip of this iceberg, meaning at least the perception of this larger picture, from both ICT designer and user perspective, but clearly encouraging the perseverance in optimization, recognizing the crucial importance to this goal for Earth ecosystem and humankind evolution.**

In the same time, this global and holistic approach is inherently a very difficult and complex chain of processes, supposing a relative level of the multi-criteria optimization, as many of the performance parameters and features have no-metric and consequently are not measurable, while the whole picture is fast changing, just because of the ICT exponential development which induce its pace all over the Earth. Here, for example, beyond technical and economical parameters, we might think at informational, environmental, ethical or social criteria (to include just few) to comply.

That is way, going to the roots of knowledge, i.e., from experience and education, the above **inspiration** is deeper and larger explained in [2]:

<<The scope of electrical engineering has been growing continuously through the years, but so too has the depth of complexity and required knowledge across this ever-larger landscape. There are many more highly trained engineers worldwide now than there were a few decades ago, so new applicable knowledge accumulates at a faster pace, while it seems that older, irrelevant knowledge leaves the field more slowly. There is more to know, and it is more demanding and complex.

I took a cursory look, for example, at the mathematics in information theory or the physics in quantum computing or in electronic and optical devices, and I said to myself, “I could do this if I wanted, but I choose not to.”>>

This way, a prominent observation is that the information/knowledge is faster generated and it contain new challenges, including the increasing complexity of knowing.

Here we can also see a face of the above-mentioned approach for both the designer and the user experience perspective, as ICT increasing complexity and on the other hand the perception of the simple human user:

“I remember when engineering seemed much simpler. As I write this, I’m noticing across the room the little blinking node on my Wi-Fi mesh network. Not so long ago AM/FM radios and TVs were the ubiquitous home electronics exploiting the electromagnetic spectrum. Those were the days when radios were just simple devices whose only standardization was the frequency band and a fairly simple modulation scheme. Take a look, though, at the specification for the IEEE 802.11ac family of Wi-Fi transceivers.”

This perspective is useful first for the ICT research (designing) engineer, when studying in the university (depth of complexity and required knowledge across this ever-larger landscape) and then when detailing the design and the specifications, at the actual complexity stage of ICT:

“There are many, many pages of complicated minutiae needed to describe the protocols, controls, signal formats, and so forth. Then, if we dig down deeper, the math for multiuser MIMO (multiple-input, multiple-output) needs to be understood. The encryption is based on elliptic curve cryptography—try checking that out. Everywhere we look at increasing depth, the complication turns to turgid complexity. That is the world we live in now.”

Sometimes I also tell to my students to be aware about the difficulty of ICT profession and especially about the ICT standards and protocols deep and complex content (I proposed a special course of communications networks and protocols, in 1996).

The cruel fact is that anything we could do now, soon in the future it will be too little (*That is the world we live in now*), so we have to further continue to refine knowledge:

“How is it that we can survive and indeed thrive in such a world? The obvious answers are specialization to narrow the field, and the layering of knowledge to reduce complexity to only that needed for a given purpose. In this latter pursuit we are aided by software that empowers the user while hiding the underlying complexity. I think that most engineers seldom will have the need, or the privilege, to examine the complex math and physics beneath so much of what we do.”

This way we have just seen a relevant confirmation of the above **larger and logical approach of using human imagination and all resources.**, i.e., *“the need, or the privilege, to examine the complex math and physics”* that could support knowledge refining for all our innovation processes for a sustainable progress of ICT/IS/KBS.

Starting from such general approach, some relevant examples could give concrete trends of the actual state and vision of ICT development, as premises and context.

Although, for most of people, Internet became a utility like water or electric power, its continue improvement is one of the prominent challenges of ICT, in spite of the impressing performances achieved, as speed, which support amazing applications like videoconferencing or home working.

As a coincidence, COVID-19 pandemic has generated, among other disturbances of life on Earth, changes which amplify some of the Internet existing challenges.

First, we have to observe that this pandemic influence is **a prove of the above mentioned global/holistic approach we have proposed for ICT progress and more than this, it lays in a zone where only an excessive imagination could forecast the evolution.**

As a matter of fact, with or without pandemic, **Internet became a strategic asset for ITC/IS/KBS and generally for life on Earth, as it is the support for most of ICT advances, including Internet of Things (IoT), AI or Cloud services**, but this side is worth to be responsibly and eventually analysed.

It is important to see how the Internet actual challenges could be addressed, at least concerning the most important applications fields, as it is detailed by [1]:

“The internet was designed to move data worldwide, and to do so in spite of disruptions from natural disasters, nuclear attacks, or other catastrophes. At first the goal was just to increase the volume of data moving over networks. But with the rising importance of real-time applications like videoconferencing and online gaming, what now matters most is reducing latency—the time it takes to move data across the network.

By forcing vast numbers of people to work and socialize remotely, the ongoing COVID-19 pandemic has greatly increased the demand for time-sensitive applications. The challenges begin at one end of the network, where the data's sender is located, and continue along the route all the way to the user waiting to receive the data at the other end. When you pass data in real time along multiple routes among a number of separate points, delays and disruptions often ensue. This explains the dropped calls and interruptions in conference calls.”

We have to notice here another example of how far the actual challenges could appear versus the past ones (well, now the above imagination does not seem to be “too much”!), i.e., the initial major criteria, “*disruptions from natural disasters, nuclear attacks, or other catastrophes*”, became surpassed by just the consequences of our “progress” in more complex applications (*videoconferencing and online gaming*), incidentally affected now by pandemic.

Before going further, we believe it is worth to observe that it is a **logical option** to use our imagination beyond any actual apparent limits and especially simply reconsider (refine) knowledge and **ask one more time** if are they all (the above complex applications, like *online gaming*) very necessary, as it is sure **they rise the costs of ICT development** (and beyond!) by many different ways and consequences.

With simpler words, understanding the deepness of these examples, we could wonder if other applications fields, like human and Earth health or people education, should be a priority versus gaming on line (for example), considering the Earth resources fading and the other mentioned challenges?

Of course, such optimization criteria do not mean to stop improving ITC performances or entertainment applications, but it is sure it will be useful to better manage Earth resources and even Internet improvement options, for example as it is further presented:

“One way to minimize such delays is by cutting a path through the Internet, one that takes into account the traffic conditions up ahead. My company, Subspace, has built such a network using custom hardware and a proprietary fiber-optic backbone. And we've shown it doesn't have to be complicated—users don't have to do anything more complicated than logging onto a Web portal. Put together, Subspace has created a “weather map” for the Internet that can spot choppy or stormy parts of the network and work around them for better, faster real-time data movement.”

By coincidence, here we further could observe a two-message issue, one as technical innovation (“*weather map*”) and the other, very well fitted and logically confirming our holistic optimization model proposal, is about priority and eventually *democratizing the Internet*:

“In the 1990s, Internet access was expanded from the world of the military and certain educational organizations to a truly universal system. Then, content delivery networks (CDNs) like Akamai and Cloudflare democratized data caching by putting commonly requested data, such as images and videos, into data centers and servers closer to the “last mile” to the ultimate users. Finally, Amazon, Microsoft, and others built cloud-computing data centers that put artificial intelligence, video editing, and other computationally intensive projects closer to last-mile users. Connections between nodes are designed around delivering as much data as possible, rather than delivering data consistently or with minimal delay.

But there's still one final stage of democratization that hasn't happened—the democratization of the paths through which data is routed. The Internet connects hundreds of millions of nodes, but the actual performance of the paths connecting these nodes varies wildly, even in major cities. Connections between nodes are designed around delivering as much data as possible, rather than delivering data consistently or with minimal delay.”

As a prove of the complexity and inherent relativity of optimization criteria, in this case the priority is expressed, even the balance between applications remains a higher-level decision/criterion:

“For one, the emergence of Netflix and other video-streaming platforms over the past 20 years has tended to impede real-time applications. Because such platforms prioritize putting often-requested data closer to network edges, these networks have become less conducive to latency-sensitive video calls and online games. At the same time, while ISPs have advertised—and provided—faster upload and download speeds over time, established network infrastructures have only become more entrenched.”

Instead, the technical premises for innovation are important and clearly revealed, as the bottle necks are pointed (network edges) and with further analyses the solutions are closer to be found, eventually including the proposed approach as:

“Subspace uses custom software to direct the traffic around any roadblocks that may lie between it and its target destination. In real time, the software takes network measurements of latency (in milliseconds), jitter (in latency variation), and packet loss (in the number of successfully delivered data packets within a time interval) on all possible paths. Whenever there is an unusual or unexpected latency spike—what we like to call “Internet weather”—the software automatically reroutes traffic across the entire network as needed.

Enterprises have tried to avoid bad Internet weather by building private networks using technologies such as SD-WAN (software-defined wide area networking) and MPLS (multiprotocol label switching). However, these methods work only when an entire workforce is reporting to a handful of centralized offices. If large numbers of employees are working from home, each home has to be treated as a branch office, making the logistics too complex and costly. Besides random bad weather, there are some traffic problems on the public Internet that arise as side effects of certain security measures.”.

As a final result, we could notice that, under deep analyses and complex context and criteria, innovations are enabled, even in the most difficult areas, like Internet actual performance improvement, using the power of other ICT advances, like AI (*In real time, the software takes network measurements of latency ... on all possible paths*) in order to globally optimize the network use (*Whenever there is an unusual or unexpected latency spike*).

In addition, the struggle for adapting Internet to the actual and future challenges is a clear link between AI/ICT innovations and refining knowledge for the core of knowledge based society, as it is difficult to imagine the optimization of the huge network of networks at Earth scale, *on all possible paths*, without the expected progress of AI and other ICT advances like Big Data, using the leveraging support of DS [20][19].

Perhaps, even a short review of the most complex and difficult challenges of ICT actual advances will not be enough, still considering the Internet above seen, without some words about Quantum Computing future.

As about complexity and the long way to “*quantum practicality*” we have already spoken [14][12] and recently this is also confirmed by [5] when is specially referring to the main stream of *superconducting qubit*, the *silicon-based* approach could be the long expected faster solution to progress [4]:

<<*Quantum computing may have shown its “supremacy” over classical computing a little over a year ago, but it still has a long way to go. Intel’s director of quantum hardware, Jim Clarke, says that quantum computing will really have arrived when it can do something unique that can change our lives, calling that point “quantum practicality.” Clarke talked to IEEE Spectrum about how he intends to get silicon-based quantum computers ...>>*

This solution could be further shortly simplified for understanding (not forgetting the general complexity that lays behind), as from the dialog of “Spectrum” with “Intel”:

<<*“IEEE Spectrum: Intel seems to have shifted focus from quantum computers that rely on superconducting qubits to ones with silicon spin qubits. Why do you think silicon has the best chance of leading to a useful quantum computer?”*

Jim Clarke: It’s simple for us.... Silicon spin qubits look exactly like a transistor.... The infrastructure is there from a tool-fabrication perspective. We know how to make these transistors. So if you can take a technology like quantum computing and map it to such a ubiquitous technology, then the prospect for developing a quantum computer is much clearer.

I would concede that today silicon spin qubits are not the most advanced quantum computing technology out there. There has been a lot of progress in the last year with superconducting and ion trap qubits. But there are a few more things: A silicon spin qubit is the size of a transistor—which is to say it is roughly 1 million times smaller than a superconducting qubit. So if you take a relatively large superconducting chip, and you say “how do I get to a useful number of qubits, say 1,000 or a million qubits?” all of a sudden you’re dealing with a form factor that is...intimidating. We’re currently making server chips with billions and billions of transistors on them. So if our spin qubit is about the size of a transistor, from a form-factor and energy perspective, we would expect it to scale much better.”>>

Here we can observe the often-used ICT way of compensating complexity by exploiting some of the already achieved technological advances, even when, this way, a compromise must be supposed, but a step ahead is provided:

<< *Spectrum: What are silicon spin qubits and how do they differ from competing technology, such as superconducting qubits and ion trap systems?*

Clarke: In an ion trap you are basically using a laser to manipulate a metal ion through its excited states where the population density of two excited states represents the zero and one of the qubit. In a superconducting circuit, you are creating the electrical version of a nonlinear

LC (inductor-capacitor) oscillator circuit, and you're using the two lowest energy levels of that oscillator circuit as the zero and one of your qubit. You use a microwave pulse to manipulate between the zero and one state.

We do something similar with the spin qubit, but it's a little different. You turn on a transistor, and you have a flow of electrons from one side to another. In a silicon spin qubit, you essentially trap a single electron in your transistor, and then you put the whole thing in a magnetic field [using a superconducting electromagnet in a refrigerator]. This orients the electron to either spin up or spin down. We are essentially using its spin state as the zero and one of the qubit. That would be an individual qubit. Then with very good control, we can get two separated electrons in close proximity and control the amount of interaction between them. And that serves as our two-qubit interaction. So we're basically taking a transistor, operating at the single electron level, getting it in very close proximity to what would amount to another transistor, and then we're controlling the electrons.>>

Of course this detailed analysis could be long continued, as every mentioned operation is a complicate set of critical technological processes, by the essential of this example is the **iceberg tip** image we can observe about this revolution, called Quantum Computing, that is coming, step by step, along with other **emergent AI/ICT advances, which will leverage progress and the refined knowledge for the core of IS/KBS.**

2. The hard ways towards the core of knowledge for sustainable progress

The sadness of Isaac Asimov could be **a start for a deeper analysis of the global consequences of progress, mainly influenced by ICT, either directly by its products, services or applications, but also by the information/knowledge globally generated or enabled.** Considering the huge amount of generated data/information/knowledge, it is crucial to analyse and optimize the ways these could become part of (or support) the core of refined knowledge needed by the IS/KBS.

In fact, we have presented examples [3][12] of how important is to timely watch the exponential evolutions of ICT, as their speed could generate or influence, along with well-known benefic consequences, other challenges for the Earth ecosystem and even for the ways the evolution of humankind is potentially affected, including climate changes, Earth resources fading, social unbalances, human health/education/behaviour, geopolitical security and so on.

Some of these challenges are referring first to the human nature/behaviour, which we also consider crucial for the future of Earth ecosystem, as it is the main factor of innovation and ... decision [7]:

"Today we have mobiles and video calling, but hardly any time to talk with our near and dear ones. We have luxurious houses and bedrooms but we lack peaceful sleep. We stay in wonderful beautiful neighborhoods but we do not know the names of our neighbors. We feel sad that our children are drifting away, yet we never had any time for our parents. We order expensive foods from fine restaurants which are unable to eat and a few blocks away some homeless destitute may be sleeping on an empty stomach.

The irony of our time is that science has made the world shrink to a global village, but the distance between human beings is increasing at a faster rate. Even members of a family

are now becoming strangers. Only true wisdom can liberate humanity from such self-destructive end."

It is easy to observe, even from these simple frustrating examples, that the fundamental role of the human nature and evolution is influencing all other challenges, starting from the pressure of time/speed (which determines the opportunity of reactions to changes) and ending with social unbalances.

On the other side, the role of science and technology for the World progress is by far essential and constructive, but, in the complexity and dynamic of processes of development at Earth scale, all implied factors and consequences must be timely analysed, as it is further pointed:

"Progress of science has always been looked upon with skepticism by many, giving rise to such debates as, whether science is a boon or bane. It is not science and technology that need to be blamed but the vices in human nature, of greed and of the urge to dominate over others.

With the deterioration in human values the world over, while the world becoming a global village, a serious introspection is the need of the hour. Without true wisdom, in our quest for reaching for the planets we shall be losing our souls...

There is a Greek mythological story about Icarus who devised a means to fly by making artificial wings made out of bird feathers and wax. When he flew over the oceans, he was so overtaken by the joy and sense of power of flying that he flew higher and closer to the Sun. The wings stuck together by was melted due to the heat and he fell on the ocean to his death.

This story shows the ambitious and self-centered nature of human beings and their inability to put self-gratification under check."

This way we have just arrived to the most complex and difficult processes of decisions, where the refined knowledge, for the core of KBS, could be generated, but this does not happen always, mainly because of ... human nature.

Here are in fact the most critical processes, because **defining the appropriate "refined knowledge", in such multi-dimensional cases on Earth, meaning a generic model 3D+time+restrictions, is almost impossibility to manage, but this does not mean we have to ignore these challenges.**

Perhaps it could shock, that for these dilemmas, the starting point remains the human value (*With the deterioration in human values the world over...*) and the timely analysis we proposed is also confirmed (*a serious introspection is the need of the hour*).

The necessity of wisdom, versus simply having intelligence (expressed in only applying science and technology to the real problems), as we also expressed many times [9][12], is again confirmed (*Without true wisdom... we shall be losing ...*).

Although almost everybody could agree with the necessity of wisdom, as refined knowledge, in the World development decisions, including AI/ICT/IS/KBS, sometimes the real problem is left at the old/last stage, mainly because it is too difficult to define and solve, which is mostly true.

What we could not accept is to ignore the new potential consequences/problems, as we have to timely analyse the context of AI/ICT/IS/KBS and refine knowledge, even when the dynamic, the speed/time or the incumbents represent obstacles for achieving this goal.

One more confirmation for the mentioned role of human values in these processes is revealed, as a part of the problem difficult premises generated by the above-mentioned human health/education/behaviour, in another approach of Isaac Asimov quote roots [8]:

“The sad truth to this quote, along with all of the quotes from the quote garden website, is that technology is beating us. It is beating us in knowledge, wisdom, tactics, and any kind of information in general. Whenever we seek a question, instead of referring to a book like most people did in the old days, we open up our phones and go to safari and ask google, the almighty know-it-all. Not too long ago students in school had to read books to find out information and go through archive newspapers to find out events that happened in the past. This was a way that not only took longer but also benefitted the students more than we are benefitted today. By reading the books and other materials, the students were able to actually learn and retain the knowledge. In the present day, we look something up on Google, write it down in the space allotted for our homework so that we will get a good grade on it, and we will most likely never think of it again.”

Our opinion is to take from such observations only the useful part, i.e., to recognize the fundamental role of Internet, we just pointed in the first section of this paper, but to identify here just one of the challenges we have mentioned referring to the potential non benefic influence of technology on human behaviour, caused mainly by the mentioned speed and superficiality involved.

We also would add an observation that could be further useful in the emergent trends of home working or online classes, as we have to introduce in these processes (like our university courses on line) elements to compensate the pointed superficiality/easiness induced by the advanced technology, i.e., to keep or improve the attention, the imagination, the thinking and generally the intellectual/creation potential of humankind.

One way toward this goal of keeping our intellect alive and creative (although it is worth to notice that also our physical condition could suffer when too much using TV or computer) is to further ask questions about:

“Science is the study of many things. The study of how the body works, how we are made, how we function, how we learn. It’s the study of how things around us work, how the plants are alive, how they produce energy, why things are the colors that they are, what things are made of. It’s also one of the creators of technology. Without science, we would not have technology today. However, without technology, would we be better off? We so deeply rely on technology for so many things in our lives that some people have the vital question of can we live without it? We rely on it to wake us up in the morning, to make our coffee, to communicate with our friends and coworkers, to get to our jobs and in most cases, technology is our job.”

It is obvious that for such radical question the answer will not be yes/no, as it is clear that the actual humankind life on Earth is highly depending on science and technology and this dependence will naturally increase in the future, as it is further suggested:

“Most people in today’s society go to science in search of wisdom or knowledge. They google symptoms of their illness and suddenly think that they have stage 4 cancer; they google quotes to put on the backgrounds of their high-tech phones to make their day more positive; they text their parents about their day just to feel like they’re doing something good. It’s too rare today that people go to their family members or elderly people that they know in person to communicate. Real wisdom is taught through experience, but science and technology restrict

our experiences because we're too caught up in showing the world how much fun we are having or taking pictures to remember it later; too busy to remember it in the moment. But the real question is, we could not live without it. It may be computers and cell phones, but it is also our emergency programs, medical machines keeping many people alive, and experiments looking to find cures for diseases trying to kill us off."

By our opinion, the actual realistic question is which are the level of dependence, in every case, where we have to worry and ask: what if this support of technology fails one moment?

As we already pointed [9], there are more and more fields and cases where we are depending too much on technology and this relative assertion is relevant for critical infrastructures, as power grid or even communications/Internet.

In fact, the answer is aiming to prevent such events and provide the compensation solutions, i.e., just to refine the core knowledge for such context and contribute this way to the sustainable progress of AI/ICT/IS/KBS.

More than these, many of the emergent projects, as autonomous cars and generally smart city/home, rely on complex systems and these premises determine high difficulties and challenges to design and optimize them.

This way, a special branch, the complexity science (*Engineering Resilient Complex Systems*), is increasing in the actual context and is expected to improve the solutions for future complex systems, as it presented by [10]:

"Engineering systems are designed to specifications. In addition to functional requirements, a system's reliability, failure tolerance, or resilience form an integral part of the design parameters. In principle, a system's resilience should provide it with a capability to preserve its functionality over varying conditions of stress or for uncertainties arising from natural or human interventions [1]. For modern day engineering systems, designing for resilience or testing resilience at the design phase, poses a significant challenge. Due to the interconnectedness and embeddedness of these systems in a nested system of systems [2]–[4], it gets increasingly difficult to adopt the traditional approach of testing a system in isolation for resilience. Here, isolation refers to engaging with stress testing using a restrictive set of predetermined input parameters and system specific conditions [5]."

Here we have to notice the main roots of actual systems complexity, we also mentioned as a difficulty factor to analyse them [9][12], given by their structures of systems of systems and the inherent interconnections (*interconnectedness and embeddedness*), which rise major problems for finding the mathematical models and algorithms useful in the design approach.

Consequently, **for the ICT/IS/KBS sustainable development it is necessary to combine the power of technology advances (first including AI) with new complexity science achievements, under the innovative approaches provided by human intelligence and imagination, in order to obtain the appropriate refined knowledge which should leverage solutions to the actual challenges of Earth ecosystem.**

3. Conclusions

As today it is more and more complicate and also difficult to maintain the exponential pace and the progressive increase of performances, the ICT actual research struggles reflect the

necessity of innovative approaches, sometimes **beyond the usual technological paths and resources**, keeping alive the necessity to refine knowledge – as we presented in [12], **in order to achieve a sustainable progress not only for ICT but also for the whole World they are aiming and influencing, by all kinds of consequences.**

Considering these premises, we think that it is crucial, from the actual stage of ICT progress, to agree that **beyond the usual** approaches could mean unlimited innovations, sometimes changing paradigm and generally using data/information/knowledge even from unexpected areas, i.e., using outmost results of the human or ... artificial intelligence. Such large and unusual approach of the research is, by our opinion, **the logical option for keeping the ICT pace and extend performances and features from the actual high levels and facing also unprecedented and complex challenges at Earth scale**, like climate changes, Earth resources fading or ... Covid 19 pandemic. In fact, the natural aim of optimizing ICT for **achieving a sustainable progress at Earth scale for IS/KBS**, considering all complex challenges and consequences, leads to **the logical approach of using human imagination and all resources, this way innovating and refining knowledge all the time**, i.e., just what we could witness today and tomorrow.

Considering the unlimited areas or issues which could be part of the innovative solutions for ICT advances, in this paper we point, by some examples, just **the tip of this iceberg, meaning at least the perception of this larger picture, from both ICT designer and user perspective, but clearly encouraging the perseverance in optimization, recognizing the crucial importance to this goal for Earth ecosystem and humankind evolution.**

In the same time, this global and holistic approach is inherently a very difficult and complex chain of processes, supposing a relative level of the multi-criteria optimization, as many of the performance parameters and features have no-metric and consequently are not measurable, while the whole picture is fast changing, just because of the ICT exponential development which induce its pace all over the Earth. Here, for example, beyond technical and economical parameters, we might think at informational, environmental, ethical or social criteria (to include just few) to comply.

Going to the roots of knowledge, i.e., from experience and education, the above general approach is detailed by some relevant examples, showing concrete trends of the actual state and vision of ICT development, as premises and context.

This way, considering the evolution of ICT engineering, a prominent conclusion is that the information/knowledge is now faster generated and it contain new challenges, including the increasing complexity of knowing.

As for most of people Internet became a utility like water or electric power, its continue improvement is one of the prominent challenges of ICT, in spite of the impressing performances achieved, as speed, which support amazing applications like videoconferencing or home working. *COVID-19 pandemic has generated*, among other disturbances of life on Earth, changes which amplify some of the Internet existing challenges (the need for lower latency). This pandemic influence is **a prove of the above mentioned global/holistic approach we have proposed for ICT progress and more than this, it lays in a zone where only an excessive imagination could forecast the evolution.**

Anyway, the **Internet became a strategic asset for ITC/IS/KBS and generally for life on Earth, as it is the support for most of ICT advances, including Internet of Things (IoT), AI or Cloud services.**

The **Internet** example (beyond a *weather map for the Internet*) is revealing how far the actual challenges (low latency expectations) could appear versus the past ones (*disruptions from natural disasters*), i.e., the last became surpassed by just the consequences of our “progress” in more complex applications (*videoconferencing and online gaming*), incidentally affected now by pandemic.

Here the conclusion is that it is a **logical option** to use our imagination beyond any actual apparent limits and especially simply reconsider (refine) knowledge and **ask one more time** if are they all (i.e., some complex applications, like *online gaming*) very necessary, as it is sure **they rise the costs of ICT development** (and beyond!) by many different ways and consequences.

Understanding the deepness of these examples, we could wonder if other applications fields, like human and Earth health or people education, should be a priority versus gaming on line (for example), considering the Earth resources fading and the other mentioned challenges? Such optimization criteria do not mean to stop improving ITC performances or entertainment applications, but it is sure they will be useful to better manage Earth resources and even Internet improvement options.

As an important result, we could notice that, under deep analyses and complex context and criteria, innovations are enabled, even in the most difficult areas, like Internet actual performance improvement, using the power of other ICT advances, like AI in order to globally optimize the network use.

In addition, the struggle for adapting Internet to the actual and future challenges is a clear link between AI/ICT innovations and refining knowledge for the core of knowledge based society, as it is difficult to imagine the optimization of the huge network of networks at Earth scale, *on all possible paths*, without the expected progress of AI and other ICT advances like Big Data, using the leveraging support of DS.

From the Quantum Computing example, presenting the advantage of Intel *silicon spin qubits*, we can notice the often-used ICT way of compensating complexity by exploiting some of the already achieved technological advances, even when, this way, a compromise must be supposed, but a step ahead is provided.

Also, the essential of this example is the **iceberg tip** image we can observe about this revolution, called Quantum Computing, that is coming, step by step, along with other **emergent AI/ICT advances, which will leverage progress and the refined knowledge for the core of IS/KBS.**

Such examples confirmed how important it is to timely watch the exponential evolutions of ICT, as their speed could generate or influence, along with well-known benefic consequences, other challenges for the Earth ecosystem and even for the ways the evolution of humankind is potentially affected, including climate changes, Earth resources fading, social unbalances, human health/education/behaviour, geopolitical security and so on.

Some of these challenges, reflected above from relevant examples (**promoting wisdom** when approaching science and technology versus human values, like empathy or solidarity), are referring first to the human nature/behaviour, which we also consider crucial for the future

of Earth ecosystem, as human is the main factor of innovation and decision and this way the fundamental role of the human nature and evolution is influencing all other challenges, starting from the ICT pression of time/speed (which determines the opportunity of reactions to changes) and ending with social unbalances. On the other side, the role of science and technology for the World progress is by far essential and constructive, but, in the complexity and dynamic of processes of development at Earth scale, all implied factors and consequences must be timely analysed.

This way we have just arrived to the most complex and difficult processes of decisions, where the refined knowledge, for the core of KBS, could be generated, but this does not happen always, mainly because of ... human nature. These processes are critical because **defining the appropriate “refined knowledge”, in such multi-dimensional cases on Earth, meaning a generic model 3D+time+restrictions, is almost impossibly to manage, but this does not mean we have to ignore these challenges.**

The necessity of **wisdom** (realistically including human values), versus simply having intelligence (expressed in only applying science and technology to the real problems), as we also expressed many times [9][12], is also confirmed (*Without true wisdom... we shall be losing ...*).

Although almost everybody could agree with the necessity of wisdom, as refined knowledge, in the World development decisions, including AI/ICT/IS/KBS, sometimes the real problem is left at the old/last stage, mainly because it is too difficult to define and solve, which is mostly true. What we could not accept is to ignore the new potential consequences/problems, as we have to timely analyse the context of AI/ICT/IS/KBS and refine knowledge, even when the dynamic, the speed/time or the incumbents represent obstacles for achieving this goal.

As the humankind life on Earth is highly depending on science and technology and this dependence will naturally increase in the future, by our opinion, the actual realistic question is which are the level of dependence, in every case, where we have to worry and ask: what if this support of technology fails one moment?

As we already pointed [9], there are more and more fields and cases where we are depending too much on technology and this relative assertion is relevant for critical infrastructures, as power grid or even communications/Internet. In fact, the answer is aiming to prevent such events and provide the compensation solutions, i.e., just to refine the core knowledge for such context and contribute this way to the sustainable progress of AI/ICT/IS/KBS.

More than these, many of the emergent projects, as autonomous cars and generally smart city/home, rely on complex systems and these premises determine high difficulties and challenges to design and optimize them. This way, a special branch, the complexity science (*Engineering Resilient Complex Systems*), is increasing in the actual context and is expected to improve the solutions for future complex systems as it presented by [10].

Here we have to notice the main roots of actual systems complexity, we also mentioned as a difficulty factor to analyse them [9][12], given by their structures of systems of systems and the inherent interconnections (*interconnectedness and embeddedness*), which rise major problems for finding the mathematical models and algorithms useful in the design approach.

As a final conclusion, **for the ICT/IS/KBS sustainable development it is necessary to combine the power of technology advances (first including AI) with new complexity**

science achievements, under the innovative approaches provided by human intelligence and imagination, in order to obtain the appropriate refined knowledge which should leverage solutions to the actual challenges of Earth ecosystem.

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