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THE COVID-19 PANDEMIC: USING NANOTECHNOLOGY AND THE LAW AS EXAMPLES OF NECESSARY TRANSDISCIPLINARITY AND INTERSYSTEMIC COMMUNICATION

A PANDEMIA DE COVID-19: A NANOTECNOLOGIA E O DIREITO COMO EXEMPLOS DA NECESSÁRIA TRANSDISCIPLINARIDADE E COMUNICAÇÃO INTERSISTÊMICA

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ABSTRACT

Objective: This article aims to answer the following research question: how may technologies (especially nanotechnology) and scientific knowledge insert themselves into the structures of the Fourth Industrial Revolution to help face the global pandemic, and its present and future effects while respecting (our) Human Rights?

Method: we used a systemic-constructivist methodological perspective in which reality is a construction an observer makes as they analyze all the peculiarities implied in the act of observation. It is a form of legal reflection.

Results: At the end of the article, we present some provisional referrals and an open question for future data and information.

Contributions: Throughout the article, we discuss the issue of transdisciplinarity and the improbability of intersystem communication, and how this can influence a future changed by the COVID-19 pandemic.

Keywords: COVID-19; Law; Transdisciplinarity; Fourth Industrial Revolution; Intersystem Communication.

RESUMO

Objetivo: *Busca-se com este artigo, responder a seguinte pergunta de pesquisa: como as tecnologias (em especial a nanotecnologia) e o conhecimento científico inserido nas estruturas da Quarta Revolução Industrial poderão auxiliar no enfrentamento da pandemia global, seus efeitos presentes e futuros, respeitando os Direitos (dos) Humanos?*

Método: *Utilizou-se a perspectiva metodológica sistêmico-construtivista, que considera a realidade como uma construção de um observador, analisando todas as peculiaridades implicadas na observação, tratando-se de uma forma de reflexão jurídica.*

Resultados: *Ao final do artigo, foram apresentados alguns encaminhamentos, ainda muito provisórios, ficando a pergunta em aberto e no aguardo de mais dados e informações.*

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Contribuições: *Ao longo do artigo, percebe-se a necessidade de discutir a questão da transdisciplinaridade e da improbabilidade da comunicação intersistêmica, e de que forma isto influencia o futuro, a partir das modificações trazidas pela pandemia de COVID-19.*

Palavras-chave: *COVID-19; Direito; Transdisciplinaridade; Quarta Revolução Industrial; Comunicação Intersistêmica.*

1 INTRODUCTION

March 2021 has been worse than any event that occurred in 2020 when the novel coronavirus took us through strange times, social distancing, and confinement. Since the end of 2019, this virus has roamed the planet Earth with a prowess never before imagined by many. Unfortunately, due to innumerable factors that we humans have created, this type of event may occur more frequently.

This article aims to answer the following question: how may technologies and scientific knowledge insert themselves into the structures of the Fourth Industrial Revolution to help face the global pandemic and its present and future effects while respecting (our) Human Rights?

To do this, we used a systemic-constructivist methodological perspective in which reality is a construction an observer makes as they analyze the peculiarities implied in the act of observation. It is a form of legal reflection about the very conditions of producing sense, and how we may comprehend multiple, dynamic, and diverse forms of communication in a complex environment, much like the one COVID-19 has generated.

This approach presupposes an understanding of the Law as an autopoietic social system where decision-making processes develop communicative operations that are elaborated within a certain legal organization. An autopoietic system builds itself as part of society's environment. Using the systemic-functionalist perspective, we intend to establish a link between the problem and a solution that needs to be built.

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If the Law is to deal with the challenges caused by the COVID-19 pandemic, and the others that will come, it will need to open itself to two paths: one crossing other areas of knowledge to better understand the complex reality of pandemics, and another path allowing ideas from other fields to enter the Law.

2 THE COVID-19 PANDEMIC IN 2020 AND 2021: DIFFICULT TIMES

On December 31, 2019, the World Health Organization (WHO) received an alert regarding several cases of pneumonia in the city of Wuhan, in the Hubei province of the People's Republic of China. The world was dealing with a new strain of coronavirus that had not been previously been identified in humans. A week later, on January 7, 2020, Chinese authorities confirmed that they had identified a new type of coronavirus. Coronaviruses are everywhere. They are the second leading cause of the common cold (after the rhinovirus) yet, until the last few decades, they had rarely caused more serious illnesses in humans than the common cold. In all, seven human coronaviruses (HCoVs) have already been identified: HCoV-229E, HCoV-OC43, HCoV-NL63, HCoV-HKU1, SARS-COV (which causes severe acute respiratory syndrome), MERS-COV (which causes a respiratory syndrome first identified in the Middle East) and the most recent novel coronavirus. This new strain was temporarily named 2019-nCoV before being changed to SARS-CoV-2 on February 11, 2020. It is responsible for causing the disease known as COVID-19 (OPAS, 2020).

On January 30, 2020, the WHO declared that the outbreak of COVID-19, the disease caused by the novel coronavirus, had become a Public Health Emergency of International Concern. This is the Organization's highest level of alert, as defined in the International Health Regulations. On March 11, 2020, the WHO characterized COVID-19 as a pandemic (OPAS, 2020).

On this day, when the WHO acknowledged the scale of the emergency before the world, the Director-General of the organization revealed the chaotic

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situation that justified the announcement of a new stage in the fight against the virus. We learned that the Planet was facing a pandemic. This word generates immeasurable distress and, after 2020, will continue to settle into our vocabulary. It is useful to remember that these emergency declarations, whether international or national, potentially result in the adoption of exceptional measures to protect public health and the need to find a balance between individual rights and collective interests (VENTURA, AITH, RACHED, 2020).

Pandemics will become more and more present in our lives, due to innumerable factors. The main one, though, is man's invasion of natural habitats, especially in the expansion of agricultural frontiers. There will be increasing contact between humans and wild animals, as well as between domestic and wild animals. Furthermore, there are many indications that some pandemics will originate in the Brazilian Amazon, precisely because of the absolutely predatory environmental devastation that has been occurring. There will be an upsurge in mutated pathogenic agents, especially viruses that can carry out so-called "spillover" events when pathogens jump from one host species to another (many believe this gave origin to the COVID-19 disease, through transmission from bats or pangolins to humans). The reemergence of diseases considered to be extinct is also expected, due to this new proximity between humans and wild animals. The issue of climate change, without a doubt, will have a significant role in the advent of new pandemics and the reappearance of diseases following changes in biodiversity.

The COVID-19 epidemic reached Latin America and the Caribbean at a time of weak economy and macroeconomic vulnerability. In the decade following the global financial crisis (2010-2019), the regional GDP growth rate decreased from 6% to 0.2%. Additionally, the 2014-2019 period demonstrated the lowest growth since the 1950s (0.4%). To this context, the dynamics of the coronavirus pandemic have added a combination of external and internal shocks that will cause the greatest economic and social crisis the region has seen in decades. There will be very negative effects on employment, the fight against poverty, and the reduction of poverty and inequality. According to estimates by the Economic Commission for Latin

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America and the Caribbean (ECLAC), economic activity in the region was expected to decrease by 5.3% in 2020. As the pandemic ensues and measures of social distancing continue to be necessary, the economic recoil is expected to be even greater than previously projected (CEPAL, 2020).

In March 2020, two scientific publications presented the following portrait of the pandemic: the world is facing a serious and acute public health emergency due to the global COVID-19 pandemic, and how countries respond in the coming weeks will have a fundamental influence on the trajectory of national epidemics (WALKER; WHITTAKER; WATSON et al. 2020). In their reports, the researchers combined data on the age and severity-specific contact patterns of COVID-19, to estimate the health impact of the pandemic in 202 countries. The expected impacts of mortality in the absence of interventions or spontaneous social distancing were compared with those of policies to mitigate or suppress transmission. Mortality and demand for health care estimates were based on data from China and high-income countries. Differences in underlying health conditions and health system capacities are likely to result in dissimilar standards in lower-income countries (WALKER; WHITTAKER; WATSON et al. 2020).

The researchers estimated that, without interventions, the COVID-19 disease would result in 7.0 billion infections and 40 million deaths globally this year. Mitigation strategies focusing on protecting the elderly (with a 60% reduction in social contact) and slowing down rather than preventing transmission (with a 40% reduction in social contact for the wider population) could cut this burden in half and save the lives of 20 million people. According to the same publication, impacts are likely to be more severe in low-income environments, where capacity is lower. Mitigated scenarios in these environments lead to a peak in demand for intensive care beds that exceeds supply by a factor of 25, whereas in a typically defined high-income environment that factor is 7. As a result, the projection is that the real burden in low-income countries seeking mitigation strategies may be substantially greater than the estimates (WALKER; WHITTAKER; WATSON et al. 2020; FERGUSON et al. 2020). The

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numbers concerning the infected and dead are frightening (DONG; DU; GARDNER, 2020).

Amid the global COVID-19 public health emergency, besides researching vaccine development or other therapeutic measures (which have not yet been fully developed), the Science System should focus on investigations to find out the origins of the pandemic. A detailed understanding of how an animal virus crossed species barriers to infect humans in such a prolific way could help prevent future zoonotic events (ANDERSEN et al., 2020).

According to data from the WHO website, on March 19, 2021, there were 121,464,666 confirmed cases of COVID-19 in the world, and 2,684,093 deaths resulting from the pandemic (WHO, 2021). In Brazil, according to data from the Ministry of Health website, the last epidemiological bulletin, No. 54, issued on March 13, 2021, reported 11,439,558 confirmed cases and 277,102 deaths resulting from the novel coronavirus (MINISTÉRIO DA SAÚDE, 2021).

These global and local scenarios have already generated social, economic, and legal repercussions among Brazilians, and affected several legal relationships. Even before the pandemic, we lived in a reality permeated by volatility, uncertainty, complexity, and ambiguity (VUCA: volatility, uncertainty, complexity, and ambiguity).

In this sense, it is increasingly imperative to comprehend how technologies and scientific knowledge can insert themselves into the current context of the Fourth Industrial Revolution to help us face the global pandemic and its present and future effects while respecting (our) Human Rights.

3 THE PANDEMIC AND HUMAN RIGHTS

In any case, we must be led by the guidelines issued by the Inter-American Commission on Human Rights (IACHR), in conjunction with the Organization of American States (OAS). On April 10, 2020, the IACHR adopted Resolution no. 1/2020, entitled Pandemic and Human Rights in the Americas. This Resolution

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establishes that, in all decisions made regarding the novel coronavirus, States must take into account respect for Human Rights:

> [...]considering that while all human rights are impacted by the different situations caused by the pandemic, the right to life, health and, personal safety, the right to work, to social security, education, food, water, and housing, among other economic, social, cultural and environmental rights, are being severely affected. (CIDH; OEA, 2020)

The same Resolution states that:

> [...] recalling that in the context of the pandemic, States have an even greater obligation to respect and guarantee human rights in the framework of business activities, including the extraterritorial application of that obligation, in accordance with inter-American standards on the matter[…] immediately adopt an intersectional human rights approach in all of their government strategies, policies and measures to deal with the COVID-19 pandemic and its consequences, including plans for social and economic recovery. They should adhere to the unconditional observance of inter-American and international standards on human rights, which are universal, interdependent, indivisible, and cross-cutting. (CIDH; OEA, 2020)

The magnitude of the effort to restore certain normality will be considerable, and this normality should be achieved while upholding the values of solidarity, sustainability, and equality, in recognition of the Sustainable Development Goals of the UN 2030 Agenda (UNITED NATIONS, 2017). While workers, companies, and governments must be prepared to contend with uncertainty, they should also be aware that individual protection will be fundamental to the well-being of the entire community. Only joint work between different systems, through transdisciplinarity, can be effective.

In this regard, the International Bioethics Committee (IBC) and the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) have highlighted some vital ethical issues from a global perspective, that urgently need to be acknowledged around the world. They have called for urgent action to be taken by governments based on the following:

> On both national and international levels, health and social policies should be based on solid scientific evidence, taking into account **the uncertainties** that exist during a pandemic, especially when caused by a novel pathogen, and should be guided by global ethical considerations. An international effort is recommended in order to adopt as far as possible uniform criteria of data collection about the pandemic spread and its impact. It is fundamental and necessary to institutionalize a political strategy which prioritizes the health and safety of individuals and the community and to ensure it is effective by enacting **an interdisciplinary dialogue** among scientific, ethical, and political actors. Political decisions should be based on sound scientific knowledge, but never legitimized by science alone. During a crisis situation with many unknowns, an open dialogue between politics, science, ethics, and law is especially necessary. (UNESCO, 2020, p. 1-2)

In this quote, it is clear that the international scientific community is seeking dialogue between different fields to protect human rights by allowing political, legal, and scientific decisions to be legitimated ethically.

This article aims to demonstrate how the System of Law can articulate with the panorama of scientific knowledge, as described by Professor Luciano Benetti Timm (2020), who points out that it has become common to hear on television that public health policies concerning COVID-19 must be based on scientific evidence and that the very performance of frontline doctors must similarly adhere to scientific findings (including medication recommendations). What does this mean? Fundamentally, using scientific methods and statistics to test hypotheses. This means that doctors and public authorities make use of the research done by academics and researchers and, more often than not, these scientists work in basic areas such as chemistry and biology. Law is one of the last fields of knowledge that has resisted the scientific method. Jurists have maintained the same traditional focus and interpretation of texts based on the opinion of debating authorities. Hence, when lawyers are asked to propose public policies, they do not have the scientific tools (i.e. statistics) to measure the effects of what they are proposing, akin to a doctor who does not consult the basic research by chemists and biologists when proposing public health policies.

Empirical observation shows that, in the scientific field, the market is a public space for human beings to interact, and exchange goods and services to satisfy their needs (from the most elemental to the most transcendental). Herein lies the central

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aspect that this article aims to address: the need for legal knowledge connected with the world of life to formulate scientific problems and propose solutions. This is what we shall direct our attention to at this point.

It is up to the Law to use different transdisciplinary tools to avoid remaining inert and sheltered from the new challenges brought about by the pandemic, in a world permeated by the disruption caused by new technologies.

The prefix trans- in the word transdisciplinarity means between, through, and beyond any discipline. Classical logic created disciplinarity, the division of knowledge into innumerable compartments, all isolated and unrelated. In this way, countless specialists have been trained into almost nothing, and also create almost nothing to solve the real problems of humanity. It is no longer feasible to continue doing science in this way, especially because of current world needs.

Transdisciplinarity is a new way of being and knowing. It aims at achieving the most adequate understanding of reality, making it possible to unveil better methods and more effective and pertinent transformations. This new form of teaching and worldview may be the only one capable of coping with the myriad possibilities that make the Law complex today, including the challenges currently generated by the COVID-19 disease in society.

Research in law is still very much centered on the description of institutes, with no social context. This is an inheritance of university teaching methods. It is too uncritical and foreign to the broader social context for a democratic revolution of justice (SANTOS, 2008). One of the roles of the knowledge law research produces, especially in graduate programs, is surmounting the understanding that underlies the theoretical common sense of jurists. These experts seek to rationalize the legal system into an abstract conception idealized by Legal Science and follow a dogmatic paradigm.

As a result of globalization, the notion of a Science of Law has shifted from a structural perspective (concerned with normative questions of law) to a functionalist perspective (focused on the social functions of law), enabling the Law to use transdisciplinary techniques.

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The Law can use different quantitative methodologies to innovate knowledge and understand more complex legal phenomena. In this way, data collected through the analysis of documents and publications can and should be the object of statistical probability.

The use of new methodologies may bring legal research closer to other forms of scientific investigation and allow desired and necessary transdisciplinary interaction in the current pandemic of the novel coronavirus. In 2015, in a Nature article, Ledford quotes an educational psychologist who states that “we have to bring people with different kinds of skills and expertise together. No one has everything that’s needed to deal with the issues that we’re facing” (LEDFORD, 2015, p. 309). The notion of crossing the barriers between disciplines still suffers a lot of resistance, but it is the greatest desire of all scientists when they face the biggest problems of society (such as the current COVID-19 pandemic).

Weyermüller (2010) reported on the communicative difficulties in the relationships between systems that are revealed in the face of complex environmental cases (where transdisciplinarity becomes indispensable), and when there is a need to find legal ways to solve problems.

It is against this backdrop that Ulrich Beck's idea of “metamorphosis of the world” arose (BECK, 2018). Why a “metamorphosis” of the world? Metamorphosis means an extraordinary change in world views, the reconfiguration of a national world view (BECK, 2018, position 142). More than that: a metamorphosis of the world is something that happens; it is not a program. A “metamorphosis of the world” is a descriptive expression, not a normative one (BECK, 2018, position 348).

Interestingly, Beck (2018, position 120) reviewed his characterization of the “global risk society” because the so-called “metamorphosis theory” does not deal with the negative side effects of ‘goods’, but rather the positive side effects of ‘bads’.

These produce normative horizons of common goods and propel us beyond a national framework, towards a cosmopolitan perspective. What draws the most attention in the panorama Beck presents, and that applies to the novel coronavirus pandemic is:

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> [...] all the images we have of the world are withering, [and] that can mean two things: firstly, the images of the world have lost their certainty, their dominance. Secondly, no one can escape the global [reality]. This global or cosmopolitized reality is not just: 'out there'. It constitutes the strategic reality we all live in. (BECK, 2018, position. 128. Our translation.)[1]

Beck may have had a premonition because the novel coronavirus is effectively surpassing any prediction of any global movement that could have been imagined before COVID-19. Metamorphosis, when also understood as a global revolution of side effects in the shadow of wordlessness, provokes a chain reaction (BECK, 2018, position 514) of failed institutions in the full splendor of their functionality.

COVID-19 has created a new range of unknowns. Delays in keeping abreast of this health emergency result in death. This is a definitive and irreversible point that it seems Ulrich Beck had not imagined when he wrote his ideas about the "metamorphosis of the world". This is a dramatic situation to be faced with the intelligence and innovation that are inherent to human beings, and the law. This is the challenge that jurists must address. The "metamorphosis of the world" precipitated by the novel coronavirus, divided the world of the Fourth Industrial Revolution (the one in force until mid-December 2019) from the "new" world (the one that emerged at the end of December 2019, with the COVID-19 disease). This is the "real world", the raw material for the Law System to observe, perceive, react to and produce new legal structures to protect the rights and duties upheld by the Democratic State of Law, based on the 1988 Brazilian Constitution. A very important gap has opened up, in which the Law can re-signify the process of creating the legal system. Similarly, one needs to open up to the future and not just photograph the past.

[1] Original translation in Brazilian Portuguese: "[…] todas as imagens que se tenha do mundo estão definhando, o que pode signifcar duas coisas: primeiro, as imagens do mundo perderam sua certeza, sua dominância. Segundo ninguém pode escapar o global. Esse global, ou seja, a realidade cosmopolizada, não esta apenas: 'lá fora', mas constitui a realidade estratégica vivida de todos"

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4 USING NANOTECHNOLOGY TO COMBAT THE PANDEMIC, THE ECONOMY, AND OTHER POSSIBLE ISSUES

According to a recent publication by Cass Sunstein (2020): "[...] researchers emphasize that their numbers depend on assumptions". That is to say, it will be necessary to run different scenarios and exercises to come up with alternatives for equating the relationship between costs and benefits (SUNSTEIN, 2020). In the current situation of global urgency due to the pandemic, everything is very provisional. No one has the correct answers. Appropriate questions are missing and, as a result, projecting information onto the scenario will be a formidable task.

According to Luciano Floridi (2015), if someone only has a question but no answer, then it is uncertain. In other words, uncertainty is what erases a correct answer to a relevant question. That is why, in information theory, from the perspective of Floridi (2015), the value of information is often discussed in terms of the amount of uncertainty that it decreases. The more information you have, the better you can shape your environment and control its development, and the more advantages you can enjoy over competitors who do not have this access. As every person finds information valuable and uncertainty uncomfortable, one can try to generalize and declare uncertainty in absolute terms: having only relevant questions is always bad, whereas adding the right answers is always good. Information is valued precisely because it reduces uncertainty. Herein, we find a point of connection and communication between the themes presented in this section.

A structuring element of the “metamorphosis of the world” (BECK, 2018), has been aggravated by the global health emergency. This is the economic crisis caused by the coronavirus pandemic that can lead more than 500 million people to poverty unless urgent action is taken to help developing countries. OXFAM (2020), a civil society organization that operates campaigns, programs, and humanitarian aid in about 90 countries, published a report with this alert on April 9, 2020. The report used estimates from the World Research Institute of Economic Development and

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from the University of the United Nations that were organized by researchers from King's College London and the National University of Australia.

Globally, only one in five unemployed people has access to benefits such as unemployment insurance. Two billion people work in the informal sector around the world - 90% in poor countries and only 18% in rich countries.

According to the same report, in Brazil, the situation is even more worrying due to precarious housing, a lack of basic sanitation and water supply, and the limited access to essential services that the poorest nationals face. About 40 million Brazilian workers have no formal work contract and about 12 million are unemployed. It is estimated that the economic crisis caused by the coronavirus has added at least 2 million people to the unemployed population (OXFAM, 2020). These data reveal a new side of the "metamorphosis of the world" (BECK, 2018).

In any case, given the absence of scientifically proven treatment[2], the slow start of the vaccination campaign in Brazil, and the current reduced availability of vaccines for the entire population, it seems that social distancing or isolation is still the best "remedy" and prevention against the COVID-19 virus. Even from an economic perspective. We already had the experience of the Spanish flu in 1918. Together with a team of researchers, an economist from MIT (CORREIA; LUCK; VERNER, 2020) recently compared the economic proportions of the novel coronavirus pandemic with those of the economic model in force in the United States in 1918 at the time of the Spanish flu. They found that cities that intervened earlier

[2] The Brazilian Academy of Sciences (Academia Brasileira de Ciências) and the National Academy of Medicine (Academia Nacional de Medicina) have issued a warning that, currently, the indiscriminate use of chloroquine (CQ) and hydroxychloroquine (HCQ) for the treatment of COVID-19 has no basis in robust scientific findings nor publications from the best scientific journals worldwide. No results from clinical studies about these two drugs anywhere in the world, with adequate numbers of patients and the best scientific practices, are available. Their use in the treatment of patients with Covid-19 should be restricted to expert care, with the patient's or family's consent and careful medical follow-up. More than once, medical science has already demonstrated that the hasty use of medicines based only on preliminary results, intuition or the simple desire to help people, in a large population, without due experimental proof of effectiveness or a treatment and safety scheme, can have serious and irreparable consequences for the population. Additionally, the widespread use of a medication with effects that are not clearly understood can negatively impact the peogress and testing of other compounds that may be more effective. Joint note from the Brazilian Academy of Sciences and the National Academy of Medicine. Available at: http://lqes.iqm.unicamp.br/images/em_pauta_novidades_3064_ABC_covid.pdf. Accessed on April 15, 2020.

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and more aggressively did not perform worse; on the contrary, they grew faster after the end of the pandemic. According to these authors, the results indicate that non-pharmaceutical interventions (NPI) not only reduce mortality but can also mitigate the adverse economic consequences of a pandemic. The MIT Technology Review recently published another article with similar reasoning (ROTMAN, 2020).

An important point that contextualizes the "metamorphosis of the world" (BECK, 2018) is that human life is still a priority. In crucial times it must be saved, and technology may not be able to address this. The decision-making should remain with humans themselves, albeit guided by the protection of (our) Human Rights. This is the basis that the Inter-American Commission on Human Rights (IACHR) has established, in conjunction with the Organization of American States (OAS), when they redacted the previously mentioned Resolution no. 1/2020 (IACHR; OAS, 2020).

Therefore, when in doubt, decision-making should protect human life. This is a major structuring element of Human Rights. The economy can be rebuilt or saved, but lost lives cannot be saved afterward.

Nanoparticle research may help us cope with one of the causes behind the spread of the COVID-19 disease: the viral contamination of surfaces. With this aim, the São Paulo company NANOX has published investigations and reports on its website about the antibacterial effect of silver. The company has dedicated itself for some time to the use of nanotechnology: "[...] the efficiency of silver as an antimicrobial agent has been recognized and studied for many years." (NANOX, 2020). However, the:

> [...] efficiency against the virus is still an object of scientific study and there are too few official protocols to attest to the universal efficiency that is already recognized against fungi and bacteria. This is mainly due to the high genetic variability in a viral population. (NANOX, 2020)[3]

[3] Original text in Brazilian Portuguese (BP): "[…] sua eficácia versus vírus é ainda objeto de estudo científico e carece de protocolos oficiais para atestar sua eficiência de maneira universal, como se faz contra fungos e bactérias, principalmente devido à grande variabilidade genética dentro de uma população viral"

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They found that "[...] scientific research has reported the successful use of silver in antiviral therapies, thus showing the possible antiviral potential of this active agent and its promise as a preventive weapon against COVID-19." (NANOX, 2020) [4]

Another Brazilian researcher (BERTI, 2020), has highlighted some contributions of the nanoscale or nanoforms amid the pandemic. First, the researcher stresses that we are in a "war"; an urgent and exceptional situation occurring between two worlds, the macro, and the nano. "Not a conventional war, but a war between the macro and molecular worlds, more specifically against trillions of soldiers in the form of highly efficient and infectious molecular machines, called viruses."[5] (BERTI, 2020). Here one can see something that has been repeated in many other publications: nanoparticles operate with a different physical and chemical perspective than particles on a larger scale. According to the same author (BERTI, 2020), viruses are: "[...] molecular machines measuring between 120 and 160 nm (nanometers) [It is worth remembering that 1 nanometer equals a billionth part of 1 meter] that act in a different world from ours; an invisible enemy from an unknown world"[6]. He makes an important warning that has not yet been well understood:

> [...] the nanoworld has rules and physical phenomena that are very different from our macroworld. That alone feels odd and puts us in a vulnerable position since, besides everything else, the macroworld contains the nanoworld. In other words, the whole of the nanoworld makes up the macroworld. We are part of a unique context and, due to a simple dimensional fact, our weapons of defense come from the macroworld and do not directly target the nanoworld. (BERTI, 2020)[7]

[4] Original text in BP: "[...] estudos científicos têm reportado o uso da prata com sucesso em terapias antivirais, mostrando assim o potencial deste princípio ativo como um possível virucida e uma possível arma de prevenção contra o COVID-19."

[5] Original text in BP: "Não uma guerra convencional, mas uma guerra do mundo macro com o mundo molecular, mais especificamente contra trilhões de soldados em forma máquinas moleculares altamente eficientes e infecciosas, chamadas vírus."

[6] Original text in BP: "[...] máquinas moleculares que tem entre 120 e 160 nm (nanômetros) [Vale lembrar: 1 nanômetro que equivale à bilionésima parte de 1 metro] atuam em um mundo diferente do nosso, um inimigo invisível de um mundo desconhecido".

[7] Original text in BP: "[...] o nanomundo tem regras e fenômenos físicos muito diferentes do nosso macromundo. Isso por si só já causa estranheza e nos coloca em posição vulnerável, pois além de tudo o nanomundo está contido no macromundo, ou seja, o conjunto do nanomundo é que compõe o macromundo. Fazemos parte de um contexto único e nossas armas de defesa são do macromundo, por um simples fato dimensional e não atingem diretamente o nanomundo".

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What weapons are available in a war scenario? Berti explains the possibilities that people in real and macro-scale society will be able to use. We will have to position our “good soldiers of the nanoscale” at strategic points, such as surfaces. These nanosoldiers, equipped with photocatalytic capacity, can be applied to any surface and inactivate viruses that come into contact with them” (BERTI, 2020). A fundamental question arises: who would these nanosoldiers be? "Photocatalytic semiconductor nanoparticles such as titanium dioxide (TiO2), a powerful photocatalyst that produces free electrons in sunlight, and destroys any organic material or dirt on surfaces". With this solution, it would be possible to protect private and urban public spaces, creating the opportunity to gain important territory in this war (BERTI, 2020). Moreover, Berti states that another fundamental piece of equipment in this battle is the rapid tests that use nanosoldiers to accurately count the number of effective enemies in an affected person's body. These nanosoldiers can visually demonstrate the level of enemy infection. With this information, the health system would be able to allocate more attention to the patients who effectively need more attention and more intensive care (BERTI, 2020).

As mentioned previously, in addition to studying the use of nanotechnology to develop products that eliminate viruses from surfaces and clothing, nanoscale research has sought to invent products that can prevent, detect, diagnose and treat viruses, especially in this pandemic. These researches, that connect nanotechnology and COVID-19, have been united in the Projeto Observatório de Interações Nano/Covid-19 – OINaCov, a project from Laboratório de Química do Estado Sólido – LQES of UNICAMP. So, the following paragraphs discuss the most recent news about the researches found in this project (ALVES, 2021).

Atomic force microscopes have been used in COVID-19 research. The aggregated nanotechnology allows viral particles of 62 nanometers to be seen. This has provided a better understanding of virus behavior (BARILLE, 2021). SPR-based biosensor platforms have been used to detect biochemical interactions in real-time, and to research COVID-19 and its changes (BARILLE, 2021).

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To prevent COVID-19, bioengineers from the Indian Institute of Science explained that a combination of biomaterials and nanotechnology can lead to the creation of more effective vaccines against the virus, especially nanoparticles based on biomaterials, to stimulate cells to produce more antibodies (BIOMATERIALS, 2020).

In the field of diagnosis, there is the nanotechnological CRP (C-reactive protein) test, created by the Centro de Estudios Avanzados (CEA) in Cuba. This test uses magnetic particles to extract the RNA (ribonucleic acid) from COVID-19, and determine whether the result for viral infection is positive or not (PRENSA LATINA, 2021).

These are examples of how the "metamorphosis of the world" has gained one more component: nanoparticles. Therefore, in addition to Ulrich Beck's characterization, it will be necessary to understand, know and regulate a component that operates on different logic and is from another "dimension": the nanoworld.

According to Schwab and Malleret, the post-COVID 19 world will be considerably affected by radical and exponential changes, and the disruption resulting from the Fourth Industrial Revolution will gain more speed (SCHWAB, MALLERET, 2020).

The authors also explain that the main structural characteristics of the world today, that assist with these changes, can also significantly influence the future, namely: 1) the interdependence of disciplines that has prevented researchers from crossing the frontiers of their own disciplines to seek joint solutions to the various challenges of the pandemic; 2) the speed at which things develop in the world today, among them technology and, in particular, the spread of the COVID-19 virus and the progression of the disease in the world. No one who makes important decisions in the reality of the pandemic has the time to properly analyze complex problems; 3) the complexity that limits our knowledge and understanding of things, and surpasses our ability to understand in general, hinders well-informed decisions (SCHWAB, MALLERET, 2020).

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In this sense, the Law is an important part of the reality of the pandemic, since it has had to deal with all the obstacles of the 21st Century that Schwab and Malleret described. The Law has had to solve existing challenges and, nowadays, these are much more accentuated, with a tendency to be more complex.

This is in line with the thinking of Benoit Frydmann (2018) when he emphasizes that jurists must urgently emancipate themselves from "very narrow, formal and rigid" legal concepts. Rather, they should turn their attention to a "broader field of normativity, in all its diverse forms and techniques". From then on, guided along a spectrum of interdisciplinarity, it will be up to the jurist to realize that "[...they] will not be the only one occupying this [legal] area, where they will be called to work and have dialogues [...] with the sociologist, the economist, the administrator, and the engineer, and also the philosopher" (FRYDMANN, 2018, p. 94).

This panorama will be essential to re-signify and reposition the Law before the inherent obstacles of the Fourth Industrial Revolution and, more contemporarily, to usefully participate in solving the present and future repercussions arising in the wake of the global COVID-19 pandemic. Rocha explains that Law cannot be observed only as Law:

> But to observe the Law, I cannot observe it only as Law. I must see it articulated with and folded into other fields of knowledge. However, this must not be seen as a chaotic situation, as if I did not fully understand what the frontiers between Law, biology, or politics were. There must be certain criteria for the observation. In other words, one must observe the Law within a complex society. If one does not do so, one observes nothing. I dare say there is no other alternative. (ROCHA, 2006, p.189).[8]

The search for answers to the challenges arising from the COVID-19 pandemic must involve different areas of knowledge, and always be guided by

[8] Original text in PB: "Mas para se observar o Direito, não posso observá-lo somente como Direito, tenho que vê-lo imbricado, envelopado com as outras áreas do conhecimento. Porém, é preciso observar-se isso, não como numa situação caótica, onde não sei bem os limites do que seja Direito, biologia ou política. Precisa-se realizar uma observação com certos critérios. Ou seja, é preciso observar-se o Direito dentro de uma sociedade complexa. Se não se observar o Direito dentro de uma sociedade complexa, não se observa nada. E digo mais, não há outra alternativa."

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constitutional principles. The ones that prioritize the protection of man and the environment.

5 FINAL CONSIDERATIONS

In his book "The time of Law", François Ost wrote that: "[…] Modernity was based on the triple postulate of a future that would be radically new, resolutely better than the past, and produced entirely by human will. Today, these certainties falter [...]" (2001, p. 324-326). He was referring to a different world. Probably the one before the Fourth Industrial Revolution. In this study, the aim was to present some small pieces from various spheres that have been confronted and challenged by the "nanoworld"; a realm where the global pandemic of the novel coronavirus is precisely structured. Ost went on to say that (2001, p. 326): "[…] Scientific objectivity is called into question, in the same way as the universality of our ethical resolutions. Our representations of the world are affected by relativity, our certainties shaken. […]". He presents the effects of the "metamorphosis of the world" that were characterized by Beck (2018), and the nanochallenges generated by the nanoworld.

As for the problem outlined in the Introduction: "how can technologies and scientific knowledge insert themselves into the structures of the Fourth Industrial Revolution to assist with the global pandemic and its present and future effects, while respecting (our) Human Rights?", we have presented some provisional references and a question that will remain open, awaiting more data and information.

Nevertheless, it is clear that the new social, economic, and legal risks brought about by the COVID-19 global pandemic, require adequate communication between the different systems of society. Especially given the risks in people's lives and in the continuity of the various legal relationships that they maintained before feeling the effects of the global declaration of the pandemic. On the other hand, potentially successful communication among fields would not occur to an equal extent in all functional spheres. Based on this premise, one must consider the

differentiated needs and means of communication of each system (LUHMANN, 1992).

Given the countless new challenges of the COVID-19 pandemic, and since Law is an applied social science, the production of its knowledge must always be contextualized by social questions instead of being restricted to theoretical discussions without any connection with the factual world. Therefore, not only legal science but other sciences as well, must emerge from their cocoons and put one-dimensional blindness aside to seek support from other areas of science.

Finally, just as mentioned at the beginning of the article, we are living in strange times, in social isolation, and hoping that the different social systems will be able to overcome the improbabilities of inter-systemic communication to act together. The goal is to guarantee global environmental health (human and environmental), as part of a broader concept of environmental sustainability, in pursuit of the sustainable development objectives of the UN 2030 Agenda. Especially objective number 3, which aims to ensure health and well-being for all, while never forgetting to protect (our) Human Rights.

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