

Can we innovate responsibly during a pandemic?

Artificial intelligence, digital solutions and SARS-CoV-2

A policy brief for public decision-makers and
developers of AI and digital solutions

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June 17, 2020 — A policy brief for public decision-makers and developers of AI and digital solutions

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This document was prepared as a part of the research project of the International Observatory on the societal impacts of AI and digital technology (OBVIA) regarding the societal effects of A.I. systems and digital tools deployed to combat the spread of COVID-19 and supported by the Québec Research Funds (FRQ)

Funding Sources: Our work benefits from the financial support of the *Fonds de recherche du Québec* (FRQ) and the Canadian Institutes for Health Research (CIHR; #FDN-143294). Hassane Alami holds a joint CIHR/FRQ-S/INESSS postdoctoral scholarship, Carl Mörch holds a postdoctoral OBVIA scholarship and Robson Rocha holds a postdoctoral In Fieri scholarship. CRéSP, where the In Fieri team works, is supported by the FRQ-S.

Acknowledgements: The authors alone are responsible for opinions expressed in this policy brief. Previous versions benefitted from comments from Lyse Langlois, Renata Pozelli, Marie-Josée Hébert and Denis Roy.

ISBN : 978-2-9818996-3-7

French version : 978-2-9818996-1-3, available online: <https://t.ly/Mjsg>

Executive summary

As deconfinement begins, the potential for artificial intelligence (AI) and digital solutions to accelerate the fight against COVID-19 is increasingly debated. Despite promises and hopes, one may wonder whether **the required conditions for innovating responsibly are met?**

Although experts and journalists repeatedly assert that the future is uncertain, one can already identify known socioeconomic dynamics and their predictable and undesirable effects. These dynamics **predate solutions based on AI and digital tools** and largely shape their future trajectories.

This policy brief illustrates and provides examples of **societal issues** raised by these trajectories and explains how **four principles** can, as of today, steer a more responsible development of innovations.

These principles are needed in normal times and prioritizing them during a pandemic will help to **match the "right" solutions with the "right" problems** so that they may **benefit the entire population**.

It is important to **immediately** commit to a responsible innovation pathway because the proposed solutions **could bolster or hinder** epidemiological surveillance strategies and efforts of the health and social services system aiming to resolve the health crisis.

While a top-down approach was adopted at the outset of the lockdown, from now on **public decision-makers** should include civil society through **bottom-up strategies** in order to resolve the health crisis and to ensure a democratic approach to deconfinement.

Developers should organize and remotely participate in interdisciplinary and intersectoral **collaborative activities** (hackathons, open platforms, Fab labs, etc.) as well as those that aim to **gather diverse viewpoints** (scientific cafés, focus groups, etc.).

The challenge for public decision-makers

→ Clarifying which innovative paths are best aligned with the common good and determining how to pursue them from now on.

General recommendation*

→ Encouraging innovations that meet the highest standards of effectiveness, safety and relevance, which are at the heart of the four responsible innovation principles.

The challenge for AI and digital solutions developers

→ Managing both expected and unexpected effects of solutions by examining a range of scenarios that call upon the expertise of social scientists and health scientists.

General recommendation*

→ Adopting business models and design strategies that meet the four responsible innovation principles in a consistent, inclusive and transparent manner.

*Please see detailed recommendations on page 8.

Artificial intelligence and digital solutions in the face of SARS-CoV-2

For several weeks, experts and journalists have stressed that the future is uncertain and that what we know today could be transformed by a new scientific discovery tomorrow. Every day, health data and study results on SARS-CoV-2 are shared, including on its ability to spread with and without symptoms and its unexpected effects.

In addition to the many hypotheses brought forward on the accelerated development of new treatments and vaccines, there are increasing expectations towards the potential of artificial intelligence (AI) and digital solutions to support research as well as epidemiological surveillance strategies during deconfinement (1).

This unprecedented media attention has the advantage of bringing science and technology development processes to the forefront which, in normal times, follow a careful, if not slow pace.

Since in normal times the scientific approach aims to ensure the effectiveness, safety and relevance of innovations before they are introduced on the market, the current situation seems unprecedented in many respects.

However, are we not facing already known dynamics the effects of which are altogether predictable?

With the help of examples, we draw from the four responsible innovation principles to clarify pre-existing socioeconomic dynamics that condition the current development of AI and digital solutions as well as future trajectories.

Since these trajectories raise major societal issues, we offer guidance for public decision-makers and developers¹ to help them shift towards a more responsible development of these innovations.

The challenge for **public decision-makers** is to determine which paths are best aligned with the common good and how to pursue them from now on.

The challenge for **developers of AI and digital tools** is to secure the skills needed to apply the responsible innovation principles in a consistent, inclusive and transparent manner.

What responsible innovation proposes for innovating during a pandemic

Responsible Research and Innovation (RRI) is a policy-oriented field of research which emerged in Europe over the last decade. RRI promotes the involvement of various stakeholders in science and technology development, via participatory and inclusive approaches, to collectively design "ethically acceptable, socially desirable and sustainable" solutions (2).

RRI aims to align innovation development to tackle major economic, social or environmental challenges, such as the United Nations' Sustainable Development Goals (SDGs). The current pandemic, and those we will face in the future, certainly constitute a major challenge for which it is important to find adequate and lasting responses.

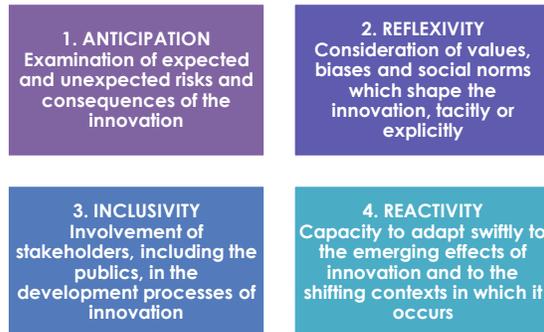
RRI has greatly influenced European scientific policies. It invites scientists to exercise caution and to be insightful with respect to the social consequences of the innovations arising from their work (3).

RRI asks for a careful consideration of the decisions that affect the trajectory of innovations throughout their lifecycle, from initial financing to a responsible disposal.

For Stilgoe et al. (4), RRI means "taking care of the future through collective stewardship of science and innovation in the present." The collective dimension of the decision-making processes and rules by which innovation development is managed is key.

This governance must take the form of a benevolent stewardship focussed on the common good.

To that end, Stilgoe et al. (4) propose the application of four principles to foster responsible innovation.



Four principles fostering responsible development of AI and digital solutions

These principles contribute to the mitigation of risks arising from the currently accelerated development of AI and digital solutions to fight against the pandemic and to support the return to social and economic activities.

The proposed solutions might support or hinder public health surveillance strategies as well as the health system's efforts to control the health crisis and to enable a safe deconfinement.

The resulting issues are necessarily connected to the surveillance mechanisms of the public and private sectors.

¹ Since civil society is directly concerned with public policies and developers' practices, a version of this document for the public is currently being prepared.

1 Anticipating... by looking at what is already there to clarify which path to take

To better anticipate the risks and consequences of innovations, developers of AI and digital solutions must examine a range of scenarios that extend beyond their field of expertise and that call upon the expertise of the social sciences, the humanities, and the health sciences.

The extent to which an innovation is responsible depends on whether it is effective in a real-world context and on close linkages between technical, social, political, economic, legal, commercial and environmental issues (5).

FOR EXAMPLE, the ability to offer remote care via a digital platform and connected medical devices that measure cardiac frequencies, glucose levels or oxygen saturation has never been as appreciated.

The March 14th Québec health emergency decree removed key barriers, such as reimbursement for medical acts performed at a distance and the definition of certain reserved professional activities, which, until now, have been limiting the deployment of telehealth.

Among the various innovations likely to be suggested to public decision-makers or directly to the public, it is highly likely that several are already available on the market or were largely developed before the pandemic.

Therefore, it is important for decision-makers and civil society to know how to select the appropriate innovations by determining whether they actually do what their promoters claim, and identifying expected and unexpected consequences of their use and their large-scale adoption.

This requires evidence regarding the clinical validity of the health data collected by the apps and connected devices (6) and their impact on service delivery, continuity of care and patient outcomes. Telehealth is also likely to entail more long-term effects on care providers' and patients' mental health, both at the individual and collective level.

Aside from the need to know their effectiveness, safety and potential undesirable effects, it is important to determine whether these solutions are interoperable and designed to be adequately integrated into the digital infrastructures of the health and social service system as well as the patients' homes.

- Is telecare equally accessible to all, in all regions of Québec?
- To what extent do patients, caregivers and professionals endorse these new treatment modalities?
- What are the implications of their expected and unexpected uses?
- What are the medium and long-term consequences of telehealth on clinical practices and the health and social service system?

Moreover, it must be recognized that data generated by digital interactions are the core business model of the 5 American companies controlling the data market: Google, Amazon, Facebook, Apple and Microsoft (GAFAM). Population data which can be collected during and after a pandemic is worth its weight in gold (7).

Therefore, anticipating the risks posed by AI and digital solutions in the current context involves a careful assessment of the already existing power relations and of their impacts:

- What firms possess the key expertise, the financial resources and the capacity to act?
- To date, to what extent have they met environmental, labour law or privacy regulations?
- To whom are these firms accountable?
- To date, to what extent have public authorities succeeded in having their requirements met by these firms?

TO KEEP IN MIND

In the urgency of fighting the pandemic, **public decision-makers** should not lose sight of the fact that the societal consequences of current developments in AI and digital solutions will follow the technological and commercial path (8)² already traced and set before the pandemic.

This path offers a competitive advantage to certain large firms, notably those supporting telework and upon which a great number of employers and employees now depend.

Developers can secure skills that will help them to better anticipate how the health and social care system will be able to incorporate the proposed solutions and how care providers "in the field" will or will not be able to bring about the expected benefits for all patients.

² "Path-dependence," a well-established concept in the literature on innovation systems (8), refers to the way in which previous solutions reinforce technical, social and commercial interdependencies that shape the path that can be taken. Since a number of actors and solutions

are already committed to this path, it becomes difficult to deviate from this path. Established players prefer the *status quo* in order to maintain their dominant position. This limits the capacity to develop new solutions and ways of operating.

2 Being reflexive about the post-COVID-19 world in which we wish to live

RRI seeks to influence the practices of scientists and of those who develop and market innovations by questioning the means chosen and the ends pursued.

The second principle of RRI invites them to be reflexive, which requires an awareness of the values and explanatory models underlying their particular discipline and field of practice (9).

For example, while epidemiology and psychology can guide decision-makers during a pandemic, each of these disciplines has its own way of looking at the problem and its own "blind spots" since they only address a single facet of what remains a multifaceted problem. When these two disciplines work together, the epidemiological risk of propagating SARS-CoV-2 can be understood as being intimately linked to the way in which social groups perceive this risk, as well as the efficacy of social distancing measures.

Questioning the values, biases and potentially erroneous or discriminatory assumptions that are embedded in the innovation becomes even more important when AI uses a deep learning approach. This approach "delegates" much of the analysis to algorithms without being able to explain the learning process at work.

FOR EXAMPLE, an algorithm may be developed to predict the survival rate of hospitalized patients with COVID-19 in order to prioritize access to intensive care.

The model will examine some individual characteristics which affect clinical vulnerability, such as age, gender, socioeconomic status, comorbidities or cognitive capacities.

Such characteristics are never exclusively *clinical*. They encompass different health determinants without fully acknowledging their roots and their effects accumulate throughout a lifetime.

To support a just and equitable decision, such an algorithm should "know" that individuals, in their lived experiences of early childhood, work and end of life care are not equal in the face of COVID-19.

An algorithm's performance depends on the quality of the data being used, which reflect what "counts" for those compiling the data (10). Thus, neutrality is not possible, neither for the humans involved nor the algorithms.

This is why one must examine the values and assumptions of the scientists who develop the innovations, of the firms who market them and of the public organizations who support their deployment.

The principle of reflexivity should also concern journalists who provide citizens with information which may help them grasp the societal issues at play and define the world in which they wish to live.

Justice and equity are at the heart of our health and social service system. Nonetheless, the operationalization of these values depends on powerful actors who, both within and outside of public institutions, shape certain decisions and reproduce established hierarchies amongst professional groups, organizations and employees.

The excessive death rate recorded in Québec's long-term residences for vulnerable senior citizens has exposed the unequal relationships that characterized the allocation of financial, human and technological resources to these organizations in recent decades. What we observe today is the result of a series of decisions that failed to prioritize the precarious condition of these vulnerable patients and their care providers.

The development of AI and digital solutions must be reflexive since they mirror the values of social groups who bear more or less conscious biases.

Apps using the Android system, used more generally by those with modest average incomes, could prove to be less effective than those using the iOS system since the latter has better access to electronic medical records (11).

Because a pandemic exacerbates health inequalities, ignoring biases that may result in discrimination against certain segments of the population amounts to developing an ineffective solution. To be effective, solutions must reach the entire population because the propagation of SARS-CoV-2 relies on a population-level mechanism.

By working with an ethical approach from the start of their design efforts, developers can draw upon the many types of knowledge and assets of a diverse society.

TO KEEP IN MIND

By creating spaces for honest and sincere discussion on the tacit and unspoken ideas on which AI and digital solutions are based, **public decision-makers** should identify the socioeconomic assumptions underlying these solutions.

Developers should make explicit any biases and value judgements associated with their data and with the modelling parameters, and substantially reduce biases at the source.

3 Encouraging inclusion in order to match the “right” solutions with the “right” problems

RRI shares affinities with participatory foresight (12) as both seek to develop inclusive governance in order to mitigate the risks of innovations and to steer their future development towards collective goods (13).

Rather than consulting with a few experts from different disciplines, those who develop AI and digital solutions should acquire the abilities to truly work in an intersectoral and interdisciplinary manner.

This should be done at an early stage since a clear definition of the problem to be solved is vital from the outset. A collaborative process allows developers to match the “right” solution with the “right” problem, while optimizing its capacity to adapt to a wide variety of users.

Consequently, an inclusive process steers developers away from ill-defined or low-priority problems, or problems whose roots extend well beyond the solution envisaged.

FOR EXAMPLE, for a contact tracing app exploiting *Bluetooth* technology to succeed in reducing the propagation of SARS-CoV-2, it must be able to distinguish material and social elements in the contexts of use (presence of plexiglass, handwashing, surface cleaning frequency, etc.).

It must be explicit and perfectly comprehensible for all citizens, meet data governance and privacy requirements (14, 15) and declare any interests at play (commercial or other).

Ideally, such a solution should make use of data centres powered by clean energy and promote the use of eco-friendly smartphones or devices (5).

It should also rely on a detailed understanding of public health workers' practices “in the field” (16) as they know the “real-life” uncertainties and intricacies of epidemiological surveillance.

Finally, such apps must be used only if the government can offer diagnostic tests in a sufficient quantity and in the right places.

If these conditions are not met, the data collected by the apps will neglect the contexts within which the interactions took place. Users will not know where and when they have been in contact with those with COVID-19 (a legitimate question when these apps claim to establish an individual risk). Thus, the undesirable consequences could outweigh the benefits.

Because interdisciplinary collaborations are often limited in normal times, it is highly likely that in time of a pandemic, developers of AI and digital solutions will lack ready access to public health experts, and health and social care practitioners.

Without this collaboration, the risk is that developers will work on solutions that only reflect their own discipline’s approach

or that rely on a misunderstanding of users' needs and practices.

From a collective standpoint, this leads to significant opportunity costs, that is, a loss of time and of human and financial resources which could be used more productively during a pandemic.

The principle of inclusion recommends broadening the views on the strengths and weaknesses of different possible solution scenarios. This includes citizens who, as taxpayers, support the development of innovations and, as users, are exposed to the benefits and risks.

In the context of deconfinement, it is important to consult employers, essential workers, teachers, storekeepers, public transport services, etc. in a structured fashion. Public health directives must remain at the heart of scenarios, whether or not there is a parallel use of digital solutions. These scenarios should be adapted to the different groups and contexts of use.

- The proper inclusion of the public and of diverse civil society groups calls for methods that go beyond unidirectional surveys.
- An adapted deliberative method should make the functionalities and risks of AI and digital solutions as tangible as possible.
- Integrating the knowledge and expertise of different social groups will allow developers to optimize their design process.

Therefore, the goal is not to launch a communication plan, but rather to make systematic efforts to clarify in plain language what can and cannot be achieved from both a technical and an ethical standpoint (13).

TO KEEP IN MIND

Public decision-makers should carefully examine the opportunity costs associated to the human, financial and technical resources deployed to develop AI and digital solutions.

While a top-down approach was adopted at the outset of the pandemic, it is important from now on to include civil society via bottom-up strategies.

This is necessary in order to be able to develop solutions that adequately address the problems experienced in different groups and contexts of use.

Developers should secure the skills to set in place largely inclusive and collaborative methods at an early stage of innovation process and thereafter.

The desire to act quickly must not undermine the collective ability to act well and on the right problems.

4 Knowing how to step back before moving forward? The importance of responsiveness

RRI invites decision-makers to create "flexible and adaptative systems" in order to regulate the dissemination of innovation and to mitigate its social, ethical, economic and environmental consequences (9).

The principle of responsiveness calls for the monitoring of an innovation's expected and unexpected effects while it is being used, the ability to swiftly react to and solve emerging problems and if necessary, the capacity to withdraw the innovation from the market.

This principle is demanding for public decision-makers and requires leadership and proactivity because it cannot be deferred. Responsiveness implies a close coordination with the authorities responsible for the regulatory and legal frameworks that govern, for instance, clinical research, access to data and personal information, and the market approval, evaluation and reimbursement of drugs and medical devices.

During a pandemic, a number of actors would like for regulatory mechanisms to be eased as they consider them as "obstacles" to innovation development.

FOR EXAMPLE, American researchers have suggested conducting "["human challenge" trials](#)" to test potential vaccines against SARS-CoV-2. In such a trial, the participants are deliberately exposed to the virus.

When the contagious mechanisms are not well known (as was the case with the Zika virus), this type of trial is controversial because volunteers (young and healthy in the case of SARS-CoV-2) could infect those around them.

Nevertheless, such a proposal gained significant popular support: the organization [1 Day Sooner](#) recruited more than 28,000 volunteers in over a hundred countries.

The justifications to rally these volunteers include a reduced duration of Phase 3 trials and of the number of participants required.

Phase 3 trials usually take place over several months and are required for marketing approval because they document undesirable effects and whether a vaccine demonstrates more benefits than risks for the general population.

How can public decision-makers be responsive to initiatives that become rapidly popular on social media? Should they remove certain regulatory safeguards?

The idea of easing the requirements of clinical research ethics committees is significant and could lead to harmful consequences

Moreover, the *1 Day Sooner* initiative depicts a rather incomplete picture of what slows down innovation development, ignoring well-documented dynamics of innovation systems (8, 17).

- Would better coordination amongst research centres, pharmaceutical firms and regulatory agencies allow for the optimization of the development, evaluation, production and distribution of vaccines?
- To what extent are intellectual property rules and patents agreements also obstacles that need to be alleviated?

In other words, we need to be twice as vigilant when organizations share only a partial view of reality which, thanks to social media, may lead the population astray.

According to the responsiveness principle, one must know how to modify an innovation's trajectory before releasing it. For Guston (18), this is a form of "anticipatory governance" which requires knowledge, skills, and the means and the power to act.

In practice, this may involve withdrawing a technology from the market, adopting stricter regulations to mitigate the undesirable effects or producing professional practice guidelines.

Currently, easing regulatory requirements seems tempting. For example, in the context of COVID-19, the American Office for Civil Rights will not impose penalties even if the requirements of the *Health Insurance Portability and Accountability Act* are not respected, as long as telecare is provided "in good faith" (19).

Responsiveness does not call for "softer" regulation, but rather for more agile regulation.

To put in place informed responsiveness, robust post-marketing surveillance and ongoing scientific horizon scans are needed.

TO KEEP IN MIND

Public decision-makers should be able to monitor the trajectory of solutions they authorize in order to analyze their impacts, know how to mitigate any emerging negative effects and withdraw these solutions from the market if necessary.

Lifting too hastily regulatory safeguards that would prove difficult or even impossible to reimpose after the pandemic could be imprudent.

With an effective and transparent regulatory framework in place, the basis on which **developers** can mitigate risks and respond to any emerging issues will be clearer and more predictable.

Such a regulatory framework can also raise the standards of the AI and digital solutions sector as a whole and increase public trust.

Decisions fostering responsible innovation

Although the future is uncertain, the technological development one is currently witnessing is easily predictable and some of its effects are well-known.

RRI spurs us to understand, rather than ignore, conflicts between different societal interests (8). This involves recognizing that responsibility does not lie in “weak forms” of consensus, but rather in the explicit articulation of points of contention (20).

For sociologists of science and technology (5, 18), it is customary to identify seats of power where human, financial and technological resources are concentrated. Large enterprises can transform a health crisis into a business opportunity and push solutions not necessarily demanded by target users.

The robust scientific process established centuries before the pandemic aims to determine the effectiveness, safety and appropriateness of innovations before they are made available to the population. The desire to speed up this process during a pandemic is understandable. Nevertheless, the requirements at the root of its rigour and legitimacy should not be lifted precipitously.

Public policies play a central role in the emergence and deployment of responsible innovation (17). This is one of the reasons why public decision-makers should curb the well-known dynamics of a commercial sector where the acquisition, analysis and sale of population data constitute the dominant business model. The negative effects of this model are predictable (14).

Developing responsible innovations anchors the principles of relevance, effectiveness, equity and justice at the heart of our health and social service system, both during a pandemic and for years to come.

RRI principles invite us to create the conditions favorable to innovations that are focussed on the common good.

- What do we need to contain the global pandemic?
- How can we envision a deconfinement which allows citizens to reclaim control over their own safety, health, education, work and mobility?
- And without excluding no one?

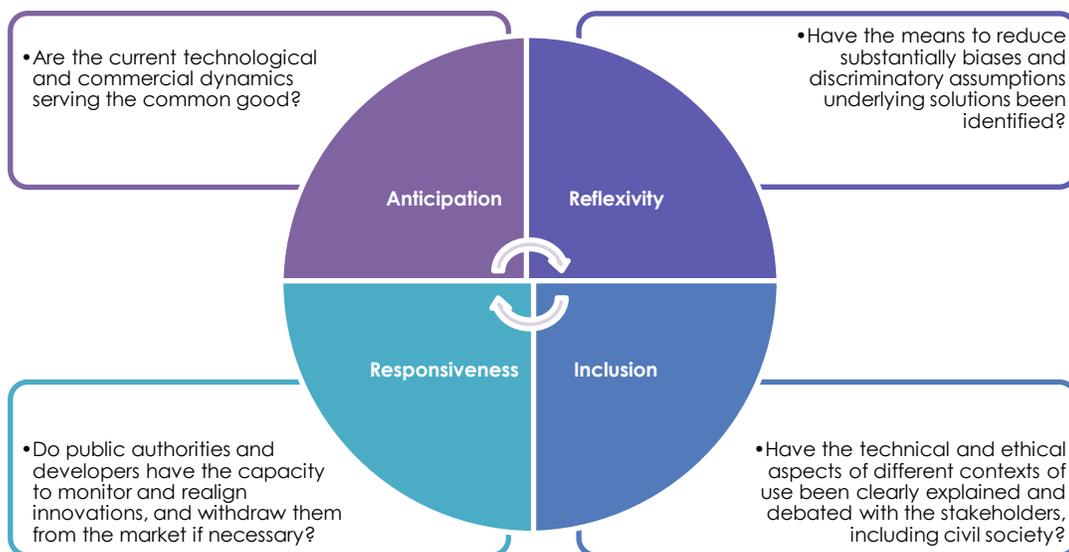
The pandemic provides a window of opportunity to renew technological and commercial activities at the interface of health policies and innovation policies and align them towards a responsible and sustainable path.

Organizations that develop AI and digital solutions possess resources that can be mustered to transition towards RRI at this point in time.

TO KEEP IN MIND

Public decision-makers have the duty and the authority to encourage innovations that meet the highest standards of responsibility, as RRI suggests.

Developers have the duty and the authority to design business models and strategies that, from the outset, integrate the four RRI principles in a consistent, inclusive and transparent fashion.



Conditions required for the responsible development of AI and digital solutions in the context of a pandemic

In summary, the four principles, the challenges and the courses of action

For public decision-makers

- The challenge is to clarify which innovative trajectories are the most closely aligned with the common good and how to immediately pursue them.

For AI and digital solutions developers

- The challenge is to develop capacities to apply the principles of responsible innovation in a consistent, inclusive and transparent way.

ANTICIPATION — Examining what is already there to clarify the trajectory to pursue **Do the existing technological and commercial dynamics lead in the direction of the common good?**

- Not losing sight of the fact that the likely societal effects of current developments in AI and digital solutions will follow the technological and commercial path traced before the pandemic.
- Developing aptitudes in anticipating how the health system will be able to integrate the solutions proposed and how care providers will or will not be able, in practice, to achieve the desired benefits for all patients.

REFLEXIVITY — With respect to the post-COVID-19 world in which we wish to live **Have the biases and discriminatory assumptions underlying solutions been reduced at the source?**

- Determining the socioeconomic assumptions of AI and digital solutions by creating spaces for honest and transparent discussions permitting the identification of values that these solutions embed.
- Making explicit and substantially reducing the biases and value judgements associated with the data used and with the model parameters selected.

INCLUSION — Matching the “right” solutions with the “right” problems **Were the technical and ethical aspects of different contexts of use clearly exposed and debated with stakeholders, including various civil society groups?**

- Attentively examining the opportunity costs associated with the resources deployed in developing AI and digital solutions.
- Including civil society through bottom-up strategies.
- Setting in place collaborative and largely inclusive methods at an early stage and on a continuing basis.
- The desire to act quickly should not undermine the collective capacity to act well and on the right problems.

REACTIVITY— Knowing how to step back before moving forward **Do public authorities and developers have the ability to monitor and take the required action to realign the innovations and to withdraw them from the market if necessary?**

- Monitoring the AI and digital solutions that will be authorized, analyzing their impacts, knowing how to mitigate their emerging negative effects and withdrawing them from the market, if necessary.
- Avoiding to remove too rapidly regulatory requirements that would be difficult or impossible to reinstate after this pandemic.
- The basis on which risks can be mitigated and adjustments made according to emerging analyses will be clearer and more predictable in an effective and transparent regulatory framework.
- The latter is also required to raise the standards of the sector as a whole and build public trust.

How can these four principles be operationalized during a pandemic?

One of our premises is that, overall, **developers’** time and effort would be better invested if they **coordinate and distribute in time and space** a series of activities.

These should be intended to develop and critique “martyr” scenarios, to test prototypes and modes of production and to acquire practical knowledge regarding the strengths and weaknesses of emerging solutions.

For example, one may combine remote **interactive activities** encouraging interdisciplinary and intersectoral **collaborative tasks-oriented** exchanges (e.g., hackathons, open platforms, Fab labs) and the **gathering of various points of view** (e.g., scientific cafés, community radio, focus groups).

References

1. Bullock J, Luccion A, Hoffmann Pham K, Sin Nga Lam C, and Luengo-Oroz M. Mapping the landscape of Artificial Intelligence applications against COVID-19. Preprint arXiv:2003.11336v2 [Internet]. 2020. Available from: <https://arxiv.org/abs/2003.11336>.
2. Von Schomberg R. A vision of responsible research and innovation. *Responsible innovation: Managing the responsible emergence of science and innovation in society* 2013. p. 51-74.
3. Stahl BC. Who is responsible for Responsible Innovation? Lessons from an investigation into Responsible Innovation in Health: Comment on "What health system challenges should Responsible Innovation in Health address? Insights from an international scoping review." *International Journal of Health Policy and Management*. 2019;8(7):447.
4. Stilgoe J, Owen R, and Macnaghten P. Developing a framework for responsible innovation. *Research Policy*. 2013;42(9):1568-80.
5. Silva HP, Lehoux P, Miller FA, and Denis J-L. Introducing responsible innovation in health: A policy-oriented framework. *Health Research Policy and Systems*. 2018;16(1):90.
6. FDA. Software as a Medical Device (SAMd): Clinical evaluation - Guidance for industry and Food and Drug Administration staff. Food and Drug Administration 2017. Available from: <https://www.fda.gov/media/100714/download>.
7. Zuboff S. Big other: Surveillance capitalism and the prospects of an information civilization. *Journal of Information Technology*. 2015;30(1):75-89.
8. Genus A, and Stirling A. Collingridge and the dilemma of control: Towards responsible and accountable innovation. *Research Policy*. 2018;47(1):61-9.
9. Sutcliffe H. A report on Responsible Research and Innovation. Prepared for DG Research and Innovation, European Commission. Michigan, United States. 2011.
10. Faraj S, Pachidi S, and Sayegh K. Working and organizing in the age of the learning algorithm. *Information and Organization*. 2018;28(1):62-70.
11. Sim I. Mobile devices and health. *New England Journal of Medicine*. 2019;381(10):956-68.
12. Bourgeois R, Penunia E, Bisht S, and Boruk D. Foresight for all: Co-elaborative scenario building and empowerment. *Technological Forecasting and Social Change*. 2017;124:178-88.
13. Lehoux P, Miller F, and Williams-Jones B. Anticipatory governance and moral imagination: Methodological insights from a scenario-based public deliberation study. *Technological Forecasting and Social Change*. 2020;151:119800.
14. Déziel P-L, Benyekhlef K, and Gaumont E. Repenser la protection des renseignements personnels à la lumière des défis soulevés par l'IA. Document de réponse aux questions posées par la Commission d'accès à l'information du Québec dans le cadre de la consultation sur l'intelligence artificielle [Document in response to questions posed by the Access to Information Commission of Quebec in the context of the consultation on artificial intelligence] : With the collaboration of Philippe Besse, Philippe Després, Richard Khoury, Mark Likhten and Sylvain Longhais. OBVIA and Laboratoire de cyberjustice; 2020.
15. Stahl BC. Responsible Research and Innovation: The role of privacy in an emerging framework. *Science and Public Policy*. 2013;6:708-16.
16. Désy M, St-Pierre J, Leclerc B, Couture-Ménard M-È, Cliche D, and Maclure J. Cadre de réflexion sur les enjeux éthiques liés à la pandémie de COVID-19: With the collaboration of Félix Lebrun-Paré. Comité d'éthique de santé publique and Commission de l'éthique en science et en technologie. Gouvernement du Québec [Public Health Ethics Committee and the Committee of Ethics in Science and Technology. Government of Quebec]; 2020.
17. Lehoux P, Daudelin G, Denis J-L, Gauthier P, and Hagemeister N. Pourquoi et comment sont conçues les innovations responsables? Résultats d'une méta-ethnographie. *Innovations*. 2019(2):15-42.
18. Guston DH. Understanding "anticipatory governance." *Social Studies of Science*. 2014;44(2):218-42.
19. Office for Civil Rights (OCR) announces notification of enforcement discretion for telehealth remote communications during the COVID-19 nationwide public health emergency [press release]. U.S. Department of Health and Human Services. 2020.
20. De Hoop E, Pols A, and Romijn H. Limits to responsible innovation. *Journal of Responsible Innovation*. 2016;3(2):110-34.