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Quantum technology and human rights: an agenda for collaboration*

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Abstract

Quantum technologies have the potential to transform many aspects of our lives as they come into wider use, but how do we ensure that these technologies promote human rights instead of harming them? This article will draw lessons from our collective experience in managing the human rights impacts of internet technologies to help the quantum science and technology community build and develop technologies that respect and promote the fundamental rights of all people.

1. Introduction

This article seeks to open a dialogue between the human rights and quantum science and technology (QST) communities. The aim is to foster collaboration between them to help ensure that quantum technologies will respect and promote human rights. The article will provide a brief overview of human rights before exploring some of the potential human rights impacts of the three 'most exciting' quantum technologies, namely, sensing, computing, and communications [1]. It will then draw some lessons from recent experiences in managing the human rights impacts of internet-based technologies and apply them to emerging quantum technologies. The critical point that will emerge is that both communities need to start working together to evaluate quantum technologies' potential human rights impacts and determine whether we can build human rights safeguards into them.

2. An introduction to human rights

The concept of human rights defies easy definition, but this article will approach the question from a legal perspective. It will focus on the body of international human rights law that has been developing since the end of the Second World War, which forms the basis of human rights protections in the constitutions and laws of many countries.

2.1. International human rights law

Our starting point is the Universal Declaration of Human Rights (UDHR) of 1948, which marks the first attempt by the international community to set out the inalienable rights each of us enjoys by virtue of our humanity. While the UDHR is an aspirational document that does not have the force of law, it inspired the development of numerous global and regional human rights treaties that are legally binding. Chief among these are the International Covenant on Civil and Political Rights (ICCPR) and the International Covenant

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on Economic, Social, and Cultural Rights (ICESCR) which, along with the UDHR, have come to be known as the 'International Bill of Rights'.

The civil and political rights guaranteed by the ICCPR, such as the presumption of innocence and the freedom of expression, will be familiar to many non-lawyers. Less familiar are the economic, social, and cultural rights enshrined in the ICESCR, which include guarantees of the 'highest attainable standard of physical and mental health' and to 'enjoy the benefits of scientific progress and its applications', among other protections.

Under international law, states have a legal obligation to protect all rights from being violated by state- and non-state actors. The nature of this obligation differs for economic, social, and cultural rights as opposed to civil and political rights, however, because the former require considerable economic resources to achieve. Correspondingly, economic, social, and cultural rights are to be 'progressively realized' over time, whereas the state must fully protect civil and political rights.

Human rights are inalienable but not absolute: most rights are subject to reasonable limitations necessary to achieve pressing and substantial public purposes. Such limitations must be prescribed by law and proportionate to the intended purposes. Correspondingly, the right to free expression can be limited by laws that criminalize child pornography, the right to privacy can be limited to permit the police to obtain warrants to search persons and property for evidence of crimes, and the freedom of movement can be limited to prevent the spread of deadly diseases during a pandemic.

2.2. Business and human rights

States have a legal *duty to protect* human rights under international law against all threats, but there is growing recognition that businesses have a *responsibility to respect* human rights. This is most clearly reflected in the UN Guiding Principles on Business and Human Rights (UNGPs) that the UN Human Rights Council unanimously endorsed in 2011.

The UNGPs provide businesses of all shapes and sizes with guidance on respecting human rights in their operations. The responsibility of businesses to respect human rights is not a legal obligation, but it is a norm of conduct that is starting to acquire the force of law in certain jurisdictions—notably in the European Union. For example, France and the Netherlands have enacted mandatory human rights due diligence (HRDD) laws that apply to large companies [2], while the European Union is considering a similar measure that would apply across the 27-member bloc [3]. Meanwhile, the European Union's General Data Protection Directive requires entities to conduct 'data protection impact assessments' when their data processing activities pose significant human rights risks [4].

Businesses respect human rights in the first instance by 'avoid[ing] infringing on the human rights of others', and further by addressing 'adverse human rights impacts with which (businesses) are involved' [5]. Doing so requires businesses to conduct HRDD 'to identify, prevent, mitigate and account for' their actual and potential human rights impacts [5]. Such due diligence should be an ongoing process that is 'initiated as early as possible in the development of a new (business) activity or relationship' [5].

2.3. The importance of human rights

The social impacts of new technologies are often evaluated from an ethical perspective, but such conversations are not a substitute for considering their human rights impacts—both positive and negative.

Consider, for example, the 'call to action' issued by several leading quantum scientists to examine the ethical implications of this technology [6], and the broader conversation that is now under way regarding the ethics of quantum technology [7]. These are welcome developments, but there are two reasons why the human rights impacts of these technologies must also be considered.

First, human rights protections are enshrined in law. Governments have a legal duty to protect human rights from abuse by state- and non-state actors, while companies face growing pressures (both legal and normative) to respect human rights in their operations. Correspondingly, respecting human rights law is not a matter of individual choice or preference in the manner that we are free to choose whether we behave ethically—above and beyond those moral and ethical precepts reflected in our laws.

Second, international human rights law provides a set of norms and a 'shared language' to discuss the impacts of new technologies that is more legitimate and determinate than any set of ethics [8]. Disagreements exist on the scope and interpretation of certain rights. Still, there is consensus that the rights exist and that they are worthy of protection. By contrast, views on what is ethical can vary significantly among and between individuals and societies, leading to concerns that the ethical commitments of some might be self-serving [9].

3. Some potential human rights impacts of quantum technologies

This section explores some of the potential human rights impacts of what the authors of a recent volume describe as the three 'most exciting' quantum technologies: quantum sensing, quantum computing, and quantum communications [1]. The emerging legal literature on quantum technology rightly focuses on the privacy impacts of these technologies [7], which are significant, but other potential human rights impacts are discernible from the new capabilities these technologies are likely to provide. We cannot yet fully predict the human rights impacts of these technologies or even whether they will ever come into widespread use. Regardless, this section will make the case for undertaking this exercise while quantum technologies are still in the early stages of their development.

As an initial matter, we should consider how developments in QST relate to the right enshrined in the ICESCR for everyone to 'enjoy the benefits of scientific progress and its applications'. This provision has been interpreted as including a right to access scientific knowledge, and to enjoy the 'material results of the applications of scientific research such as vaccinations, fertilizers, technological instruments, and the like' [10].

Correspondingly, we should begin asking how we ensure that all of humanity enjoys the benefits of quantum technologies as they come more widely into use. We must work to avoid the 'digital divide' that has arisen in the Internet sphere between those who have the means to access the online world and those who do not. We will have to think very carefully about how we ensure that the benefits of quantum technology are shared by all humanity—as the ICESCR requires—given that new technologies are costly and are usually developed by powerful actors in society, such as governments, multinational corporations, and wealthy universities.

3.1. Quantum sensing

Two authors recently suggested that quantum sensing has 'the most potential to change our lives in the next decade and beyond' [1]. Such technologies, which use quantum states to 'measure or sense physical things', open up the promise of developing sensors with powerful new capabilities [1]. For example, quantum properties can be used to develop sensors that penetrate clothes, buildings, rocks, and other materials far more effectively than current technologies (like radar, sonar, and LIDAR) [1]. Some even suggest that 'quantum illumination' could be used to sense objects that are not within the line of sight of a sensor [1].

The human rights implications of quantum sensors are as vast as the range of its potential civil and military applications. For example, quantum sensors in medicine may positively impact the enjoyment of the right to health, by helping to diagnose diseases sooner than current technologies permit. Yet they may also exacerbate existing inequalities in healthcare delivery, with concomitant effects on the right to equality [11].

Quantum sensing as a class of technologies pose significant privacy implications, however. Such sensors can peer into places that are inaccessible to conventional sensors, and the law governing the use of technologies that augment our biological sensing abilities will need to be adjusted accordingly.

Courts have had enormous difficulty in regulating the use of new kinds of sensors—from roadside breathalyzers [12] to IMSI catchers [13]—by the police and other governmental actors. International human rights law and many domestic constitutions require the police to obtain a warrant from a judge prior to searching places or things where individuals are recognized as possessing 'reasonable expectations of privacy'. Hence the police must obtain a warrant to search your house, but one is not necessary to search your bags prior to boarding a plane in the interests of aviation safety. In many countries, police officers seeking judicial permission to wiretap a phone must demonstrate that they have no alternative means of obtaining evidence of a suspected crime. Yet, a warrant is not required to obtain a lifetime's worth of call logs from the phone company.

In 2001, the US Supreme Court ruled that police must have a warrant before using thermal cameras to detect marijuana cultivation operations [14]. It so ruled because the search used novel technological means to peer into one's home, which the law recognizes as a place where people have strong privacy expectations. Three years later, in a factually identical case, the Supreme Court of Canada ruled that no warrant was needed for thermal imaging because such cameras record heat signatures on the surface of the house rather than peering inside [15].

Considering some of the potential human rights implications of quantum sensing—including privacy—the need for dialogue between QST and human rights communities becomes clear. Such

discussions should evaluate how safeguards can be built into these technologies to prevent misuse and how sensible rules can be developed to govern their appropriate use.

3.2. Quantum computing and human rights

Classical computers have transformed our lives and continue to impact individuals and society in unpredictable ways. But quantum computing's potential to solve problems that confound classical computers points to a set of human rights implications that warrant careful consideration.

Quantum computers hold great promise in modeling quantum phenomena, with significant implications for drug discovery, advanced materials, and many other scientific fields [16]. But quantum computers may also overcome many of the limitations classical computers face in solving combinatorics problems, which 'involve finding an arrangement of items that optimizes some goal. As the number of items grows, the number of possible arrangements grows exponentially'—making it difficult for classical computers to calculate the optimal solution [17].

Many computing problems are combinatorics problems—from the 'traveling salesman' problem of finding the most efficient route with multiple stops, to modeling complex systems ranging from the weather to financial markets to biological systems. Some in the QST community are optimistic that quantum computers will significantly improve our ability to solve such problems [18], but others note that significant technical barriers must be overcome for quantum computers to meet their promise [19]. Regardless, it is worth considering the human rights implications of using a new class of computers to solve such problems better.

Combinatorics problems inherently involve optimizing 'some goal'. This raises the question of what goals we should be optimizing and who decides whether they are the right ones to pursue. Consider Bova et al's example of how quantum computing could improve financial modeling [17]. They note that banks could use quantum computers to devise more powerful models to inform their lending decisions. These models could leverage quantum properties (like entanglement) to help verify the accuracy of customers' information in their loan applications and determine if they are lying.

Detecting lies and discouraging lying through better detection seems like a beneficial use of quantum computing, but how should we think of using these capabilities in other situations where individuals face pernicious adversaries? There are already serious concerns about how machine learning algorithms running on classical computers can discern sensitive information about us (such as our pregnancy status) by analyzing what would seem to be innocuous signals that we send out (such as our purchasing history.) [20, 21].

How might entities that already know a great deal about us—from governments of all persuasions to the behemoth companies that have given rise to our current reality of 'surveillance capitalism' [22]—leverage this powerful new technology to advance their goals? What are the risks of doing so with the additional insights we might gain about individual behavior and other phenomena from quantum sensing technologies? And what, if any, technical safeguards can we build into quantum computing systems to prevent such misuse? The stakes are incredibly high if these capabilities of quantum computers are used to make consequential decisions about us, in the way that current machine learning algorithms are used to predict everything from our risk of recidivism to decisions about our medical care [11].

3.3. Quantum communication and cryptography

We should also begin to think seriously about the human rights impacts of quantum communication. At first glance, this transition promises to improve privacy greatly, as the use of quantum properties may make it impossible to intercept communications content or metadata without detection by the intended sender and receiver [1]. Yet, as explained earlier, privacy (like all human rights) is not absolute and can be subject to reasonable limitations by governments to achieve pressing and substantial objectives.

There have been longstanding concerns that improvements in conventional encryption technology are preventing governments from detecting, investigating, and prosecuting criminal conduct—with adverse impacts on the right of all people to security of the person [23]. These concerns are overstated given the relative ease with which digital devices can be hacked, but the ability of quantum computers to quickly find the prime factors of large numbers risks undermining most current forms of encryption [16]. Correspondingly, work is underway to develop new encryption algorithms that can operate on classical hardware yet are resistant to quantum-facilitated attacks [24].

Since quantum technologies are likely to render most existing forms of cryptography obsolete, while also creating new communications systems that are more private and secure than current technologies, we must begin considering how society should respond to these possibilities should they become our new reality.

4. Managing the human rights impacts of quantum technology: lessons from the internet revolution

We can draw three important lessons from how we managed the human rights impacts of the Internet and apply them to ensure that the positive impacts of quantum technologies on human rights outweigh any negatives.

First, there is no substitute for examining the potential human rights impacts of new technologies at the earliest stages of their development, so that we can design and build human rights considerations right into their architecture. Even if we cannot foresee all the possible human rights impacts of the many different quantum technologies that are likely to be developed and each of their individual applications, we can still do our best to forecast the likely impacts to inform the design and risk mitigation process.

While the evidence shows that the designers of such core Internet protocols as IMAP and HTTP understood the broader social implications of the new communications infrastructure they were designing [25], the concepts of BHR and HRDD had yet to be developed in the 1970s. Consequently, and in view the technical limitations of the day, important human rights protections (such as encryption by default) were left out of these protocols. The ramifications of these architectural decisions have been long-lasting in their effect on privacy, security, and free expression online [26]. Efforts are underway to upgrade these protocols to build human rights considerations into their newest versions, but this is considerably more difficult and less effective than incorporating them by design [27]. Correspondingly, as the QST community begins the important work of developing standards and protocols for this exciting new family of technologies, human rights considerations should be at the forefront of design decisions.

Second, it is vitally important for developers of particular products and applications embodying quantum principles to engage in HRDD throughout the lifecycle of these technologies.

As noted earlier, HRDD is a process for identifying potential and actual adverse human rights impacts, to prevent, mitigate, and remedy them. Such processes should be ongoing, but at certain key junctures it may be necessary for a business to conduct a human rights impact assessment, which is a formal, point-in-time exercise that should be undertaken when ongoing HRDD identifies significant risks that require study, evaluation, and mitigation.

Many of the most significant adverse human rights impacts associated with the conventional Internet occurred in situations where companies did not conduct adequate HRDD before undertaking risky business operations. The serious harms caused by Facebook's operations in Myanmar are a case in point. The company's products were misused to facilitate the commission of genocide against the country's Rohingya Muslim minority in 2016–17 [28]. Unfortunately, Facebook did not conduct a 'baseline assessment for potential human rights impacts prior to operating in Myanmar' [28]. We cannot know if such an assessment would have resulted in changes to Facebook's operations that would have prevented the genocide or at least reduced Facebook's role in contributing to its severity. Unless a company is aware of the potential human rights harms that its business activities can cause, there is very little it can do to prevent or mitigate those harms.

Facebook's experience in Myanmar points to the critical importance of conducting HRDD as quantum technologies move from the lab bench and into the marketplace. Such due diligence, which should always include consultations with relevant stakeholders, can help those who are developing a new product or technology understand its potential adverse human rights impacts and design appropriate mitigations. These might include safeguards built right into a product, or decisions to limit the sales of particular products to specific end-users.

Third, governments have a vital role in ensuring that quantum technology develops in a rights-respecting manner. Governments bear the duty to protect human rights under international law. Unfortunately, they often fail to discharge this duty—either through their inaction in the face of threats to human rights, or their involvement or complicity in abuses carried out by state and non-state actors.

Government failures to timely address the adverse impacts of the Internet on human rights ranging from privacy to equality have resulted in significant harm to many people. Yet we are now seeing the pendulum swing too far in the other direction with the enactment of stringent regulations to prevent online harms that are causing human rights challenges of their own [29].

Governments need not enact legislation to regulate quantum technology at this stage. They must, however, be active participants in conversations about the design and deployment of such technologies—as architecture is as much a tool of governance as legislation. Governments can also create the conditions for successful self-regulatory and multi-stakeholder initiatives to address the human rights impacts of quantum technologies [30], while building the capacity to legislate should it become necessary.

5. Conclusion

We have an opportunity with quantum technologies to ensure that they will be a positive force for human rights. Informed by the lessons of the Internet era and the recent development of the concept of HRDD, we now have the knowledge and capabilities we need to design and deploy these technologies to maximize their benefits while preventing harm.

Quantum technologies may not yet be at the level of development where their potential impacts can be examined in detail. Even so, now is the time for the QST and human rights communities to begin a dialogue to prepare for the deployment and commercialization of these technologies in a rights-respecting manner.

Data availability statement

No new data were created or analysed in this study.

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