



Global Transformative Leadership in the 21st Century: A Science, Engineering, Technology Integrated and Strategic Perspective

**Rodolfo A. Fiorini, Carlos Alvarez-Pereira, Garry Jacobs, Donato Kiniger-Passigli,
Alberto Zucconi, Nebojša Nešković, Herwig Schopper, Vojislav Mitic,
Hazel Henderson, Mariana Todorova, Witold Kinsner & Luigi Cocchiarella**

Abstract

The goal of this paper is to focus on the Global Leadership Challenge in the 21st Century with an integrated and strategic perspective in science, engineering and technology (SET). "In any crisis, leaders have two equally important responsibilities: solve the immediate problem and keep it from happening again. The COVID-19 pandemic is a case in point. We need to save lives now while also improving the way we respond to outbreaks in general. The first point is more pressing, but the second has crucial long-term consequences," according to Bill Gates. What is happening is a vivid example of a global "tipping event", in which multiple social systems flip simultaneously to a distinctly new state. A global arbitrary multiscale systems science (GAMSS) perspective might create the required knowledge and paradigm shift in thinking.

The SARS CoV-2 virus seems well-tuned to exploit the specific characteristics of the world we have created for ourselves, with our massive population tightly linked together by air travel and marked by brutal inequalities in health care and physical wellbeing. We treat others as we treat the Earth. Two key factors, high connectivity and high uniformity, together leave us increasingly vulnerable to global tipping events, in which shocks propagate like a row of dominoes falling over. Human life cannot be wholly understood in terms of generalizations and statistics only, we need to take fully into account the role of conscious individuality in human affairs. Nevertheless, one can determine under what conditions systems are prone to cascading effects. Moreover, weak system components can be used to produce early warning signals. If safety precautions are lacking, however, spontaneous cascades might be unstoppable and become catastrophic. In other words, statistical predictability and controllability are a matter of proper systems design and operation.

In fact, cascading changes in our global social systems do not always have to be so pernicious like COVID-19. Some might be virtuous, and it is here that we can glimpse those silver linings. Today's emerging pandemic could help catalyze an urgently needed tipping event in humanity's trust, collective moral values, priorities and sense of self and community. We are one step away from the abysmal catastrophe humanity can avert. Sri Aurobindo depicts human social evolution as a progressive dance between rising levels of consciousness and rising levels of organization. "Life evolves through growth of consciousness. Consciousness

evolves through greater organization and perfection of life: a greater consciousness means a greater life.”

Nevertheless, some current responses to COVID-19 based on existing policies and methods threaten to undermine democracy and human rights, underlining the absence of human-centred attitudes. Therefore, a new human-centred paradigm is essential. Its realization will require the commitment and active involvement of all of us. “Because we all share this small planet Earth, we have to learn to live in harmony and peace with each other and with Nature. This is not just a dream, but a necessity,” according to Tenzin Gyatso, the 14th Dalai Lama.

1. Introduction

The current situation of the worldwide coronavirus outbreak has brought new concerns surrounding government ethics to the table, as citizens are posed with dilemmas related to the government’s role in their daily lives. Although the pandemic is impacting every part of society, there are dilemmas that are especially prominent in the minds of members of Generation Z (WKGE, 2020) as they embark on a transitional period in their lives. The impacts of this pandemic are expected to have lasting marks on their lives, especially as many enter the workforce and adulthood.

Nevertheless, individuals have within themselves vast resources for self-understanding and for changing their self-conceptions, basic attitudes and self-directed behavior, and these resources can be tapped if a climate of facilitative psychological conditions is provided. This is the basic assumption of the Person-centered Approach Institute (Zucconi, 2015). As an example, in Italy, Limbix Italia gave virtual reality (VR) headsets to Schiavonia COVID Hospital (Monselice, Veneto Region, Italy) in an attempt to improve the psychological and emotional wellbeing of its staff. The VR hardware uses visualization and guided breathing techniques to reduce stress and anxiety (LeDoux, 2015) in healthcare workers to support staff working long shifts treating patients suffering from coronavirus.

The current global pandemic threatens us all, without distinctions of race, culture or gender, and our response must be as one humanity, providing for the most essential needs of all. The world today will never again be as it was just a few months ago. The social structure of our world has already changed, and a major economic crisis is looming. In addition, COVID-19 (WKCO, 2020) has had a significant psychological impact. The world that emerges from the coronavirus pandemic may be a warring collection of countries that are more closed off and nationalistic than before.

At least for now, heavy-handed nationalist responses predominate. Division and fragmentation of reality are still the governing rules and “modus operandi” in the social sciences. Alongside curfews, lockdowns, and requisitioning, governments are closing borders and using wartime rhetoric to rally their populations. Global supply chains and trade are being disrupted not just by lockdowns, but also by wealthy countries’ competition for supplies. The most recent event of this kind was the 2008-09 financial crisis. The warning example, the loss of trillions of dollars in the stock markets during the financial crisis, was

largely caused by a loss of trust. It marked an abrupt shift in the world economy from a state of relatively high growth and modest inflation to a new state of much lower growth flirting with deflation. The world economy never returned to its pre-2008 state. But without rapid and effective global cooperation, the world may not exit this crisis safely at all (Jacobs & Ramanathan, 2020).

Recent developments in the area of digital technologies, especially concerning big data, artificial intelligence (AI) and the digital transformation, have generated a wide debate about the social, ethical and political implications of these changes. Many international organizations, professional groups and governments are promoting reflection on these changes with a view to ensuring that they serve the good of all human beings. Acknowledging the importance of these issues, and based on Pope Francis' encouragement to find new ways of dialoguing about how we are shaping the future of our planet (*Laudato Si'*, 14, 2015), the Dicastery for Promoting Integral Human Development (DPIHD) and the Pontifical Council for Culture (PCC) organised a seminar of experts to foster an in-depth debate on the topic of the common good in the digital age. Scientists, leaders in industry and labor, government officials and humanitarians gathered in the Vatican at the end of September 2019 for a three-day conference titled "The Common Good in the Digital Age".

The goal of the conference was to reflect on how the tremendous advances of science, engineering and technology (SET) can move beyond being used mainly for profit to serve the good of all human beings. "Humanity has entered a new era in which our technical prowess has brought us to a crossroads," says Pope Francis in *Laudato Si'*, 102 (2015). "Technoscience, when well directed, can produce important means of improving the quality of human life . . . It can also produce art and enable men and women immersed in the material world to 'leap' into the world of beauty" (Pope Francis, *Laudato Si'*, 103).

At the same time, though, ethical and moral judgments have not made similar leaps. "The economy accepts every advance in technology with a view to profit, without concern for its potentially negative impact on human beings," says the Pope (Pope Francis, *Laudato Si'*, 109, 2015). Conference-goers discussed the ethical jump needed so that technology can serve the common good of all. Discussions ranged from AI, machine learning, cybersecurity, drones, nuclear weapons and effects of automation on the workforce.

On Friday, February 28, 2020, at the conclusion of the Vatican workshop titled "A Human-Centric Artificial Intelligence", the Pontifical Academy for Life, Microsoft, IBM, the United Nations Food and Agriculture Organization (FAO) and the Italian government signed the "The Rome Call for AI Ethics", a document developed to support an ethical approach to Artificial Intelligence (AI) and promote a sense of responsibility among organizations, governments and institutions with the aim to create a future in which digital innovation and technological progress serve human genius and creativity (De Giacomo & Fiorini, 2015) and not their gradual replacement (RCAIE, 2020).

The complexity of the technological world demands an increasingly clear ethical framework, so as to honor our commitment to serve every individual without discrimination or exclusion. This can only become truly effective through collective intelligence and

collaborative innovation. (Fiorini, 2020). In the encounter between different visions of the world, human rights are an important point of convergence in the search for common ground. The “good algorithm” points to the need for renewed reflection on ethics, rights, and duties in the science, engineering, and technology (SET) areas.

Technology ethics is the application of ethical thinking to the practical concerns of technology. The reason technology ethics is growing in prominence is that new technologies give us more power to act, which means that we have to make choices we did not have to make before. While in the past our actions were involuntarily constrained by our weakness, now, with so much technological power, we have to learn how to be voluntarily constrained by our judgment: our ethics (Metzl, 2019). For instance, since the dawn of the Internet the sheer quantity and quality of data have dramatically increased and are continuing to do so exponentially. Big data describes the large amounts of data as voluminous and complex that traditional data processing application software is inadequate to deal with them.

Recent innovations in medical research and healthcare, such as high-throughput genome sequencing, high-resolution imaging, electronic medical patient records and a plethora of Internet-connected health devices, have triggered a data deluge that will reach the exabyte range in the near future. Big data ethics or simply data ethics refers to systematizing, defending, and recommending concepts of right and wrong conduct in relation to data, in particular personal data. It is of increasing relevance as the quantity of data increases because of the scale of the impact. Big data ethics is different from information ethics because the focus of information ethics is more concerned with issues of intellectual property and concerns relating to librarians, archivists, and information professionals, while big data ethics is more concerned with collectors and disseminators of structured or unstructured data such as data brokers, governments, and large corporations.

These changes obviously present some powerful risks, and we should ask ourselves whether we think such changes are worthwhile, because we do have choices in the technologies we create and live by. We can govern our technologies by laws, regulations, and other agreements. Some fundamentally ethical questions that we should be asking of new technologies include: What should we be doing with these powers now that we have developed them? What are we trying to achieve? How can this technology help or harm people? What does a good, fully human life look like? As we try to navigate this new space, we have to evaluate what is right and what is wrong, what is good and what is evil.

Additionally, we have become so powerful now that we not only have the power to destroy ourselves, but we also have the ability to change ourselves. With CRISPR and synthetic biology, we can choose to genetically modify people, and by implanting biomedical devices into our bodies and brains we can change how we function and think. Right now, most medical interventions are done for therapy, but in the future, we shall have to consider enhancement, as well. At some point we could potentially even change human nature (Metzl, 2019). That is a tremendous power, one that must be matched with serious reflection on ethical principles such as dignity, fairness, and the common good. The temptation of power without ethics is something we need to avoid now more than ever. If one is powerful without

goodness, one becomes dangerous and capable of very evil actions. In fact, such dangerous power may well destroy itself and perhaps take many innocent lives with it.

As long as there is technological progress, technology ethics is not going to go away; in fact, questions surrounding technology and ethics will only grow in importance. As we travel this path into the future together, we will choose the kind of future we create. Given our growing technological power, we need to pay more and more attention to ethics if we want to live in a better future and not a worse one.

As daily lives are changing, we are relying more on things like SET and the Internet to complete tasks that might otherwise have been done in person. As children switch into online classes and people work from home, the topic of access and what a government should ensure as basic rights for people become more relevant. This is especially an issue as some people already lacked access to the Internet before the outbreak and now may be unable to pay their bills, with fear of losing such access. Should the government aim to ensure all children have Internet access and the basic tools to learn online the same way they provide books and meals?

2. Global Transformative Leadership and Global Ethical Followership

The unprecedented disruption by COVID-19 is accelerating the urgency for agility, adaptability and transformation. Industry structures and business models are being disrupted, and the digitalization of the economy is being rapidly accelerated. An estimated 70% of new value created in the economy over the next decade will be based on digitally enabled platform business models. However, 47% of the world's population remains unconnected to the Internet. Digitalization has been accompanied by ever-increasing energy and resource consumption, as well as global production and consumption patterns that place an even greater burden on ecosystems. Technical innovation surges do not automatically translate into sustainability transformations but must be closely coupled with sustainability guidelines and policies (WBGU, 2019).

Our ideas of what human rights are or what classifies as a necessity are shifting and therefore, we ask whether it is now the government's job to provide those in the way they help others. What happens when children cannot take classes due to lack of access to technology? The Internet is one of the biggest resources that people are relying on now and seeing as a necessity, especially members of Generation Z, who have grown up alongside technology and require it for classes and jobs, yet until the pandemic, it was seen as a privilege rather than a right. If this definition and the need for the Internet have changed, what does it mean for privacy and security rights? The list of concerns with regard to government ethics that has arisen from this pandemic is long, and directly impacting the lives of Generation Z all over the world. Although all these issues have different focuses and affect people differently, in different countries, their similarities stand in the idea that the role of government is changing as the virus spreads.

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need to save lives now while also improving the way we respond to outbreaks in general. The first point is more pressing, but the second has crucial long-term consequences,” according to Bill Gates (Gates, 2020). Another sound leadership principle is to never ask someone to do something you would not be willing to do yourself. People have been asked to work when they do not feel safe, in all ways, physically and psychologically, for decades. In the way OSHA, Maslow, and #MeToo reporters would measure safety, in ways people sense instinctively. Now is the time to prioritize the care of people while they work, and the care they provide for people at home.

“The coronavirus has not broken our world. It just exposed a world that was already breaking.”

We may never have another moment where there is such a shared awareness of what matters most: how we care for one another. As leaders plan for what needs to happen next, they have the opportunity to put human welfare and wellbeing first (Fiorini et al., 2016). They should not miss the moment. Some long-discussed changes about how to care for each other now seem possible: basic healthcare, an end to homelessness, year-round school to close the achievement gap for children from low-income families; care for society’s most vulnerable, the sick, the children, the aged, and the marginalized. To care for them, we must see them first, a clarity the global pandemic has offered.

Philanthropists must step up. There is too much money sitting on the sidelines right now. Now is the time to redistribute some wealth, creating a society that works better for everyone. We are finding the will, the solidarity, to address problems we could not tackle before the virus. Now that we have imagined a way to shelter the homeless in hotels in the midst of this crisis, can we imagine a way to sustain their support?

There is a lot of emphasis on leadership in society and certainly during moments of crisis, like this one. What is standing out, and serving humanity at a time of great need, is a global transformative leadership complementarity that we can call augmented “ethical followership”. Our confidence in one another, and humanity broadly, is being restored, one ethical followership example at a time. Followership is a concept explored by scholars like Robert E. Kelley, at Carnegie Mellon University, amongst others. Ethical followers are independent thinkers with a positive mindset. They do not blindly follow the decisions or actions of someone in a traditional authority position without evaluating and understanding them on their own. They can succeed without a leader being present.

In the midst of a pandemic, there is an abundance of examples of moral autonomy and ethical followership. People are making great decisions about who to listen to and follow. In the United States of America, Dr. Anthony Fauci has emerged as the leader whom followers have chosen. In Italy, Dr. Massimo Galli and Dr. Andrea Crisanti, in Lombardy and Veneto Regions respectively, have gained the same status. There are others with institutional leadership roles that might be more logical choices, like the head of the “Center for Disease Control and Prevention” in the USA (CDC, 2020) and the head of “Istituto Superiore di Sanita” in Italy. But only in those physicians do followers see bravery and expertise. They

have been willing to calmly and clearly disagree with elected officials. They have confidence in their understanding of infectious diseases and share it plainly. Followers see their courage, following their bravery in speaking out. They appreciate the doctors' knowledge base. People have chosen to follow them.

Many different cultures are tangling with this foe, COVID-19. They are all going about it differently, honoring the norms of their locale, and, in some cases, forging new norms. When we look at where the virus has been tamed, at least a bit, it seems to be in places where people have learned the value of followership. Now it is up to the rest of us to follow as ethically as we can; to follow bravery, courage, expertise, humanitarianism, compassion, equity, and truth.

With our health infrastructures, economies, governments and global power structures collapsing and with billions of people around the world, including the most vulnerable, at risk, we find ourselves at a transitional moment of our planet. The last time we experienced something like this was in the early years of World War II. Lessons concerning the weaknesses of social systems must be studied in depth and analyzed to understand why and how conventional thinking has led to global crises, the vulnerabilities generated by globalization and networking, and the ideas needed to foster effective social innovation. The coronavirus has not broken our world. It just exposed a world that was already breaking.

We should try to figure out new prospective scenarios where information and the conditions for its circulation will continue to play a crucial role, as we are experiencing in this epidemic period, and SET will effectively and appropriately fertilize (EM, 2020) the various and heterogeneous local cultural contexts worldwide in a more targeted and more flexible way.

We must learn from this lesson and make the necessary investments to limit the impact of future pandemics now. It will require post-Bertalanffy Systemics (Minati et al., 2016; Fiorini, 2019) and Cybernetics insights to steer the new situation to an equilibrium that increases the chances of health, equality, and viability to all stakeholders in society (Fiorini, 2015). The investment needed is tiny compared with the economic and human toll of another pandemic (EM, 2020). It just makes total financial sense; anything else does not. The world needs an insurance policy against pandemics from now on. A better understanding of what is happening at the global level necessitates a deep, shared perspective change, based on a global arbitrary multiscale system approach.

3. Global Arbitrary Multiscale Perspective

A crucial lesson for leaders (particularly at the local level) is that resilience is most important when it comes to risks that are difficult to predict or, owing to a dearth of knowledge, manage effectively to get global system sustainability. The most important lesson is to avoid examining these risks in isolation. Instead, leaders should adopt the mindset of systems thinking, relying on a multi-factorial, multi-layered process to determine risks (Gill & Kadziński, 2012). Most current governments are not ready enough or totally educated to see the implications of these new understandings and what is happening in response to the worldwide spread of the SARS CoV-2 (and COVID-19, the disease it causes,

is a vivid example of that): a global “tipping event,” in which multiple social systems flip simultaneously to a distinctly new state (Helbing, 2013; Fiorini, 2015). Complex systems can abruptly flip from one state to another (Homer-Dixon, 2010). A system might appear to be chugging along normally one day and then, bang, it shifts to an entirely different behaviour the next (Holling, 1973). Remember the collapse of the east coast cod fishery, or the world economy’s sudden flip in 2008 from an inflationary state to one that barely skirts deflation.

In the past, around the world, national institutions and political systems have been designed to deal with single-cause problems and incremental and almost reversible change, according to the traditional, reductionist Newtonian mechanics of simple systems. But the real world has never been like that. Take a problem like climate change. Its causes are many and tangled; the climate system has flipped from one state to another in the past, and could do so again under human pressure; and once it flips, we will not be able to get the old climate back.

Human beings introduce complexity into their social, economic, and technological systems to solve their problems. In 1994, the economist W. Brian Arthur wrote an article that is one of the foundation pieces of complexity science. He suggested there are really three deep sources of complexity: (1) co-evolutionary diversity; (2) structural deepening, and (3) capturing software (Arthur, 1994, 2014). The first is growth in co-evolutionary diversity. This process applies equally to societies, economies, and ecological and technological systems. Ecological systems offer, perhaps, the clearest illustration. Each ecological system has a number of niches or ecological roles that may or may not be filled by various species. Niches filled by one or more species are separated by vacant niches. If you think of different firms and products as being different species, then you have to be very aware of how that entire network of different companies operates, even if they are quite peripheral to you. It is a process that looks like the fractal, analytical method which is used to analyze structures in materials, natural, technical, security, financial and social sciences in order to make a prognosis of designed structural properties (Mandelbrot, 1977; Mitić, 2017).

The second source is structural deepening (Moore, 2020). It is a very different phenomenon from the previous one: if growth in co-evolutionary diversity happens at the level of the whole system, structural deepening happens at the level of the individual component or unit within the system. As a species, firm, or organization confronts problems in its environment, it responds by becoming more complex. We can see structural deepening at work in many of our technologies. Compare for instance an automobile engine back in the 1960s with one produced today. The modern engine runs much more cleanly, it is far more efficient, and it has other attributes that make it a great improvement over the earlier version. But back in the 1960s, you might have been able to fix the engine yourself. Please, try it today!

Finally, the third is the phenomenon of capturing software, in which larger systems appropriate or capture the grammar that governs the operation of smaller or subordinate systems. Think about the way societies have captured the software, or the fundamental physical grammar, of electricity and have then used electricity in all kinds of marvelous ways to improve people’s lives. But in the process, we have made our world much more complex.

Following this line of thought, as habitat destruction and biodiversity loss increase globally, the coronavirus outbreak may be just the beginning of mass pandemics (Vidal, 2020). We cannot predict where the next pandemic will come from, so we need mitigation plans to take into account the worst possible scenarios. The only certain thing is that the next one will certainly come. We must think about global biosecurity, find the weak components and bolster the provision of health care in developing countries. Otherwise we can expect more of the same. The risks are greater now. They were always present and have been there for generations.

It is our interactions with that risk which must be changed. We are now in an era of chronic emergency. Diseases are more likely to travel further and faster than before, which means governments must be faster in their responses to be successful (Fiorini, 2017a). It needs investments, change in human behaviour, and it means we must listen to people at community levels. Getting the message about pathogens and disease to hunters, loggers, market traders and consumers is key. These spillovers start with one or two people. The solutions start with new education and awareness. We must make people aware things are different now. Local communities have the hunger and desire to receive reliable information; they are eager to learn.

Today, leaders need to think of their country as part of a complex system that is comprised of smaller systems and is a part of larger systems that affect their country's resilience at least. They need to take into account the understanding of socio-ecological systems developed around the term "resilience," and more recently the term "panarchy," in the work of Holling, Gunderson (Holling, 1973; Gunderson & Holling, 2002; Holling, 2004), and others. Panarchy theory represents the evolution of complex adaptive systems (that is, systems that adjust or adapt to their external environment as the environment changes) in three-dimensional space. This space is defined by three local variables: potential, connectedness (connectivity), and resilience. When your system has achieved global resilience, the next step is developing the system's antifragility, the ability to adapt and adjust to unforeseen events, to absorb change, and to learn from adversity. Even better, thriving from unexpected events (Taleb, 2012).

Furthermore, network science explains that strongly connected global networks have produced highly interdependent systems that we do not understand and cannot control well. These systems are vulnerable to failure at all scales, posing serious threats to society, even when external shocks are absent (Dehmamy et al., 2018). As the complexity and interaction strengths in our networked world increase, man-made systems can become unstable, creating uncontrollable situations even when decision-makers are well-skilled, have data and technology at their disposal, and do their best (Ravasz et al., 2002).

To make these systems manageable, a fundamental redesign is needed. A global arbitrary multiscale systems science (GAMSS) perspective might create the required knowledge and paradigm shift in thinking (Fiorini, 2016). This GAMSS can also show that until we manage this connectivity better, which could mean, among other changes, reducing our international travel, simplifying global supply chains and bringing some production processes closer to home, we are likely to experience more frequent tipping events of ever-higher destructive force.

When we look at this larger picture, we see a striking reality: The SARS CoV-2 seems well-tuned to exploit the specific characteristics of the world we have created for ourselves, with our massive population tightly linked together by large cities and air travel, exotic tourist excursions and just-in-time supply chains, and marked by brutal inequalities in health care and physical wellbeing. From a technical point of view, the Internet itself, including the Internet embedded in smart things and places, smart cities, and landscapes, could be of unprecedented help in creating new hybrid environmental sets, calling for a new approach to the proxemics of public spaces, and consequently to the design of a newly built environment.

4. Globalization, Connectivity and Uniformity Factors

Recent global crises reveal an emerging pattern of causation that could increasingly characterize the birth and progress of future global crises. Human-induced changes in natural systems now often rival or exceed changes arising from non-human processes (Steffen et al., 2002). Future crises will increasingly arise from the conjunction of the following three underlying, long-term, and causally linked global trends (Homer-Dixon et al., 2015).

The first trend is the dramatic increase in the scale of human economic activity in relation to Earth's natural resources and systems. As of July 29, 2019, humanity has already officially used up more ecological resources that year than the Earth could regenerate by the end of the same year. The occasion even has a name "Earth Overshoot Day". Global Footprint Network, a sustainability organization which calculates the day, says humanity is currently consuming nature 1.75 times faster than the planet can regenerate. "We cannot use 1.75 without destructive consequences," says Mathis Wackernagel, founder of Global Footprint Network, in a statement.

The second trend is the rapidly rising density, capacity, and transmission speed of the connections carrying material, energy, and information among the components of human technological, economic, and social systems (Helbing, 2013). The revolution in information technologies, the quintupling of global trade, and the homogenization of human institutions, culture, and technologies have produced a sharp increase in the connectivity and the speed of operation of human, social and economic systems (Chase-Dunn et al., 2000; Young et al., 2006).

The smart and connected world in which services, products, and people are somehow embedded in broader systems, is reshaping society. Emergent domains such as Web 3.0, Industry 4.0, Government 3.0 (Refer to Gov3.0 project: <http://www.gov30.eu/>), or even Life 3.0, which discusses the implications of artificial intelligence on the future of life on Earth, are changing the role of digital technologies and data on designing and rethinking human systems. For example, in the industry sector, the pervasiveness of digitization has been reshaping products toward a layered architecture that includes devices, networks, services, and contents.

The third trend is the increasing homogeneity or declining diversity of human cultures, institutions, practices, and technologies (Boli & Thomas, 1997; Meyer, 2000; Young et al., 2006), including technologies that exploit ecosystem services, such as agriculture and aquaculture. The second and third of these trends are reciprocally related, that is, they are both

the causes and consequences of each other, although not exclusively so. Greater connectivity facilitates homogenization, while homogenization encourages greater connectivity.

Therefore, two major key factors, high connectivity and high uniformity, together leave us increasingly vulnerable to global tipping events. Research shows that high connectivity and high uniformity can combine to make large systems, such as our global financial, energy, food and information systems, far more susceptible to rapidly cascading change, in which shocks propagate like a row of dominoes falling over. Taken together, humanity is now among the largest bodies of genetically identical, multicellular biomass on Earth; all told, we weigh nearly a third of a billion tons. Combined with our proximity in huge cities and our constant travel back and forth around the globe, we are now an enormous Petri dish brimming with nutrients for cultivating current and future new diseases.

Complexity scientists are not surprised by this kind of precisely tuned exploitation; it is exactly what one should expect in constantly evolving living systems. New viruses survive or fail by Darwinian logic. In recent years, countless viral mutations have certainly arisen and then vanished without a trace, because they were not “fit” enough to survive, that is, they could not successfully reproduce in the specific world we have created. The high connectivity and high uniformity combination boosts the risk of synchronized crises across normally independent systems. In the current coronavirus crisis, dominoes may soon start falling in major financial systems, especially in the heavily indebted Chinese economy, as the downturn caused by the pandemic drives up the proportion of non-performing loans.

A perspective shift on the ideas of “globalization” and “network” is required. Quite paradoxically, looking at the pandemic behavior, we see that even the present SARS CoV-2 is working apparently “naughtily”, showing different faces and impacts on different local situations. But as it has been mentioned before, we also know that this is a relevant part of its genetic program, since it uses adaptation strategies based on mutation to survive at a global level, as a resemblance of Darwinian Law.

One thing is becoming quite clear, the pandemic is spreading fast in the world’s crowded and polluted areas. In the first week of April 2020, evidence emerged that dirty air makes COVID-19 more lethal. This fact surprised no one who has followed the science of air pollution, but the scale of the effect was striking. The study, which must still undergo peer review for publication, found that the tiny pollutant particles known as PM2.5, breathed over many years, sharply raise the chances of dying from the virus. Cities are already home to well over half of the world’s population and are expected to draw roughly 2.5 billion more people by 2050. They are also hotspots for air pollution.

Urban areas have a high concentration of emission sources: vehicles, buildings, industrial activity, waste, and wastewater, etc... Carbon emissions were once thought of as a costless “externality” by business. But as the evidence of climate change has mounted and public opinion has shifted, energy companies have begun to look at the real financial consequences. This has been most notable in the rising cost of capital for groups on hydrocarbons and ever-cheaper money for renewables. Cleaning the air means improving human health, mitigating climate change, and protecting biodiversity.

The effects of air pollution on people, the environment, and the global economy are profound, and often under-recognized. The burden of pollution tends to be greater for poorer nations, and for marginalized groups in high-income countries. But the good news is that we can eliminate much of this pollution with existing technologies and practices, and at a surprisingly low cost, if we strategically invest in the right infrastructure, services, and incentives. And thanks to continuing advances in air pollution detection and analytics, we will increasingly have the intelligence necessary to drive positive change.

The “monolithic” face of globalization and network we have known and used up to now, is basically representative of the “monolithic” powers behind them. Big giants have played the game and little Lilliputians have been crushed on the way, including those who were on the shoulders of giants when they staggered. Indeed, keeping the universal human rights firmly fixed, the rich cultural, social and economic variety of the human communities on the “globe”, the extreme adaptability of the digital “net” can be better focused and linked, in order to pave way for new models of sustainability and anthropic development, more sensitive to the inputs from/to their real local contexts and environment by an active, wiser use of SET.

Let us skip, for a while, the point making SET appropriately available (infrastructures) worldwide, to focus on the point of the interaction between knowledge and know-how (literacy and practice), since in their absence SET simply cannot exist, or, it cannot work effectively. To fully express its potential, SET needs to be adequate to the communities reached, renouncing to propose itself as the past “monolithic” set which has already failed, but predisposing itself to release actions in a very targeted way, according to local realities. The collection and the monitoring of all the local situations, actions, and feedbacks detected, will offer a permanent and dynamic global overview to be processed by human and intelligence algorithms.

Consequently, one priority in the agenda should be mapping knowledge and know-how from/to the human cultural contexts worldwide, with the help of the local institutions. Further priority should be on sharing and transferring knowledge and know-how, paying attention to those local identities, and how they interact inside/forming the global system, based on a “glocalization” approach. Of course, alongside local experiences and traditions, a relevant part in the process will be played by oriented education, to be considered, again, not as a “monolithic” block but as an overly sensitive tool tuned to specific social and cultural realities. Compared to the past, we have greater technology and education resources, then the challenge will be to have a clear understanding of how to wisely, flexibly, and effectively use and manage them, and how to sustain several and differentiated communication and collaboration channels open worldwide, with the aim of building and feeding a real sense of global feeling.

5. Thriving from Complex Systems by a Quantum Understanding of Education

But cascading changes in our global social systems do not always have to be so pernicious like COVID-19. Some might be virtuous, and it is here that we can glimpse those silver

linings. Today's emerging pandemic could help catalyze an urgently needed tipping event in humanity's trust, collective moral values, priorities and sense of self and community. It could remind us of our common fate on a small, crowded planet, a shared spaceship with dwindling resources and fraying, limited natural systems, where each crewmember must make a strong contribution to save our "Apollo 13" mission: to guarantee a sustainable future to our children and the children of our children.

We will not address this challenge effectively if we retreat into our tribal identities and try to wall ourselves off from each other, perpetuating dysfunctional, outdated, mechanistic, reductionist ways of seeing and doing that are part of the problem and not of the solution. COVID-19 is a collective problem that requires global collective action, just like climate change mitigation and global biodiversity loss. Even more effectively, as with climate change and biodiversity restoration, we need the best science we can muster. A 2015 study in the journal *Nature* offers the strongest evidence yet that biodiversity strengthens ecosystems, increasing their resistance to extreme climate events and improving their capacity to stem climate change (Isbell et al., 2015).

Many interdisciplinary, multidisciplinary and transdisciplinary initiatives are under way (Fiorini, 2017b). Here, we offer five examples. The first one is represented by the New Engineering Education Transformation (NEET) initiative at MIT (started in 2017). Offerings are structured as threads built around wider topics of social relevance, e.g. Energy, Digital Cities, Smart Materials, Autonomous Systems. Curriculum is multidisciplinary and contextual, project oriented. The stated vision is to teach how to design and build a new generation of machines, materials, and systems to address the complex societal challenges of the 21st century.

The second one is by The Singapore University of Technology and Design (SUTD) in Singapore, a globally pioneering programme set up in the late 2000s in cooperation with MIT. The programmes offered are structured in "Pillars" and curriculum is delivered through multidisciplinary design projects, which contextualize learning.

The third example comes from the findings of the SHAPE-ID EU H2020 project (ongoing) whose stated aim is "to address the challenge of improving interdisciplinary cooperation between the Arts, Humanities and Social Sciences (AHSS) and STEM (Sciences, Technology, Engineering and Mathematics) and other disciplines". Their recent report identified 25 factors that hinder (or help) transdisciplinarity, broadly classified as institutional, disciplinary and epistemic (SHAPE 2019 Report). Fundamentally, the change must be top-down with a transformation of research funding programmes, accreditation, university structures and career paths. The H2020 programme is a good example of science policy: social impact and integrated system thinking (which goes beyond just interdisciplinary collaboration) are basic requirements in most projects.

The fourth example is offered by the East, from which the present pandemic spread. China has created a network of 10 research institutes in different universities with the common theme of "Ecological Civilization". The network is directly reporting to the highest level of

Chinese authorities, and the goal is to bring ideas to the top to be adopted in the next 5-year plan for practical implementation of the concept of “Ecological Civilization”. This is done “à la Chinoise”, a sort of enlightened despotism with which we are not in love in the Western world but which seems to be working for their purposes.

The Club of Rome is the fifth and last example of interdisciplinary system and integrated thinking. Founded in 1968 at Accademia dei Lincei in Roma, Italy, the Club of Rome consists of current and former heads of state, UN bureaucrats, high-level politicians and government officials, diplomats, scientists, economists, and business leaders from around the globe. If we look at what happened from 1968 to the 1980s, the period produced a shift in thinking which was actually being adopted by many levels of the establishment at least in the Western world, until Reagan and Thatcher arrived. Since its foundation, it has produced more than 65 reports, declarations and statements. It might be assumed that the reports of the Club of Rome, as a set, constitute the reference points on a map for governance in the future. The report on “The Limits to Growth” was intended to serve that purpose to some degree. Many more reports since “The Limits to Growth” indeed constitute markers for such governance. Given that the Club of Rome initiatives of the past, and the bifurcations, together reflect a primarily Western bias, the emergent role of China on the global scene suggests the special merit of giving some consideration to frameworks emerging from that culture.

Fundamentally, the change must be top-down with a transformation of research funding programmes, accreditation, university structures and career paths. To be fully successful, all these efforts must be supported by effective catalytic strategies like the alignment of higher education goals with government goals and strategic investments. This is a particularly important factor to consider as the center of gravity in SET education is shifting to the emerging economies and powerhouses of Asia and India.

Furthermore, new accreditation and assessment frameworks and methodologies for delivering student/project-centered active learning to large student cohorts, with international integrated programmes to offer global perspectives and awareness to students must be made mandatory. Such new disruption with respect to the structured education of the past requires a new generation of faculty with the capacity to deliver student-centred curricula at scale and new university structures. European higher education also faces the major challenge and the ensuing opportunities of globalization and accelerated technological developments with new providers, new learners, and new types of learning.

Such disruption requires a new generation of faculty with the capacity to deliver student-centred curricula at scale and new university structures. “Student-centred learning and mobility will help students develop the competencies they need in a changing labour market and will empower them to become active and responsible citizens” (Bologna Process 2009, p. 1). Current universities are still by large siloed monodisciplinary structures which are unable to get full advantage from new communication technologies and digital transformation. This creates barriers and prevents evolution. Interdisciplinary teaching is underpinned by interdisciplinary research. Furthermore, faculty appointment and promotion systems must be radically changed to encourage and consider interdisciplinary research by young scientists.

During the mid-20th century there was a surge of interest in how children learn, especially after WWII. Maria Montessori first and Loris Malaguzzi later, like their American, Swiss, and Russian contemporaries, emphasized active learning, problem-solving, and self-discovery as critical components of early childhood development and education. Europe has been a rich source of many influential educational ideas. In elementary and early childhood education, two of the best-known approaches with European origins are Montessori and Reggio Emilia. Both are seen as strong educational alternatives to traditional education and as sources of inspiration for progressive educational reform.

The two programs have several key areas of similarity and complementarity. Both are child-centered approaches in which children are viewed as active participants in their own development, strongly influenced by natural, dynamic, self-correcting forces within themselves, opening the way toward growth and learning. The Montessori Method and the Reggio Emilia approach have much in common. Their similarities make it possible to blend them. It is their differences, however, that make combining them so effective. The synthesis of these two philosophies creates an educational method that best develops the whole child. Their integrated approach supported by the digital transformation can create a flexible and effective fast learning environment to explore and nurture future leadership.

While humanity waits on tenterhooks for treatments and vaccines, we need to rebuild our collective trust in new educated scientists in the anthropic scientific method (Meißner, 2015), and scientific findings, based on a deep quantum understanding (Walleczek et al., 2019) of our common shared reality. According to one definition (Echterhoff et al., 2009), shared reality is the product of the motivated process of experiencing a commonality of inner (mental) states (e.g., attitudes or judgments) with others about the world. It is thus conceptualized as an interpersonally achieved, subjective psychological phenomenon which is the common approximated representation of the shared external world representation (Hardin & Higgins, 1996; Higgins, 2019). The beautiful interlocking connectedness of the laws of physics indicates how finely tuned and remarkable the universe is, which proves that the universe is more than just random chance. According to this line of thought, social institutions are shared agreements of the consciousness of individuals, and money is simply a token of trust. It is only a symbol for productive capacity and public trust, not a thing in itself of any inherent value. Individual personality and social culture are interdependent expressions of a unified reality.

Physics does not change, but what is popular in physics does change, and old physics gets rebranded as new physics continuously, till a real “tipping point” materializes. As an example, traditional quantum computer is the research topic “*du jour*”. What we call qubits are nothing more than the two-level systems such as spin-1/2 and two-level atoms physicists have studied since the dawn of quantum physics. We must be very skeptical of doing what is trendy and popular because then you are just playing the acclaimed, so-called “leader of the moment” game. Everyone jumps into the field all doing more or less the same stuff because that is where the funding is and that is the easiest way to publish papers.

Our current vision of social reality is based on an erroneous separation of consciousness and force, created by the obsolete, reductionist Newtonian paradigm, which we were educated

with. A quite limited precision and polarized rendering of our universe. In fact, the classic scientific method evolved during the Enlightenment as an impartial, “objective” means of validating truths of natural phenomena freed from the distorting influence of the physical senses, personal belief, superstition, religious dogma, preference and prejudice. It proved ideally suited for a study of material objects and processes that lent themselves to external, finite and precise observation and analysis, apparently.

“Human accomplishment is the product of subconscious and conscious perceptions and forces that are influenced by past events, present perceptions and future possibilities. The reunification of these three dimensions of time into a triple time vision will mark an important contribution to the emergence of the new anthropic scientific method.”

But over time the focus of early science on the study of external manifestations of “The Real” (Johnston, 2013-18) gradually morphed into the notion that only phenomena which can be instrumentally measured can be approached rationally and scientifically. Eventually many scientists began to speak and act as if the subjective dimension were somehow less real than the shared manifestations. The study of subjective forms of reality was confuscated by the distorting and unscientific notion of personal preference and prejudice (Jacobs et al., 2014). That which is not observable or measurable as an object came to be regarded as somehow less real than external material things.

The traditional notion of value-free science (Newtonian science) artificially divorced us from the living laboratory in which we live and blinded us to the implicit values that frame our perception (Viceconti et al., 2020) of “The Real” (Johnston, 2013-18). For instance, the development of the technology for social organization lags centuries behind the development of material technologies. What is the value of a perfect theoretical model for decision-making if it does not provide guidance for public policy and private enterprise? Human directed energy becomes force. Force organized becomes power. Power expressed through knowledge, skills, positive attitudes and values is converted into productive results. So, we place our own hope in the possibility of virtuous cascades of such positive, “normative” change, based on contributions from emotional crowdsourcing and crowd-inclusion initiatives, facilitated and amplified by new communication technologies, for convenient and sound solution materialization.

We offer five examples, first recalling the 2006 Netflix Prize which utilized crowdsourcing to develop an innovative solution to improve its recommendation engine. The process lasted 3-years and attracted more than 44,000 submissions. (<https://www.netflixprize.com/>); second, the Serious Games and Participatory Simulation Development to provide input for policy innovation so that stakeholders can obtain a holistic, future-

oriented perspective (<https://ieeexplore.ieee.org/document/6465051>); and then the Internet Engineering Task Force (IETF) RFC System (Request for Comments) and Internet Drafts which has shaped and continues to shape the development of the Internet (<https://www.ietf.org/standards/>). The fourth example is the Crowdsourced Protein Simulation Project that exceeds supercomputers' power. Folding@Home, currently focused on deciphering the workings of SARS CoV-2, is the first project to have exascale-level computational muscle. The number of Folding@Home participants surged from 30,000 in February 2020 to 400,000 in March, and has since increased by a further 300,000. *Ars Technica* reports that it now has a peak performance of 1.5 exaFLOPS, making it seven times faster than the world's most powerful supercomputer. Folding@Home's distributed disease-busting network is now running at over 1,000,000,000,000,000 operations per second, at least one or two years before Intel, AMD, IBM, or Cray could do it! The fifth and last example is centred on open data and open source software initiatives combined with crowdmapping. All over the world, organizations are increasingly considering the adoption of open source software and open data. In the geospatial domain, this is no different, and the last few decades have seen significant advances in this regard. A recent review focused on the Open Source Geospatial Foundation (OSGeo) software ecosystem and its communities, as well as three kinds of open geospatial data (collaboratively contributed, authoritative and scientific), confirms that openness has changed the way in which geospatial data are currently collected, processed, analyzed, and visualized (Coetzee et al., 2020).

Global open source geospatial software and open geospatial data communities support the United Nations Charter (UNCUN, 1945), e.g., by achieving "international co-operation in solving international problems of an economic, social, cultural, or humanitarian character" and can facilitate that "All Members shall give the United Nations every assistance in any action it takes in accordance with the present Charter," e.g., humanitarian and peace-keeping actions that require the use of geospatial data. Open data and open source software in a technological and hyper-connected world are, together with the other dimensions of openness offered by the Open Knowledge Foundation, one possible barrier against a society of control. Open source geospatial software and open geospatial data are here to stay and are likely to have more impact in the future.

Furthermore, a new type of social governance has arisen; one enabled by the Industrial Internet of Things (IIoT). Governments now actively engage partners to improve the efficiency and quality of municipal services. Empowered by digital tools, communities and people are active stakeholders in social governance. Co-governance, involving multiple participants, is emerging as a new model for today's increasingly complicated society.

For instance, the "Health QR Code" lets users submit information regarding travel to major epidemic outbreak regions and details about close contact with infected people and other relevant information. A three-colour scale indicates the person's recent virus-related health history, enabling them to cooperatively comply with virus-related prevention and control policies. The industrial Internet provides a fundamental infrastructure for empowering individuals and organizations. Enterprises, government and individuals have all actively

engaged in the war on COVID-19 through this technology and the advantage this creates has helped China almost stop the outbreak.

“The ultimate problem we face today is not the coronavirus, or deadly pathogens, or any other single threat. It is our inability to solve most of the shared existential challenges we face.”

The coronavirus emergency is already causing terrible human suffering. But it is also just possible that it could set us on a far better path in the future. It is up to us (Homer-Dixon, 2020). For conscious human beings, the future already exists in the form of our aspirations, expectations, imaginations, perceptions, hopes and fears. Unlike rolling stones and falling apples that are propelled by the past into a future course, human beings are moved to act in the present according to their anticipation of future outcomes. Human accomplishment is the product of subconscious and conscious perceptions and forces that are influenced by past events, present perceptions and future possibilities. The reunification of these three dimensions of time into a triple time vision will make an important contribution to the emergence of the new anthropic scientific method.

Art has the power to move beyond representation and critique into work that directly enables communities to effect change, both in attitude and in action, as the breathtaking piece by Flyntz and Chianese shows (2020). As a collective catalyst for technological, social and political change, art is unique in its capacity to provide the tools and platforms for community members to represent their own experiences and aspirations, to enable visionary thinking and practice, and to bring communities together to engage in challenging conversations that can lead to advocacy, action, and change. A marvelous example is the movie directed by Arthur Kanegis, written by Garry Davis, titled “The World Is My Country” (2017). Some artwork directly catalyzes social action; other works prompt reflection and create the opportunity for people to consider the kind of future they want to create. Art can also deepen our understanding of social issues in powerful ways and provide a means for self-representation.

There is an increasing amount of scientific evidence that proves Art enhances brain function. It has an impact on brain wave patterns and emotions, the nervous system, and can actually raise serotonin levels. Art can change a person’s outlook and the way they experience the world. Decades of research have provided more than a sufficient amount of data to prove that artistic education impacts everything from overall academic achievement to social and emotional development and so much more. Research has proven the arts develop neural systems that produce a broad spectrum of benefits ranging from fine motor skills to creativity and improved emotional balance. Quite simply, the arts are invaluable to our proper functioning individually and as a society.

The one essential facility we possess for the study of our individual and collective humanity, indeed for the study of all reality, is the power of the human mind and

consciousness. Our capacity to effectively utilize that power of knowledge depends very much on our understanding of its characteristics, modes of operation and its limitations. As is the consciousness, so is the power. Limited precision representation and knowledge means limited power for accomplishment. The future of science requires that we focus much greater effort on understanding the workings and limitations of the human brain in representing “The Real”, solving the logical relationship between experience and knowledge extraction from it.

This also means to clear the field from any misleading misconception or misunderstanding, placing emphasis on Art as a process (root) more than on the aesthetic quality of the products (final result). Assuming unpredictability as a substantial part of the process, Art shows itself as an open field, has the ability break down and recombine even consolidated standards. Although it makes use of them all, it can be analyzed from their points of view. Art as a process should not be confused with traditional Science, Techniques or Humanities. Thanks to its holistic approach, not sensitive to the disciplinary barriers, and having no pre-fixed channels to follow, it can uninhibitedly cross any set of disciplinary fields, realizing a sort of “*sui generis*” or “subconscious transdisciplinarity”, sometimes showing the world under a totally unexpected light.

Although it is to be “handled with care” and not directly translated into SET until reaching a deep sense of understanding reality, its unique status may offer interesting cues, and an extraordinary wealth of millenary experiences, profitable to be investigated and processed by appropriate intelligent systems, as well as by human intuition. As Kant observed, “All human knowledge begins with intuitions, proceeds from thence to concepts, and ends with ideas.” Einstein stated it this way: “The intellect has little to do on the road to discovery. There comes a leap in consciousness, call it intuition or what you will, and the solution comes to you and you don’t know why or how.”

Scientists of all stripes should work together to multiply their intuitions and to improve public health, and none should mistake a professional tendency or a specialist’s rule of thumb for an unshakable epistemological principle. We must talk of the world. We all need each other’s help right now. It is clearer than ever that none of us will be safe until all of us are safe. As former President Ellen Johnson Sirleaf, who beat Ebola in Liberia, put it: “Coronavirus anywhere is a threat to people everywhere.” It means stopping this virus from exploiting the inequality between rich and poor people in every country.

While the richest of countries across the globe are getting tested and treated fast, with healthcare and cash to get by, most of humanity faces this crisis with neither. The time has come for a massively ambitious plan to overcome this crisis, on a scale we have never seen before in our lifetimes. We cannot wait. Every government, institution and person must play their part. And the richest and the most powerful among us must bear the greatest cost, as we play our part to bring our world together to beat this deadly virus.

Looking at these challenges collectively makes it increasingly clear that the ultimate problem we face today is not the coronavirus, or deadly pathogens, or any other single threat. It is our inability to solve most of the shared existential challenges we face. We have not been able to create an empowered global public health system to protect ourselves from deadly

pandemics, a global environmental authority to coordinate efforts to save our planet, or a mechanism to prevent the widespread diffusion of weapons of mass murder, all for the same reason. In each of these areas, the narrow interests of our specific nations overpower our collective needs as members of one species sharing the same planet. Our national political leaders have failed to protect us not because they have not done their jobs but because they have precisely done the job we hired them to do.

“Human life cannot be wholly understood in terms of generalizations and statistics, we need to take into account the role of conscious individuality in human affairs.”

We must always keep in mind that the pursuit of science itself is entirely a human activity with its own technological, sociological, cultural, mental, psychological and spiritual dimensions. As an example, take The European Organization for Nuclear Research (CERN) (Streit-Bianchi, 2018) and the Joint Institute for Nuclear Research (JINR) which are considered to be the most successful global scientific and technological organizations. CERN is the largest laboratory for particle physics and nuclear physics in the world. It was founded in 1954 by 12 European states, and is located in the vicinity of Geneva at the Franco-Swiss border. Today, CERN includes 23 member states and eight associate member-states. Japan, Russia and the USA have the observer status in it, together with UNESCO, the European Commission and JINR. In 1956, 11 states founded JINR in Dubna, Moscow region, Russia. CERN and JINR have been successfully demonstrating advancement and excellence in science and technology at the global level for more than 60 years. Besides, they have been providing the cultural bridges between numerous states worldwide and enabling them to successfully practice diplomacy through science.

Cooperation between the member states within the two organizations is going on via groups of scientists from the states integrated into the organizations’ projects, and companies from the states specialized not only in accelerator and nuclear technologies, delivering advanced technology goods and services to the organizations, i.e., providing industrial returns to the states from the organizations, in many cases by a considerable technological know-how transfer. Such a two-way cooperation ensures continuous concrete contributions to both scientific and technological developments of these states. This example of global cooperation, founded on a direct connection of basic science and high technological development, is unique. It proves that it is possible to carry out jointly national and global interests, irrespective of cultural and ideological differences.

Sri Aurobindo depicts human social evolution as a progressive dance between rising levels of consciousness and rising levels of organization. “Life evolves through growth of consciousness. consciousness evolves through greater organization and perfection of life: a greater Consciousness means a greater life” (Sri Aurobindo, 1970). Biology, culture, and society are dependent at all levels on the vitality of interaction they produce both internally

and externally. Gregory Bateson said, “The evolution is in the context” (Bateson, 1972-2000). So why don’t we have a word for mutual learning in living contexts? Nora Bateson is proposing “Symmathesy” (Noun): an entity composed by contextual mutual learning through interaction. Our process of interaction and mutual learning takes place in living entities at arbitrary multiscale levels of symmathesy (Bateson, 2015).

6. Digital Frameworks and Collaborative Innovation Platforms

Many twenty-first-century challenges we have to manage, like the present digital transformation, the Fourth Industrial Revolution, the Internet of Things (IOT), Brain Computer Interfaces (BCI), etc. have social components and cannot be solved by technology alone. Technosocial or sociotechnical interactive systems, be they social or economic systems, artificial societies, or the hybrid system are made up of our virtual and real worlds. Mixed, hybrid, and shared realities built by symbiotic autonomous systems (SASs) and digital twins are characterized by a number of special features, which imply additional risks; the components (for example, individuals or SASs) take autonomous decisions based on (uncertain) future expectations.

As its name suggests, a digital twin is a virtual replica of an object, being, or system that can be continuously updated with data from its physical counterpart. Supported by an estimated 25 billion connected global sensors by 2021, digital twins will soon exist for millions of things. A jet engine, a human heart, even an entire city—everything will have a digital twin that mirrors the same physical and biological properties as the real thing. The implications are profound: much more precise real-time assessments and diagnostics; repairs literally executed in the moment; and innovation that is faster, cheaper, and more radical. They produce and respond to complex and often ambiguous information. They have to face cognitive complexity. They have individual learning histories and therefore different, subjective views of reality.

Human individual preferences and intentions are diverse and imply conflicts of interest, competition, solidarity, and cooperation. The behaviour may depend on the context in a sensitive way. For example, the way people behave and interact may change in response to the emergent social dynamics on the macro scale. This also implies the ability to innovate, which may create surprising outcomes and “unknown unknowns” through new kinds of interactions. Furthermore, social network interactions can create social capital such as trust, solidarity, reliability, happiness, social values, norms, and culture. The potential power of society is not subject to any inherent limits.

Human capital and social capital are potentially limitless resources. The more we develop them, the more they grow and the greater their capacity for further development. Nevertheless, to assess systemic risks fully, a better understanding of social capital is crucial. Social capital is important for economic value generation, social wellbeing, and societal resilience, but it may be damaged or exploited, like our environment and biodiversity. Thus, the world is confronted by the paradox that vast underutilized social capacities exist side by side with persistent poverty, suppressed rights and unmet needs. Therefore, humans need to learn how to quantify and protect social and common capital in a conscious way first. It is important

to stress that risk insurances today do not consider damage to social capital. However, it is known that large-scale disasters have a disproportionate public impact, which is related to the fact that they destroy social and common capital. By neglecting collective and social capital in risk assessment, we are taking higher risks than we would rationally do.

For today's anthropogenic system, predictions seem possible over short time periods but only in a probabilistic sense. Having all the data in the world would not allow one to forecast the future. Human life cannot be wholly understood in terms of generalizations and statistics (Taleb, 2012); we need to take into account the role of conscious individuality in human affairs. Nevertheless, one can determine under what conditions systems are prone to cascades or not. Moreover, weak system components can be used to produce early warning signals. If safety precautions are lacking, however, spontaneous cascades might be unstoppable and become catastrophic. In other words, statistical predictability and controllability are a matter of proper systems design and operation.

In fact, we need to consider both global and local phenomena and effects, and their reciprocal influences, something that the global digital network may help us to monitor and manage. The data flows recorded and processed would form a permanent and self-updating system. The dynamic retention of data on the network would continuously increase the overall amount of information necessary to statistically simulate future customized scenarios, that is, locally efficient scenarios consistent with the global conditions, and to update them or react to them in a reasonable time-lapse.

The digital transformation we are currently experiencing has necessitated a retooling of the scholarly processes to handle data and software, but this is proceeding at varying speeds across different communities, disciplines, nations, and governments. Today we have a new way of solving really big, hard, complicated problems at a scale, and with a degree of collaboration that was never possible before, but we have still to learn how to manage those resources to let them offer us their best returns.

The collaborative innovation approach for social technology assessment at the government level is not a new idea since the creation of the U.S. Office of Technology Assessment (OTA) by the United States Congress in 1972. This concept was copied in about forty foreign countries and then it was shut down by Newt Gingrich (Republican party) in 1995. The justification was that there is no need to assess the socio-environmental impact of technologies on society because the market already does that. This is the usual neo-liberal economic ideology which of course still rules the Republican party in the USA today. During its twenty-four-years, the OTA produced about 750 studies on a wide range of topics, including acid rain, health care, global climate change, and polygraphs. Princeton University hosts The OTA Legacy site, which holds "the complete collection of OTA publications along with additional materials that illuminate the history and impact of the agency". On July 23, 2008 the Federation of American Scientists launched a similar archive that includes interviews and additional documents about OTA.

A major reason why the OTA must be revived is the accelerating pace of technological innovation, in countries such as China. To illustrate this, we need to assess the effect of AI

(whether advanced in the U.S., China, Israel or elsewhere) on the destruction of jobs; the safety of driverless autos; the morality of the use of CRISPR for genetic engineering; facial recognition as a public safety tool; the impact of social media on democracy and society; and much more.

While the OTA was closed down, the idea of technology assessment survived, in particular in Europe. Formally established in 1990, the European Parliamentary Technology Assessment (EPTA) network coordinates members of technology assessment units working for various European governments. The US Government Accountability Office (GAO) has meanwhile established a Technology Assessment unit, taking on former duties of the OTA. In 2010, GAO joined EPTA as an associate member. In 2019, GAO established a new mission team, the Science, Technology Assessment, and Analytics team, which has primary responsibility for technology assessments.

Today, technology aided collaborative innovation is an important ally in scientific knowledge management and distillation. For instance, to ensure no one is left behind through lack of access to the necessary tools and resources, Zenodo (developed by CERN) helps researchers receive credit by making research results citable and through OpenAIRE integrates them into existing reporting lines to funding agencies like the European Commission (EC). Citation information is also passed to DataCite and onto the scholarly aggregators. It is one of the major working examples of a digital platform for collective intelligence (CI) (Coin, 2020) and collaborative innovation (Fiorini, 2020), a phenomenon where a shared or group intelligence emerges from the collaboration and/or competition of many individuals.

If the coming period of innovation and creativity were to have one overarching theme, it would be “collaboration”. Today the “3Cs” of an innovation culture are “Collaborate”, “Communicate”, and “Create”, to develop creative leadership skills and put them to use in your personal life or work. Fostering a culture of innovation will allow you to harness the power of design thinking. You need to learn the process, tools, and techniques of design thinking to generate and validate ideas with and for your interaction subjects. Learn how to engage and collaborate with others for an organizational culture of innovation that is agile and human-centered. Develop the skills, mindset, processes, and actions needed to launch focused and strategic innovation for your work, and for your own life.

One of the most dramatic and not surprising outcomes of the global response to the coronavirus pandemic has been a surge in interactions via video meetings. What was before a corporate paradigm has become the only way for most of us to visually interact with each other. Since January 2020, Google Meet, Google Cloud’s video conferencing solution, has seen its peak daily usage grow by 30x. In April, Meet hosted 3 billion minutes of video meetings and added roughly 3 million new users every day.

A new breed of business meeting is emerging, defined less by agendas and pie charts, and more by human connections. Some of these video interactions are clearly remote manifestations of a traditional business meeting or university lesson, as virtually all coworkers, customers and students meet remotely during this time. But in this new world of video interactions, meetings are more varied, as organizations everywhere establish new ways to interact with

each other, their customers, and the world at large. With video meetings, our challenging world is becoming more manageable, thanks to our ability to interact in a more human way, even though we are remote.

For instance, video conference app Zoom's usage has skyrocketed as people have turned to the free video conferencing service to stay in contact with friends, family, colleagues, and even their yoga teachers. But that increased usage has also made the platform a target for hackers, pranks, and harassment. In fact, as Zoom has surged in popularity due to increased usage amid the coronavirus pandemic, federal officials are now warning of a new potential privacy and security concern called "Zoombombing." The term refers to a form of cyber harassment reported by some of the app's users, who reported that some of their calls had been hijacked by unidentified individuals and trolls who spew hateful language or share graphic images. "Zoombombing" has become so prevalent that the FBI issued a news release to warn people of the threat. The FBI received "multiple reports" of video conference calls being interrupted by "pornographic and/or hate images and threatening language," the agency said in its release.

Federal officials urged those using video teleconferencing apps to exercise "due diligence and caution" in their cybersecurity efforts to help mitigate these threats. Both the FBI and Zoom shared some steps to help secure video conference calls and protect people from potential hackers or trolls. They recommend users to make their meetings private (Zoom has options to require a password, as well as a waiting room function to control who is allowed to join the call); avoid sharing the meeting link on public online forums; and limit screensharing to just the call's host. Luckily for those of us who prioritize secure communications, Zoom is not the only videoconferencing tool on the market who has seen its star rise. Cisco Webex has seen a huge surge in usage, as has Microsoft Teams and Google Hangouts and Meet.

Nevertheless, in our modern digital age, there are new exciting ways to interact with our audiences at Conferences and Events using Virtual Reality (VR) and Augmented Reality (AR) social platforms. Both can be strategically used to enhance the experience of event attendees visually while providing direct engagement to the host or sponsor. VR and AR are leading the way in creating unique and singular experiences for attendees. As the use and accessibility of this technology continue to expand, we should expect to see VR and AR make an even larger impact in the years to come. The advantage that AR has over VR is that the former is more accessible to consumers. Given that popular apps like Snapchat already use forms of AR and the iPhone X has AR functionality built into the software, the technology is becoming more available to users.

It makes sense to use VR and AR technology in a way that remains simplistic but still leverages its fascinating capabilities. VR social platforms can be used by businesses in any field, as their feature sets are not geared toward any specific industry. However, these tools are ideal for large companies with employees scattered all over the country, or even the globe, for the following reasons.

As a working example, in March 2020, the IEEE Conference on Virtual Reality and 3D User Interfaces (IEEE VR) was converted into a five-day all-virtual event in response

to coronavirus concerns. It integrated video conferencing, video streaming, and online chat platforms into a custom-hosted version of the Mozilla Hubs shared virtual world platform. It successfully provided a seamlessly immersive, inclusive, and green experience to its expanded audience of over 2,000 registrants. Taking place entirely online, the event featured all of the content planned for the in-person event, including live-streamed presentations, invited talks, and panels, as well as poster sessions, demos, and a 3D user-interface (3DUI) contest hosted in a social virtual world, deftly utilizing some of the technology that would have been displayed at the conference itself, and creating and sharing its own social and birds-of-a-feather sessions, at ieevr.online.

“The mental tendency to divide reality into contrary polar opposites by dichotomization results in a continuous clash between mutually exclusive contradictions that resolve into complementarities at a higher level.”

Important environmental benefits were also incurred as a result of the virtual venue change, including reduced carbon impact from no flights. The conference experienced no food waste, as well as no paper waste related to the typical plastic and paper materials used for signage, collateral, and proceedings. According to “Achieving Zero Waste: A Study of 100% Diversion of Convention-Generated Waste”, the average conference-goer generates 61 lbs. of waste at a conference, as opposed to 13.5 lbs. generated at home over the same time period (Mantz & Mantz, 2016).

In addition to the tragic human cost, the global pandemic has changed many aspects of our lives, and disrupted industries across the world. When an incident this large and disruptive occurs, it leaves an indelible mark on the people who live through it, not to mention on industry and society as a whole. If you are having trouble keeping up with the changes, hang on, even after the immediate danger of COVID-19 subsides, we are going to be looking at a radically different world. The tech industry showed its ability to step up and meet the challenges of the last few months. When all is said and done, we believe many companies and trends will only continue to accelerate.

While more and more employers have embraced letting their employees work from home in the last several years, we think the COVID-19 experience could represent a real paradigm shift, after the immediate danger recedes. After what basically amounts to the biggest work from home experiment the world has ever seen, we expect many will not be eager to return to the office. Additionally, some employers who may have been dragging their feet on WFH (Work From Home) will now see that it is possible.

Also moving forward, we believe most companies will need to have an explicit “pandemic plan”, with the capability to get around 95% percent of their workforce out of the office and working remotely, if need be. An interesting side effect, though, may be the deceleration of

the so-called “open offices” that have become widespread and a return to cubicles, for the sake of hygiene and limiting the spread of pathogens throughout the workplace.

Furthermore, the potential of smart cities, 5G, and edge IoT has grown in response to COVID-19. While this might sound like multiple different sectors, the fact of the matter is that these areas, for the most part, depend on each other to function. These interconnected technologies are actually poised to go through some interesting, if not controversial growth in the coming years as a result of coronavirus. The government may soon have the technology to not only perform facial recognition scans in public places, but to determine, based on body temperature, who is likely to be carrying the virus. This will certainly raise a lot of big brother privacy questions, but as we have seen before, many people are sometimes willing to make compromises on civil liberties in exchange for perceived safety or for the sake of the economy.

7. Conclusion

Leadership ethics explores the relationships between leaders and followers and provides tools for those in leadership roles to bring ethics forward in organizations. It shows how leadership happens on a continuum from the personal to the formal, building from a leader’s character and including actions the leader takes, with elements combining to render the impact the leader has. Going forward, for we are never going back, leaders must first ask how the cares and concerns of their employees and the cares and concerns of the people those employees care for are met. How do we return to an acceptable level of productivity and personal freedom while danger, currently in the form of a deadly virus we cannot see, and may not even know we have, lingers? How do we raise people’s confidence and comfort in moving about safely?

Some current responses to COVID-19 based on existing policies and methods threaten to undermine democracy and human rights, underlining the absence of human-centered attitudes. Therefore, a new paradigm is essential. Its realization will require the commitment and active involvement of all of us. Human behavior is purposeful, even when it is intended simply for relaxation and enjoyment. Security, sustenance, wealth, status, power, knowledge, beauty, love and enjoyment, self-realization and spiritual fulfillment are common human pursuits, synthesized by the new perspective of the global wellbeing approach. In 1943, Maslow defined a hierarchy of needs (Maslow, 1943). Lasswell grouped them under eight categories of values which human beings seek to realize: power, enlightenment, wealth, wellbeing, skill, affection, respect, and rectitude (Lasswell, 1948), to which Nagan adds a ninth, aesthetics (Nagan & Haddad, 2012; Jacobs et al., 2014).

Knowledge without capital is nothing. Capital without knowledge is a disaster! The mental tendency to divide reality into contrary polar opposites by dichotomization results in a continuous clash between mutually exclusive contradictions that resolve into complementarities at a higher level. As Carl Jung suggested: “Everything needs its opposite for its existence. The indivisible, whole being that the Individual is, is made complete when he accepts and integrates all aspects of his personality, realizing in the process that contradictions are complements” (Jung, 1938-2018).

It will be a twenty-first-century global leadership challenge to learn how to turn these understandings into practical, convenient solutions at the social level and how to trigger the positive sides of cascade effects through active wisdom. In the book titled “Composing a Further Life: The Age of Active Wisdom,” Mary Catherine Bateson shares the stories of men and women who are flourishing examples of this “age of active wisdom”. Retiring no longer means withdrawing from life but engaging with it more deeply. She redefines old age as an opportunity to reinvent ourselves and challenges us to use it to pursue new sources of meaning and ways to contribute to society (Bateson, 2011).

These are acts of positivity that multiply and can also spread from person to person. In 2010, researchers from the University of California at San Diego (UCSD) and Harvard published the results from their experiments in an article titled: “Cooperative behavior cascades in human social networks” (Fowler & Christakis, 2010). They showed that cooperative behavior can be just as contagious as bad behavior. They showed that positivity can spread from person to person, up to three degrees of separation, with random acts of cooperation, generosity and other positive behaviors. This creates a cascade of cooperation that influences dozens of people who were not involved in the initial trigger event. The results suggest that each additional contribution a subject makes to the public good in the first period is tripled over the course of the experiment by other subjects who are directly or indirectly influenced to contribute more as a consequence. Likewise from GAMSS, positive cascades can produce a large-scale coordination of traffic lights and vehicle flows, or promote the spreading of information and innovations, of happiness, social norms, and cooperation.

Taming cascade effects could even help to mobilize the collective effort needed to address the challenges of the century ahead. “The best way to predict your future is to create it”. Abraham Lincoln, 16th President of the United States of America, and countless others have uttered some variation of this quote. That statement was true when Honest Abe first said it, and even more true today, when the world is a whole lot less predictable than it was. “Honest Abe” was a nickname that Abraham Lincoln embraced with pride. He believed in his own integrity and worked diligently to maintain his reputation as an honest politician and lawyer, something that was not always easy in either of those fields. It gives a nod to the problematic issue of predicting our future today, if we add a complex “together” to it.

In fact, looking at our goal to focus on the Global Leadership Challenge in the 21st Century with an integrated and strategic science, engineering and technology (SET) perspective, it seems that we can agree on some pivotal points, such as the need for a transdisciplinary approach to SET, including the contribution of Art regarded as a human process, together with the need for appropriate intelligent strategies enabling the understanding and the enhancement of the local identities behind globalization. In order to figure out realistic and reasonable sets of customized local scenarios consistent with/influencing the global scenario and its evolution and mutations, a strong technological support to sustain easily collective intelligence and collaborative innovation is needed. In this process, the further advantages offered by the synergistic power of the Internet of Web, the Internet of Things, the Internet of Places, considered as a system, are clear.

In this perspective, the leadership agenda may fix some basic steps, from mapping the geographic cultural contexts, to setting the digital network and opening the communication channels worldwide, engaging local institutions to implement the databases, and defining strategies for intelligent data processing aiming at predicting and updating local and global interacting scenarios. A simple chain to be described in the paper, which the worldwide scale of the expected applications makes tremendously complex, not only in terms of policy making and data management and time, suggesting that the appropriate connection between theory and praxis, and its “customization” in the various geographic contexts of life, will be the most challenging point to reach. However, the Leadership we are aspiring to does not have any chance to be realized without SET being supported by Art, and we have no chances to feed SET without setting human-centred education and lifelong learning as priority points in the 21st Century Agenda.

Whether we like it or not, we have been born on this earth as part of one great family, of one large crew. Rich or poor, educated, or uneducated, belonging to one nation or another, ultimately each of us is just a human being like everyone else. Furthermore, we all have the same right to pursue happiness and avoid suffering. When we recognize that all beings are equal in this respect, we automatically feel empathy and closeness towards others. Out of this comes a genuine sense of universal responsibility: the wish to actively help others overcome their problems. “Because we all share this small planet Earth, we have to learn to live in harmony and peace with each other and with Nature. This is not just a dream, but a necessity,” according to Tenzin Gyatso, the 14th Dalai Lama (Gyatso, 1989).

2020 will be remembered as the year when we faced the greatest global crisis since the Second World War, and its impact will be felt for generations to come. For those of us who campaign for openness, our beliefs were already under threat before this outbreak in many different and challenging ways. Now, with disinformation becoming rampant, governments introducing emergency measures, and restrictions being imposed on people, our endeavour is even harder.

But there is hope. Openness is the way through which we will get through this global crisis. Open research and sharing data and information openly will likely lead to the creation of a vaccine in record time which will save lives hopefully. If ever there was an example of the importance of open knowledge to the public, here it is. We will get through this, and we will emerge on the other side of the coronavirus pandemic. When we do, our world will have changed. Our job is to make sure that the future we emerge into is a fair, free, open, and sustainable future.

Authors Contact Information

Rodolfo A. Fiorini (Corresponding Author) – Email: fiorini@worldacademy.org
Trustee, World Academy of Art and Science;
Professor of Bioengineering, Politecnico di Milano University, Italy

Carlos Alvarez-Pereira – Email: calvarez@innaxis.org
Founder and Chair of Innaxis Foundation & Research Institute, Spain;
Fellow, World Academy of Art and Science

Garry Jacobs – Email: garryj29@gmail.com

CEO and President, World Academy of Art and Science;
Vice President, The Mother's Service Society, India

Donato Kiniger-Passigli – Email: kiniger@worldacademy.org

Vice President, World Academy of Art and Science

Alberto Zucconi – Email: alberto.zucconi@iacpedu.org

Chairman of the Board, World Academy of Art and Science;
President, Person Centered Approach Institute, Italy

Nebojša Nešković – Email: nneskovic49@gmail.com

Secretary General, World Academy of Art and Science;
President, Serbian Chapter of Club of Rome

Herwig Schopper – Email: herwig.schopper@cern.ch

Former Director General, CERN;
Trustee, World Academy of Art and Science

Vojislav Mitic – Email: vmitic.d2480@gmail.com

Scientific Adviser, Serbian Academy of Sciences and Arts

Hazel Henderson – Email: hazel.henderson@ethicalmarkets.com

Founder of Ethical Markets Media;
Fellow, World Academy of Art and Science

Mariana Todorova – Email: mariana_g_todorova@yahoo.com

Assistant Professor, Bulgarian Academy of Sciences;
Fellow, World Academy of Art and Science

Witold Kinsner – Email: w.kinsner@ieee.org

Professor, Department of Electrical and Computer Engineering, University of Manitoba,
Canada; Life Senior Member of the IEEE

Luigi Cocchiarella – Email: uigi.cocchiarella@polimi.it

Associate Professor, Polytechnic University of Milan, Italy

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