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A NEW CONCEPTUAL FRAMEWORK TO PREVENT TECHNOLITARIAN FUTURES

Abstract: This contribution explores in a provocative way the shortcomings of our current understanding of Science and Technology (S&T) and their role in modern, complex societies. It identifies some social blind spots which seem to be key in preventing the emergence of a new framework of interpretation, required to ensure that the extraordinary achievements of further S&T could be exploited for the common good of humanity, life and the planet at large.

INTRODUCTION

Although ignored by the mainstream currents of our societal thinking and behavior, alarms have been raised since a very long time about the challenges that humankind is facing as a consequence of its own actions and development. Those alarms trace back at least to Robert Malthus at the end of the 18th century and received a strong impulse in the 60 s and 70 s of past century, due to research promoted by the Club of Rome and other farsighted institutions and individuals ([16], [23]).

Nowadays, the awareness about the challenges and risks of our civilization is certainly higher than ever: issues such as the deepening of social inequalities, the over-exploitation of resources, the loss of biodiversity, and diverse forms of pollution and large-scale climate destabilization, to name just a few, are mentioned explicitly in the public agendas. In this context, it is taken for granted that Science and Technology (S&T) are key to find social and technical solutions to those and other dramatic challenges.

This of course is a strong paradox, since S&T have been indeniably not only central elements of the development model followed by human societies in the last two centuries, but often (and still today) very effective instruments used for mass destruction, environmental degradation and social exclusion. This paradox (S&T as part of the problem and as core of the solution) is grounded in some implicit assumptions, namely that the evolution of human societies is mainly driven by tech-

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nological change and that S&T are essentially beneficial and neutral with respect to their practical applications, which depend on human decisions.

Although increasing human knowledge may certainly be a source of benefits for humankind, it can be argued that the processes and rules through which scientific discoveries and technological innovations are promoted and produced are not neutral at all, but rather reflect a particular organization of society and therefore embody certain values and interests, explicit or not, which of course have a strong impact on the outcomes of S&T activities. This paper explores in a provocative way some of the issues around the challenge of ensuring that S&T produce benefits for humanity and its sustainability.

THE ILLUSION OF TECHNOLOGY

Technological innovation is the „deus ex machina" invoked to solve all challenges. In many senses we praise science and technology today as much as we revered ancient gods. We consider them to be the source of modern truth, since scientific knowledge is labelled with the prestige of objectivity and neutrality per se. And science and technology (S&T) feed our dreams since their secular success has made feasible many crazy wishes of human imagination, like flying, travelling to the outer space or chatting with other people wherever they could be on the planet. Not least, precisely because of that success, we easily extrapolate the future of S&T to bring us omnipotence, an infinite capacity to break the physical limits which restrain us and, who knows, even that of time and death.

In other words, the wonders made possible by S&T in the last centuries are not enough, we add to them an extra layer of enthusiasm which goes much beyond their actual capacity. All the technological miracles we take now for granted have required huge efforts, a lot of patience, large investments over long periods and a good amount of serendipity. And, most important, they are based not on breaking the physical limits but on better understanding them and finding ways to build on our limitations: we do not fly by ourselves as birds, we mobilize our knowledge and resources to create artifacts which transport us in the air while still respecting physical laws. Of course this is an extraordinary achievement but it is bounded by reality, something we easily forget.

Somehow we deal with the rationality of S&T in an irrational, almost religious way, which is nothing but the expression of our emotional nature. We are driven by a complex perception of reality and so many times by our fears, and we need some kind of belief. For three centuries the driving belief has been in the progress of humanity, of course reinforced by the success of S&T. But, while for generations born before the 1980 s changing the world for the better would require also (or primarily) political and social innovations, now it seems that S&T has even displaced every other source of hope. The launching of the latest digital artifact creates a widespread frenziness, but also a true and exciting entrepreneurial spirit is mobilized by the potential of technologies to address human challenges. In a sense, we put *S&T at the core of societal evolution*, or to say the least we do not conceive any transfor-

mation without them playing a significant role, and this is also why we think they should rescue us from all disasters, even those provoked by ourselves.

This is ironical, since science and technology (S&T) have been not only central to the development model followed by human societies in the last centuries but often (still today) very effective instruments of mass destruction, environmental degradation and social exclusion. *S&T have been definitely part of the problem*, a key component of our model of economic development, and not only an exogenous factor as considered by mainstream economics, which anyway recognize their crucial role to improve productivity and sustain long-term growth. But they are also deeemed to be the core of the solution, a paradoxical vision grounded in the mentioned beliefs, and in the idea that finding a technical fix is a good way to avoid the less comfortable question of how power and wealth are distributed in society and with what consequences.

Of course, the essential role of S&T cannot be denied. On the contrary, in their capacity to shape human perceptions their role is even greater than their actual abilities to change our relationship to nature. But are not we being unrealistic in expecting them to solve every relevant challenge?

FACING THE CHALLENGES

Let us have a quick look at how S&T are used, intentionally or not, in human responses to some of the large-scale challenges that we face today: global governance, economic growth, social inequality and environmental challenges.

Regarding governance, let us recognize first that there is a strong historical record to state that one of the primary uses of S&T (and in many cases the driver itself of their development) has been their capacity to provide more effective instruments of destruction to fight wars against other humans. Is it so different today? Could we ensure that further S&T developments are building up peace and preventing wars?

Of course the answer is complex and mixed, but the latest technologies have definitely been used to redefine warfare in a double way: by limiting almost to zero the losses of tech-savvy armies (to conciliate public opinions in Western countries), and by pretending a high precision in killing only the „bad guys". But instead of deterrence of wars, the effect has been to relegitimate them after the fiasco of Vietnam (and actually that was the political intention). So, has this been good to build up a peaceful global governance or rather a sure bet for further violence and destabilization?

Also, along with deep demographic trends like the progress of literacy and the change in status of women, S&T have contributed to make people more autonomous and more connected, and therefore to increase the complexity and uncertainty of our societies: now, everybody could be the initiator of a trend of worldwide impact, and we are getting farther and farther away of what could be a „controllable system" [19]. That could be good news, and in a boast of technnological optimism we could even imagine that this would bring us to a new era of planetary „collective intelligence" ([1], [24], [28]) but for the time being this is still just an as-

piration and not yet an effective tool of governance. It is pretty clear that S&T could contribute to build new, higher ways of governance but this would require both a re-examination of their role and a long road of collective learning.

Regarding economic growth, mainstream economics expects S&T to deliver „external" shocks in order to produce high growth rates which are needed to keep the system running, but is that what really happened in the last decades? This is a controversial topic, and different types of evidence could be found, but it seems pretty clear that S&T, and in particular information and communication technologies (ICT), have been central to the ultra-sophisticated financialization of the economy and the artificial, debt-driven growth model in which we have been living. Further progress in S&T is now subject to an *endless stream of speculative bubbles* on financial markets [20]. Their logic is short-term obsession, to cash in now on future and fully uncertain realizations of innovative ideas, which is a good recipe for inflating an already huge amount of fictitious capital and actually preventing that enough investments are made at the right pace over enough time to ensure that the benefits of S&T are reaped for the common good. S&T could be part of a sustainable model of development but not in the way their relationship with the economy works today.

Regarding social inequalities, the role of S&T is definitely ambiguous. Yes, the benefits of knowledge can be distributed evenly, but they can also be used to concentrate more power and wealth in few hands. This is what typically happens in activities with high network externalities, like software business or the commercial exploitation of telecommunications and the internet, and so are created private monopolies like Microsoft, Google or Facebook. And last but not least, S&T will certainly be fundamental to address the environmental challenges but today this is not what we are using them for, or only in a marginal way. Instead, they are used to produce a continuous flow of new and more things, in disregard of the many environmental threats this creates. Our culture praises innovation, a magic word omnipresent in our mass media, but it generally translates to a high-speed consumerist stream of instantly obsolete artifacts for which we put in danger the supply of rare earth minerals [29] while it is the fuel of wars being fought in Africa. And on a larger scale, we consistently ignored over the last decades the opportunity to increase resource productivity [30], because our policies ensured that wasting nonrenewable resources imported from the other side of Earth makes more economic sense than using the potential of local labour.

FRAMING S&T IN SOCIETY

All in all, increasing our knowledge and applying it into new artifacts have for sure a strong potential to benefit humankind, but the processes and rules through which scientific discoveries and technological innovations are promoted and produced are not neutral at all. It is legitimate to ask on which factors does it depend that S&T could contribute *to overcome or to aggravate the challenges* we face [18]. Of course this question has much to do with the key players in the domains of scientific research and technological innovation. Under the dominant view of who should have the leading role in the evolution of society, we almost forgot that the state has

been the most consistent player in research and innovation, with a unique capability to mobilize and orient public and private efforts through its multi-faceted capacities: as the nᵒ 1 client in every country and as such able to drive large-scale innovative demand, as the regulator pushing companies to invest heavily in R&D effort (f. i. in pharma and biotech sectors) and, not the least, as an entrepreneur able to bear the burden of uncertainty and long-term planning much better than private corporations [15]. In the last decades we have been unlearning this historical experience and vision acquired in the second half of 20th century [5] which was so successful in the USA and other countries to produce a long-term gigantic leap forward.

As a consequence of relying more and more on private initiatives, the agenda of S&T itself is deeply changed. While the public agendas of research and innovation include „societal challenges" as part of their targets (as f. i. in the Horizon 2020 programme of the European Union), most of the innovation really happening is driven not by the type of concerns exposed above, but by the existence or not of short-term profitable demand which businesses could exploit (as is coherent with their logic). And if the demand does not exist yet, it is created by bubbles of speculative investments and the pressure of fashion.

In this context, a very specific role is being played by ICT, for most simply a synonym of „technology", the paradigm since the 1980 s of technological innovation „changing the world". No doubt, their impact is huge, but do we fully understand it? And do we harness it for the common good? Nothing is less sure. The digital industry is brilliant in producing a succession of fast-moving *rhetoric waves* which are tuned to our most irrational beliefs in the omnipotence of S&T. For instance, intangibility and dematerialization are used as a call to get free from limits, as is implicit in terms like „zero cost" or the „cloud", while this is made of huge material infrastructures and, of course, we still are physical beings living in a physical (and finite) planet with physical costs. A different, real kind of dematerialization should certainly happen, enabling human development to be free from the accumulation of material artifacts, but this is not what the digital industry is doing.

And the disruptive power of digital technologies is often used as well to change the social fabric by pretending a capacity to reduce costs (cf the illusion of „zero marginal costs") while they actually change the structure of prices, i. e. the distribution of power. So for instance taxi drivers, presented as if they were abusing of a monopolistic position, are in risk of dispossession by Uber, which intends to avoid the full costs of transport (including social charges and the fulfilment of public regulations) in order to create a new brand, not a publicly owned service but, this time for good, a private monopoly. Yes, the „sharing economy" could be real and full of hope for humanity [12], but using that label as a mechanism to create capital accumulation in monopolistic hands is simply a false metaphor and a fraud.

Moreover, digital innovation is increasingly focused on the *disposability of humans*, on replacing them by automated machines, potentially threatening every single job on Earth, skilled or not, up to that of President of the USA for which the IBM Watson software has been proposed, and the campaign is not a joke. Even analysts of stock markets are at risk of being replaced by automated machines in the ultimate self-devouring pirouette of financial capitalism [21], pointing to the true

dystopia of a world owned by the happy few and operated by machines, while the 99% of us would have to struggle for the crumbs. Instead of falling into the messianic *illusion of „digital solutionism"*, we should pay serious attention to how it is practiced today and to its contingent nature ([14], [17]), since it could pave the way to full dehumanization, „technolitarian" futures in which human and environmental purposes would be secondary to the logic of technological innovation. „Transhumanism" and the quest for „singularity" are examples of an arrogant techno-utopianism full of metaphoric promises which are just vaguely related (or not at all) to the challenges mentioned above and could instead aggravate the risks of collapse.

When facing this contradiction between the potential benefits of innovation for humanity and its practical outcomes, one cannot help remembering TS Eliot, as he asked almost a century ago where is the knowledge lost in so much information and, worse, where is the wisdom lost in so much knowledge. Drowned as we are by an endless deluge of gossip, our minds get lost in the „trending topics" of the day and thinking in perspective becomes extremely difficult: if we connect to everyday reality we are not able to think; if we disconnect from it, will our thinking be valuable or even heard? Of course alternative thinking exists and is probably richer and stronger than ever but we do not pay much attention to it. We live in a constantly accelerated time [25] and we are not so interested in learning relevant knowledge when it is contrarian to the high-speed mainstream. Conversely, we are able to unlearn easily some wise lessons acquired at high cost in the past (f. i. that of a strong regulation of financial markets). And while the active participation of stakeholders (actually, the whole planet) would be key to reap the benefits of S&T for the common good in an „innovation democracy" [27], we look at what happens as if it was a show. Debord was right, we live in the „société du spectacle" and thus in a *gridlock of thinking*, in which our lives are entertained as much as to block genuine humanity [22] and to avoid a real impact of modern art and creation on our conformist mass-media culture.

The combination of scientific knowledge and technological sharpness has a strong generative capacity, which could lead either to old-fashioned accumulation in very few hands or to the emergence of vibrant ecosystems for the benefit of sustainability and diversity of humankind. But right now innovation is obsessed with speculation, not driven by societal challenges, focused on „solutionism" rather than on specific contexts and produced without the stakeholders. So, we cannot take for granted that it will drive our course away from socio-ecological disasters. It could be (it is right now) doing the opposite. Overcoming this situation requires making explicit the processes, rules and motivations driving S&T, as an expression of our social organization, and developing the appropriate conceptual framework and criteria to assess the relevance of new inventions for the course of humanity.

A COMPLEX VIEW OF SOCIETY AND ITS BLIND SPOTS

Society is a complex system of systems in which a multitude of autonomous agents, individuals and organizations, play a central role. It is always evolving, and its evolution depends on how people live and dream for them and their children,

how they are inspired and motivated, how they perceive and grasp opportunities of fulfilment and how they deal with the frustration of hard presents and uncertain futures. Neither human society nor any of its parts can be reduced to a mechanistic artifact with well-defined boundaries: they are but parts of a much more complex living system, whose meaning and purpose, yet to be resolved, may be just the persistence of life itself. And do we know enough about life to be sure that we are not destroying the very conditions of its human variant?

The more we know, the less we know. Scientific discoveries often provoke dramatic changes in the foundations of what we thought we knew. Suddenly we discover that plants have mechanisms enabling them to communicate and learn [2]. And now we know that we have a „second brain" in our stomach, hundreds of millions of neurons active in our guts amid billions of bacteria which not only do the digestive work but influence our moods and perceptions [9]. What we call the „brain" is not a biological equivalent of the central processing unit of our computers, but an extremely complex network of networks fully intertwined with our corporal ecosystem and beyond, thru the zillions of sensors which make us perceptive of our environment. Dualism, our reductionist view of mind and body, is dead for good. But now that we are getting more and more aware of the complexity of life, and of the amplitude of our ignorance, how could we claim that we live in the „knowledge society", or that we will reach it by using the current conceptual frameworks, or even that we are able to act in a way consistent with the degree of knowledge we think we have?

The more we know, the less we know. Our world is becoming more predictable and less predictable, at the same time. On one side our advances help to have a better understanding of partial phenomena and to produce sophisticated artifacts, which we design to be effective and predictable (although we succeed less and less in that). And at the same time the outcomes of our actions make the world more difficult to apprehend: the societal dynamics produce more autonomy for individuals, groups and organizations of many kinds, and the connections between them do nothing but grow. Autonomy and connections are what makes society a complex system that is much more than the sum of its parts, and as such also truly, intrinsically unpredictable, even more when we destabilize our environment beyond what it can deliver in a sustainable way. The balance between both trends, towards predictability and the opposite, is pretty obious. We who hate uncertainty, we actually excel in producing more and more uncertainty on a massive scale. As a result of our dreams coming true, we live in a small world in which the distant flap of a butterfly can produce a tornado next door, in which details and macro-behaviors are connected and the center of the world is everywhere. The more we know and act, the more uncertain is our future.

The more we know and act, the less we are able to understand and control. Fortunately, this also brings the opportunity of unexpected emergent behaviors, of new capabilities of self-organization for the sake of life [11]. And it could create as well the feeling that we are all together, of any origin, language or color of skin, in the same adventure, and that the best ideas may come, why not, from a remote place in Africa, where the whole story began. But who could ensure that our course

will be happy? How could we think and work for a better future? How could we pursue any kind of relevant reflection about life, society and the future?

We could try to assume the gap between our anxiety to control and the fact that living systems are complex, autonomous, self-referring and self-constructing, but not controllable. And who said anyway that life should or could be controlled? We are emotional beings, in spite of consciousness we do not control our intelligence, which for the most of it is unconscious. Modern neuroscientists have at last redis-covered what poets know since the beginning of times: that we do not take any de-cision without emotions, that emotions are an integral, irreducible part of what we call intelligence [7]. But again, if the behavior of our social systems relies on human intelligence and most of it is unconscious, how could we consciously work for a bet-ter future? Let us try a crude extrapolation, the crazy hypothesis that we have *social blind spots*, which respond to deep emotions widely shared and could create, when facing the contradictions of life, the kind of hysterical behaviour which could drive us to collapse, in spite of our high degree of achievements in S&T.

Let us dare to name some of those blind spots on which we build our societal systems.

Fantasy of exclusion, denial of bonds. There is a subtle but critical difference be-tween distinction and exclusion, which we override all the time. The first princi-ple of social organization is still to establish who are „Us" and „Them". Heritage is still based on kinship, and we indulge ourselves with the concept of the individual as a microcosm, while alone we are strictly nothing. But of course this is useful to ground a moral superiority of „Us" over „Them" and to build up artificial bound-aries, on which we practice zero-sum games, avoiding responsibility and recogni-tion of unpaid labor and ecological externalities, on which ultimately we base ex-ploitation of the many weak by the few strong, of helpless natural resources, of fu-ture time as the scarcest resource.

Fantasy of omnipotence, denial of limitations. Again, there is a subtle but crit-ical difference between inquiring into our limitations and ignoring them, it is the difference which separates art and science, on one side, and the bulimia of instant consumerism and void entertainment to death. While in our natural instincts for drink, food, sex and fertility, sufficiency is the rule (and excess is a sign of disor-der), we are insatiable in looking for material gratification at a growing speed and we feed with it our weird dreams of unlimited growth, control over the universe and insane eternity.

Fantasy of measurability, denial of complexity. The obsessive act of measuring embodies our values much better than our public discourse. When we strive to translate everything into quantitative figures, we forget that life at large but also the value of ecosystems or the performance of human organizations are complex, diverse, infinite-dimensional realities, so that they are not commensurable with a scalar, one-dimensional magnitude, whatever it is. In spite of that, we try to reduce the value of companies or the ecological impact of our actions to money, and the welfare of nations to GDP. Somehow, we have not yet abandoned the habits of slav-ery, when we used to do the same with humans.

Fantasy of capital, denial of potential. A prosperous future is of course built on the best we can get from past generations, infrastructures and resources, and especially the non-computable: cultural and artistic heritage, scientific knowledge, institutions and „social capital". But at a point capital can disconnect from the productive economy and from reality itself, when it becomes a pure abstraction in computerized systems where it reproduces itself in a fictitious way without the backing of any human labor creating authentic value. At that point we start taking for granted that the past should have greater rights than the future, because the yields of fictitious capital absorb more and more resources and finally inhibit the potential for further progress, until overwhelming debt is simply repudiated, as it happens once and again.

Fantasy of power, denial of learning. Entitled by tradition or as a reward to the heterogeneous distribution of skills and capacities, we accept the existence of inequalities and hierarchies, and the right of a minority of people to take decisions on behalf of the rest, even in the most democratic of regimes. In many senses this is a practical solution to organize societies, until power forgets the contingent nature of its position, originated in history and certainly some capacity and tenacity but also pure chance, and maitains itself over time through self-preservation and inheritance. At that point, power becomes „the ability not to have to learn anything" [26].

Fantasy of certainty, denial of time. Our imagination is the most powerful of tools but when coupled with fear, it makes us hate the uncertainty of future, as much as we avoid the certainty of our own death. So it is no surprise if we appreciate so much the determinism of classical mechanics and its capacity to predict, which we would like to imitate in every other discipline, and in particular in economics. And looking for relief we implicitly assume, as a social taboo of our time, that money cannot lose value, that it has a natural right to reproduce itself whatever happens to society, whereas the second law of thermodynamics ensures that value does nothing but erode with time, unless we learn and work to create new possibilities.

Needless to say, the understanding of distinctions, the impetus to overcome (not override) our limitations, the capacity to measure, the accumulation of useful assets, the organisation of society and the will to create some certainties are valuable drives without which social life would simply be a nightmare. But they easily fall into the blind spots we have described because these are deeply rooted in our many fears, the fear of pain and hardship, the fear of loneliness and irrelevance and of course the ultimate one, „the fear to rule them all and in the darkness bind them", that of our sure death. We feel that we are increasing the contradictions between our human drive and the future of life as a whole, on a planet whose biophysical limits have been reached, whose climatic stability is endangered by human activity, whose living and mineral resources are being exhausted at great pace, all of that without eliminating human hardship. And afraid as we are of this permanent conflict with the world, we invent self-delusions to alleviate our fears. We observe social status and practice individual accumulation to protect ourselves not from need but mainly from the feeling of personal irrelevance and the anxieties we face everyday in our eternal quest for meaning. And we rely on S&T to imagine a future of omnipotence where all challenges would be solved. Is that the right response to our fears?

FOUNDATIONS OF A NEW FRAMEWORK

We cannot take for granted that S&T will necessarily drive our course away from socio-ecological disasters. On the contrary, as they are mainly practiced today, they could pave the way to „technolitarian futures" in which human and environmental purposes will be secondary to the fulfillment of the current logic of technological innovation. „Digital solutionism", „transhumanism" and the quest for „singularity" are just examples of a techno-utopianism full of metaphoric promises which is not connected properly (or not at all) to the challenges mentioned above and could instead aggravate the risks of collapse. In view of the simultaneous growth of inequalities and unsustainabilities in the last decades, who could ensure that S&T developments will prevent a dystopia like that of the movie „Elysium" [4]?

Overcoming this situation requires building a different conceptual framework, starting by recognizing that we live in a *complex system of systems* which pertains to the domain of „post-normal science" [8], which means that *uncertainty* about the future is not a limitation of our knowledge but an intrinsic and irreducible characteristic we cannot escape (fortunately). And the challenges we face to avoid collapse are themselves complex, multidimensional and incommensurable and they need new ways of coordination, involving all kinds and dimensions of human intelligence, both individual and collective. For that we need the holistic paradigms of 21st century science [10], in order to acquire a higher level of consciousness. Our proposal is that new processes have to be created to assess the role of S&T in society in a participatory way, driven by true societal challenges and with the active involvement of all stakeholders, to address the impact of S&T in the most comprehensive way, not only for citizens but also for living beings and the planet at large.

In order to do so, the social blind spots mentioned above have to be taken into account. The way out of them is still unknown, „one makes the way by walking", but some principles and rules can be proposed to illuminate how to advance step by step. One is that, at the level of complexity of societal life, ontology (what things are), epistemology (how we understand them) and ethics (how they should be) are not separate but inevitably entangled [13]. Another principle relevant for the future of S&T could be that of *Material Sufficiency and Exuberant Creativity,* which is exactly what life teaches. Instead of dreaming with omnipotence and applying innovation to produce more artifacts, we could realize there is one unlimited game to which we can direct our human drive in harmony with the environment, that of learning and experiencing together in the infinite variety of disciplines of knowledge, of sports and crafts, of art and science, of beauty and truth. Unleashing human potential is another way of ensuring the universal right to beauty while avoiding burning the planet. And if we were able to transform education away from reproducing social hierarchies and selecting narrow elites towards the realization that everybody has the same right and obligation to achieve personal fulfilment, it could lead us to a *World of Symmathesies,* to use a term recently invented to think beyond individuality and exclusion, to emphasize that there is no difference

between living and learning, that we are always experiencing contextual mutual learning through interactions [3].

Of course that would be part of a bold claim, that of *Opening the Space of Possibilities.* Instead of suffering from our limitations, we should realize that what binds us to others, human or not, is also what makes us free, what opens new possibilities for desirable futures [6]. The obligation to do good is not separate from recognizing the complexity of life and our connection to every other part of the universe, exactly the contrary of exciting the bulimia of individualism which is so frequently associated to modern innovation. These could be some of the starting points to rethink the role of S&T in society and to ensure that, out of the many gridlocks into which we are entangled today, we could bifurcate towards more holism and richness, co-creating with citizens of all over the world, through a combination of top-down, bottom-up and cross-generational approaches without which no future will be desirable.

CONCLUSION

The paradox is that while we praise so much, and for good reasons, the achievements of science and technology, their role in society is definitely ambiguous, due to the same blind spots which drive our perception of what societal life is. In view of the challenges we face, most of them created by ourselves, we are entitled to ask if we understand that there is no difference between living and learning, if we are not committing suicide of the human species at the same time that we destroy many others, and in the end, if bacteria are not more resilient and therefore more intelligent than humans. To give hopeful answers to these questions, the processes, roles and outcomes of S&T have to be fundamentally reassessed, to ensure that societal evolution continues towards desirable futures.

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