SARS-CoV-2 as a Trigger of Technological Transformation

El SARS-CoV-2 como detonador del cambio tecnológico

Sergio Octavio Contreras Padilla
Director of the Research Center at the Zacatecas Institute of Transparency, Information Access and Personal Data Protection
scontrerasp@gmail.com

Abstract:
This article discusses how the SARS-CoV-2 pandemic has accelerated technological transformation, both in terms of combating the disease and countries' economic, educational, political, and working environments. Yet not all countries have been able to adapt effectively and run the risk of being definitively excluded from the "technological promise" that seemed so elusive even before the pandemic.

Resumen:
Se analiza la manera en que la pandemia provocada por el SARS-CoV-2 ha acelerado la transformación tecnológica, tanto para enfrentar a la enfermedad como también lo que hace a la dinámica laboral, política, educativa y económica de los países. Sin embargo, no todos los países se han podido adaptar de la misma manera y se corre el riesgo de que millones de personas en todo el mundo que ya estaban excluidas de la "promesa tecnológica" queden marginadas definitivamente.

Key Words:
Pandemic, SARS-CoV-2, technological transformation, education, health, social inclusion, social exclusion.

Palabras clave:
Pandemia, SARS-CoV-2, cambio tecnológico, educación, salud, inclusión social, exclusión social.

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The outbreak of a new coronavirus reported in late 2019 in a market selling seafood and exotic animals in Wuhan, China, marked the beginning of a global crisis that has instigated far-reaching changes to our social practices. Initial studies identified the new pathogen as the SARS-CoV-2 virus, which causes the disease known as *coronavirus disease 2019* (COVID-19).[1] Scientists discovered that one of the main ways the virus is transmitted is via physical contact in the form of droplets of saliva expulsed when people talk or breathe. International and local health authorities subsequently recommended social distancing, hand washing, precautions when coughing or sneezing, temperature control and the use of PPE, such as masks.

On March 11, 2020, the World Health Organization (WHO) declared that the novel coronavirus outbreak had escalated into a pandemic. Governments took a variety of measures to prevent the virus spreading, such as closing schools and businesses, and restricting travel. Certain Asian countries like China, Japan, Taiwan and Singapore started using invasive technologies like thermal cameras in public spaces, GPS systems and applications to track the movements of people using public transportation, while companies

[1] Roujian Lu, Xiang Zhao, Juan Li, *et. al*., "Genomic Characterisation and Epidemiology of 2019 Novel Coronavirus: Implications for Virus Origins and Receptor Binding", in *The Lancet*, vol. 395, no. 10 224, January 30, 2020, 565-574, at *http://dx.doi.org/10.1016/S0140-6736(20)30251-8* (date of reference: November 12, 2020).

began adopting home office modalities. Yet the virus continued to spread and people continued dying from the disease throughout the rest of the year. By late 2020, according to official figures reported by the Coronavirus Resource Center at the prestigious Johns Hopkins University, the number of people infected worldwide had exceeded 78 million and the disease had claimed close to two million lives.[2]

During the early months of the pandemic, international agencies like the Organization for Economic Cooperation and Development (OECD) recommended authorities employ new information and communication technologies (ICTs) to mitigate the impact of the health crisis. These digital technologies support the organization of modern societies by structuring production, consumption, experience and power relationships into networks.[3] Network technology of this kind facilitates remote communication, meaning interlocutors need not coincide in time or space. The majority of our material and symbolic production processes require human interaction, but thanks to the Internet and its innovations, in a short time, these social interactions were able to recommence despite social distancing. The COVID-19 pandemic served to accelerate the integration of devices connected by the Internet into daily activities impacted by lockdown.

This digitalization of our lives triggered by the health crisis also triggered improvements in the software and hardware of available technologies. ICTs include computers and equipment for the processing, transmission, modification and storage of data, but also for applications, connected devices, mobile phones, smart televisions, drones, the Internet of Things, video games, etc. In the midst of the health crisis, research and innovation centers were forced to accelerate the adaptability of artefacts, and invent new devices and applications to address the new normal. Governments made use of digital tools to keep public services functioning, maintain communication with the public and handle the health crisis in a transparent fashion. People found new ways of using technology to facilitate their daily lives: students were able to continue their classes on digital platforms, employees worked from home, businesses offered their products on social

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[2] Figures as of January 28, 2021: 100 998 542 people infected and 2 177 819 deaths.

[3] Manuel Castells, *La galaxia internet*, Barcelona, Alianza Editorial, 2001, 15-17.

media and electoral processes were able to proceed thanks to the Internet. In this context, we need to look at the transformation new technologies underwent during the health contingency and the social practices derived from digitalization.

This paper focuses on technological transformation in the area of information and communications systems, but it should be noted that the most significant technological breakthroughs prompted by the pandemic were in the field of health. On January 8, 2020, the characteristics of the first genome of the 2019-nCoV virus were shared on an open database. At least 183 research centers pooled their knowledge of the sequences of the variants of the SARS-CoV-2 virus on the National Library of Medicine platform. The pharmaceutical industry and 172 countries focused their efforts on finding a cure for COVID-19. According to the Pan American Health Organization (PAHO), as of December 2020, 200 vaccines were under development worldwide. Of this figure, 50 were already being tested on human subjects. Governments entered into pre-purchase agreements and partnerships with other States and companies to secure the acquisition and distribution of immunization technologies. A year since the pandemic was declared, the most advanced vaccines include BNT162b2, developed by Pfizer and BioNTech, Moderna's MRNA-1273, Ad26.COV2.S, developed by Johnson & Johnson, Novavax's NVX-CoV2373, AZD1222/ChAdOx-1, developed by AstraZeneca and Oxford University, CSK SARS-COV-2 by Sanofi and GSK, CVnCoV by CureVac, Ad5-nCoV by CanSino Biologicals and Sputnik V, developed by Russia's Gamaleya Research Institute.

Technological transformation

One of the first theoreticians to analyze the effect of technological change on capitalist societies was the German thinker Karl Marx,[4] who viewed the material evolution of the instruments humankind uses as an uninterrupted movement that allows for the automation of the operations in a

[4] Karl Marx, "Cuaderno V. Las máquinas", in *Progreso técnico y desarrollo capitalista (manuscritos 1861-1863)*, Mexico, Siglo XXI, 1982, 77-106.

process, accentuates the division of labor, simplifies the task of the worker in the workshop, leads to a greater concentration of capital and disarticulates man. In Marxist theory, technology experiences diverse metamorphoses, like the steam engine that gave rise to the Industrial Revolution and sparked radical changes in the way material goods are produced. As such, technological change can be understood as the application of new knowledge or information within a productive process to improve the use of the resources employed and the results obtained.

Some studies see technological change as a catalyst of social transformation. Robert Solow deems improvements to devices as a source of economic wealth,[5] while Thomas Hughes sees them as a type of power,[6] and Robert Heilbroner as the main driver of social history.[7] In the twentieth century, the formidable machinery of industrialism gradually lost ground to new inventions like electric engines and the development of informatics. Electricity, the miniaturization of instruments and digital computer language marked the beginning of what some consider a new technological revolution. In the last 50 years, the development of the Internet and the advent of a great many ICT-related innovations have ushered in profound changes in the technical ecosystem. Medicine has been one of the sciences to benefit most from these new technologies.

Today's technological change is a global occurrence, but one whose impact on societies has varied. The globalization of technology makes it possible to exchange information and know-how, but it also creates new differences and inequalities.[8] And while new technologies foster interculturality, they can also encourage individualism, the subjectivity of knowledge and the evasion of reality. The availability of innovations is generally inclusive and at the same time exclusive. Inclusion refers to the entire

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5 Robert Solow, "A Contribution to the Theory of Economic Growth", in *The Quarterly Journal of Economics*, vol. 70, no. 1, January-February 1957, 65-94.

6 Thomas Hughes, *Networks of Power: Electrification in Western Society, 1880-1930*, Baltimore, Johns Hopkins University Press, 1983, 461-465.

7 Robert Heilbroner, "¿Son las máquinas el motor de la historia?", in Merritt Roe Smith and Leo Marx (eds.), *Historia y determinismo tecnológico*, Madrid, Alianza Editorial, 1996, 69-82.

8 Néstor García Canclini, *Diferentes, desiguales y desconectados. Mapas de la interculturalidad*, Barcelona, Gedisa, 2005, 13.

population that has access to the new devices. According to Internet World Stats, in 2020, 63.2% of the world's inhabitants were Internet users,[9] while the 2019 National Survey on the Availability and Use of Information Technologies in Homes, conducted by the National Institute of Statistics and Geography (Inegi), revealed that 70.1% of the Mexican population had access to the Internet.[10] As regards exclusion, this can be conceived as a gap or divide among individuals, homes, economic and geographical areas with different socioeconomic levels in terms of their opportunities to access ICTs and their use of the Internet to perform a wide variety of activities.[11] The health crisis caused by the novel coronavirus highlighted the technological strengths and weaknesses of States and social and economic inequality has also come to be equated with inequalities in the availability of and access to technology. Despite progress in connectivity, a large portion of society has still not integrated ICT-derived practices into their daily lives.

Inclusion and exclusion are both components of the relationship between society and technology. According to Langdon Winner, technology ultimately represents a scenario of power in that it has become a crossroads of manifold political, economic and cultural interests.[12] One of these new crossroads is the relationship between society and technology, and the pandemic. The outbreak of SARS-CoV-2 has made it necessary to attempt to determine whether or not these relationships have triggered improvements in ICTs and their practices. Empirical evidence suggests they have. Recent transformations in digital technology are the result of interests fueled by scientific knowledge, the economy and politics. The design of applications, geopositioning, the use of drones, special cameras, modern social media chatrooms, artificial

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9 "World Internet Usage and Population Statistics 2020", in Internet World Stats, December 31, 2020, at *https://www.internetworldstats.com/stats.htm* (date of reference: February 8, 2021).

10 "Encuesta Nacional sobre Disponibilidad y Uso de Tecnologías de la Información en los Hogares (ENDUTIH) 2019", in Instituto Nacional de Estadística y Geografía, February 17, 2020, at *https://www.inegi.org.mx/programas/dutih/2019/* (date of reference: November 12, 2020).

11 María del Carmen Agustín Lacruz and Manuel Clavero Galofré, "Indicadores sociales de inclusión digital: brecha y participación ciudadana", in Fernando Galindo and Aries J. Rover (eds.), *Derecho, gobernanza y tecnologías de la información en la sociedad del conocimiento*, Zaragoza, Prensas Universitarias de Zaragoza, 2009, 143-148.

12 Langdon Winner, *La ballena y el reactor*, Barcelona, Gedisa, 2008, 68-81.

intelligence, new streaming services and the extension of network storage capabilities are just a few examples of the changes new technologies have undergone during the pandemic.

Technology and the new normal

During the SARS-CoV-2 health crisis, the political system used the expression "new normal" to denote the gradual return to everyday activities brought to a halt by the lockdown. In the early months, the term alluded to a post-quarantine phase; however, as time passed and no effective treatments were found, the new normal came to refer to a post-pandemic era. During this phase, the health measures imposed were prolonged until they became part of daily life. First used in the United States during the credit crisis of 2007-2008, the term *new normal* was coined by Bloomberg News journalists Matthew Benjamin and Rich Miller in their article "Post-Subprime Economy Means Subpar Growth as New Normal in U.S.", published on May 18, 2008. In their article, Benjamin and Miller say American society needs to get used to a new definition of "normal". In the years to follow, "new normal" was used to refer to economic events, like China's economic slowdown of 2012.

On speaking of "normal", it is useful to consider the thoughts of the French philosopher Michel Foucault, who says ours are societies of normalization, where the rules that regulate individuals are linked to the mechanisms used to govern populations.[13] According to his theory, in capitalist societies, power is exercised by applying laws and public policies to human life. Foucault believes that, via established apparatus, practices, ideologies and the repetition of behaviors, "normal" is naturalized without being questioned.[14] By the same token, Winner says that technological innovations can be likened to laws or political foundations that establish a pattern for public order that will endure for many generations. In the throes of the COVID-19 pandemic,

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[13] Michel Foucault, *Seguridad, territorio, población*, Buenos Aires, Fondo de Cultura Económica, 2006, 73-108.

[14] Michel Foucault, *Vigilar y castigar*, Mexico, Siglo XXI Editores, 2009, 9-40.

"new normal" is peppered with the political decisions made by States to protect their interests and their citizens, and check the economic crisis, but it is also shaped by the decisions of individuals and relevant social groups as they attempt to adapt available technologies to the emerging social order.

Technological change

The dissemination of technology has an effect on society, but that effect differs depending on the context. It has been proven that, during the first years following their introduction, the impact of new technologies on society is very visible. These tend to be impacts that bring benefits or that do good—devices that have the capacity to improve people's lives, solve social problems, make it possible to perform certain activities with fewer resources, etc. It is in this context that the World Summit on the Information Society, held in Tunisia in 2005 by the United Nations Educational, Scientific and Cultural Organization (UNESCO), was called. At this summit, it was concluded that the generation of knowledge is vital to the development of ICTs.[15] Conversely, heretofore invisible secondary effects appear over the long term and are generally negative.[16] For example, the automobile became a problem decades after its invention due to the high levels of environmental pollution it causes. In this regard, all technological development processes can be said to have both positive and negative impacts on society.

Globally, the pandemic has favored technological change by complementing or replacing production processes that required face-to-face interaction, while exposing a myriad of primary impacts gradually integrated into individual, group and institutional practices. During the first year of the SARS-CoV-2 outbreak, we witnessed technological progress in areas related to social practices: the digitalization of daily activities, educational innovations, home office tools, telecommunications improvements, business applications, etc. As entire countries retreated into quarantine, people managed to combine practices

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15 "The World Summit on the Information Society: Outcome Documents", in Unión Internacional de Telecomunicaciones, December 1, 2005, at *https://www.itu.int/net/wsis/index.html* (date of reference: September 10, 2020).

16 Rudi Volti, *Society and Technological Change*, New York, Worth Publishers, 2014, 21-37.

from the physical world with habits involving new information technologies. Technical improvements were also developed in technological production spaces invisible to social practices, with equipment, devices and programs being redesigned or manufactured to cater to the new normal.

The Internet and telecommunications

In the telecommunications industry, several reports postulate that, despite the economic crisis, the pandemic has accelerated the expansion of fifth-generation mobile phone technologies known as 5G. This new network allows devices to navigate at 10 gigabits a second, reduces the response time between devices connected to the Internet and allows information to be transmitted at high speed in real time. In late 2019, the first commercial networks using this technology were set up to substitute 4G networks. According to reports by Ericsson, there will be 220 million 5G connections by year-end 2020, *i.e.* 30 million more than projected at the beginning of that same year.[17] Likewise, Statista projects more than 75 billion devices will be connected worldwide by 2025,[18] while a Qualcomm Technologies study predicts that the number of 5G tech-related jobs will increase from 22.3 to 22.8 million in the next 15 years.[19]

In Europe, a study conducted by Comscore revealed growth in the use of the Internet, mainly for digital interaction and activities related to entertainment and leisure.[20] In Spain, the use of social media increased 55%, in Italy,

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17 "More than 1 billion people will have access to 5G coverage by the end of 2020 globally", in Ericsson, November 30, 2020, at *https://www.ericsson.com/en/press-releases/2/2020/11/more-than-1-billion-people-will-have-access-to-5g-coverage-by-the-end-of-2020* (date of reference: December 4, 2020).

18 "Internet of Things (IoT) Connected Devices Installed Base Worldwide from 2015 to 2025", in Statista, November 26, 2016, at *https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/* (date of reference: October 11, 2020).

19 Qualcomm, "5G Economic Opportunity Proves Resilient", press release, November 17, 2020, at *https://www.qualcomm.com/news/releases/2020/11/17/5g-economic-opportunity-proves-resilient* (date of reference: December 1, 2020).

20 "Consumo de medios durante la pandemia de coronavirus", in Comscore, March 17, 2020, at *https://www.comscore.com/lat/Prensa-y-Eventos/Blog/Consumo-de-medios-durante-la-pandemia-de-coronavirus* (date of reference: November 12, 2020).

30%, the United Kingdom, 18%, France, 14% and Germany, 11%.[21] Similarly, in the United States, a study by *The New York Times* pointed to an increase in video interactions. Platforms like Zoom and Skype were used by universities, companies and government offices so students and employees could continue to work from home, while the use of computers to consult information on Facebook increased 27%, to watch movies or series on Netflix 16% and direct events on YouTube 15.3%.[22] In Latin America, the consulting firm Shareablee estimates Internet traffic increased 30% and the same trend was seen on fixed networks, as was the case in Colombia and Ecuador.[23] According to Speed Test, data upload traffic increased 80%.[24] In Brazil, the Núcleo de Informação e Coordenação do Ponto BR (NIC.br) reported a record 10 terabits transferred a second on March 18 and 19,[25] and in Mexico, Izzi and Movistar estimated that demand for Internet services increased 40%.[26] The most popular services were streaming, work-from-home, e-learning and video games.

According to the 2020 We Are Social report compiled in partnership with Hootsuite, total Internet users have grown by 346 million in the last 12 months,

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21 Antonio Lorenzo, "Los españoles son los europeos 'más sociales' para consumir información online sobre el coronavirus", *El Economista*, March 23, 2020, at *https://www.eleconomista.es/tecnologia/noticias/10434591/03/20/Los-espanoles-son-los-europeos-mas-sociales-para-consumir-informacion-online-sobre-el-coronavirus.html* (date of reference: August 17, 2020).

22 Ella Koeze and Nathaniel Popper, "The Virus Changed the Way We Internet", *The New York Times*, April 7, 2020, at *https://www.nytimes.com/interactive/2020/04/07/technology/coronavirus-internet-use.html* (date of reference: August 29, 2020).

23 Fernando Vega, "América Latina: el impacto mediático del coronavirus en redes sociales", in Comscore, April 3, 2020, at *https://www.comscore.com/lat/Prensa-y-Eventos/Blog/America-Latina-El-Impacto-Mediatico-del-Coronavirus-en-Redes-Sociales* (date of reference: September 19, 2020).

24 "Las oportunidades de la digitalización en América Latina frente al covid-19", in Economic Commission for Latin America and the Caribbean, July 4, 2020, at *https://repositorio.cepal.org/handle/11362/45360* (date of reference: December 14, 2020).

25 "IX.br alcança marca de 10 Tb/s de pico de tráfego Internet", in Núcleo de Información y Coordinación del Punto BR, March 25, 2020, at *https://nic.br/noticia/releases/ix-br-alcanca-marca-de-10-tb-s-de-pico-de-trafego-internet/* (date of reference: December 13, 2020).

26 Adrián Arias, "Crece 40% demanda de internet en México por covid-19", *El Heraldo de México,* April 3, 2020, at *https://heraldodemexico.com.mx/economia/2020/4/3/crece-40-demanda-de-internet-en-mexico-por-covid-19-165035.html* (date of reference: December 13, 2020).

which is equivalent to inter-annual growth of more than 8 percent. This means that an average of 11 new users connected for the first time every second in the last year.[27] The pandemic also drove higher consumption of streaming contents than in 2019. For platforms like Netflix, Prime Video and Disney Plus, this translated into more subscribers and higher revenues. The figures revealed that 40% of Internet users spent more time on social media and one in seven people uploaded more videos in this period than before the health crisis. Also, more than 80% of smart phone users said the Internet was instrumental in helping their children continue their studies (76%), enabling them to keep in touch with friends and family (74%), and improving their health (43%). An increase in the use of smartphone apps, instant messaging services, video games and podcasts was also reported.

Education and economy

As regards education, according to UNESCO, 1.37 billion students and young people the world over were affected by the closure of schools and universities in the first half of de 2020. Also, 60.2 million teachers were forced to leave their physical classrooms.[28] Education ministries attempted to mitigate the effect of the pandemic using whatever they had at hand, coming up with new strategies on the go. For teachers, the workload was heavier than usual as they found themselves having to master platforms, learn to use applications, create contents, etc. Parents had to guide their children in their distance-learning activities, while governments drew on a variety of resources, such as the provision of educational packages, the broadcasting of educational programs on radio and television, and Internet-based classes and learning materials. During the pandemic, ICTs were the tools most widely used by ed-

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27 Simon Kemp, "Digital Use Around the World in July 2020", in We Are Social, July 21, 2020, at *https://wearesocial.com/blog/2020/07/digital-use-around-the-world-in-july-2020* (date of reference: November 7, 2020).

28 UNESCO, "1.37 billion students now home as COVID-19 school closures expand, ministers scale up multimedia approaches to ensure learning continuity", March 24, 2020, at *https://en.unesco.org/news/137-billion-students-now-home-covid-19-school-closures-expand-ministers-scale-multimedia* (date of reference: September 4, 2020).

ucational systems. In Estonia, Internet service providers offered schools platforms free of charge; in France, the Ma classe à la maison system was put at the disposal of elementary students, and in Greece, teachers gave classes in real time.[29] Existing technologies were adapted to new uses—smart phones became educational forums, video chat platforms like Skype and Google Meet the new online classrooms, and companies like Facebook and Microsoft created distance-learning chatrooms. Some countries, including Denmark, Finland, Sweden, Iceland, Norway, Latvia and Lithuania, put their digital-learning platforms at the disposal of the international community.

According to the World Bank (WB), the pandemic has caused the most severe economic recession since the Great Depression. In Latin America and the Caribbean, improvements to the productive system involve technological innovations and changes that could put jobs at risk throughout the entire region.[30] COVID-19 served to accelerate the far-reaching labor transformations that have become evident in recent decades. For many developing countries, the chances of achieving a higher level of industrialization or reindustrialization are limited. To avert the potential loss of jobs and wages as an economic crisis loomed, sectors like commerce turned to available digital tools, such as the use of streaming to sell beverages, social media like TikTok and Instagram to reach new clients, direct transmissions, the collecting of data on consumer behavior and drones to deliver goods.

The Special COVID-19 Edition of the 2020 Global CEO Outlook study conducted by KPMG International indicates that the majority of CEOs are of the opinion that the health crisis has favored technological change at their

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29 Fernando Raimers, Andreas Schleicher, Jaime Saavedra and Saky Tuominen, *Supporting the Continuation of Teaching and Learning during the COVID-19 Pandemic: Annotated Resources for Online Learning*, Paris, OECD, 2020, at *https://globaled.gse.harvard.edu/files/geii/files/supporting-the-continuation-of-teaching-and-learning-during-the-covid-19-pandemic.pdf* (date of reference: December 26, 2020).

30 World Bank, "Technological Revolution Accelerated by Coronavirus Crisis in Latin America and the Caribbean", press release no. 2021/035/LAC, September 28, 2020, at *https://www.worldbank.org/en/news/press-release/2020/09/28/coronavirus-revolucion-tecnologica-americalatina* (date of reference: December 6, 2020).

companies.[31] Approximately 80% said the pandemic accelerated the transformation of their operating model, while 50% said that it merely prompted them to bring forward plans already in place for the future. Of the CEOs surveyed, 67% said they would invest more in the acquisition of technology than in the development of their personnel. Despite economic uncertainty, a third project annual growth in profits of more than 2.5% at their companies over the next three years. Based on the most recent report published by the Mexican Association of Online Sales (AMVO), 55% of Mexico's Internet users purchased products online to comply with social distancing measures and the "Stay at Home" campaign. AppsFlyer estimated online sales apps saw their revenues swell by 50%. Video conferencing platforms, video and music services, online education tools and apps for daily tasks (nutrition, exercise, e-banking, etc.) ranked highest in terms of data consumption, which can be partially attributed to the fact that 82% of companies allowed their employees to work from home.[32]

Technologies and SARS-CoV-2

ICTs became the backbone of countless productive, educational and governmental activities during the health crisis, with special attention being paid to the development and adaptation of new technologies to directly address problems caused by the pandemic. According to a report published by the European Parliament, during the first few months of the outbreak, artificial intelligence (AI) was used to help identify people infected with the virus by means of CT scans of the lungs, real-time monitoring of body changes using portable sensors and the collecting of open

[31] KPMG International, "Talento y responsabilidad corporativa: principales inquietudes de los CEOs del mundo ante la pandemia de covid-19", September 3, 2020, at *https://home.kpmg/mx/es/home/sala-de-prensa/press-releases/2020/09/talento-y-responsabilidad-corporativa-principales-inquietudes-de-los-ceos-del-mundo-ante-la-pandemia-de-covid-19.html* (date of reference: December 14, 2020).

[32] "Estudio: medidas de las empresas y reclutadores frente al covid-19", in OCC Mundial, April 14, 2020, at *https://www.occ.com.mx/blog/empresas-y-reclutadores-frente-al-covid-19/* (date of reference: November 22, 2020).

code data to track the spread of the disease.[33] To avoid exposing hospital workers, China entered into an agreement with Sunay Healthcare Supply and the Danish company UVD for the provision of robots to disinfect facilities using ultraviolet light. At the Shenzhen hospital, robots performed video conferencing tasks and monitored patients and visitors' temperature, and at the Los Angeles, San Francisco and John F. Kennedy airports, a robot called GermFalcom was used to disinfect aircraft.

Algorithms to fight the pandemic

Given that physical proximity entails a higher risk of infection, automated algorithms, webcams and chatbots were designed to treat patients remotely. The WHO defines this as telemedicine, *i.e.* the use of information technologies to provide healthcare services, from diagnoses to treatments and preventive care.[34] U.S. Centers for Disease Control and Prevention and some local health systems promoted "doctors' visits" using computers, tablets and smart phones. In 2020, the U.S. Congress approved US$500 million for telehealth services, while demand for the services of companies like Doctolib, Qare, Livi, Push Doctor and Compugroup Medical increased as much as 50%. Some hospitals also implemented programs to monitor their patients' heath via the Internet, like the Sheba Medical Center in Israel. Text, audio and video technologies were all used to treat patients, like e-mail, Messenger, WhatsApp and Facebook in the first case; Telegram and phone calls in the second; and platforms like Skype, Zoom, Team and Facetime in the third.[35]

Blockchain, a technology based on a chain of blocks that have codified information on a network transaction, also came into play. In this

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[33] Mihalis Kritikos, *Ten Technologies to Fight Coronavirus*, Brussels, European Parliament, 2020, at *https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/641543/EPRS_IDA(2020)641543_EN.pdf* (date of reference: January 26, 2020).

[34] WHO, *Telemedicine: Opportunities and Developments in Member States: Report on the Second Global Survey on eHealth*, Geneva, WHO (Global Observatory for eHealth Series, 2), 2009, at *https://apps.who.int/iris/bitstream/handle/10665/44497/9789241564144_eng.pdf* (date of reference: January 26, 2021).

[35] J. Ena, "Telemedicina aplicada a covid-19", in *Revista Clínica Española*, vol. 220, no. 8, November 2020, 501-502, at *https://doi.org/10.1016/j.rce.2020.06.002* (date of reference: December 20, 2020).

new model of interaction between clients and service providers, a network of nodes verifies the authenticity of the transaction and eliminates intermediaries. Blockchain developers like Genobank and Telos created apps to facilitate private COVID-19 tests and in late July 2020, the Telos Foundation launched a mobile app that connects individuals with suppliers of coronavirus tests. When a test is done using the Telos blockchain, any link between the person taking the test and their results is eliminated, thereby guaranteeing anonymity. Privacy is further ensured by eliminating direct payments; instead, untraceable, cryptographically protected coupons are provided along with each test kit. Blockchain technology also made it possible for immigrants in several countries to get tested for coronavirus anonymously without fear of being arrested or deported.

Technological development and medicine

As the outbreak evolved into a global emergency, health systems and hospitals began to run short of supplies and medical equipment. Some governments partnered up with tech companies to guarantee their inventories, while 3D printers played a major role in covering supply gaps. This so-called additive manufacturing or rapid prototyping was first used for medical purposes in the 2000s, namely for dental implants and personalized prosthesis,[36] but the pandemic forced manufacturers to modify its applications to print essential medical supplies. In Brazil, Smart Solutions teamed up with Stratays to manufacture face shields for health workers at public hospitals in Río de Janeiro. In Spain, a group of entrepreneurs created the Coronavirus Makers collective to design, print and distribute 3D-printed PPC supplies. Working as a network using the Telegram app, by late 2020, the Makers had printed over one million face shields, almost half a million ear savers and over 52 000 masks.[37]

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[36] Amelia Ortiz Gil, "Las impresoras 3D como herramientas científicas", in *Encuentros Multidisciplinares,* no. 61, 2019, 1-8, at *http://hdl.handle.net/10486/687514* (date of reference: December 4, 2020).

[37] "Comunidad de voluntarios makers", in Coronavirus Makers, December 21, 2020, at *https://www.coronavirusmakers.org/* (date of reference: February 12, 2020).

In the event of an outbreak of a contagious disease, drones can play a vital role in monitoring its spread. Some countries chose to use them as part of their strategy to contain the COVID-19 pandemic. To perform these new tasks, manufacturers and governments had to adapt their equipment and rewrite their software. Drones were used primarily for social surveillance purposes during the quarantine, to disinfect public places, deliver food and medicines, capture thermal images via sensors, monitor road traffic and identify zones with a high risk of infection. In African countries, which face logistical problems due to deficient infrastructure networks and geographical obstacles, drones were used to transport medical supplies. In Ghana, for example, the Californian company Zipline used drones to collect COVID-19 tests at rural healthcare centers and take them to labs for processing. SMSs were used to place orders for inputs and medicines,[38] which were then transported by drones in packages that were air dropped on reaching their destination, which could be as far as 85 kilometers from the supply site. In partnership with Draganfly, Vital Intelligence and the University of South Australia, the Australian government created a project to fit drones with sensors that could measure patients' temperature, respiratory and heart rate remotely.[39] During the December 2020 holidays, the Belgian police used drones fitted with thermal cameras to enforce the ban on large gatherings of people in municipalities in the north of the country.[40] And in Mexico, the civil initiative "Drones por México vs covid-19" put a fleet of drones at the disposal of the authorities to disinfect public spaces in several municipalities of Oaxaca. The drones sprayed a liquid

[38] Noah Lewis, "Una empresa tecnológica ha desarrollado drones para entregar medicamentos de primera necesidad contra el covid-19 a zonas rurales de Ghana y Ruanda en cuestión de minutos", in Business Insider, May 16, 2020, at *https://www.businessinsider.es/covid-19-drones-entregar-suministros-medicos-ghana-ruanda-639875* (date of reference: November 9, 2020).

[39] Dory Gascueña, "Drones para frenar la pandemia de covid-19", en Banco Bilbao Vizcaya Argentaria, April 16, 2020, at *https://www.bbva.com/es/drones-para-frenar-la-epidemia-de-covid-19/* (date of reference: September 25, 2020).

[40] "Policía belga usará drones con cámaras térmicas para vigilar las normas covid", *La Vanguardia,* December 10, 2020, at *https://www.lavanguardia.com/vida/20201210/6108747/policia-belga-usara-drones-camaras-termicas-vigilar-normas-covid.html* (date of reference: December 20, 2020).

called Drutri Clean that eliminates virus, bacteria and spores.[41] The same technique was employed in Yucatán, Jalisco and Mexico City.

Conclusion

The financial system, school, work, family relations and most production methods that required face-to-face interaction were impacted by SARS-CoV-2, which has transformed not just our physical world, but our very thought structures. The progress made by science and medicine in the last century was not sufficient to contain the health emergency, but it was ICTs that enabled us to cope with the stress caused by this new pathogen—developers wrote new codes and languages to adapt the functionality of existing digital devices, and the Internet helped maintain forms of social organization by bridging physical distances. Socialization and communication practices became hypermedialized and the technological change triggered by the pandemic reinforced the paradigm of a digitalized life.

In today's world, there is a technological ecosystem that imposes itself on social practices: mobile phones, tablets, computers, smart TVs, video games, automobiles connected to the Internet, the Internet of Things, etc. We inhabit a technological environment in which we have ample freedom to think, express ourselves and act. Lockdown altered the predominant forms of human interaction. Paradoxically, the new normal, characterized by the use of ICTs, was one of the solutions to reducing the spread of the disease. The use of devices formerly used primarily for socialization, leisure and entertainment purposes could also be the answer to problems caused by pandemics: home office, e-commerce, distance learning, telemedicine, etc. The health crisis drove companies, governments and civil society to redesign devices to address emerging problems. People continued working from home, while governments, health institutions and the private initiative formed alliances to combat the pandemic. Use was made of existing technologies like educational platforms, open code databases,

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[41] Patricia Briseño, "Drones por México vs Covid-19 dona su tecnología a Oaxaca", *Excelsior*, April 9, 2020, at *https://www.excelsior.com.mx/nacional/drones-por-mexico-vs-covid-19-dona-su-tecnologia-a-oaxaca/1375072* (date of reference: July 8, 2020).

digital office tools, drones equipped with infrared cameras, robots to disinfect public spaces, 3D printing and other such tools.

The pandemic was an opportunity to explore technological transformations and new social practices. And if technological change was able to modify the way we produce material goods, then it follows that the application of a specific technology implies a specific social change. The new normal will reinforce practices self-imposed by the omnipresence of technology. Increasingly, the world will use technology to make sense of reality. The coronavirus could well lead to tighter social controls that employ invasive technologies to prevent new epidemics. Social institutions have been forced to embrace technological change because they are unable to operate the way they did before. At school, work and home, remote models will remain the most viable alternative to preventing activities grinding to a halt. However, we do not yet know the secondary effects these technological changes will have on society. Social distancing, hygiene practices, the use of masks, working from home, e-commerce and online education will all be part of the future. The technological change ushered in by the pandemic will indubitably leave its mark on human habits. Societies will have to learn to exist under a new set of rules, but in time, every new reality is normalized. Likewise, the digitalization of our lives will imperceptibly impose new decrees established by relevant social groups.