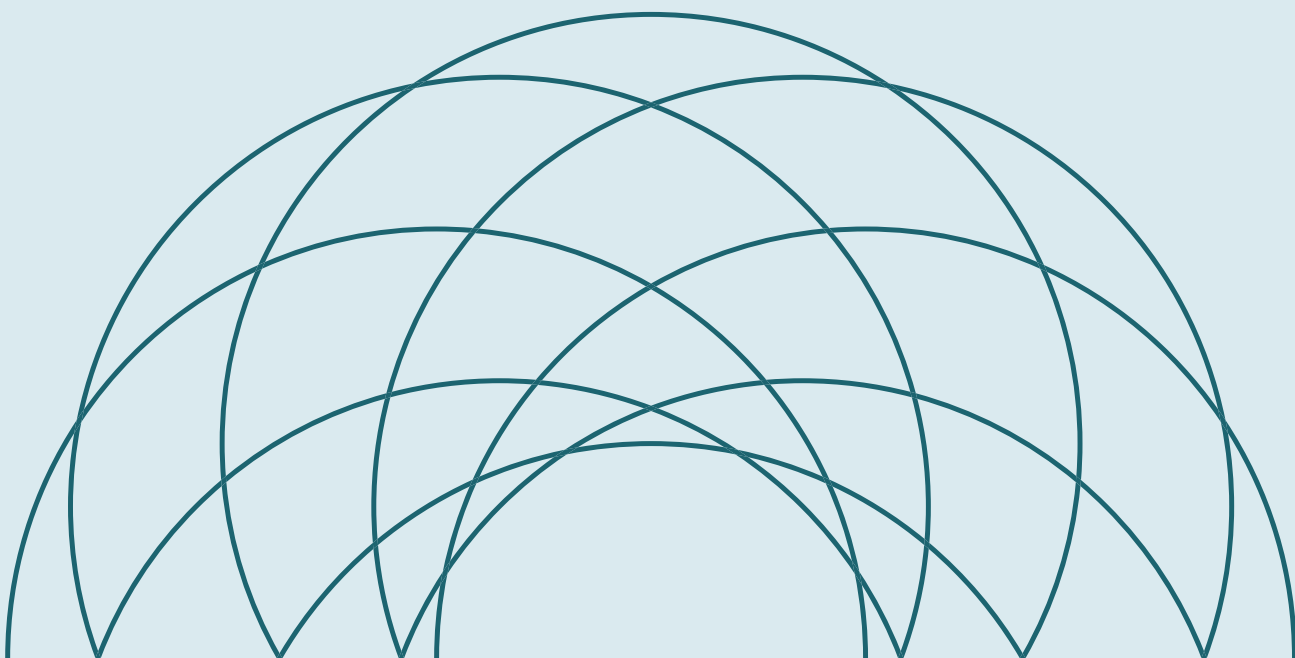THE NEXT GENERATION OF

EMERGING GLOBAL CHALLENGES

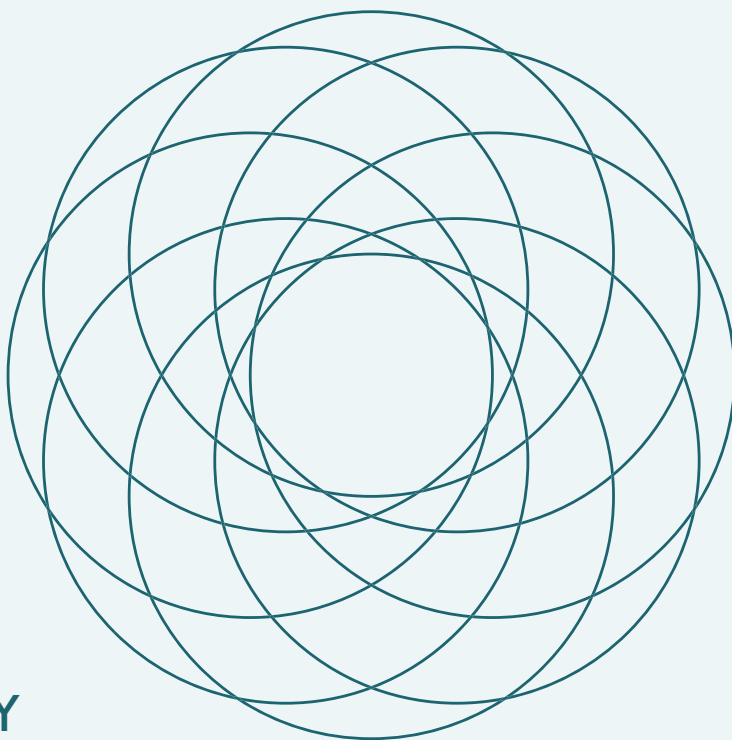**A HORIZONS 2030 PERSPECTIVE ON RESEARCH OPPORTUNITIES**

Prepared for the Social Sciences and Humanities Research Council

Policy Horizons Canada   Horizons de politiques Canada

Canada

EXECUTIVE SUMMARY

GOALS OF THE STUDY

The objective of this project was to identify the next generation of global challenges for consideration by the Social Sciences and Humanities Research Council (SSHRC) as part of its *Imagining Canada's Future* (ICF) initiative.

Climate change is a familiar global challenge. While that problem is far from solved, we were focused on what else lies over the horizon. The challenges we explored have several shared characteristics. They are emerging problems with the potential to shape society in profound ways. Publicly-funded research could help inform public dialogue and policy development. Each challenge is multi-disciplinary and requires broad cooperation to solve. Many emerge from technological innovations and, as current headlines attest, those challenges are perhaps in greatest need of attention from social science and humanities researchers. The point at which each challenge may become pressing varies but all of the challenge themes would benefit from proactive, transdisciplinary exploration and discussion.
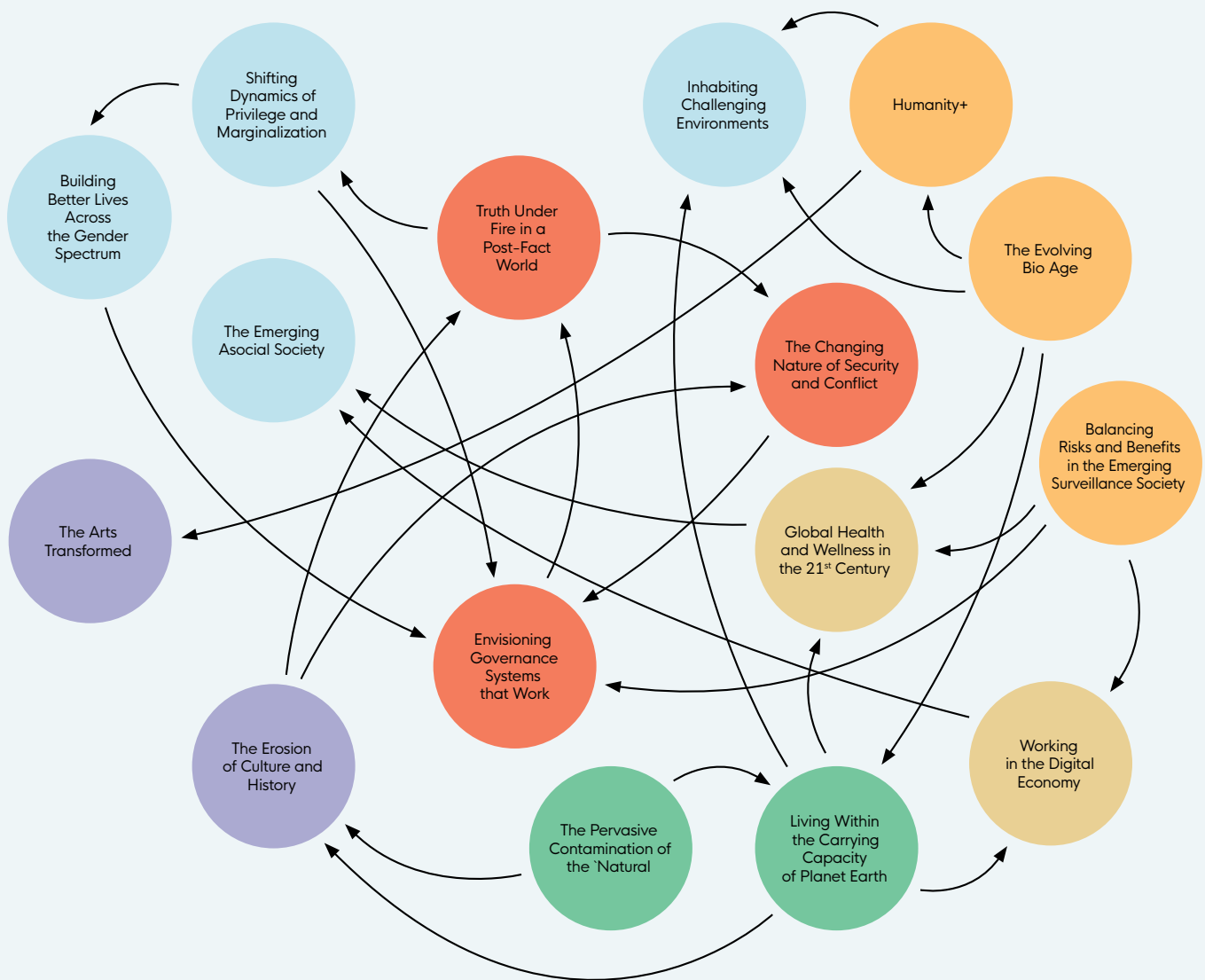
METHODS / APPROACH

Horizons primarily drew on sources across digital media, academic research studies and foresight projects to identify and analyze change data for the global scan. We conducted a literature review of over 600 weak signals and examined other material produced by Horizons, other government employees and other think tanks around the world. Many of the Horizons' insight papers were supplemented by interviews with experts from a variety of countries.

In addition, Horizons sent out a crowdsourcing questionnaire to various Horizons contacts, including professional foresight communities, spanning more than 60 countries. Respondents also helped promote the exercise through their own social networks. In total, 236 people external to Horizons participated in the crowdsourcing exercise and made 707 substantive contributions.

AN OVERVIEW

A SYSTEM MAP OF THE CHALLENGES

The 16 emerging global challenges described on the following page are complex within themselves, cutting across multiple sectors and disciplines. They are also interlinked, as the graphic below suggests. Each challenge raises the possibility of opportunities and new directions for societies as well as warning of potential crises.

Shifting Dynamics of Privilege and Marginalization

Inhabiting Challenging Environments

Humanity+

Building Better Lives Across the Gender Spectrum

Truth Under Fire in a Post-Fact World

The Evolving Bio Age

The Emerging Asocial Society

The Changing Nature of Security and Conflict

The Arts Transformed

Balancing Risks and Benefits in the Emerging Surveillance Society

Global Health and Wellness in the 21st Century

Envisioning Governance Systems that Work

The Erosion of Culture and History

Working in the Digital Economy

The Pervasive Contamination of the `Natural

Living Within the Carrying Capacity of Planet Earth

LEGEND

- Culture
- Society
- Technology
- Economy
- Governance
- Environment

CHALLENGE SUMMARIES

The following list briefly summarizes the SSHRC Global Challenges, including the key changes contributing to each challenge as well as its potential impacts.

ECONOMY

Working in the Digital Economy. Over the next two decades, eight new technologies will transform the economy, work, business and learning. All stakeholders are preparing for the transition, but the optimal strategies are unclear.

Digital technologies are creating a global digital infrastructure. Traditional jobs are being unbundled into tasks and allocated to qualified, low-cost bidders across the planet. The system customizes goods and services to the needs of the individual consumer as it eliminates the middleman and reduces costs. All this contributes to a potential future of income insecurity, surplus workers, mental health issues, ineffective nation state instruments, demand deflation, and no or slow growth. It also creates an opportunity to either move up the value chain and create whole new jobs and industries, or rethink the nature of work and envision economic models built on very different assumptions about scarcity, inequality, and sustainability.

Global Health and Wellness for the 21st Century. Delivering health and wellness in an effective, equitable and sustainable way could pose challenges in the near future, as new technologies and other disruptive changes emerge.

Healthcare is an increasingly international business, one in which DNA-based innovations are leading to improved prediction, prevention, and personalized medicine. Big data analytics draw on health and lifestyle data, and enable telemedicine platforms, regenerative medicine and human augmentation. Possible resulting futures include new opportunities to improve health and wellbeing and contribute to life extension. Society's view could also change regarding who should be responsible for health costs and outcomes, as well as regulatory bottlenecks and institutional constraints.

SOCIETY

The Emerging Asocial Society. Despite hopes that technology would enhance our social connectedness, more people feel lonely and disconnected, suggesting continued social challenges in a future where asocial behavior could grow in unexpected ways.

More and more people are living on their own, working alone in the gig economy, and isolating themselves in the real world by fixating on digital worlds. They are using goods and services tailored to their desires, encouraging individualism. This contributes to a potential future where our virtual communities mean more to us than our physical neighborhoods. Antisocial and hostile behavior could rise; we may need technology to coach us in lost social skills, and governments may need to step in to help establish rules and norms for digital society.

Shifting Dynamics of Privilege and Marginalization. Geographic, economic, political, and cultural changes are bringing people face to face with a wide variety of 'others', generating dynamic landscapes of power, wealth, culture, and attitudes which may create new social strata of privilege, and marginalize many.

An increasingly volatile and uncertain world is driving entire communities to migrate, creating hostilities on the borders of cultural identity. Those boundary problems are increasingly echoed as new human tribes evolve, courtesy of human augmentation and biodesign; and as we invent new tribes of robots and their digital ecosystems, with signs of abuse against these 'others' already emerging. This could lead to a future of new anxieties and anomie as people question their identities; a rise of new underclasses and new taboos; and a backlash against innovations that redefine humanity, resulting in heightened moral and ethical challenges to our relationship with 'the Other.'

Building Better Lives Across the Gender Spectrum. As shifting power structures and changing social norms challenge global gender inequality, informed interventions could improve quality of life in many countries. Innovations in human enhancement and biodesign could raise new questions around gender in the medium-term future.

Gender issues are being reframed around the world as traditional power structures shift and rights across the gender spectrum are increasingly recognized in law. This could result in new patterns of privilege and an accompanying backlash of misogyny and 'other' phobia, all of which could be complicated by emerging innovations in human augmentation and biodesign. The future may see gender equality achieved unevenly; along with transformations in the construction of masculinity and in the diversity and complexity of the gender spectrum.

Inhabiting Challenging Environments. The launch of the first automobile into the asteroid belt leads us to consider how planning and inventing for people to live in challenging environments could change us physically, socially, culturally, and politically.

Exploration focused on human work and habitation in space and in oceans is increasingly driven by privatization and investment, while technological advancement and citizen science focused on establishing new communities in space and at sea are accelerating it. Potential futures include human adaptation of mind and body to extreme environments, with innovations resulting in social structures, cultures, the arts, and governance.

TECHNOLOGY

Balancing Risks and Benefits in the Emerging Surveillance Society. In a world where data sharing and surveillance systems allow others to know more about us than we do, we may find surprising benefits and challenges as we renegotiate the meaning of privacy.

Every day in every way, we are building surveillance into our lives. Our personal devices listen to us, smart cities monitor conditions 24/7/365, AIs make sense of the floods of resulting data, and those in the know increasingly take advantage of that analysis. This creates conditions for a possible future where even as surveillance monitors our brains, quantum encryption breaks the last hope of privacy protection, and a digital backlash erupts. The solution may involve renegotiating the definition of privacy and rights. Yet at the same time, people's lives are safer and healthier, and goods and services are more tailored to their needs.

Humanity+. Increasingly sophisticated physical and cognitive augmentation technologies will unlock new potential for human abilities, health, and longevity, potentially raising divisive ethical, social, legal, and psychological issues.

Innovations in medical technologies, robotics, prostheses, and bio-compatible microprocessors have coupled with early adopter interest in human augmentation, creating a possible future that unlocks human potential and redefines what we mean by humanity. But it will also produce regulatory challenges and new vulnerabilities such as body system sabotage hacks, as people embed technologies, along with entirely new dimensions of inequality and biased access.

The Evolving Bio Age. Innovations in genetic editing and engineering allow researchers to create synthetic life with huge potential for benefits as well as unexpected outcomes, both good and bad, resulting from human tinkering with living systems.

Increasing understanding of complex living systems enables inventions that borrow from designs found in nature, innovations that blur the boundaries between micromachines and cells, and the redesign and synthesis of living organisms. These contribute to a possible future with more ecologically benign technologies, living machines and sensors, and deliberately designed human characteristics. It might also lead to unregulated biodesign for illicit purposes or weaponization, potentially resulting in world-scale ecological errors and accidents.

ENVIRONMENT

Living within the Carrying Capacity of Planet Earth. Humankind is putting an unsustainable strain on the Earth's capacity to support life. Fundamental changes in our economic and political systems and our way of life may be needed if humans are to live within Earth's carrying capacity.

Environmental challenges like climate change and ocean acidification are symptoms of a deeper problem. Human demands are exceeding the absorptive and productive capacity of global ecosystems. The pressures on several of the planet's ecosystem services are near a tipping point. For instance, soon we may need a way to share the remaining carrying capacity for carbon. In the past, war was the main way to resolve such resource scarcity issues. A combination of denialism, faith in technological solutions, and the weakness of international environmental agreements are all contributing to a slow-moving planetary crisis. To make progress we need deeper collaboration across disciplines and among stakeholders to develop public understanding and plausible pathways to living within the carrying capacity. Learning to share the remaining carrying capacity of the planet could be one of humanity's most important challenges.

The Pervasive Contamination of the 'Natural'. Science indicates that a growing number of natural environments and their products are polluted. We will be challenged to thrive in a world where contamination is so pervasive.

We are increasingly contaminating every aspect of nature as we flush chemicals into water supplies; create toxic airborne cocktails of pollutants and particulates; spread micro-granularized plastic around the world; and leave no hour unlit and no silence undisturbed. The long-term outcomes could include an adulterated food chain and toxic air, leading to a 'pristineness divide' between those who can avoid pollution and those who can't, as well as a noisy, light-blasted, sleepless world of irritable wakefulness, and general ecological disruption.

GOVERNANCE

Envisioning Governance Systems that Work. Existing forms of governance at the local, national and international levels are facing wicked problems they were not designed to solve, necessitating more effective, efficient and networked governance structures and processes.

People 'left behind' by economic and social transformation are increasingly losing trust in democratic norms and values, as new ideologies and non-state actors become more influential, and the adequacy of nation-states to address the challenges and opportunities of the digital age are ever more apparent. Possible futures that could result include new models of governance for collaboration in solving wicked problems, including technology-enabled customized governance, fluid citizenship, and not only re-invented democracy but a reinvention of the global international order.

The Changing Nature of Security and Conflict. New technologies will change the nature and location of conflict, threatening our security in physical and virtual ways.

Advancements in weapons technology, combined with the erosion of privacy, could create a future in which everyone can arm themselves easily and affordably, challenging the ability of the nation state and the global international order to control conflict and security. The ability and capacity to innovate could be a key determinant of power.

Truth Under Fire in a Post-Fact World. In a post-fact world, political, social, and economic systems could become dysfunctional.

The changing media and information ecosystem coupled with declining trust in institutions and skepticism of scientific expertise could result in a future featuring a proliferation of reputation systems, social engineering, dysfunctional democracies, and stagnation in scientific progress.

ARTS/CULTURE

The Arts Transformed. Digital technologies and social media have blurred the lines between artist, critic, audience, and patron; while new artistic media and human augmentation revolutionize expressive and perceptive possibilities to further transform the arts.
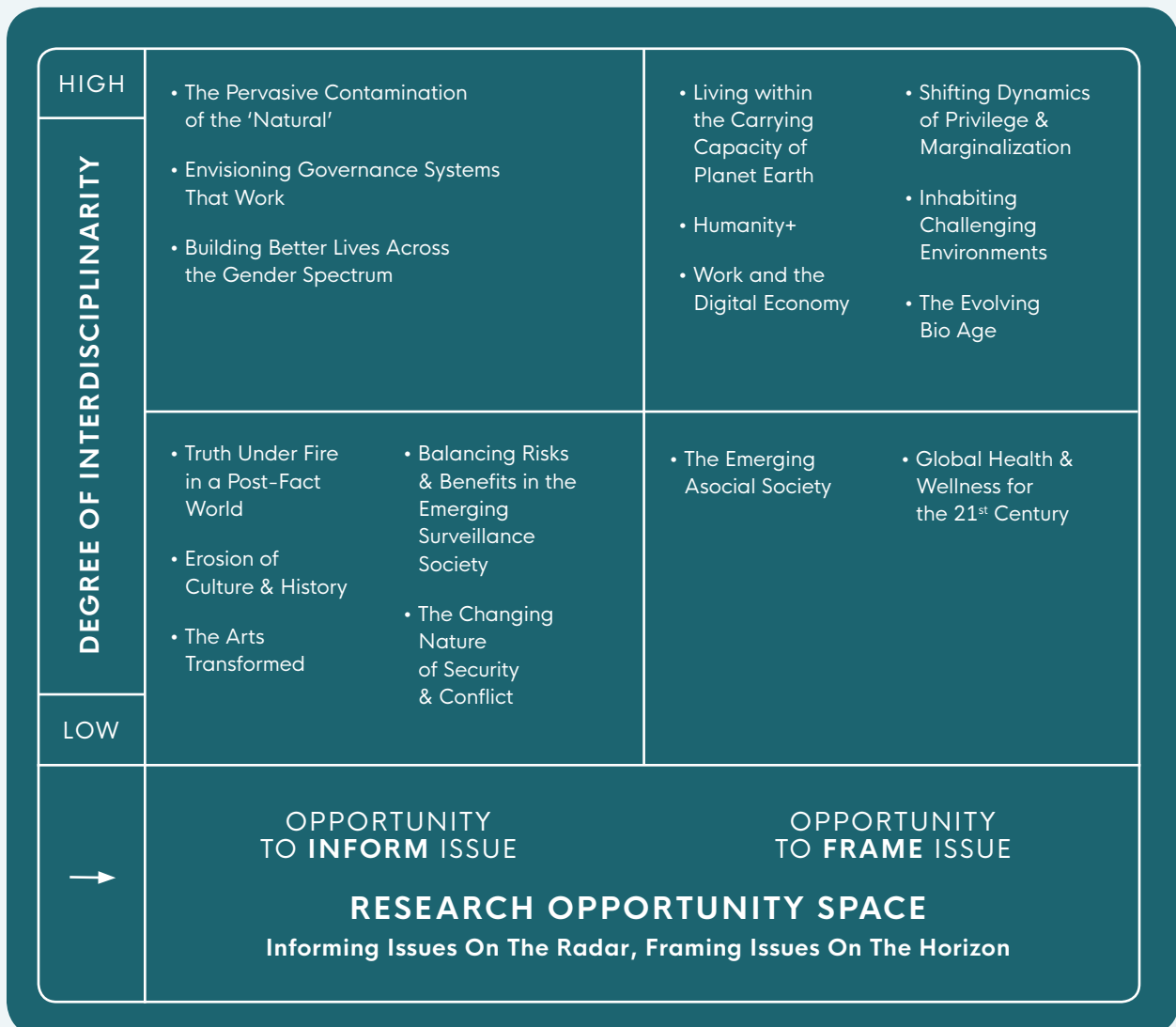
Digital media and connectivity have revolutionized the context and support systems in which artists create. Drivers include rapid innovations in digital media and disintermediated production. The resulting participatory culture closes the artist-fan divide, enables crowd-financing of artworks, and provides instant global dissemination, with the potential for big data analysis of fan and financer profiles. The emerging possibilities of human augmentation and synthetic biology imply a new frontier for art of enhanced or invented sensory experiences as artistic media. Potential futures include enhanced diversity of ideas and voices instantly distributed to global art spaces, amplifying interest and support, and easing the transition from audience to amateur to professional. This could expand points of view represented in the arts, but could also create challenges for curation and artistic authenticity.

Erosion of Culture and History. Languages, traditions, artifacts, and world views are fading from existence and memory in many parts of the world, pointing to a weaker social fabric, damaged potential for innovation and solutions, and cases of lost or forgotten identity.

Globalization, conflict, and environmental disasters are damaging ancient monuments, artworks, and artifacts, and contributing to language extinction and loss of cultural diversity, suggesting a possible future where humanity's diverse cultural resources have dwindled to monoculture, decreasing adaptive resilience, thinning the foundations of profound insight and vision, privileging the cultures that remain and creating crises of identity in resulting cultural vacuums, with the hope that machine-mediated cultural archives and interfaces might preserve cultural and linguistic treasures.
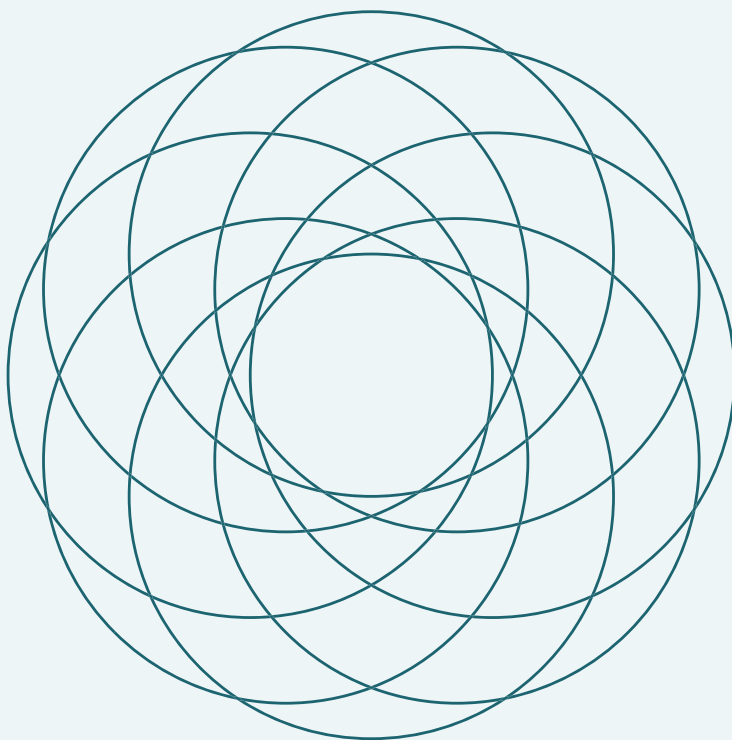
THE RESEARCH OPPORTUNITY SPACE

The diagram below attempts to organize the challenges. One axis is an estimate of the degree of interdisciplinarity required to make progress on the challenge. It is a measure of the number of disciplines that could be involved. On the other axis is an estimate of the current state of knowledge of, and preparedness for, the challenge. People may be aware of the challenges on the left but there is a need to inform and deepen thinking about each issue. For the challenges on the right, significant opportunity still remains to frame the issue.

	OPPORTUNITY TO **INFORM** ISSUE	OPPORTUNITY TO **FRAME** ISSUE
HIGH	• The Pervasive Contamination of the 'Natural' • Envisioning Governance Systems That Work • Building Better Lives Across the Gender Spectrum	• Living within the Carrying Capacity of Planet Earth • Humanity+ • Work and the Digital Economy • Shifting Dynamics of Privilege & Marginalization • Inhabiting Challenging Environments • The Evolving Bio Age
LOW	• Truth Under Fire in a Post-Fact World • Erosion of Culture & History • The Arts Transformed • Balancing Risks & Benefits in the Emerging Surveillance Society • The Changing Nature of Security & Conflict	• The Emerging Asocial Society • Global Health & Wellness for the 21st Century

DEGREE OF INTERDISCIPLINARITY

→ **RESEARCH OPPORTUNITY SPACE**
Informing Issues On The Radar, Framing Issues On The Horizon

CONTENTS

INTRODUCTION

Policy Horizons Canada (Horizons)
reached an agreement early in 2018
with the Social Sciences and Humanities Research
Council (SSHRC) to conduct a scan of global emerging
challenges for SSHRC's Office of Future Challenges.

With a mandate to provide foresight for the public service, Horizons considers the global context as it helps anticipate emerging policy challenges and opportunities for Canada in a rapidly changing, complex world.

The scan conducted for SSHRC is one of our most comprehensive to date. It will comprise the first stage of a strategic foresight exercise that SSHRC is undertaking as part of its Imagining Canada's Future (ICF) initiative. The scan will be followed by engagement exercises and an ICF forum of key domestic and international stakeholders to assess research capacity and future knowledge needs.

METHODS

Horizons took a multi-pronged approach to gathering and analyzing information for this study. The majority of the research was conducted via an extensive environmental scan, augmented by interviews and crowdsourced to check for gaps.

We started by looking for "weak signals" of potentially disruptive change across a variety of platforms and issue domains. Weak signals can surface in many different forms: as events (e.g. protests), as experiments (e.g. new living arrangements), as new technological developments and as ideas or proposals. They are not mainstream realities yet. As an example, the use of drones in warfare is not an emerging issue (it is, in fact, "The New Normal"); yet the possibility of a persistent and global ecosystem of unmanned aerial platforms of all shapes and sizes is an emerging issue. The raw scanning data was fed into a visualization tool called Futurescaper which makes links between all scan hits. The visualization assisted in identifying emerging global challenges with various characteristics, including impact across many areas, potential involvement of many disciplines and how novel or well known the issue is.

The environmental scan included:

- 600+ **weak signals** produced by Horizons' analysts over the last two years;
- dozens of more recent weak signals contributed as part of Horizons' weekly scanning club, which includes public and private sector guests;
- material developed as part of the 2017-18 Canada Beyond 150 leadership development initiative which examined a variety of cross-cutting, complex policy challenges; and
- dozens of Horizons' insight publications, many of which have been supplemented by **expert interviews** from around the world.

Note: some of these papers are still works in progress and have not yet been published. As part of this exercise, Horizons also drew on the expertise and contacts of external foresight expert Wendy Schultz.
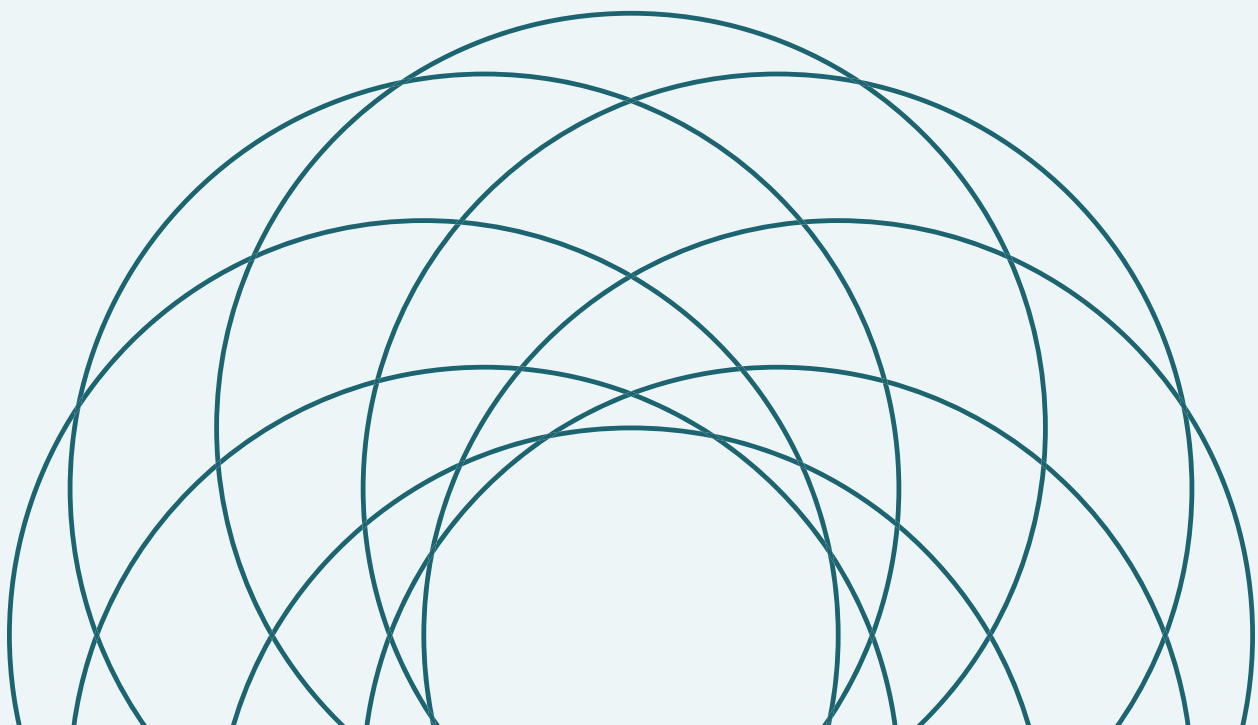
Many of the aforementioned sources also drew on digital news aggregators/feeds, social media, and foresight tools such as the Shaping Tomorrow AI-assisted research tool and the Futurescaper crowdsourcing tool.
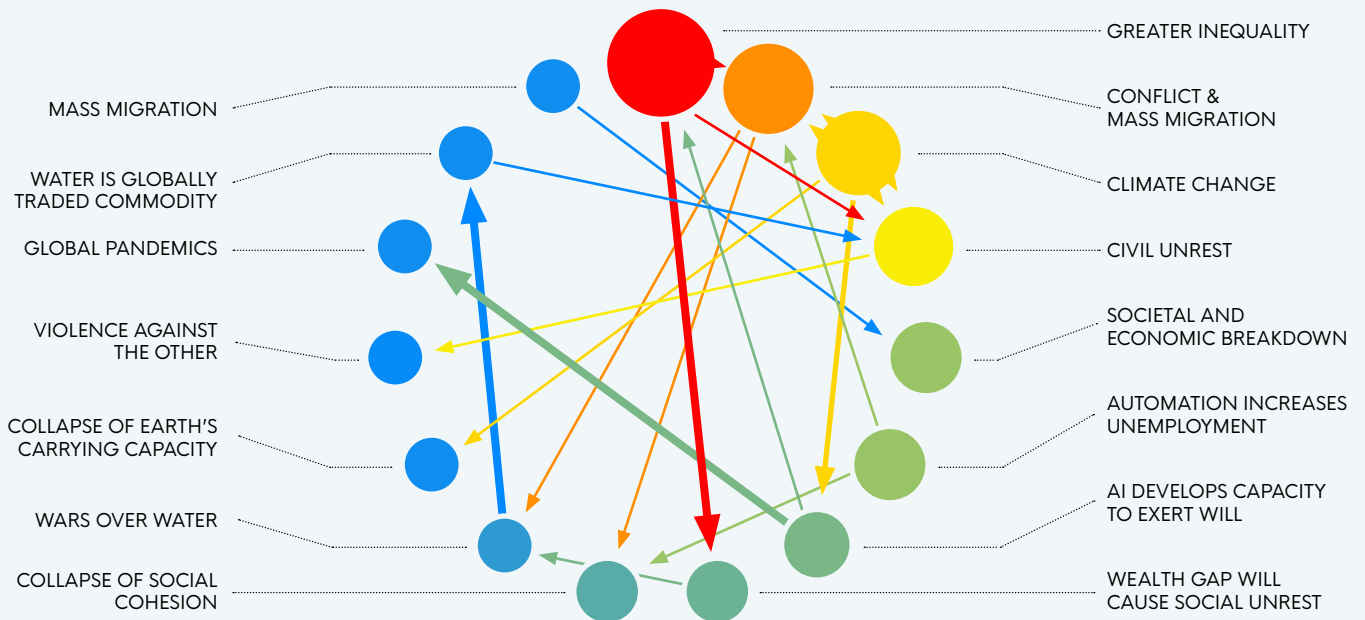
The literature review was followed by an approximate 6-week **crowdsourcing initiative** in Spring 2018. Brief Futurescaper crowdsourcer questionnaires were sent out in English and French (see appendix B) to members of:

- the World Futures Studies Federation (thousands of members from more than 60 countries)
- the Association of Professional Futurists (~400 members from 33 countries)
- the Millennium project
- Horizons' mailing list of ~2,500 subscribers which is comprised of close to 2,000 Government of Canada public servants, and a further 500 people from other levels of government inside and outside Canada, as well as academics and other individuals interested in foresight.
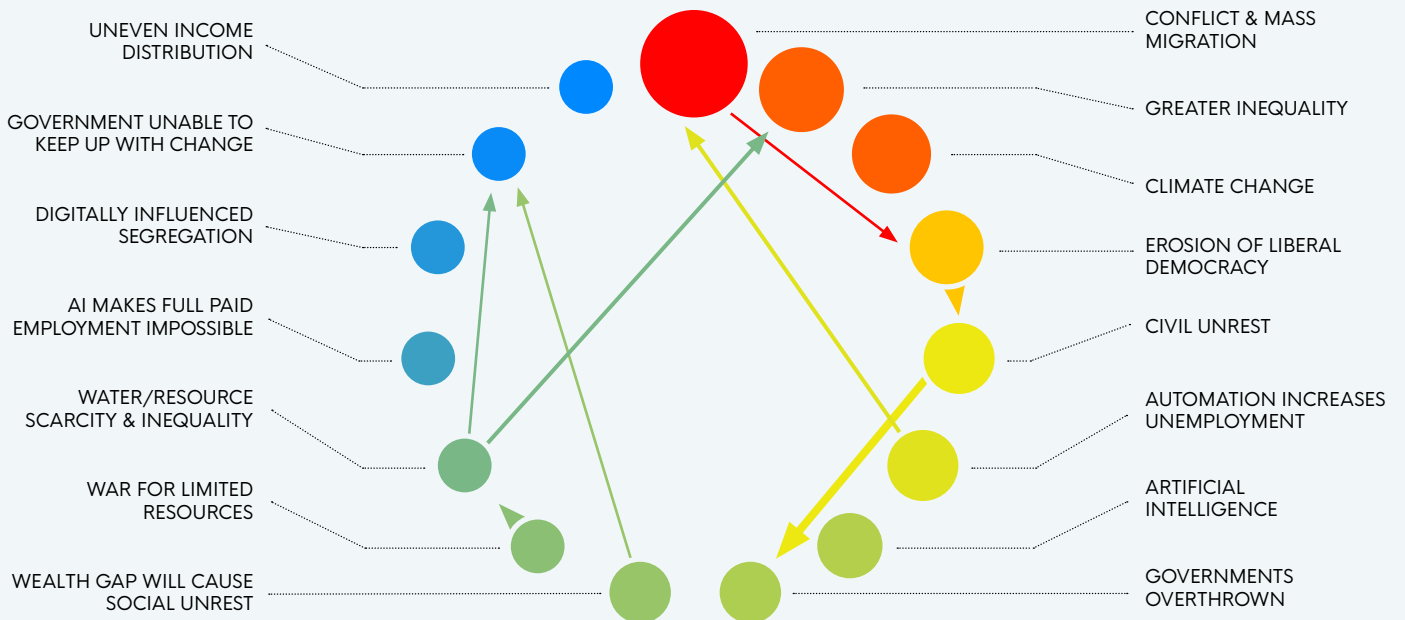
As well, respondents were encouraged to help increase participation in the **crowdsourcing initiative** by promoting it through their own social networks. To help them in this endeavour, we provided social icon links to Facebook, Twitter and LinkedIn. This was particularly useful as in some cases participants were able to extend the invitation to close to 5,000 people in their personal networks.

In total, 236 people external to Horizons participated in the crowdsourcing exercise and made 707 substantive contributions. The respondents were *public servants* (81), *academics* (27), *futurists* (45), and *other* (83). The graphic on the following page ranks the top 15 suggestions for a 'critical global challenge' across all 237 participants. This graph view ranks the suggested challenges by *importance*. In Futurescaper, *importance* considers how often an entry was mentioned by different respondents, and then adds to the number of mentions the number of outgoing and incoming links to other concepts - that is, the degree of interconnectedness that entry has to all the other entries.

GREATER INEQUALITY

CONFLICT & MASS MIGRATION

CLIMATE CHANGE

CIVIL UNREST

SOCIETAL AND ECONOMIC BREAKDOWN

AUTOMATION INCREASES UNEMPLOYMENT

AI DEVELOPS CAPACITY TO EXERT WILL

WEALTH GAP WILL CAUSE SOCIAL UNREST

COLLAPSE OF SOCIAL COHESION

WARS OVER WATER

COLLAPSE OF EARTH'S CARRYING CAPACITY

VIOLENCE AGAINST THE OTHER

GLOBAL PANDEMICS

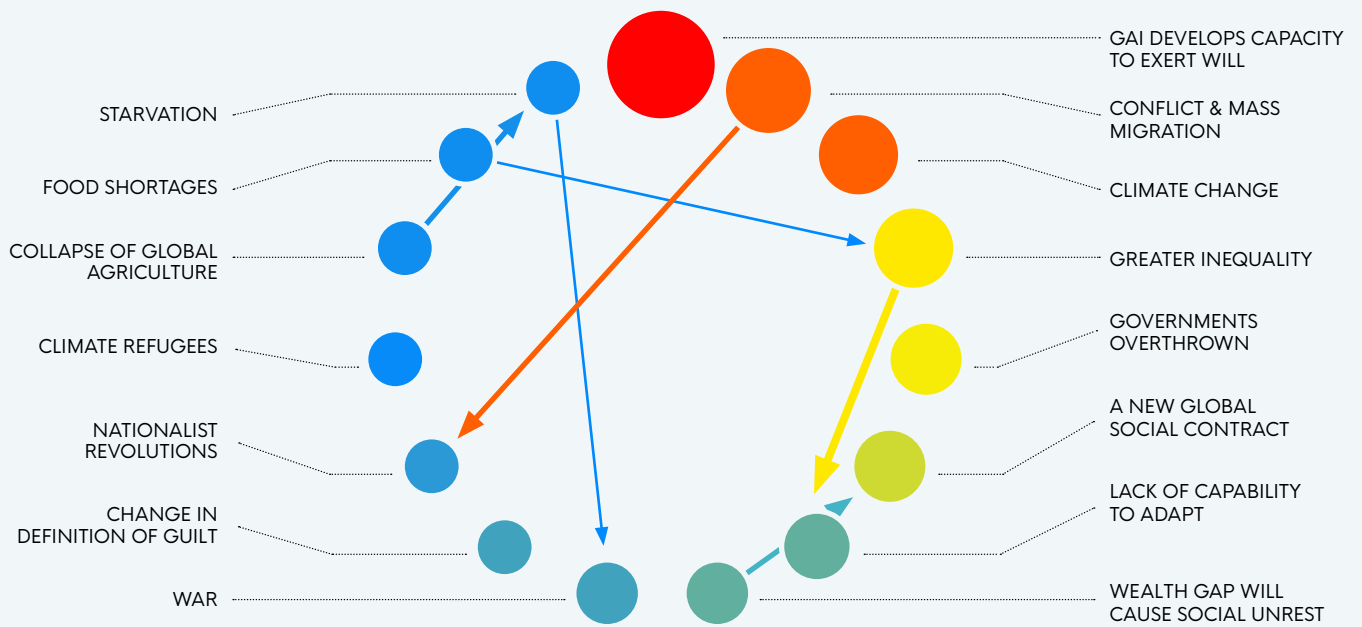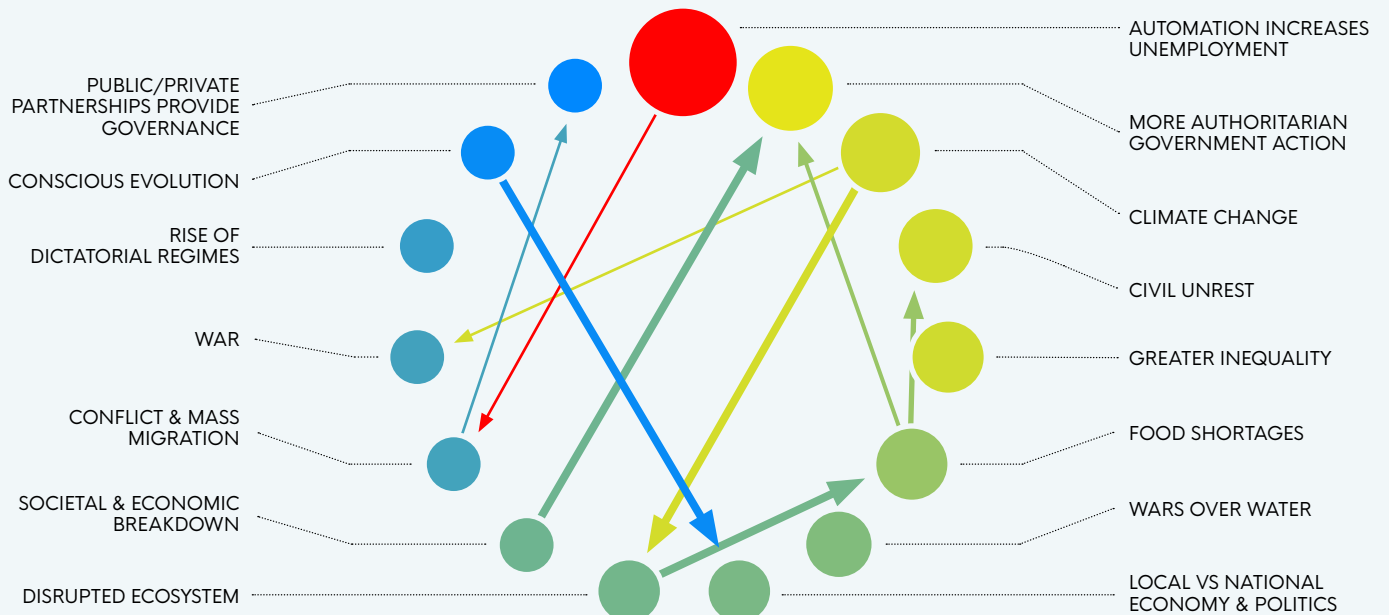WATER IS GLOBALLY TRADED COMMODITY

MASS MIGRATION

Looking at responses from all the crowdsourcer participants, *greater inequality* ranked highest in importance, followed by *conflict and mass migration*, *climate change*, *civil unrest*, and *societal and economic breakdown*.

CONFLICT & MASS MIGRATION

GREATER INEQUALITY

CLIMATE CHANGE

EROSION OF LIBERAL DEMOCRACY

CIVIL UNREST

AUTOMATION INCREASES UNEMPLOYMENT

ARTIFICIAL INTELLIGENCE

GOVERNMENTS OVERTHROWN

WEALTH GAP WILL CAUSE SOCIAL UNREST

WAR FOR LIMITED RESOURCES

WATER/RESOURCE SCARCITY & INEQUALITY

AI MAKES FULL PAID EMPLOYMENT IMPOSSIBLE

DIGITALLY INFLUENCED SEGREGATION

GOVERNMENT UNABLE TO KEEP UP WITH CHANGE

UNEVEN INCOME DISTRIBUTION

In comparison, a different pattern emerges when looking solely at the contributions of (mostly Canadian) public servants. They ranked conflict and mass migration as most important, followed by greater *inequality*, *climate change*, *erosion of liberal democracy*, and *civil unrest*.

GAI DEVELOPS CAPACITY TO EXERT WILL

CONFLICT & MASS MIGRATION

CLIMATE CHANGE

GREATER INEQUALITY

GOVERNMENTS OVERTHROWN

A NEW GLOBAL SOCIAL CONTRACT

LACK OF CAPABILITY TO ADAPT

WEALTH GAP WILL CAUSE SOCIAL UNREST

WAR

CHANGE IN DEFINITION OF GUILT

NATIONALIST REVOLUTIONS

CLIMATE REFUGEES

COLLAPSE OF GLOBAL AGRICULTURE

FOOD SHORTAGES

STARVATION

Academics ranked *AI develops capacity to exert will* most highly, followed by *conflict and mass migration*, *climate change*, *greater inequality*, and *governments overthrown*.

AUTOMATION INCREASES UNEMPLOYMENT

MORE AUTHORITARIAN GOVERNMENT ACTION

CLIMATE CHANGE

CIVIL UNREST

GREATER INEQUALITY

FOOD SHORTAGES

WARS OVER WATER

LOCAL VS NATIONAL ECONOMY & POLITICS

DISRUPTED ECOSYSTEM

SOCIETAL & ECONOMIC BREAKDOWN

CONFLICT & MASS MIGRATION

WAR

RISE OF DICTATORIAL REGIMES

CONSCIOUS EVOLUTION

PUBLIC/PRIVATE PARTNERSHIPS PROVIDE GOVERNANCE

Futurists, on the other hand, ranked *automation increases unemployment* most highly, followed by *more authoritarian government action*, then *climate change*, *civil unrest*, and *greater inequality*.

Finally, Futurescaper enabled the Horizons team to identify weak signals from the crowd-sourced material which became starting points for potential challenges. It also allowed us to explore the complex causal chains that emerge as contributors link their analysis to other people's ideas. All of the above input played a role in framing the proposed "emerging challenges".

CAVEAT

This exercise should not be mistaken for a systematic public opinion research survey. There was no representative sampling frame. The purpose of the crowdsourcing exercise was to tap into the collective knowledge of a broad swath of experts, to help Horizons diversify its thinking, and confirm emerging patterns.

The tool also helped people unfamiliar with foresight techniques to push their thinking out further by asking them to consider challenges and their impacts, and offered them the opportunity to incorporate challenges and impacts entered by other people. It is the interlinking of challenges and potential impacts by multiple respondents that enables Futurescaper to plot an emerging systems map of participants' responses, and to rank input by both the number of mentions, and the degree of interconnectedness.

WORKING IN THE DIGITAL ECONOMY

Over the next two decades, eight new technologies will transform the economy, work, business and learning. All stakeholders are preparing for the transition, but the optimal or robust strategies are unclear.

——— SUMMARY ———

Emerging technologies, such as artificial intelligence (AI), data analytics, sensors, blockchain, robotics, telepresence, 3D printing and synthetic biology, are creating a global digital infrastructure that will transform the economy and the nature of work. Over the next decade, many jobs, industries and communities are expected to face disruption. Firms may become more virtual. There may be fewer traditional jobs, and more virtual gig work. Some people may become "surplus" to requirements. The structural changes could have implications for macroeconomic theory and policy. The digital transition could have widespread positive and negative impacts.

—— WHAT IS CHANGING? ——

• **Digitization of global value chains.** New technologies are creating a global digital infrastructure and digital platforms that use AI to match demand and supply. Platforms like Freelancer.com allow anyone, anywhere to find qualified virtual workers online. Amazon is providing the infrastructure that links producers and consumers. Devices like Alexa and Google Home automate the process. Uber and many others are automating services like transportation and delivery, and self-driving vehicles will take that a step further. As this digital infrastructure evolves, service industries are becoming global, manufacturing could become more local (3D printing) and natural resources could be produced locally (synthetic biology).

• **Unbundling traditional jobs into tasks.** Jobs traditionally performed by individuals are being unbundled into discrete tasks. Internet-based tasking platforms allocate tasks to the lowest competent bidder from an increasingly global labour pool. This labour market flexibility is leading employers to use more part-time and intermittent contract workers. As competition grows, some workers could find themselves being pushed out of the market. Less qualified workers, and those in higher cost of living areas, may experience longer periods without work, or become permanently out-competed.

• **Digitization eliminates the middleman.** Increasing digitization often eliminates human intermediaries from the value chain and reduces transaction costs (e.g. shift from physical retail to online shopping). In several decades, a highly digitized and AI-integrated economy could provide many goods and services in bespoke peer-to-peer value chains, which may have no human intermediaries.

• **Technologies reduce scarcity of human labour.** Automation and robotics will reduce manual labour scarcity. Information, skills, and expertise will be accessible across the planet through AI, telepresence, AR, VR, and other enabling tools. In many areas, scarce knowledge and cognitive capacity could be addressed by AI and algorithms that can be quickly and easily replicated from one device to many. This could be seen as a job crisis, or a huge opportunity to build a better world.
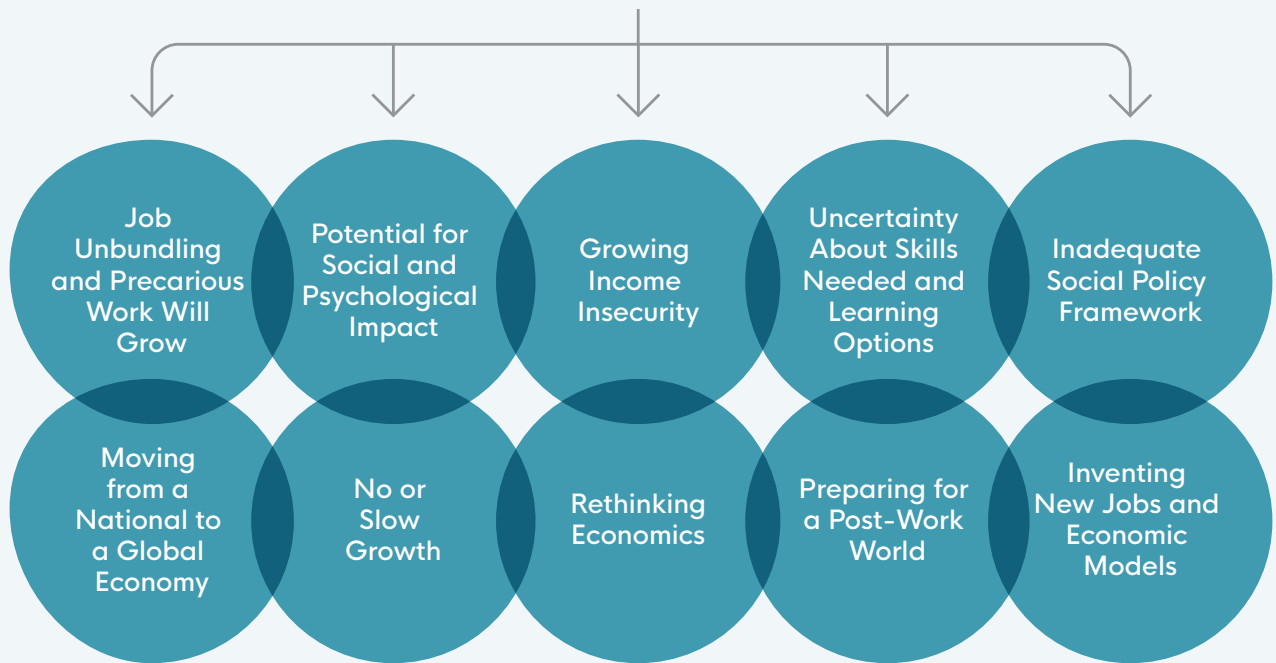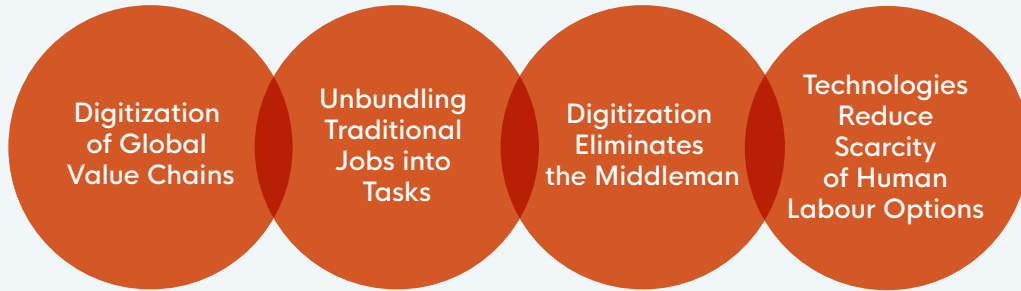
—— WHY IS THIS SIGNIFICANT IN 10-15 YEARS? ——

• **Job unbundling and precarious work will grow.** A 2018 survey of gig work research estimates approximately 11 percent of the U.S. working adult population primarily work as full-time independent contractors in the gig economy. A 2016 survey by Randstad notes that "85% of the companies surveyed figure that they will increasingly move to an "agile workforce" (contract, temporary or freelance) over the next decade. The switch to gig work is first and foremost about employers moving to what is efficient for them".

• **Potential for social and psychological impacts.** The rise of task-based and gig work could change how people connect. More time spent working alone, or not working, could lead to new or increased mental health issues surrounding loss of identity, loneliness, and depression.

• **Growing income insecurity.** Many surveys report that income adequacy and security are major concerns for gig workers. As virtual gig work platforms grow, people with similar skills will likely get similar wages across the planet.

> There will be a need to reframe basic ideas about work and income. We could enter a new era where we take advantage of the human potential in new ways.
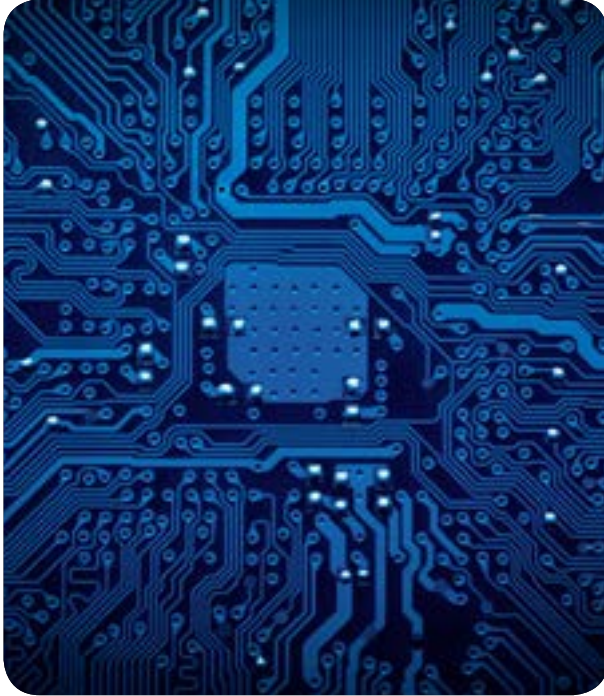
- **Uncertainty about skills needed and learning options.** A recent McKinsey study claims workers with a strong set of social, technological and high cognitive skills will be in demand. Inflexible and expensive options for accelerated learning could become a stumbling block for many displaced workers in a time of rapid change.

- **Inadequate social policy framework.** The 2017 IMF World Economic Outlook notes we need to rethink the nature of social insurance programs. Much of current social policy assumes that people have full-time jobs, or will have one soon. There is a need to explore more robust responses to income insecurity, and the rise of precarious work.

- **Moving from a national to a global economy.** A technology-enabled global market of on-demand resources is emerging. Many tools of the nation state may be less effective in areas like minimum wage, labour standards, tax and trade rules.

- **No or slow growth.** Reduced costs from unbundling and automation, and increased competition in digital value chains will reduce the number of intermediaries. In the current economy, a number of jobs and sectors may shrink or disappear which could lead to demand destruction and periods of no or slow GDP growth.

- **Rethinking economics.** Current macroeconomics theory may need to examine some of its core assumptions. Current policy instruments may not effectively deal with the "structural slowth" emerging from the digital transition. As trade moves towards a global open market of on-demand resources, traditional trade deals could have distortionary or unexpected consequences in an increasingly digital world.

- **Preparing for a post-work world.** As automation grows, a growing number of people may be surplus to requirements. What would people do if there is no work? There will be a need to reframe basic ideas about work and income. We could enter a new era where we take advantage of the human potential in new ways. For instance, people could be rewarded for building social capital, such as caring for children, building community, social experiments and creating art or music.

- **Inventing new jobs and economic models.** Digital technologies will enable new organizational models for production and ownership. Innovation could create opportunity for every actor in the economy, by inventing whole new categories of jobs and industries. It could also involve envisioning a different economic model built on very different assumptions about scarcity, inequality and sustainability.

CHANGE DRIVERS

Digitization of Global Value Chains

Unbundling Traditional Jobs into Tasks

Digitization Eliminates the Middleman

Technologies Reduce Scarcity of Human Labour Options

- - -
WORKING IN THE DIGITAL ECONOMY
- - -

Job Unbundling and Precarious Work Will Grow

Potential for Social and Psychological Impact

Growing Income Insecurity

Uncertainty About Skills Needed and Learning Options

Inadequate Social Policy Framework

Moving from a National to a Global Economy

No or Slow Growth

Rethinking Economics

Preparing for a Post-Work World

Inventing New Jobs and Economic Models

IMPLICATIONS

GLOBAL HEALTH AND WELLNESS FOR THE 21ST CENTURY

Delivering health and wellness in an effective, equitable and sustainable way could pose challenges in the near future, as new technologies and other disruptive changes emerge.

—— SUMMARY ——

Healthcare is expected to transform rapidly over the coming decades, driven by massive technological innovation, increasingly interdisciplinary medical fields, and growing demand to treat aging populations with longer lifespans. The future of medicine could be more predictive, preventive, personalized and participatory.

—— WHAT IS CHANGING? ——

- **Healthcare is increasingly international business.** As modern urban lifestyles spread beyond industrialized nations, developing countries face the double healthcare burden of both rising chronic disease and infectious diseases. The pressure for low-cost innovative solutions could present game-changing approaches and differing standards for care, leading to a rise in medical tourism, and competition for western pharmaceutical producers.

- **Medicine will harness improved tools for prediction and prevention.** DNA will grow more useful for (pre)diagnosis of chronic conditions, and for tracking pathogens leading to viral outbreaks. Sensors, digital data and social media will also facilitate virus tracking, while synthetic biology may play a role in formulating just-in-time vaccines. Prenatal interventions, early-life treatments, genetic and epigenetic therapy could prevent or even eradicate some chronic diseases. Nano-based theranostics (diagnostics with therapy) could allow earlier cancer treatment, while epigenetic therapy could prevent cancer development altogether. Nanotechnology and synthetic biology solutions could address growing antibiotic resistance.

- **Sequencing patient DNA may lead to personalized medicine.** This will help medics to identify safer, more effective drug treatments tailored for individual patients. A patient's own cells could be used to grow specific tissue, for drug testing, repair (e.g. after a heart attack), or to 3D print an organ.

- **Healthcare could occur remotely.** Tiny sensors are increasingly cheap, appearing in consumer self-monitoring health products/apps, time-release medicines, smarthomes and everyday objects. Combined with telemedicine platforms and companion robots, these could enable round-the-clock care for seniors in their own homes. As some consumers experiment with, track and share their health practices, they are generating health data beyond patient records and genetic information.

- **Bio-informatics, big data and artificial intelligence.** Real-time behavioural data and powerful data tools could lead to medical insights (e.g. simplified drug testing) and address the preventable risk factors largely responsible for chronic diseases. While the behavioural, social and environmental determinants of one's health will be increasingly predictable, public health interventions are limited by a lack of evidence of what works. Big data supported by blockchain could expand datasets of electronic health records or public health surveillance, providing new possibilities to focus and test interventions at various population levels. Governments may find new ways to gamify behaviours or enforce regulations.

- **Regenerative medicine and human augmentation.** These fields could extend lives and transform disabilities into super-abilities. Stem cell use for tissue engineering, and nano-features to mimic bone properties, suggest that many of our parts could be replaceable. Human augmentation developments may lead individuals to demand not only medical interventions, but physical and cognitive enhancements beyond typical human capabilities.
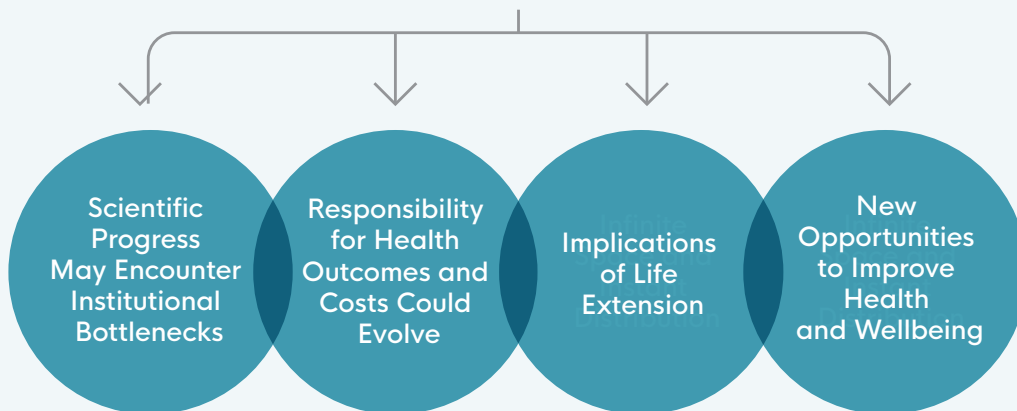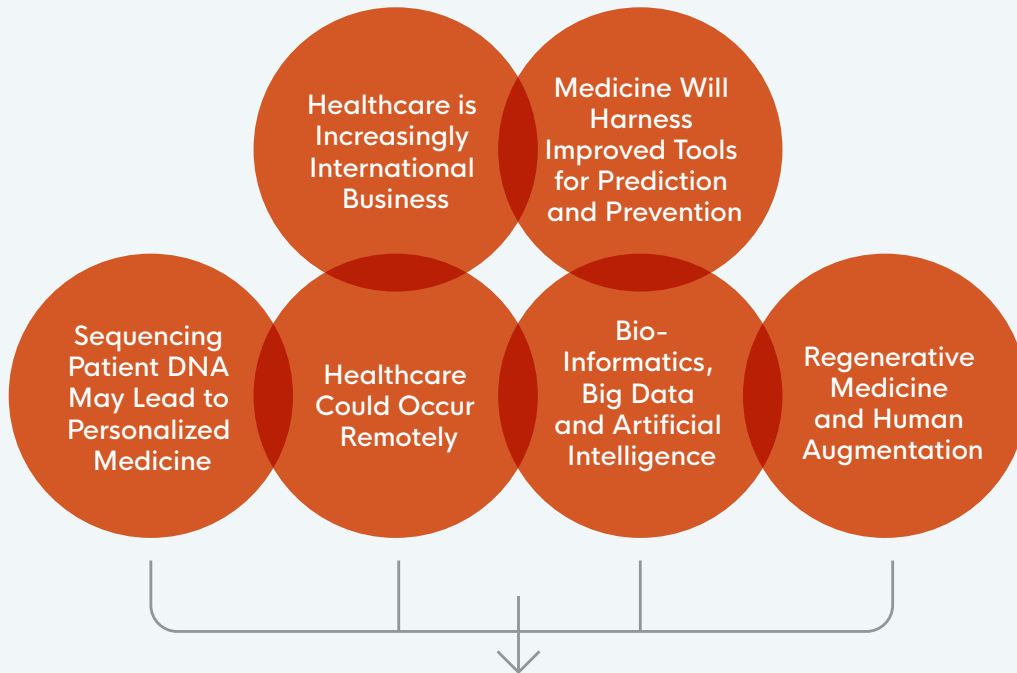
—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

• **Scientific progress may encounter institutional bottlenecks.** Rapid medical developments may encounter institutional bottlenecks if roles and responsibilities are not fully in place to ensure oversight. The priorities of health systems may need review to consider new risks, opportunities and investment issues. Regulatory hurdles and skills shortages could set back the application of new technologies, notably the potential for big data to drive progress in health. International cooperation may be needed to develop uniform standards for health products and services, and to manage infectious diseases.

• **Responsibility for health outcomes and costs could evolve.** The high cost of some new treatments (e.g. personalized medicine) could provoke debate on ethical considerations related to accessibility. As consumers have more information (and incentives) linking their behaviours to health outcomes, there may be greater expectations of personal freedom and responsibility, as has occurred in other systems (e.g. work, education, retirement planning). Alternatively, epigenetic inheritance (e.g. impacts of parents' and grandparents' exposure to toxins) could drive demand for governments to address inequalities through public health investments or epigenetic treatments. This could set a precedent for new liabilities and raise the level of scrutiny for future product safety standards.

• **Implications of life extension.** Life extension and augmentation will introduce ethical questions concerning all aspects of life. Health systems increasing years of good health could result in dramatic shifts in how people with disabilities, older generations and new super-humans participate in work and society. These possibilities may affect life course patterns as people may (have to) work longer, which could affect work intensity and timing of education, family planning and retirement. Extending meaningful participation in community life could also require adjustments, as older populations compete with younger populations and influence culture and institutions. Life extension could also create prolonged periods of dying and boredom, and challenges of overpopulation and social strife. A greater societal focus on self-preservation could distract from the goal of living a meaningful life. New means of preventing or eliminating disease and disability could fuel right to life and right to die debates.

• **New opportunities to improve health and wellbeing.** Outside the medical system, emerging and future lifestyle and urban design options could present opportunities to address health and wellbeing goals. A number of areas merit exploration for their health risks and opportunities, including: the use of digital media and the Internet of Things in personal and professional life; remote working and precarious work patterns; 3D printing applications; transit and land use implications of self-driving cars and smart city design; diet implications of vertical farming and genetic modification in food.

CHANGE DRIVERS

Healthcare is Increasingly International Business

Medicine Will Harness Improved Tools for Prediction and Prevention

Sequencing Patient DNA May Lead to Personalized Medicine

Healthcare Could Occur Remotely

Bio-Informatics, Big Data and Artificial Intelligence

Regenerative Medicine and Human Augmentation

GLOBAL HEALTH AND WELLNESS

Scientific Progress May Encounter Institutional Bottlenecks

Responsibility for Health Outcomes and Costs Could Evolve

Implications of Life Extension

New Opportunities to Improve Health and Wellbeing

IMPLICATIONS

THE EMERGING ASOCIAL SOCIETY

Despite hopes that technology would enhance our social connectedness, some data indicates that more people are feeling lonely and disconnected from the world around them, suggesting continued social challenges in a future where more people feel isolated.

—— **SUMMARY** ——

Recent research suggests that many people feel increasingly isolated
and lonely. This trend is particularly prevalent in more developed countries, to the
detriment of individual and societal well-being. These reports of loneliness may signal
a socially disconnected way of life, driven by circumstances including the
changing nature of work, the increasing valuation of individualism in society, and the
rising ubiquity of toxic social media messages. This trend could lead to a general
loss of social intelligence, a rise in antisocial backlash, and a decline in
physical and mental health. Human inability to interact meaningfully without
the intervention of technology could prompt questions regarding
access, privacy, and ethics.

—— WHAT IS CHANGING? ——

A growing cultural emphasis on overwork as a virtue could also discourage workers from maintaining social circles.

- **The rise of living alone.** Increasing numbers of people are living alone, as they delay or choose not to build a family. Longer lifespans, urbanization, and declining rates of childbirth are also major contributors to this phenomenon. Although the number of one-person households doesn't correlate directly with feelings of loneliness, a higher number of such households increases the risk of feeling isolated.

- **Changing nature of work.** Shifting conditions of finding and maintaining work can cause further social isolation. Short-term work opportunities can discourage employees from creating lasting social bonds in their workplaces. While telepresence allows more flexible work arrangements, it can also cause physical isolation from others. A growing cultural emphasis on overwork as a virtue could also discourage workers from maintaining social circles.

- **Antisocial development and use of technology.** The most widely used social media platforms are designed in a way that, if relied upon for social fulfillment, can cause feelings of loneliness and general depression. Younger generations who grew up using social media are among the loneliest-feeling subsets of the population. Children who grew up using social media reportedly show lower social literacy and emotional intelligence. Social networking engines that mimic the function of online social networks are now being implemented into many other aspects of life that previously had no "social" component, risking a rise in these effects.
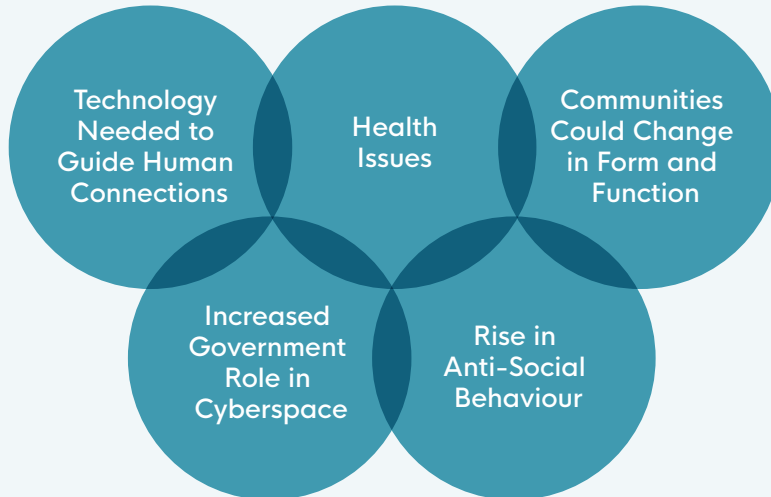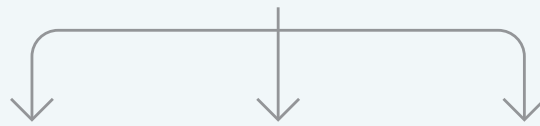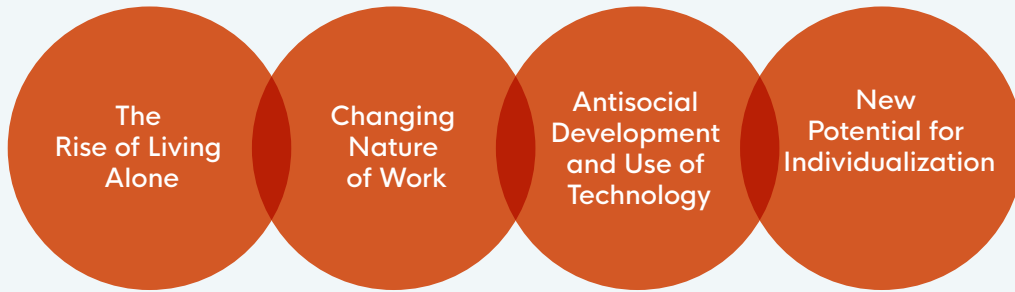

- **New potential for individualization.** Technology's increasing ability to tailor products and experiences to the end user encourages a greater focus on individual needs and personal preferences. While a focus on the individual is widely acknowledged in the traditional western mindset, advances in technology are securing this mentality. The rise of 3D printing and just-in-time manufacturing allow for increased tailoring in areas such as design and production. In the future, technologies like artificial intelligence (AI) and augmented reality could enhance the potential for tailoring moment-to-moment experience. Technology is enabling relationships between people that transcend geographical or physical limitations.

WHY IS THIS SIGNIFICANT IN 10-15 YEARS?

- **Technology could become necessary to guide human connections.** A decline in the ability to interact meaningfully with others may increase demand for technology to compensate for lost social skills. Software engines fueled by social media data may act as an intermediary in basic human interactions, using AI to read and convey emotional states and complex social cues, which could generate new privacy and accountability challenges. Replacing intuitive processes with explicit cognitive ones could transform the social experience.

- **Asociality could lead to health issues.** Evidence suggests that feelings of loneliness pose risks to physical and mental health. Health care systems could be strained by the increase in people experiencing ailments related to social isolation. There may be more demand for healthcare systems to provide medicinal options to combat the feelings of loneliness caused by increasingly asocial lifestyles. Feelings of social isolation have been shown to shorten the human lifespan, which could run counter to the advancements in modern medicine.

- **Communities could change in form and function.** An increase in the ubiquity of opportunities for individualization could cause new issues in the realm of identity and community. Communities determined by circumstance (such as where one lives) may become deemphasized in favour of digitally connected "chosen" communities. With these communities able to bring together people with shared interests and views, how we interact with immediate, physical communities remains in question – and may affect people's sense of citizen responsibility to local and national polities.

- **Governments may play a greater role in cyberspace.** Many people may turn to virtual reality and other technologies offering social experiences for their social fulfillment. As these platforms become more sophisticated and widely used, governments will need to consider complex issues regarding virtual spaces, such as ensuring access for all citizens, and establishing rules and norms for interactions.

- **Rise in antisocial behaviour.** The feeling of inescapable loneliness has been associated with feelings of hostility towards others. This hostility has been known to manifest in associations with extremist or violent groups. A rise in lonely isolation could increase the number of young people who establish connections with antisocial or hostile groups for their social validation, posing risks to public and national security. Preventing lonely people from turning into anti-social actors could become a significant future challenge.

CHANGE DRIVERS

The Rise of Living Alone

Changing Nature of Work

Antisocial Development and Use of Technology

New Potential for Individualization

THE EMERGING ASOCIAL SOCIETY

Technology Needed to Guide Human Connections

Health Issues

Communities Could Change in Form and Function

Increased Government Role in Cyberspace

Rise in Anti-Social Behaviour

IMPLICATIONS

SHIFTING DYNAMICS OF PRIVILEGE AND MARGINALIZATION

Shifting landscapes of power, wealth, culture, and attitudes will create new social strata of privilege, and marginalize many.

─── SUMMARY ───

The 2008 economic crisis gutted the middle class sense of security
and privilege. Evolving and emerging crises are creating new refugee populations,
which challenge existing structures of culture, identity, and traditional privilege.
Innovations raise the possibility of creating new human subgroups
and new non-human minds.

—— WHAT IS CHANGING? ——

As social primates, humans are hardwired to perceive, create and function within competitive hierarchies. Geographic, economic, political, and cultural migrations bring people face to face with a wide variety of 'others', generating dynamic landscapes of privilege, marginalization and bias. Technological innovation will amplify this by creating entirely new categories of 'other'.

• **Volatility and uncertainty.** Growing instabilities within historical, social, economic, and power structures are challenging traditional gender norms and family structures; gutting communities and cities; eroding middle class expectations; creating enough victims/refugees to challenge charitable impulses; and polarizing politics and civic dialogues.

• **Emerging new human tribes.** From simple body augmentation – tattoos, scarification, body jewellery – more and more people are experimenting with embedded technology, augmented physiology, and eventually genetic redesign.

• **Evolving robotic ecosystems.** Interconnected smart devices are evolving beyond smart vacuum cleaners, refrigerators, and autonomous vehicles (AVs); smart assistants like Alexa, Siri, and Google are increasingly able to communicate with and act on the world – and are interconnecting to amplify that capacity.

• **Patterns of abuse and conflict.** Abuse of the other (e.g., other races, cultures, animals, or artificial entities) is rising, with more incidents of people abusing Roombas, robots, autonomous vehicles (AVs), and smart assistants, as well as victimizing those humans seen as usurping privilege.
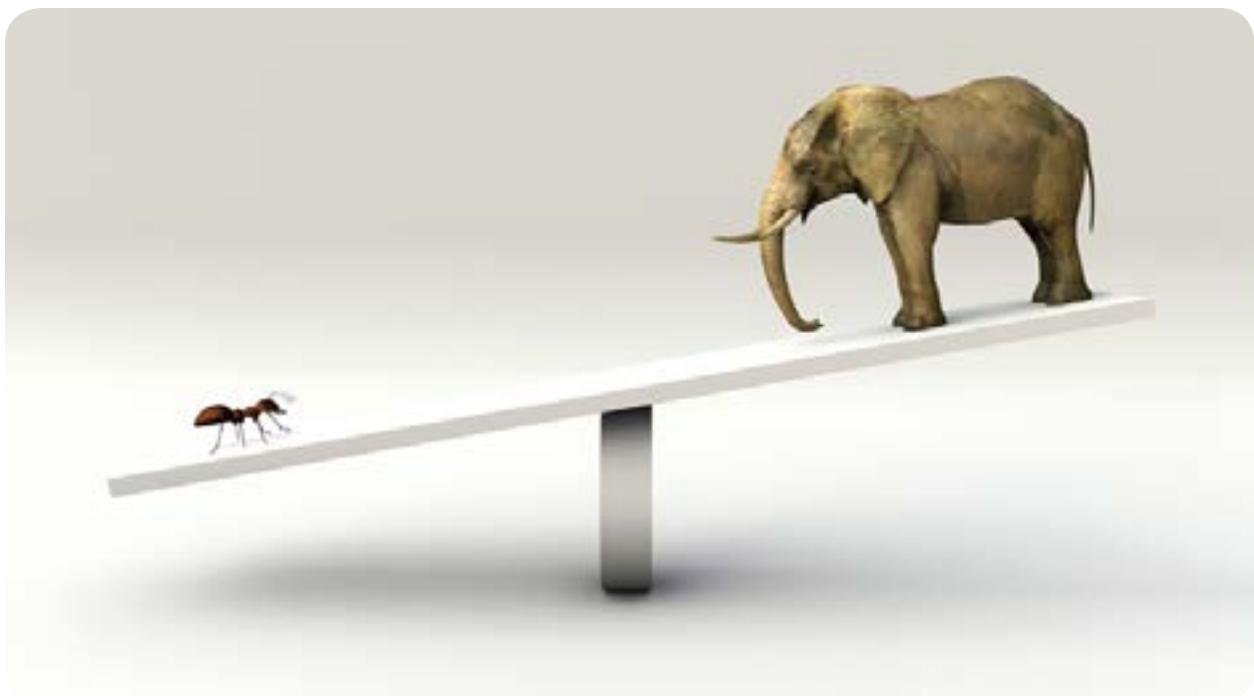
—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

Humanity faces several decades of environmental, economic, political, cultural, and technological upheaval. As the speed and magnitude of changes increase, so will social volatility and uncertainty.
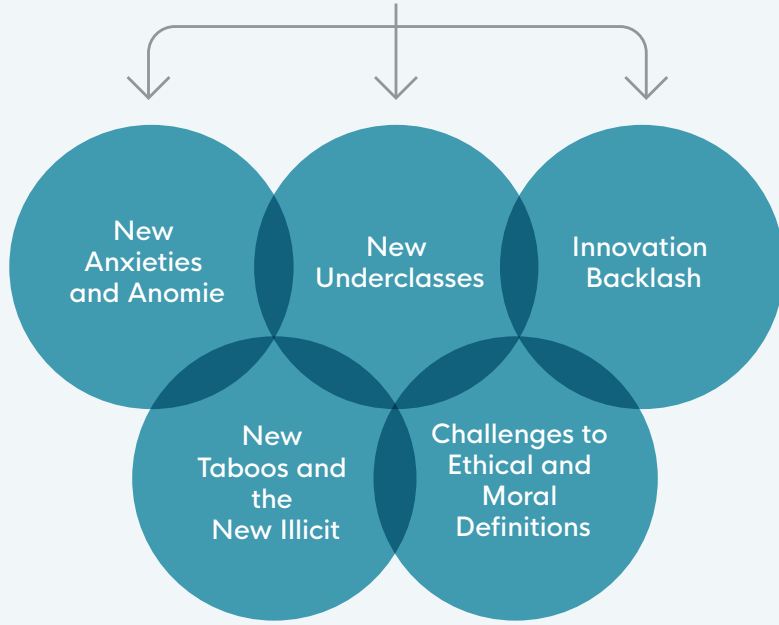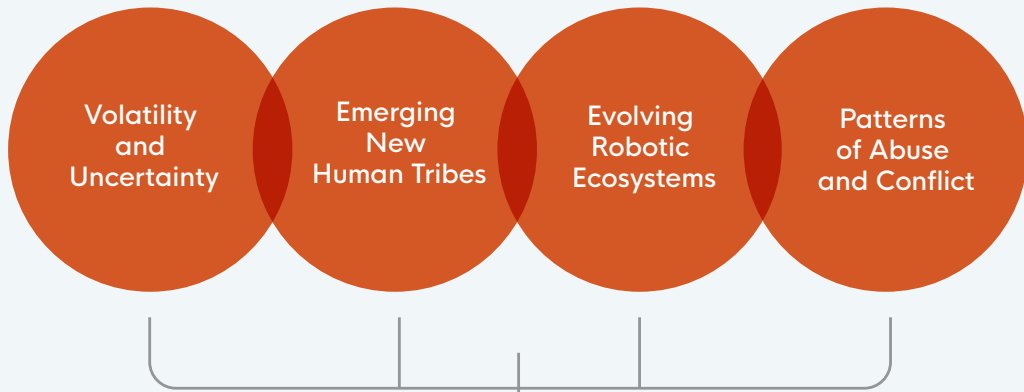

- **New anxieties and anomie.** Increasing uncertainties could create a future of rising social fears, collapsing sense of connection to shared norms, and increasing social tensions across novel identity boundaries. Proliferating human tribes and cultures could create an overchoice of potential identities – perhaps for some meaning no choice at all, and a rise in social isolation. No or slow acceptance of people with new identities could lead to an increase in mental health issues, particularly for "designer children" whose bodies and personalities were engineered without their agency.

- **New underclasses.** Growing political, economic, and environmental crises will continue to create waves of refugees and asylum seekers. Displaced peoples could be increasingly marginalized and demonized by nationalists and populists, viewing any outsiders as unworthy of the full array of civil rights. In the longer term, tribes of the enhanced, the augmented, and the genetically optimized could also be ostracized by 'pristine' humans, with visible augmentation treated with the suspicion that tattoos once caused. Alternatively, only the wealthy can afford augmentation and optimization, and the unenhanced may become the underclass. Street crime could victimize the under-optimized – or the over-optimized, if 'pristine humans' fanatics arise.

- **Innovation backlash.** These new human tribes could trigger religious backlash, preaching to keep the body as God or the gods created it. Hostility and resentment against autonomous robots and intelligent systems for encroaching on human roles and jobs, could take the form of increased pranking, vandalism, and violence against synthetic intelligences, and spark a tech-free 'living simple' movement.

- **New taboos and the new illicit.** As cultures, philosophies, and ethnicities increasingly collide when refugees and asylum seekers mix with established communities, conflicting traditions could create new taboos and definitions of the illicit. In the longer term, attitude studies comparing Western cultures with China and India suggest innovations in augmentation and genetic redesign will gain more support in the East. 'Augmentation tourism', underground biohack rings, and a black market enhancement trade could rise as attitudes harden in the West, giving rise to taboos against augmentation/biohacking. China and India may see the reverse, where being unhacked would be the illicit behavior.

Societies of the future could be micro-fragmented, fracturing along the stress lines of shifting perspectives on traditional attitudes and on designed human and non-human cultures.

- **Challenges to ethical and moral definitions.** Societies of the future could be micro-fragmented, fracturing along the stress lines of shifting perspectives on traditional attitudes and on designed human and non-human cultures. The resulting lack of an agreed and stable centre of values, ethics, and morals, could paralyze civic debate on human rights issues, and the very definition of humanity.

CHANGE DRIVERS

- Volatility and Uncertainty
- Emerging New Human Tribes
- Evolving Robotic Ecosystems
- Patterns of Abuse and Conflict

– – – SHIFTING DYNAMICS OF PRIVILEGE AND MARGINALI-ZATION – – –

- New Anxieties and Anomie
- New Underclasses
- Innovation Backlash
- New Taboos and the New Illicit
- Challenges to Ethical and Moral Definitions

IMPLICATIONS

BUILDING BETTER LIVES ACROSS THE GENDER SPECTRUM

Shifting power structures and changing social norms challenge global gender inequality. Informed interventions could improve quality of life in many countries. Innovations in human enhancement and biodesign could in future radically reframe gender issues.

—— SUMMARY ——

Women, trans and non-binary people are making advances in economic
and social spheres, and existing systems of power are responding. Some men are
acting as champions of change, while others need to adapt or risk being left behind.
Complacency and resistance to changing traditional patterns of privilege are
barriers to lasting gender equality and equity. Further studying the enhancing,
augmenting, or biodesigning of human physiology could expand the popular
conception of the gender spectrum and the related cultural, social,
political, and economic assumptions.

⎯⎯ WHAT IS CHANGING? ⎯⎯

- **Shifting power structures.** Historical patriarchal structures are being challenged and changed through public pressure (e.g., #metoo and other online campaigns) and political interventions (e.g., women on boards). There are growing global efforts to increase women's political participation. Many men are also playing a role in gender equality with calls for pay equity in high-profile industries, and advocating for an end to gender-based violence. Some men of colour are challenging the same patriarchal systems in new ways.

- **Recognition of rights.** Responding to changing social norms, many companies are moving towards gender-neutral marketing. Developing countries are beginning to make important social and legal advances in protecting women and LGBTQ2 rights. Notable changes have included the repeal of laws forcing women to marry their rapists across the Middle East, the decline of child marriage in Africa, and the recognition of trans rights in Pakistan.

- **Widening gaps between men and women.** While women are achieving higher education levels, boys and men are falling behind in academic achievement. In North America, traditionally male-dominated industries are disappearing, leaving some men with largely non-transferable skills due to automation. These shifts are leaving primarily white men more vulnerable to depression and suicide. Despite a history of discrimination, some gay men now out-earn their straight counterparts. Traditional gender roles still persist, as some millennial women are still wary of earning more than their partners and hesitate to invest their earnings.

- **Doubling down on misogyny, homophobia and transphobia.** With women, trans and non-binary people making gains, resistance to change is evident. Women in politics and in male-dominated industries are subject to cyberbullying across the globe. The religious right continues to push for the reversal or denial of access to abortion and birth control. The link between online misogyny and violence has new prominence in the alt right and incel movements, while the acceptance of LGBTQ2 people has increased in some countries, yet decreased in others.

- **Advancements in gender-affirming medical services and technology.** Where accessible, progress in technological and surgical capacity and healthcare provider expertise is giving trans and non-binary people more freedom to choose how to express their gender, as well as more support for their reproductive choices. Trans individuals are increasingly identified at younger ages, and have better access to applicable family, medical and social support. Expanding technological capacity for human augmentation and enhancement, as well as outright bio-redesign, could influence society's understanding of gender identity and expression.

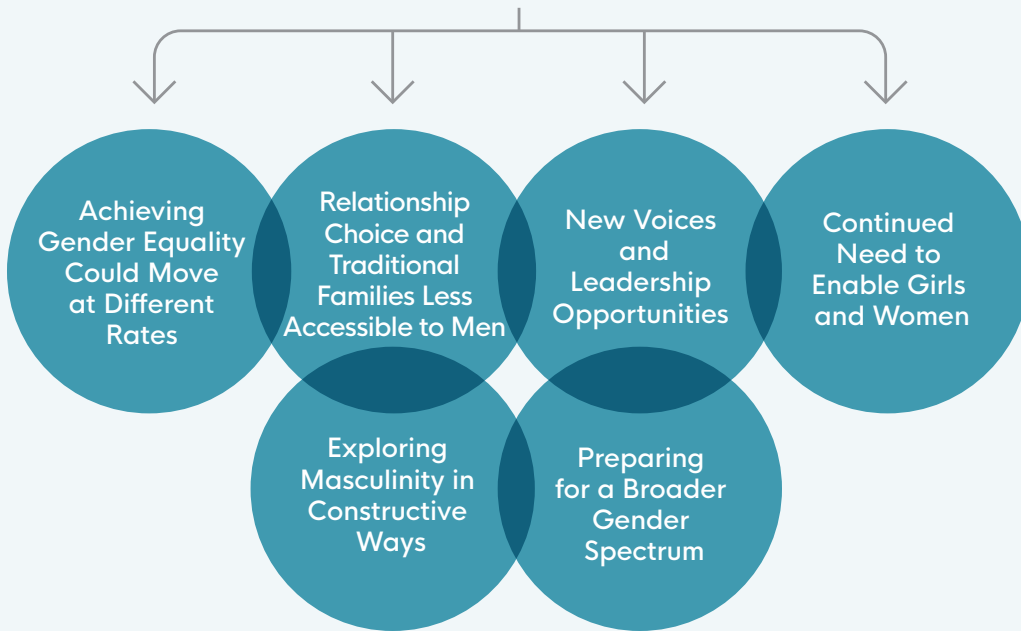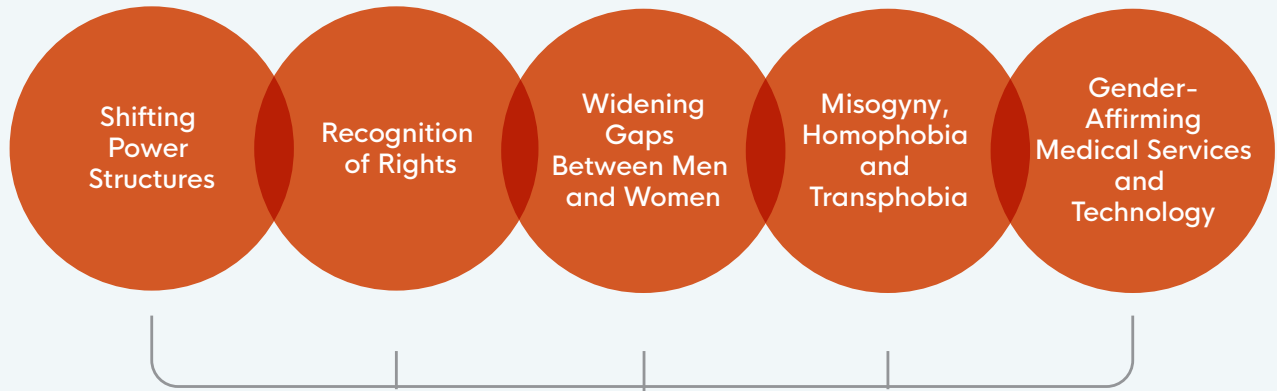# —— WHY IS THIS SIGNIFICANT —— IN 10-15 YEARS?

Some of these changes could be transformational (positively and negatively) across society. Those most vulnerable may not benefit at the same rate or not at all.

- **Achieving gender equality could move at different rates.** Education levels, access to the labour market, and personal autonomy regarding relationships and age of marriage could still vary worldwide as some social norms remain entrenched. Progress could be made as companies tailor recruitment for women, and migrant workers gain rights in the Middle East and Asia. Artificial intelligence could prevent bias in hiring, but not without risk of error or abuse. Increased understanding of the needs of people across the gender spectrum could lead to structural changes to some institutions as well as public and private services (e.g., healthcare).

- **Relationship choice and traditional families could become less accessible for men.** Women's increased economic autonomy could empower them to demand more diversity in their relationship arrangements, impacting population growth. This could present a number of policy challenges, including in programs like public pensions, private insurance, and property rights. Women who want families (with or without a partner) could make expanded use of surrogacy. Commodification of sperm and eggs could change norms of the reproductive years, yet make some women more vulnerable to exploitation. If driven by women and LGBTQ2 people, polyamory could become more prominent and acceptable. In some countries, gender imbalances will offer men with higher incomes more relationship options, but make women increasingly vulnerable to human trafficking and violence. Legal frameworks would have to catch up.

- **Emergence of new voices and opportunities for leadership:** With a societal shift towards inclusion, we could see substantial diversity in positions of power. Women worldwide could fill gaps and access new opportunities, particularly in countries where women's rights have been limited. Benefiting from their lived experiences, Indigenous women, immigrant women, women of colour and LGBTQ2 people could lead systemic change in addressing gender equality in the public and private spheres.

- **Continued need to enable girls and women.** Persistent gaps in social supports for both single people and families could continue without political responsiveness to change, affecting lower-income women, trans and non-binary people most. Women with disabilities could still be far behind in their economic and social autonomy, and many senior adults could find themselves without support. Different models of justice could emerge on a wider scale to address gender-based violence and discrimination. Technologically enhanced preventive measures could arise, such as blockchain for police records and humanitarian settings, to increase accountability.

- **Exploring masculinity in constructive ways.** Developing a deeper understanding of "the male experience" could help men understand their own biology and behaviour. It would provide a solid foundation for non-patriarchal relationships and cross-gender dialogue. Societal norms of masculinity could shift on a large scale, enabling men to take a more active role in their mental and physical well-being. A more flexible view of what defines masculinity could help tailor education curricula to reinforce these values; men could be open to non-traditional work that is less vulnerable to automation; and there could be a decrease in online harassment and gender-based violence.

- **Preparing for a broader gender spectrum.** As biodesign and synthetic biology become more sophisticated, people's capacity to transition to their self-identified gender may become quicker, less invasive, and relatively pain-free. Unconstrained from binary gender norms, we could see a future of designer non-binary genders with a side order of augmented physiology, in which some people could take 'gender sabbaticals' to broaden their perspectives through immediate experience.

CHANGE DRIVERS

- Shifting Power Structures
- Recognition of Rights
- Widening Gaps Between Men and Women
- Misogyny, Homophobia and Transphobia
- Gender-Affirming Medical Services and Technology

BUILDING BETTER LIVES ACROSS THE GENDER SPECTRUM

- Achieving Gender Equality Could Move at Different Rates
- Relationship Choice and Traditional Families Less Accessible to Men
- New Voices and Leadership Opportunities
- Continued Need to Enable Girls and Women
- Exploring Masculinity in Constructive Ways
- Preparing for a Broader Gender Spectrum

IMPLICATIONS

INHABITING CHALLENGING ENVIRONMENTS

The launch of the first automobile into the asteroid belt leads us to consider how planning and inventing for people to live in challenging environments could change us physically, socially, culturally, and politically.

—— SUMMARY ——

As space exploration advances, priorities may shift from government concerns (strategy and defence; technology challenges and innovations; costs; and legalities of extraterrestrial resources) to private sector concerns. In the emerging age of privately sponsored space exploration, Elon Musk's 'Tesla in Space' exemplifies the unique approach to space initiatives made possible by private funding. Orion Span's Aurora Station orbital hotel initiative opens up space as a leisure destination, and the Mars One initiative demonstrates public interest in space colonization.

New marine technologies and architectures are playing a role as people propose and pilot innovative schemes to inhabit oceans – on and below the surface. A future of undersea hotels, undersea farming, and floating city-states is evolving, leading to a reframing of culture, economics and governance.

Research exists on the psychology of space exploration, and many of the pilot projects and historical data come from studying submarine communities and experiments in undersea labs. There is less information on possible undersea and deep space human habitation. Several major biological, psychological, and cultural shifts in our species could emerge as we evolve, or redesign ourselves, to live in challenging environments - including the increasingly challenging environment of the Earth after climate change.

—— WHAT IS CHANGING? ——

Human exploration and habitation of space and oceans is moving beyond government-funded science, exploration, and military activities. It is shifting to privately-funded business ventures, citizen science, community building, polity design, and artworks.

- **Privatization.** Space exploration is evolving from projects of national pride to corporate and non-profit initiatives, as seen with Virgin Galactic, SpaceX, Orion Span, Conrad Hotel's Muraka undersea villa, and the Sea Orbiter.

- **Technological advancement.** Breakthroughs in materials science, propulsion, energy, and computing support habitat design for extreme environments; and bioengineering innovations could lead to redesigning humans themselves for extreme environments.

- **Citizen science.** Interested laypeople increasingly use cheap, adaptable microcomputers and microsensors to explore, map, and monitor the environment. They also use them to mount inexpensive, small-scale scientific initiatives, even to the edge of space.

- **Crowdsourcing colonies.** People impatient with the slow pace of government-led space exploration are organizing the Mars One colonization initiative, and libertarians support creating free cities at sea.
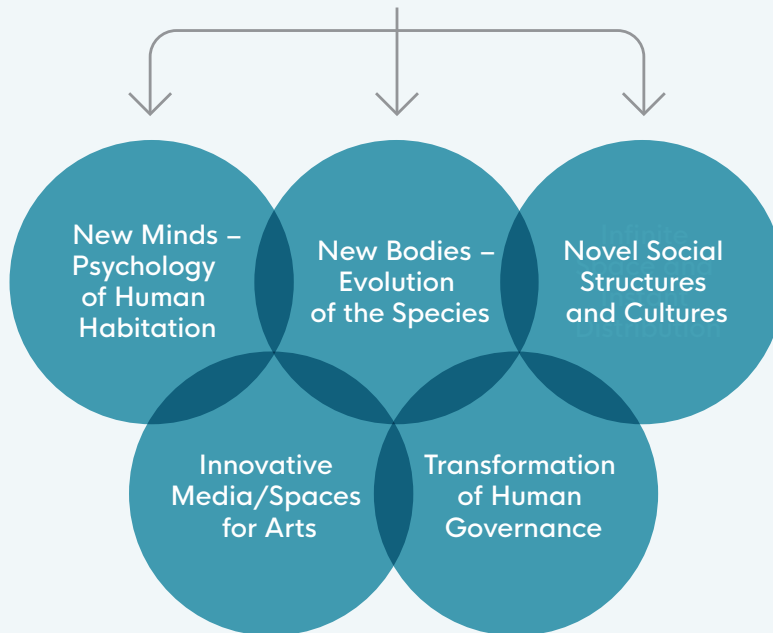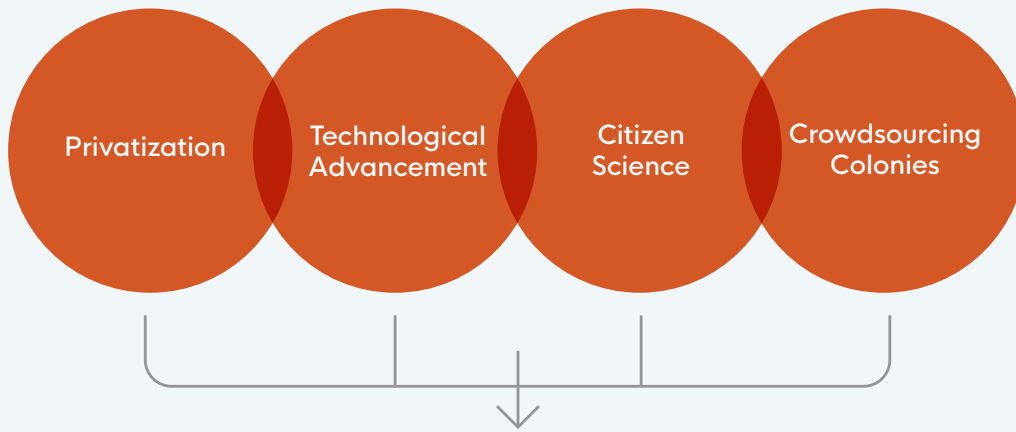
—— WHY IS THIS SIGNIFICANT —— IN 10-15 YEARS?

Homo sapiens stella may have very different values than homo sapiens terra - or homo sapiens aquatica.

- **New minds – psychology of human habitation.** Astronauts uniformly report seeing the world - and everything in it – differently upon return to Earth. *Homo sapiens stella* may have very different values than *homo sapiens terra* - or *homo sapiens aquatica*.

- **New bodies – evolution of the species.** People adapt physiologically to their environments, including both short-term exposure to microgravity, and generations of free diving. Could extreme environments lead to speciation (perhaps designed speciation via technologies such as CRISPR-Cas9 and gene drives)?

- **Novel social structures and cultures.** As small communities adapt to extreme environments, novel family structures, such as negotiated extended families, could evolve to enhance emotional stability and security. These new experiences could lead to transformative space-based religions.

- **Innovative media / spaces for arts.** Extreme environments present not only challenges, but also unique opportunities to the creative arts. What new design, sculptural, or performance arts might arise in undersea or space habitats?

- **Transformation of human governance.** As people move full-time to challenging environments – working, playing, creating, raising families – their priorities may diverge from folks 'back home', and novel ideologies and forms of governance may evolve into new states. Political divides between space-based, sea-based, and land-based human communities could erupt into wars.

CHANGE DRIVERS

Privatization

Technological Advancement

Citizen Science

Crowdsourcing Colonies

– – –
INHABITING CHALLENGING ENVIRONMENTS
– – –

New Minds – Psychology of Human Habitation

New Bodies – Evolution of the Species

Novel Social Structures and Cultures

Innovative Media/Spaces for Arts

Transformation of Human Governance

IMPLICATIONS

BALANCING RISKS AND BENEFITS IN THE EMERGING SURVEILLANCE SOCIETY

In a world where private corporations, our personal A.I.-enabled assistants, and other actors may know more about us than we do, easy privacy disappears or becomes a luxury good. Corporations could see their trade secrets and confidential information become more difficult to secure. Research and public dialogue could support the transition to a new deal to address the risks and seize emerging opportunities for an open democratic information society.

—— SUMMARY ——

We are subject to omnipresent surveillance when we travel, communicate, bank, work, and consume digital goods. To the extent that they are aware, users of social media and other online platforms, such as Facebook, currently seem to accept that their information will be harvested in return for access to the service. But individual choices are currently constrained: either 'buy in,' to gain access, or 'opt-out,' and be excluded. In the coming years, the erosion of practical anonymity could be almost complete. Instead of being able to assume that there are private spaces and contexts, we may need to negotiate new deals to respect the boundaries of the person. We may need better concepts and tools to weigh the downsides of surveillance against new value propositions from businesses and governments.

—— WHAT IS CHANGING? ——

- **Surveillance becoming ubiquitous.** Over the next decade, our everyday lives will likely be monitored by ubiquitous surveillance systems hidden in plain sight and disguised as little everyday helpers. Self-driving vehicles, ground and aerial delivery drones are likely to have a growing presence, and are already fully equipped with audio and video systems. Augmented reality glasses that are able to provide the wearer with a "heads-up display" (HUD) can overlay digital information onto real world objects and people. Thus institutional surveillance will increasingly be matched by citizen sousveillance, resulting perhaps in a balance of equiveillance.

People and organizations who understand the ramifications of technological changes behave differently than those who are oblivious to the issues.

- **Smart cities** extend data collection: Cities are now offering free public WiFi and deploy sensors and cameras to collect data on everything from traffic flows to air quality. As 5G wireless networks roll out over the coming years, enabling faster, real-time data collection and analysis, the amount of big data collected is expected to grow exponentially.

- **Artificial intelligence systems make sense of it all:** A.I. sifts through everything collected in public and private spaces on individual levels, down to semantic analysis of conversation snippets we have **with or near** our digital assistants, and deduce very personal information. No longer limited to reviewing text, AI is recognizing faces and forming interpretations about individuals' thoughts and intentions based on their expressions.

- **Information asymmetry:** People and organizations who understand the ramifications of technological changes behave differently than those who are oblivious to the issues.
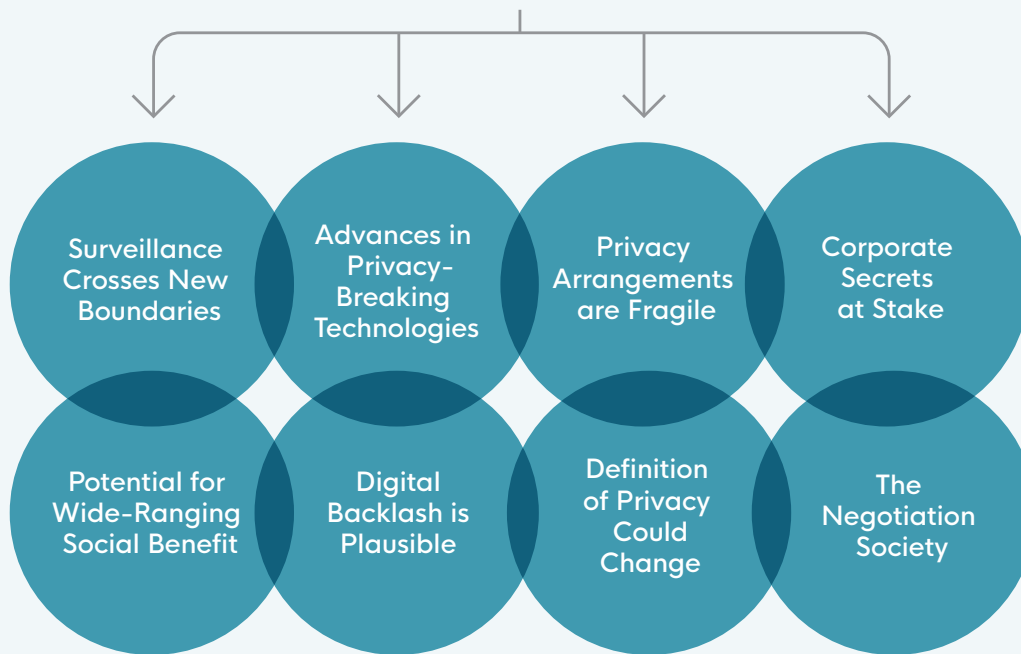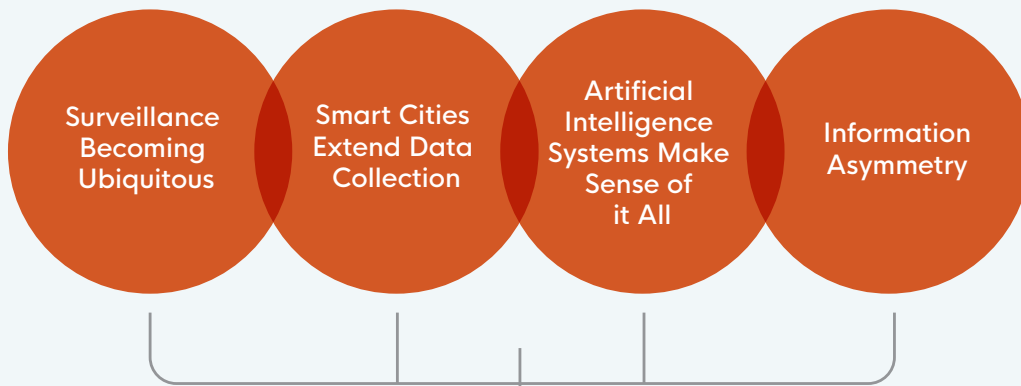
—— WHY IS THIS SIGNIFICANT —— IN 10-15 YEARS?

In ten to 15 years, our practical opportunities for privacy may be very different. Access to data and insights about our lives could impact health, wealth and distribution of power in some ways that we may welcome and others that we may find jarring. There will be trade offs, but also possibilities for harmonizing privacy and the social benefits of data.

The end result could be a 'good surveillance society' that offers practical anonymity and a right to not be interfered with

- **Surveillance crosses new boundaries.** Advances in neurotechnology may allow us to monitor brain events in detail, and even to 'read and write' to the brain. We may engage in brain-monitoring surveillance for work or leisure purposes. This may allow surveillance of brain events in a way that is not currently available even to the person experiencing them.

- **Advances in privacy-breaking technologies.** While improvements to encryption and security mechanisms, such as homomorphic encryption, could temporarily open up new possibilities to data use without identifying individuals, quantum computing is expected to be able to defeat any existing encryption system.

- **Privacy arrangements are fragile.** If cyber-security continues in 'catch-up' mode, then our continued immersion in networks will make us increasingly vulnerable to hacks and 'class breaks.' This could undermine good-faith attempts to design for privacy. Our attempts to regulate this risk may require a reassessment of responsibility in this area.

- **Corporate secrets at stake.** As big and open data shapes the business world, it may become more difficult for companies to maintain trade secrets and confidential information. Their loss could eliminate competitive advantages and put industries at risk.

- **Potential for wide-ranging social benefit.** Corporations and governments at all levels could use IoT devices and data analytics to customize services to individuals, from garbage recycling and taxes to food and health programs. Optimizing and improving the lives of citizens and customers could become a major area for cooperation or competition.

- **Digital backlash is plausible.** Neo-luddism could grow in proportion to unmanaged privacy and security risks. If individual disengagement is no longer effective because surveillance is ubiquitous, neo-luddism could become a political force instead of an individual reaction.

- **Definition of privacy could change.** In the late 20th century, informational privacy was understood as relating only to data that could be linked to an identifiable person. This could change if individuals feel their interests are engaged even when de-identified information is harvested from their life to serve the purposes of a private or public sector organization.

- **The negotiation society.** Context-dependant meanings and definitions of privacy may need to be negotiated between actors. The end result could be a 'good surveillance society' that offers **practical anonymity and a right to not be interfered with**, based on assertive claims about the boundaries of persons and the contexts in which they build their lives.

CHANGE DRIVERS

- Surveillance Becoming Ubiquitous
- Smart Cities Extend Data Collection
- Artificial Intelligence Systems Make Sense of it All
- Information Asymmetry

– – – EMERGING SURVEILLANCE SOCIETY – – –

IMPLICATIONS

- Surveillance Crosses New Boundaries
- Advances in Privacy-Breaking Technologies
- Privacy Arrangements are Fragile
- Corporate Secrets at Stake
- Potential for Wide-Ranging Social Benefit
- Digital Backlash is Plausible
- Definition of Privacy Could Change
- The Negotiation Society

HUMANITY+

The increasing sophistication of physical and cognitive augmentation technologies will unlock new potential for human abilities, health and longevity, potentially raising divisive social, legal, and psychological issues.

—— SUMMARY ——

Physical and cognitive augmentation technologies, such as bionic limbs, neurological enhancements, and gene editing, may soon become part of everyday life for many people. Currently, these technologies are developed mainly to eliminate disease and nullify disability, yet they could soon be deployed to augment and enhance otherwise healthy humans. Through the introduction of a new type of physically or cognitively augmented human, societies may face new issues around inequality, human rights, and traditional notions of human-ness.

—— WHAT IS CHANGING? ——

- **Development of technologies.** Bionic limbs, brain-computer interfaces, neurotechnologies, and gene editing are making significant advances towards mainstream use. No longer the stuff of science fiction, many of these technologies have been tested in laboratories and are currently being introduced through medical practice.

- **Augmentation communities.** Distinct from the clinical development of augmentation technologies, communities of "biohackers" currently use available technology to make custom augmentations to their own bodies. The existence of the BDYHAX, a convention dedicated to showcasing the various ways that these individuals augment their bodies, is an example of the growing popularity of the practice. Even today, a lack of regulation of this practice is a concern for governments.

- **Mixed opinions around augmentation.** In mainstream society, augmented humans are often met with apprehension or suspicion. Apprehension around augmentation technologies varies by culture, yet one can reasonably expect diverse opinions on the ethics, safety, and overall benefit of augmentations to exist everywhere.
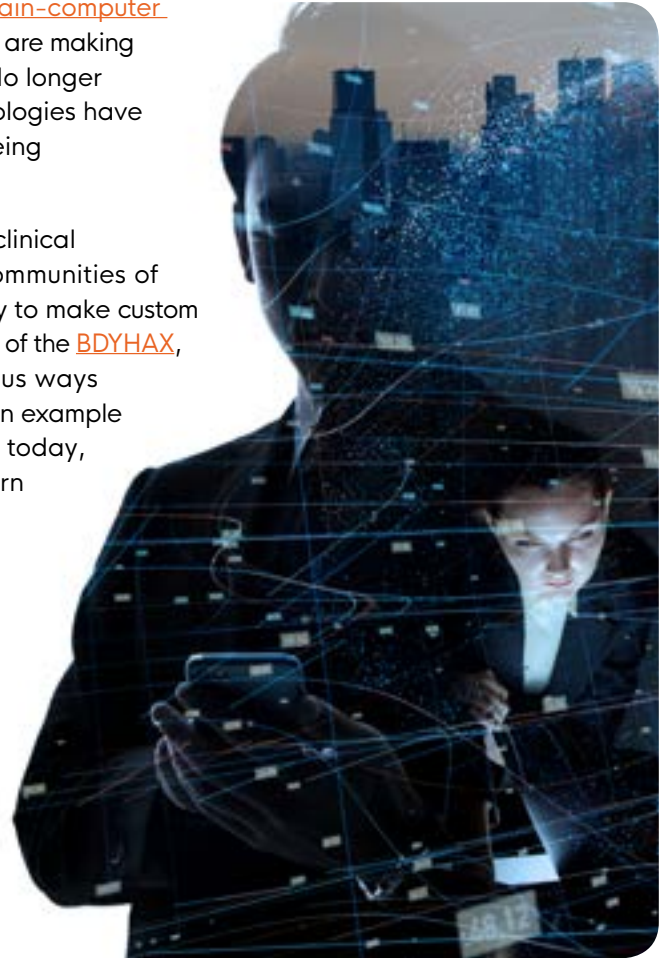
—— WHY IS THIS SIGNIFICANT —— IN 10-15 YEARS?

While augmentation technology creates further opportunities for nullifying disabilities, augmenting humans to put healthy and capable people ahead of others could lead to new dimensions of inequality and conflict. Rapid development and widespread use of augmentation technologies could give rise to social issues centered on the divide between organic and augmented humans.
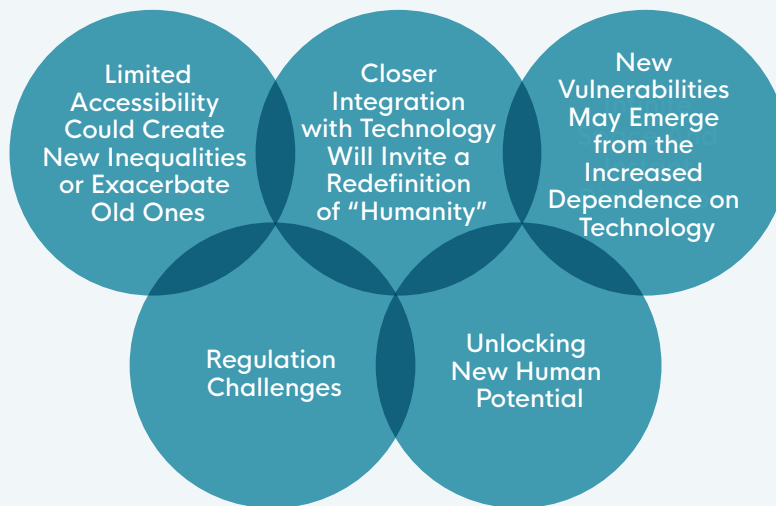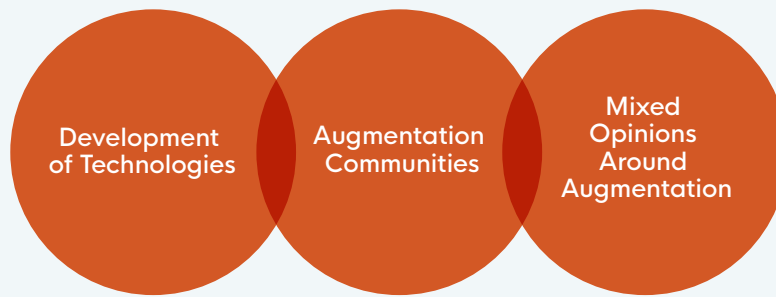
- **Limited accessibility could create new inequalities or exacerbate old ones.** If access to health-improving or ability-enhancing augmentations is reserved only for wealthy buyers, the gap between rich and poor could further expand by enabling the wealthy to live longer and perform better than those unable to afford enhancements. Through this practice, social stratification would be "hardwired" into the human form. If only a select group can "design" their unborn children with the traits necessary for success, where does that leave those without such benefits?

If our reality is to be shaped by technology– enhanced perception, we could become more concerned about manipulation from unapproved users.

- **Closer integration with technology will invite a redefinition of "humanity".** As the distinction between human and computer increasingly blurs, societies may struggle with the social and legal implications of accommodating humans with various degrees of augmentations. How will we regard ourselves and each other if all of our thoughts and feelings could be digitized and replicated? This also has implications for human rights and who or what is subject to them.

- **New vulnerabilities may emerge from the increased dependence on technology.** Due to the fragility of networked systems, opportunities for hacking and other forms of exploitation emerge when we integrate technology closely with our bodies and minds. If our reality is to be shaped by technology-enhanced perception, we could become more concerned about manipulation from unapproved users. The security and resilience of augmentation technology may become an important facet of their wider societal use. Meanwhile, psychological vulnerabilities may reveal themselves as the human mind's capacity to connect with technology is explored further.

- **Regulation challenges.** Governments could seek to control and regulate the use of augmentation. This could be followed by resistance or subversion by groups advocating for the freedom to experiment with various forms of augmentation. In another scenario, governments could require their citizens to obtain specific augmentations for public health or security purposes, putting values such as free choice and diversity at risk.

- **Unlocking new human potential.** The abilities unlocked by cognitive augmentation technology in particular could radically alter the way we think, feel, and organize. Being able to instantly recall vivid information about a past experience and perhaps share that information just as vividly with others, for example, could invite change to our legal and other organizational structures. Not being bound by our biological functions could herald an entirely new chapter in the story of humankind.

CHANGE DRIVERS

Development of Technologies

Augmentation Communities

Mixed Opinions Around Augmentation

– – –

HUMANITY+

– – –

Limited Accessibility Could Create New Inequalities or Exacerbate Old Ones

Closer Integration with Technology Will Invite a Redefinition of "Humanity"

New Vulnerabilities May Emerge from the Increased Dependence on Technology

Regulation Challenges

Unlocking New Human Potential

IMPLICATIONS

46

THE EVOLVING BIO-AGE

Innovations in genetic editing and engineering
allow researchers to create synthetic life with huge
potential for benefits. It also offers unexpected outcomes,
both good and bad, resulting from human
tinkering with living systems.

—— SUMMARY ——

The social, economic, cultural, and civilizational impacts of digital and information technology often absorb the attention of business leaders and policy-makers. Yet the emerging biological age could greatly impact these areas, by radically disrupting our notions of what is natural, blurring the boundaries between the inorganic and organic, and raising foundational issues of ethics and accountability.

—— WHAT IS CHANGING? ——

Scientific discoveries have progressed from Newtonian mechanics and physics, through the emergence of information and digital technologies, to breakthroughs in understanding living systems. Over the next decade, investments in bio-science will likely bear fruit and give rise to a host of new issues.

- **New paradigms and approaches.** Emerging paradigms of <u>complexity and chaos</u> help us understand changes that lie ahead, either as unexpected properties that arise when living systems adapt to their environments, or as surprising patterns of order emerging from seemingly random behaviour. Both contribute to a watershed shift away from reductionist, mechanistic, scientific worldviews.

- **Biomimicry.** This research paradigm accelerates environmentally benign innovation by <u>drawing upon designs found in nature</u>. Rather than brute-force industrial age approaches of "*heat* (forge using extreme temperatures), *beat* (form under extreme pressures), *treat* (manufacture with toxic chemicals)," biomimicry emulates biochemical materials and processes used by living organisms, resulting in more efficient use of raw materials and fewer environmental impacts.

- **NBIC (nano-bio-info-cogno).** At the microscopic level, innovations in nanotechnology and <u>micromachine design</u> may be more indistinguishable from gene engineering, synthetic biology, and organic design. This could result in a capacity to <u>create living tools and organic computers</u>.

- **Designed life.** Improvements in genetic manipulation tools like <u>CRISPR-cas9</u> have accelerated explorations in <u>synthetic biology</u>, as seen in the <u>iGEM</u> student competition to design simple life-forms. Where Gen X grew up hacking computer code, tomorrow's students will assume the ability to hack life.


Where Gen X grew up hacking computer code, tomorrow's students will assume the ability to hack life.

—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

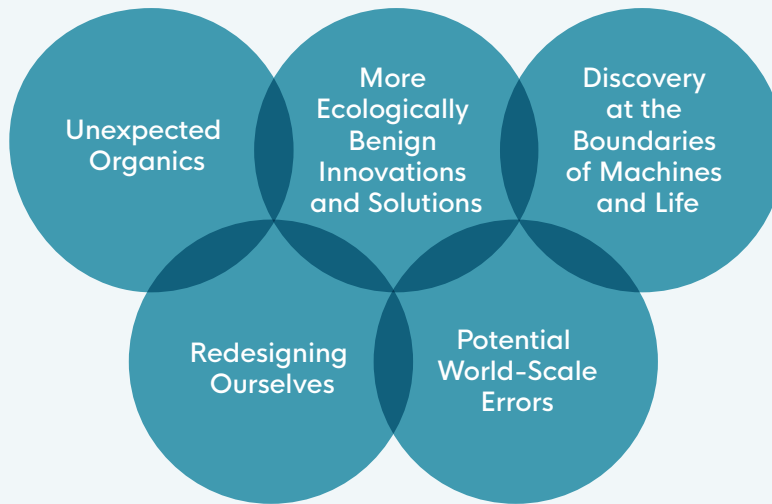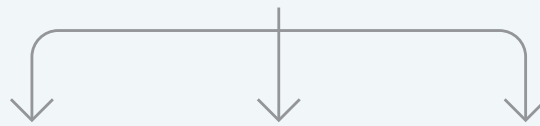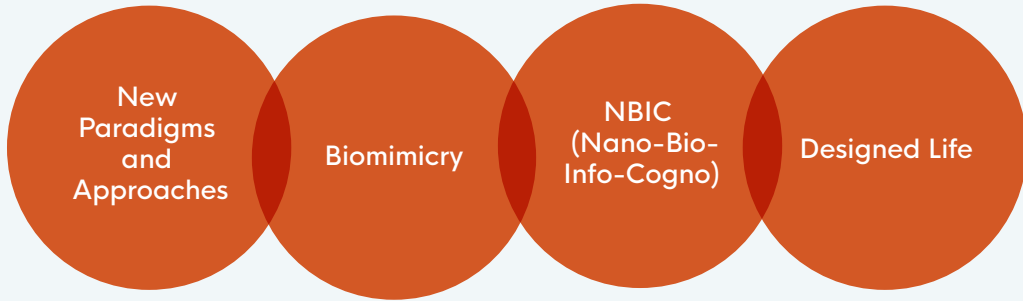## As technology grows more reliable, personal redesign could become merely a fashion choice.

The convergence of new scientific paradigms focused on living systems, tools to analyze and manipulate those systems, and the potential to edit or design them for human purposes offers potential for creating a built environment, infrastructure, and manufacturing processes based on living systems rather than mechanical ones.

- **Unexpected organics.** Biotechnology is increasingly used to produce pharmaceuticals – such as yeasts modified to produce morphine. These modified organisms could adapt or mutate, and spontaneously pollute by emitting toxins. In the future, criminals could use genetic modification techniques to transfer the genes for illegal drugs into common food plants, where they can be more easily disguised.
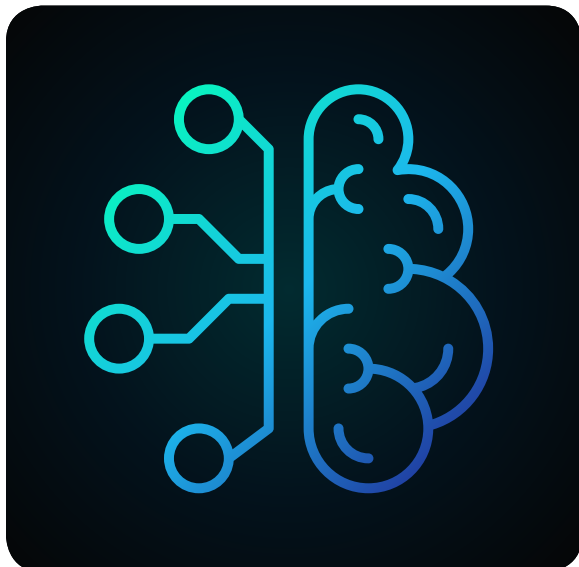
- **More ecologically benign innovations and solutions.** Bio-design could address future humanitarian and environmental crises, via salt-tolerant food crops, renewable energy sources like algal biofuels, and organic bioremediation and climate change mitigation. Rather than actually editing living systems themselves, biomimicry could simply model ecologically benign infrastructure, manufacturing, and products or processes in living systems – and then evolve to transform a brick-and-mortar environment into a city composed of living systems.

- **Discovery at the boundaries of machines and life.** Combining genes with sensitivity to an environmental factor (like arsenic in water), with a detectable metabolic response, creates living bacterial biosensors. In the future, the easiest way to design medical nanotechnology may be to 'domesticate' bacteria and viruses as programmable microbots. The upside is targeted health; the downside is weaponization.

- **Redesigning ourselves.** Humans could be more willing to redesign themselves as they face greater challenges from crises (war, famine, water stress, changing climate) or aspiration (moving into challenging environments in space, undersea, or post-climate change). As technology grows more reliable, personal redesign could become merely a fashion choice.

- **Potential world-scale errors.** Entire species – and entire ecologies – could be redesigned, thanks to the capacity for creating 'gene drives' that build CRISPR-Cas9 RNA editing into reproductive mechanisms. How might humanity address globe-spanning issues of regulation, permission, monitoring, and fixing potential errors and impacts?

CHANGE DRIVERS

- New Paradigms and Approaches
- Biomimicry
- NBIC (Nano-Bio-Info-Cogno)
- Designed Life

THE EVOLVING BIO-AGE

- Unexpected Organics
- More Ecologically Benign Innovations and Solutions
- Discovery at the Boundaries of Machines and Life
- Redesigning Ourselves
- Potential World-Scale Errors

IMPLICATIONS

LIVING WITHIN EARTH'S CARRYING CAPACITY

Humankind is putting an unsustainable strain on the Earth's capacity to support life. We are at, or near, the tipping point for several ecosystem services. Fundamental changes in our economic and political systems and our way of life may be needed over the next two or three generations if humans are to live within the carrying capacity of the planet.

— SUMMARY —

Rising global temperature, growing ocean acidification, more frequent forest fires, expanding desertification, decreasing biodiversity, and more destructive weather are symptoms of a deeper problem. Human demands are exceeding the absorptive and productive capacity of global ecosystems. To survive and thrive, humankind must find a way to live within the carrying capacity of the planet. We face social, economic and political challenges in making the transition to sustainability; and potential consequences if we fail to live sustainably.
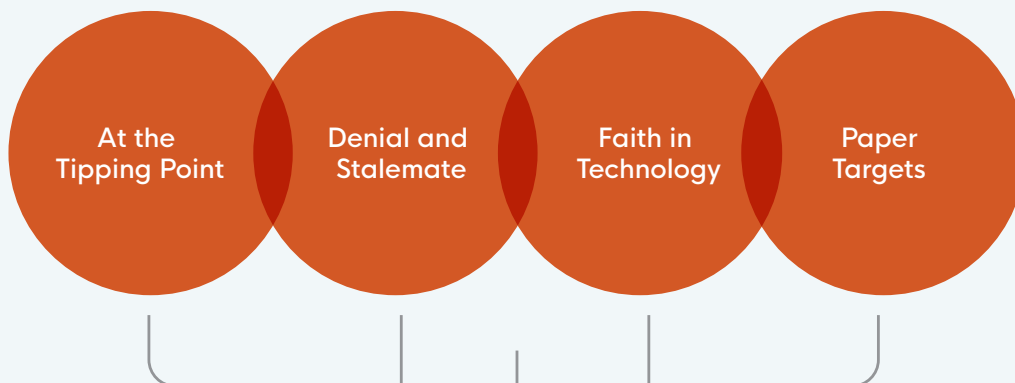
—— WHAT IS CHANGING? ——

- **At the tipping point.** Unsustainable patterns of production and consumption are undermining the ecosystem services (i.e. the biochemical processes) that support life on the planet, leading to rapidly changing environments. For instance, Earth's atmosphere has a limited capacity to absorb carbon. In April 2018, we measured 411 ppm (parts per million) of carbon in the atmosphere – 50% higher than in 1880, the highest measure yet – and the pace is accelerating. Current science suggests that 450 ppm could be a major tipping point towards more severe changes. Over the next century, a new equilibrium could emerge that is distinctly unhealthy for humans, due to growing drought, food insecurity, rising sea levels, extreme temperatures and weather.

- **Denial and stalemate.** The science is deepening our understanding; yet science deniers seem to capture the headlines and undermine collective political action. While many polls show popular support for action on some well-known issues, the public often rejects programs, like a carbon tax, that bring a personal cost or impact. Over the last 40 years, we have made little progress on the most significant threats, including climate change.

- **Faith in technology.** New technology could help mitigate, offset, and combat these changes. For instance, carbon capture, water desalination, fourth generation nuclear power and geo-engineering, incentivize a business-as-usual approach to symptom mitigation. The underlying assumption is that "technology will save us", which ignores the fact that many of these technologies are untested, expensive, may have unintended consequences; even if they work, they may not save us in time.

- **Paper targets.** The Paris climate agreement is the first time we set this kind of goal in international negotiations; but most countries see it as a suggestion rather than a legally binding obligation. While some rich countries are prepared to limit their sovereignty in an international agreement because they see it is in our long-term collective interest, the core problem is many developing countries are much poorer and want to catch up to the West without constraining their pursuit of economic development. They believe that the West, which has already used most of the carrying capacity, should pay for developing countries' low-carbon transition. Equitable sharing of carrying capacity and less destructive growth models will be key to long-term buy-in and cooperation.
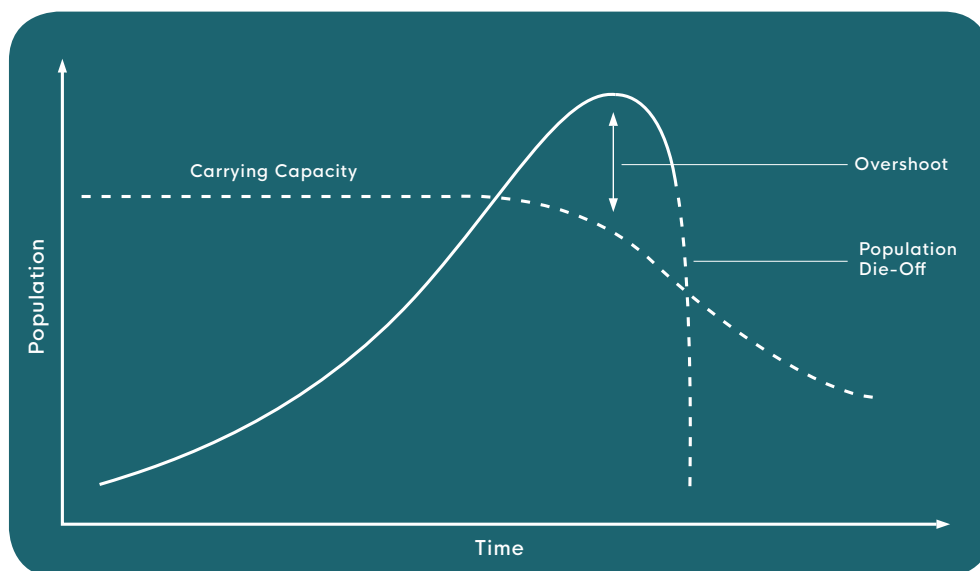
—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

- **Inaction has high human and financial costs.** As governments back away from climate promises, many people could suffer the consequences of repeated floods, droughts, migrations, etc. Some desperate countries could initiate geo-engineering projects to protect their own interests at the expense of others. Alternatively, coalitions of affected countries could take dramatic action that antagonizes other groups. The recurring costs of dealing with the symptoms will be high, but will not help adapt or mitigate the fundamental cause. There is some evidence that the longer we wait, the more difficult and costly the consequences and solutions will be.

- **Resistance continues if the path forward is unclear.** The shift to a sustainable society involves profound change. People resist change unless they can see how it will work and make their lives better. If we take sustainability seriously, it would be useful to explore what would have to change in order to truly live within the carrying capacity. Virtually every aspect of our current lifestyles, beliefs, business practices, homes, cities, and economies would likely need to change. Surfacing the profound questions for debate and exploring alternative theories and practices decades before a crisis, would be valuable ways to prepare society for the transition and envision a better world.

- **War if we don't share the carrying capacity.** If we are unable to turn things around in the next few decades, we will be at or near the 450-ppm tipping point and face a very difficult question: how do we share the remaining carrying capacity? To avoid crossing the 450-ppm threshold for carbon, we need a way to control or ration use. What is an effective strategy? Do the powerful countries just take it? Do we divide it by population so every person has an equal share? In the past, war was one way to solve battles over strategic resources. We may need to figure out a way to share carrying capacity long before we confront a crisis.

- **Need to invent the sustainable economy.** New technologies like artificial intelligence, data analytics, sensors, robotics, 3D printing, and synthetic biology are transforming the economy and creating new opportunities to rethink the economy-environment-society interface. The overarching task is to promote growth and expand equity, while living within the absorptive and productive capacity of global ecosystems. There may be a need to rethink fundamental theory, policy and practice across a number of disciplines.

- **No progress without new knowledge and collaboration.** Saving the planet will require deeper understanding of the problem, and how to move society forward. Better understanding of the linkages across all ecosystem services will help identify their potential interactions and tipping points. We need to determine why we have made so little progress, and how to build support for a commitment to change among citizens and key stakeholders across the planet. To make lasting progress, a number of disciplines need to set and monitor effective targets and metrics (human, economic and environmental), to ensure we live within the carrying capacity. To guide effective action, we need to develop and incentivize sustainable production and consumption patterns. Finally, in the realm of public policy, there is a need to develop effective tools, policies and programs to support every stage of the transition.

CHANGE DRIVERS

- At the Tipping Point
- Denial and Stalemate
- Faith in Technology
- Paper Targets

LIVING WITHIN THE CARRYING CAPACITY

- Inaction Has High Cost
- Resistance If Path Forward Unclear
- War If We Don't Share Carrying Capacity
- Need to Invent the Sustainable Economy
- No Progress Without New Knowledge and Collaboration

IMPLICATIONS

56

THE PERVASIVE CONTAMINATION OF THE "NATURAL"

Everything is contaminated. What is safe?
Trash is obvious, but microplastic contamination
of marine fish stocks is not, nor is the chemical
contamination of groundwater resulting from our modern
reliance on pharmaceuticals. We will be challenged
to thrive in a world where contamination is
pervasive at all scales and in all environments.

—— SUMMARY ——

The mechanical, electronic, and chemical infrastructures that support the
21st century lifestyle make daily life easier, safer, and more convenient. Monitoring
the world now makes the pervasiveness and impacts of those conveniences
increasingly clear. Modern life externalizes the midden – for decades,
'out of sight, out of mind' has allowed the 'throw-away society' to evolve with
little consideration for long-term impacts of garbage and waste-water.
The ebb tide of our discards is washing back in as pervasive
contamination of land, water, and atmosphere.

—— WHAT IS CHANGING? ——

Global development and affluence has amplified the scale of human waste, effluent, and manufacturing by-products. As monitoring the worldwide environment becomes easier, it is obvious that every part of the planet is affected.

- **Seeps.** Pharmaceuticals and chemicals we rinse away and flush pass through municipal water treatment and return to groundwater, contaminating aquifers, and affecting entire ecologies as well as people. Our water shows rising levels of both medical and recreational drugs. Water treatment can actually exacerbate chemical pollution – during wastewater treatment, the levels of two antibiotics was shown to increase up to 120 per cent due to interaction with microbes.

- **Cocktails.** Breezes mix exhaust chemicals and airborne particulates; water currents mix household and industrial effluents and waterborne particulates. These chemical cocktails can create new and potent ambient poisons. Research suggests that 50 chemicals not originally thought carcinogenic can cause cancer when combined, suggesting current "safe" levels are incorrect.

- **Granularization.** Ocean agitation pulverizes solid contaminants, particularly plastics, and they enter the food chain when marine species eat them. Plastic microcontamination was even found in remote Antarctica.

- **Light.** Our 24/7/365 lifestyle demands instant access to light, and erodes the night's dark, disturbing animal biorhythms as well as our own sleep cycles.

- **Noise.** Our 24/7/365 infrastructure generates persistent noise that shatters the natural ambient soundscape and can disturb wildlife.

—— WHY IS THIS SIGNIFICANT IN 10-15 YEARS? ——

Little will be left pristine. Both the human body and the human mind will be affected, as will all animals and plants. Will we have fouled our ecological nest beyond repair?

- **Adulterated food chain.** We are increasing the adulteration of arable soil with excess nitrogen, salts, and trace metals like arsenic, cadmium, lead, and mercury, which impairs plant metabolisms. Bee honey and eggs are contaminated with insecticides; fish are contaminated with mercury and plastic particulates; and livestock with hormones. Water is contaminated with insecticides, fertilizers, industrial effluents, and pharmaceuticals – and the food chain concentrates all these contaminants via bioaccumulation, and ships them worldwide.

- **Pristineness divide.** Food and water sensing and filtering technologies could become critical personal health tools, and pristine food and water products may become luxury goods. Pricing may create a 'pristineness divide' between households that can afford to filter for or avoid contaminants, and those doomed to absorb them, with accompanying adverse impacts on health, quality of life, and productivity.

- **Danger in the air.** Airborne chemical cocktails could make air filtration masks fashionable, while personal environmental monitors become ubiquitous urban survival gear. Mutations could increase among exposed animals, and the built environment – buildings, monuments, artworks – could erode. Mandated biodesign of urban environments may help absorb and mitigate air pollution.
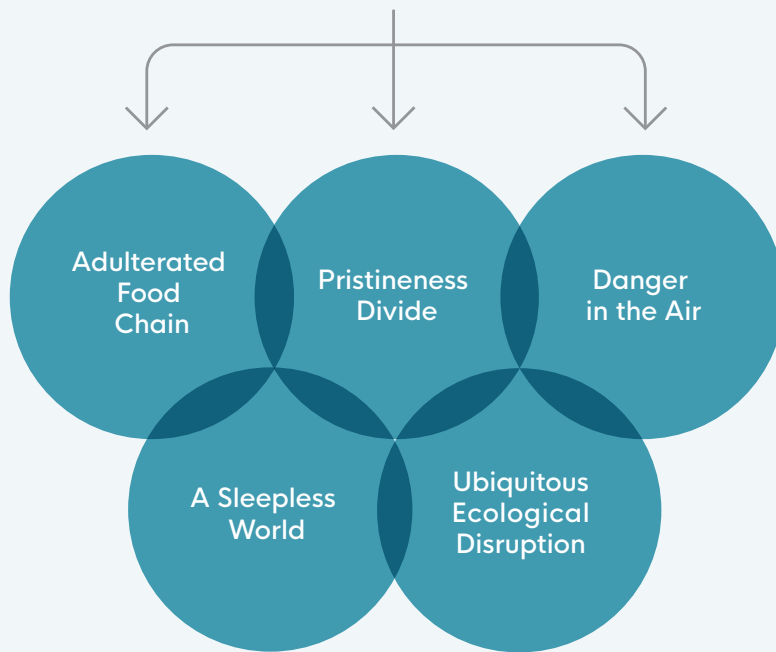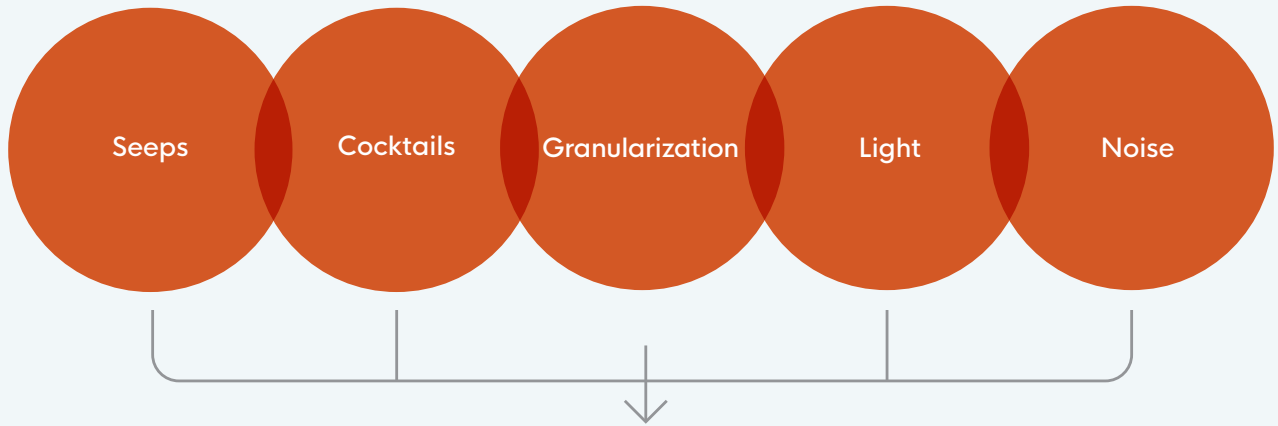
- **A Sleepless world.** With constant noise and light pollution, the resulting sleeplessness epidemic could increase irritability and thus conflicts among humans, as well as reduce memory, clear thinking and problem-solving capacity. Disruption of animal diurnal cycles may contribute to extinctions – or to novel adaptations.

- **Ubiquitous Ecological Disruption.** Pervasive contamination will affect wildlife and ecological webs, driving many species extinct, and causing mutations in others. What will the resulting local and global ecologies look like, and what ecosystem services will they still provide? Could non-Western and traditional cultures frame new solutions?

Social backlash could arise against the industrial and economic systems – particularly late-stage global industrial capitalism. Any backlash could cause political conflict and civil protest, or critical public dialogue about workable alternative models to address human needs within the planet's limits.

Social backlash could arise against the industrial and economic systems – particularly late-stage global industrial capitalism.

CHANGE DRIVERS

- Seeps
- Cocktails
- Granularization
- Light
- Noise

THE PERVASIVE CONTAMINATION OF THE "NATURAL"

- Adulterated Food Chain
- Pristineness Divide
- Danger in the Air
- A Sleepless World
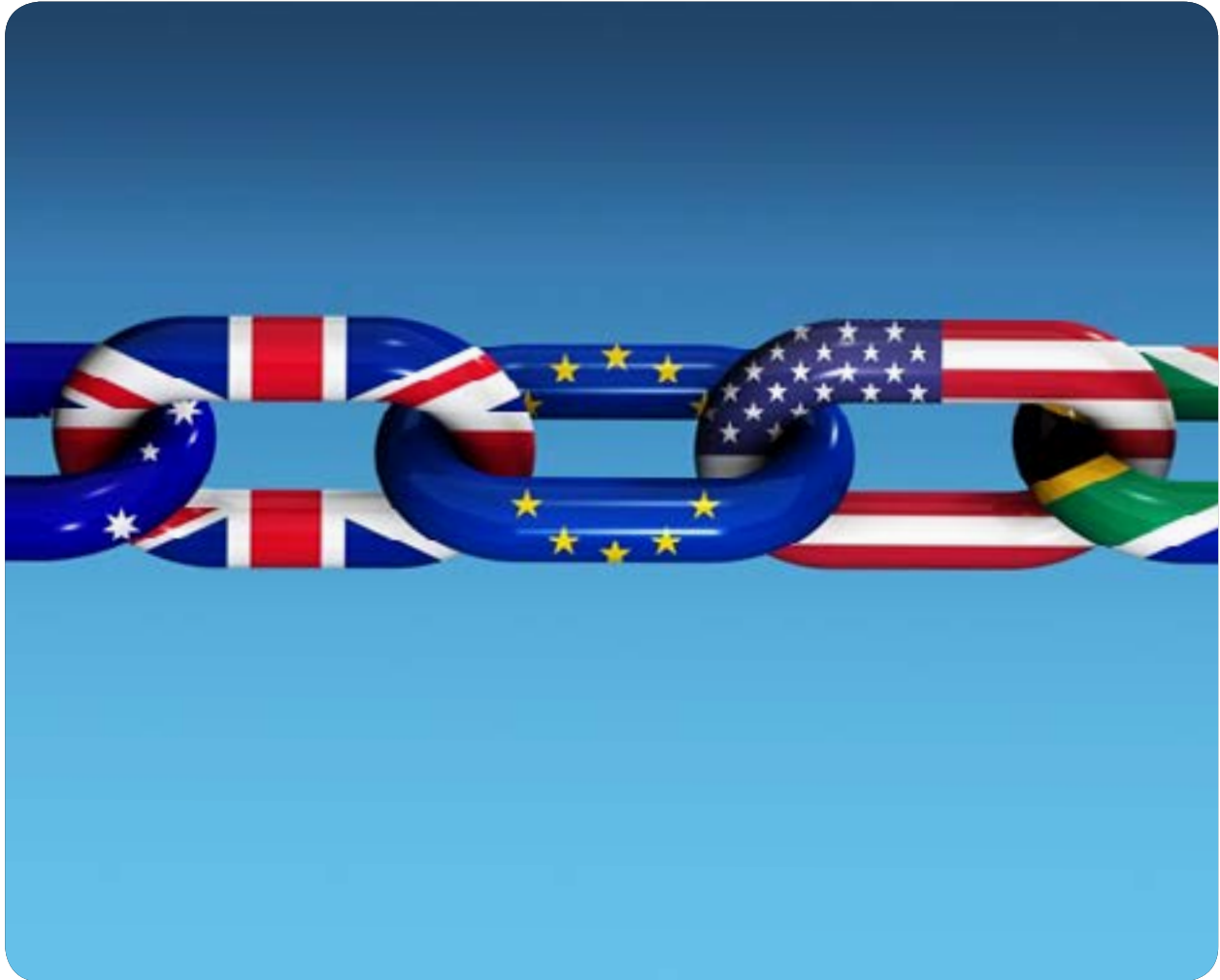- Ubiquitous Ecological Disruption

IMPLICATIONS

ENVISIONING GOVERNANCE SYSTEMS THAT WORK

Existing forms of governance at the local, national and international levels are facing problems they were not designed to solve. There is a need to explore more effective, efficient and networked governance structures and processes at all levels.

—— SUMMARY ——

A growing number of wicked problems (such as climate change, pandemics, growing inequality, and dislocation in the transition to a global digital economy) threaten our security and prosperity, and require cooperation at every level of government to solve. Patching up old systems may not suffice. To solve these problems, we may need to explore new models for citizen engagement, policy development and service delivery that transcend traditional notions of sovereignty, borders and citizenship.

── WHAT IS CHANGING? ──

The growing digital economy is threatening states' ability to "grow the economy"

- **Democracy under threat.** Those "left behind" economically and politically are turning to alternative narratives and ideologies that may erode democratic norms and values.

- **Digitization of citizenship and government.** Digital technologies could transform the role of government. Estonia's x-Road system is the backbone of its e-residency system, which not only digitized almost all government services, including healthcare, but allows non-Estonians to acquire a digital Estonian passport. And Bitnation is a virtual nation that provides state-like services to its e-residents. It has been widely used since 2015 to help refugees access essential services and aid.

- **Non-state actors are gaining influence.** Global corporations such as Facebook, SpaceX, and Google are working on connecting the next billion people to the internet; the Gates Foundation is providing healthcare services; and BlackRock is calling for increased social responsibility by corporations, all of which strengthen the importance and power these non-state actors now have. NGOs like Greenpeace and Worldwatch Institute have become global environmental monitoring bodies, and individuals like Jody Williams of the International Campaign to Ban Landmines can use digital networks to change international policies.

- **Nation state powers in question.** The growing digital economy is threatening states' ability to "grow the economy" and control new trade flows. The emergence of crypto currencies that are outside the control of central banks is undermining the policy levers of states. New technologies put powerful weapons in the hands of non-state actors, and can undermine the state's abilities to enforce its powers of coercion.

—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

- **Governance needed to solve wicked problems.**
The entire governance spectrum, from local to global, is focussed on short-term interests. Much of the system is in stalemate, and unable to invent the new programs, strategies and visions that address emerging problems. Issues such as environmental sustainability, pandemics, crime, and terrorism transcend borders. To solve a growing number of transnational problems, governments at all levels may need to explore new ways to collaborate. In some areas, they may need to cede sovereignty (upwards or downward) to create effective hierarchical governance, or invent new non-hierarchical, network structures to put resources and services in the right place at the right time.

- **Technology enables customized governance.**
Emerging technologies, including artificial intelligence, data analytics, sensors and telepresence, are transforming government structures and processes. Policy development, service delivery, and citizen engagement could be customized to the individual. New types of collaboration across levels of government are possible. For instance, governments

and other actors could work together to provide some aspects of health care, such as AI-enabled diagnostics, as platform-based global services, as a global public good to all people at very low cost.
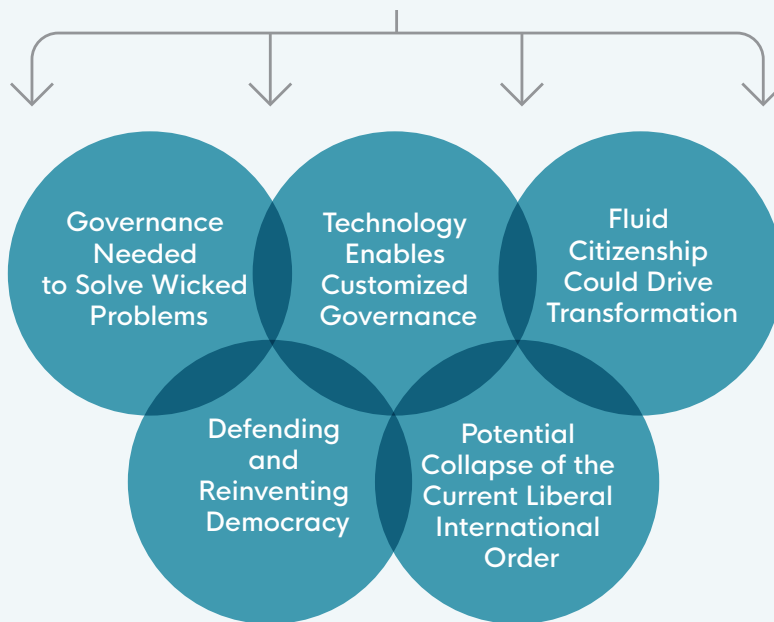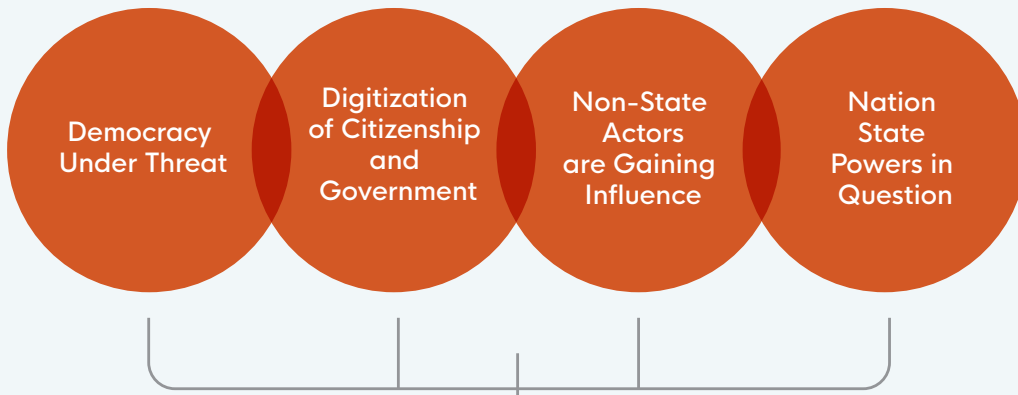
- **Fluid citizenship could drive transformation.**
In a world where people perform virtual "gig" work across the planet, their loyalties could be split across a broad spectrum of countries and entities, based on where they are from, where they currently live, where they work, and from whom they receive their physical and digital services.

- **Defending and reinventing democracy.** Western democracies face a variety of threats, from fake news to ideological stalemate, that hinder their ability to solve emerging problems. The apparent success of several anocracies (i.e. countries with certain democratic features, in which autocratic elites use big data to understand citizen sentiments and provide the goods and services their citizens want), could undermine support for democratic processes, and become the aspirational model of governance for disgruntled people in the west and in emerging economies – or entirely new models of governance could emerge.

- **Potential collapse of the current liberal international order.** Three recent reports suggest that the multilateral institutions, as well as international rules-based trading systems built in the industrial/colonial era, could unravel. This could create pressure to reinvent the institutions, processes and services to address the issues of the mid-21st century. The current policy framework built on U.S. and Western economic dominance may need re-thinking, partly to reflect growing economic power in Asia. The new system may be more of a distributed network than a hierarchy, and involve actors from local to global, in an effort to mobilize their expertise, resources and buy-in.

CHANGE DRIVERS

Democracy Under Threat

Digitization of Citizenship and Government

Non-State Actors are Gaining Influence

Nation State Powers in Question

ENVISIONING GOVERNANCE SYSTEMS THAT WORK

Governance Needed to Solve Wicked Problems

Technology Enables Customized Governance

Fluid Citizenship Could Drive Transformation

Defending and Reinventing Democracy

Potential Collapse of the Current Liberal International Order

IMPLICATIONS

THE CHANGING NATURE OF SECURITY AND CONFLICT

New technologies will change the nature and location of conflict. The security of our homes and cities could be threatened in physical and virtual ways, changing many aspects of our lives. The advantage will go to the best innovators, whether state or non-state actors.

—— SUMMARY ——

The battleground of the future could look very different than it does today. **Lethal weapons, with precision targeting capabilities, will be much more accessible.** Technology could document our every move, with privacy evaporating, and our lives becoming **increasingly connected**. This connectivity could lead to a myriad of access points for malicious actors to hijack our lives. **Manipulation** of individuals, groups, and communities could be the norm, with little ability to mitigate the consequences. The most powerful actors in this world are those with the **best innovators**. Non-state actors may seek out disruption and chaos over death, possibly engaging in satellite destruction and hacking smart cities. Ethical dilemmas may hinder some actors, as they struggle to innovate in areas such as **human augmentation** and **autonomous weapons**.

—— WHAT IS CHANGING? ——

- **Connectivity.** Societies are becoming increasingly connected through digitization and the growth of Internet of Things (IoT) devices. IoT capabilities are being built into many aspects of everyday life, such as in household devices, public transit, and smart cities. The connection of our devices and digital lives can be integrated into our bodies for a seamless experience, such as through microchipping and smart glasses.

> As society moves to a more connected and monitored world, hyper-targeted messages can be catered directly to an individual or group.

- **Autonomous weapons**. Lethal autonomous weapon systems (LAWs) for land, air, and sea already exist. These weapons, such as the Taranis, have largely been used semi-autonomously, for defensive and reconnaissance capabilities, with a human in the loop. Offensive autonomous weapons systems, however, could act of their own accord, with human involvement in the programming but not the execution.

- **Memetic warfare.** With the shift of information to the digital realm, memetic warfare has become paramount in psychological operations (psyops). As society moves to a more connected and monitored world, hyper-targeted messages can be 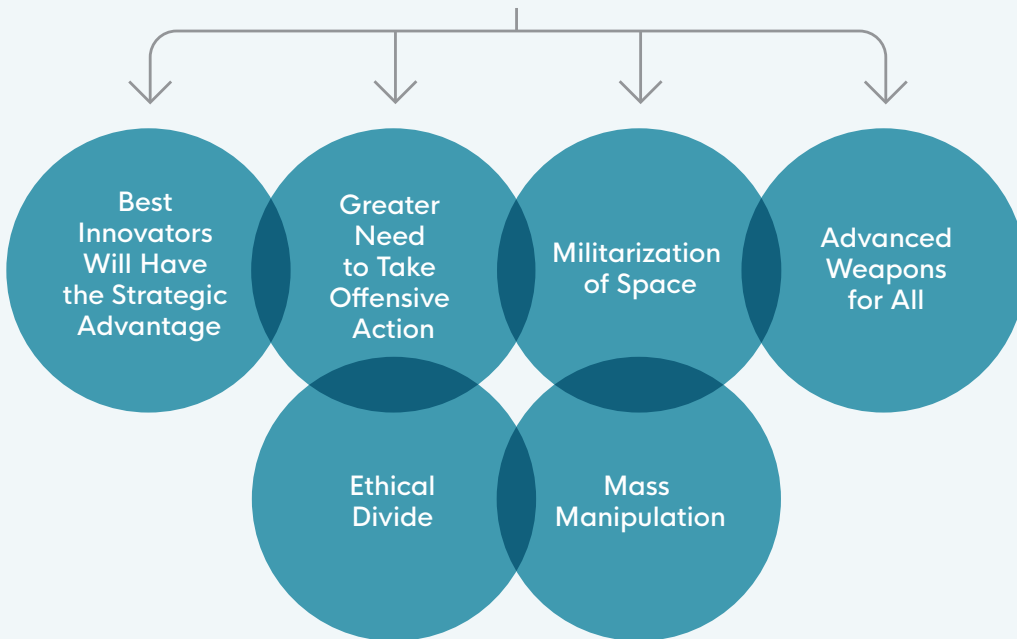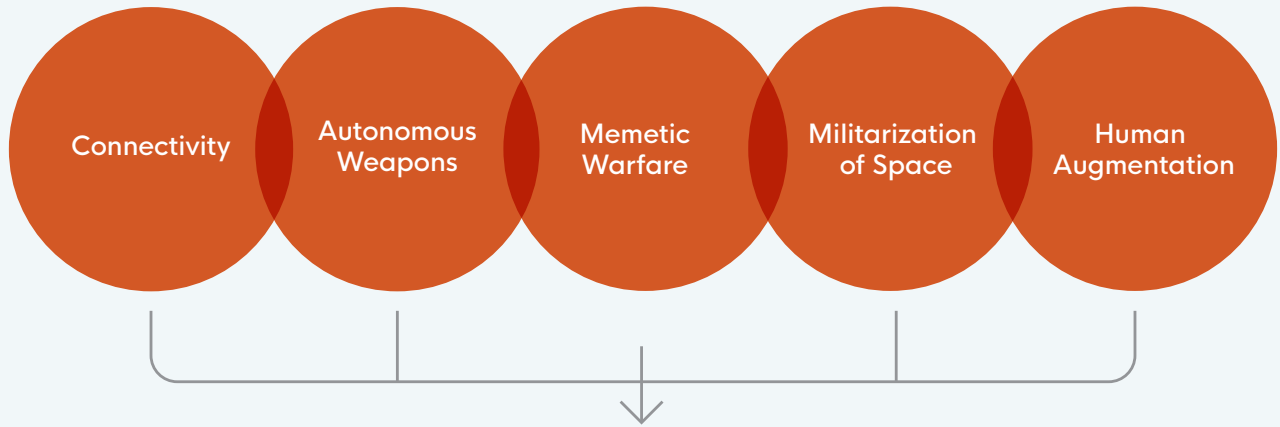catered directly to an individual or group. The effectiveness of memetic warfare can be seen in the recent Cambridge Data Analytics scandal, Brexit, and election tampering in the United States. This ability to wage contactless war has become important to military strategic planning.

- **Militarization of space.** States are gaining momentum in anti-satellite technology, including earth-to-space missiles. There have also been advancements in orbital lasers, designed to emit bursts of light that send space debris away from important assets, or into the atmosphere to be destroyed.

- **Human augmentation.** Military use of human augmentation includes biological and robotic enhancements for future soldiers. Research is being done into how devices implanted into soldiers could enhance situational awareness, monitor health, control emotion, and allow for brain-to-brain communication.

—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

violence. Virtually anyone could inflict mass harm without detection, thanks to hyper-specific targeting of individuals, groups, and communities made possible by AI, data analytics, surveillance, and robotics. With attribution becoming harder to ascribe in a world of digital and remote weaponry, violent non-state actors could increasingly act without reprisal. While there is debate, synthetic biology could give amateurs the capacity to create bioweapons.

As innovation in weapons technology continues, ethical and regulatory barriers could affect which actors, both private and public, lead the new arms race.

- **Best innovators will have the strategic advantage.** As new realms of conflict, such as cyber, space, and autonomous weaponry rise in strategic importance, innovation capabilities could become the strongest determinant of military strength.

- **Greater need to take offensive action.** Increasing digitization and connectivity brings greater emphasis on cyber tactics to maintain security. Offensive cyber action, such as hacking back, could rise as states and businesses seek to gain the upperhand in the digital realm.

- **Militarization of space.** The race to militarize space could alter power structures. Previous international efforts to ban the militarization of space could be ignored in the future. Dominance in space could serve as a key area for deterrence, and shift the balance of power between state actors.

- **Advanced weapons for all.** Advancements in dual-use technology, largely led by the private sector, are lowering the barriers to entry of weapons technology. States could struggle at both the national and international level in the future, in efforts to regain the monopoly on

- **Ethical divide.** As innovation in weapons technology continues, ethical and regulatory barriers could affect which actors, both private and public, lead the new arms race. Contentious security programs, such as human augmentation, bio-weapons, retaliatory hacking, and autonomous weaponry, may receive less support in certain nations. All of these advancements could lead to international discord in efforts to establish global norms and rules of combat in the future battlefield.

- **Mass manipulation.** In a world where truth is increasingly difficult to verify, privacy is obsolete, and sophisticated psychological warfare exists, societies could be increasingly vulnerable to manipulation. As some societies face fragmentation due to imbalanced economic conditions and ideological divides, they could be particularly susceptible to memetic warfare.

CHANGE DRIVERS

Connectivity

Autonomous Weapons

Memetic Warfare

Militarization of Space

Human Augmentation

THE CHANGING NATURE OF SECURITY AND CONFLICT

Best Innovators Will Have the Strategic Advantage

Greater Need to Take Offensive Action

Militarization of Space

Advanced Weapons for All

Ethical Divide

Mass Manipulation

IMPLICATIONS

TRUTH UNDER FIRE IN A POST-FACT WORLD

Fact-based reasoning has provided a foundation for progress in modern societies. While emotions play a positive role in analysis and decision-making, emotion-based appeals and reasoning have recently become more common in public discourse and social media. In a post-fact world, political, social, and economic systems could become dysfunctional.

— SUMMARY —

We live in a world where information is flowing at unprecedented rates, and the media ecosystem has drastically changed. Political leaders and ordinary citizens can disseminate their thoughts at the click of a button, bots can wreak political and societal havoc, and there is growing distrust of our peers, institutions, and scientists. Continuing down this path could undermine the importance and concept of truth. Fact-based evidence could be mired in suspicion, due to beliefs steeped in personal preference, emotional reactions, and past and current system grievances. In response, some societies could opt to adopt mass profiling systems as a means to seek ultimate transparency and truth.

—— WHAT IS CHANGING? ——

- **Declining trust.** Many Western nations are seeing a continued decline of citizen trust in institutions, namely media, government, and non-governmental organizations. 2018 also saw rising distrust in peer-to-peer discussion as well as in social platforms and search engines.

Surveillance, biometrics, and artificial intelligence are making human profiling systems a reality

- **Distrust and suppression of science.** Public trust in science is faltering around politicized global issues such as climate change, genetically modified food, and vaccinations. Political leaders have also contributed to skepticism over science in decrying scientific studies.

- **Transformation of the media ecosystem.** As digitization rolled through the media sector, how and from whom we consume news drastically changed. In this new environment, traditional media companies lost their hold on the market, as well as their mechanisms for generating revenue. In this transformed media ecosystem, virtually everyone has a voice, and there is a deluge of information and opinions to sift through.

- **Emerging technologies enable mass manipulation.** Bots and algorithms allow small groups to target emotion-based, fact-free messages to individuals and groups. Consumers both prefer and most trust news broadcast by video. But even in this arena, it is possible to falsify information - the capability to alter live video and audio exists today.
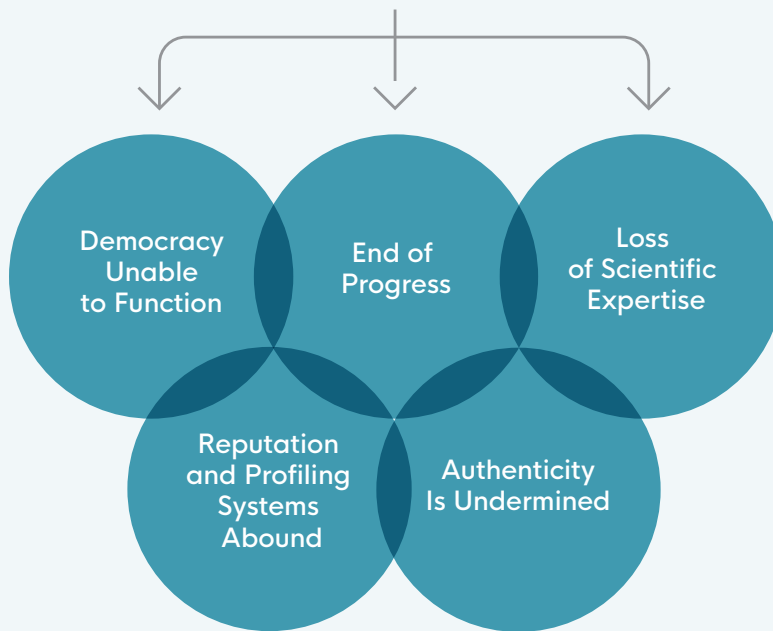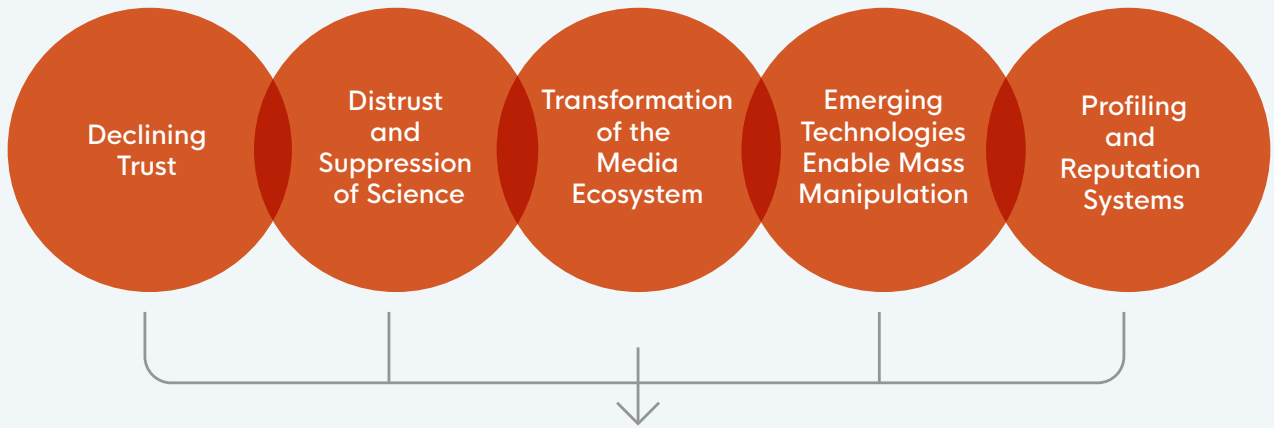

- **Profiling and reputation systems.** Surveillance, biometrics, and artificial intelligence are making human profiling systems a reality. In China, AI and biometrics are used to identify and arrest fugitives, profile potential future criminal activity, and track individuals and alert if they move into areas that are restricted based on their profiles. Tencent, a private company, also rolled out a trial credit granting system based on morality scores. In the U.S., predictive policing has been used for years and tech giants like Taser are working on AI systems that could profile propensity for criminal action.

—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

• **Democracy unable to function.** As society struggles to tell fact from fiction, political, ethical, moral, religious, and regulatory conversations become impossible. The fact-based common ground for pragmatic consensus disappears, threatening our ability to effectively debate important issues.

• **End of progress.** If politically convenient research and science becomes the only kind leaders acknowledge, there could be irreversible long-term consequences for progress on issues that require informed rational treatment.

• **Loss of scientific expertise.** Fearing political and societal backlash, experts may be less willing to continue research or share their results. This could result in less scientific innovation that could be key in tackling important global issues.

• **Reputation and profiling systems abound.** As societies continue to pursue a way to find truth, people could become more willing to adopt profiling and reputation systems across the board. These systems could seem attractive as a way to "trust" one another. If these systems are adopted, they could be used in many areas, such as how goods and services are allocated, where we are allowed to travel, what benefits we are eligible to receive, where we can gain employment and live, and what virtual and physical realms we are allowed to access.

• **Authenticity is undermined.** In the future, profiling and reputation systems could become the norm, affecting how we interact, trust, and relate to one another. If we know that our every move, right down to our facial expressions, are being monitored and evaluated, we could live in a world where everyone behaves in a way that feeds information into the system that works to their advantage. This environment could stifle real conversations, and people could lose a sense of connection with each other and their communities. In a world where truth is too difficult to identify, society could shift away from upholding truth as a value. Conversely, there could be a move to create truth systems that do not impede on civil liberties.

CHANGE DRIVERS

- Declining Trust
- Distrust and Suppression of Science
- Transformation of the Media Ecosystem
- Emerging Technologies Enable Mass Manipulation
- Profiling and Reputation Systems

– – – TRUTH UNDER FIRE IN A POST-FACT WORLD – – –

- Democracy Unable to Function
- End of Progress
- Loss of Scientific Expertise
- Reputation and Profiling Systems Abound
- Authenticity Is Undermined

IMPLICATIONS

THE ARTS TRANSFORMED

Digital technologies and social media have
blurred the lines between artist, critic, audience, and
patron; while new artistic media and human augmentation
revolutionize expressive and perceptive possibilities
to further transform the arts.

—— SUMMARY ——

Artists create within a support system of relationships featuring patrons, artists, suppliers, distributors, licensees, critics, and their audience. These relationships may support high art, popular art, or folk art (art made within communities for their own enjoyment). Digital connectivity, disintermediated production, novel expressive media, crowdsourcing, and the augmentation of human senses and cognition are disrupting these relationships, and are blurring the roles of production, consumption and critique. They also challenge notions of creative monopoly, authenticity, and artistic rights and ownership. The erosion of traditional hierarchies and power structures is also creating more artistic freedom and potentially greater vulnerability with regard to intellectual property rights.

—— WHAT IS CHANGING? ——

During the twentieth century, the art community clearly distinguished producers or artists from audiences or consumers. In the twenty-first century, technological innovations are changing how art is, or can be, created and consumed. Global digital platforms and social media open new spaces for artistic voices and perspectives worldwide, including many that were previously marginalized. Production and distribution costs are substantially lower, allowing consumers to become active cultural producers.

- **Digital media, new media, and transmedia.** Digital arts are rapidly evolving, as are artists' capacity to scan, record, and digitize (and potentially reprint) plastic, design, artisanal, or architectural arts; emerging synthetic biology and bioengineering innovations enable manipulation of DNA and cells as art.

- **Social media and participatory culture.** Any artist can have a web page that doubles as a gallery/portfolio, a Wikipedia entry, and an extensive global following; any critic or fan can have the same.

- **Crowdfinancing.** Finding a patron is decentralized and distributed via digital outreach and online banking, and through emerging blockchain-based crowdfunding.

- **Disintermediated production.** Digital media enables cheap, fast decentralized production and duplication of artworks, allowing artists to authenticate and control the production and distribution of their art themselves; new models are emerging for artists to retain fractional ownership in the equity and value of their works.

Global digital platforms and social media open new spaces for artistic voices and perspectives worldwide, including many that were previously marginalized.

- **Enhanced humanity.** Human augmentation and enhancement, coupled with ongoing discoveries in neurosciences, could create new senses and possibilities for aesthetic perception, performance, and appreciation, and entirely new media and artistic works.

- **Art and Big Data.** Artists are taking advantage of data mining and 'Big Data' to both fine-tune identifying possible audiences, and create new art works focussed on large-scale data set visualization.
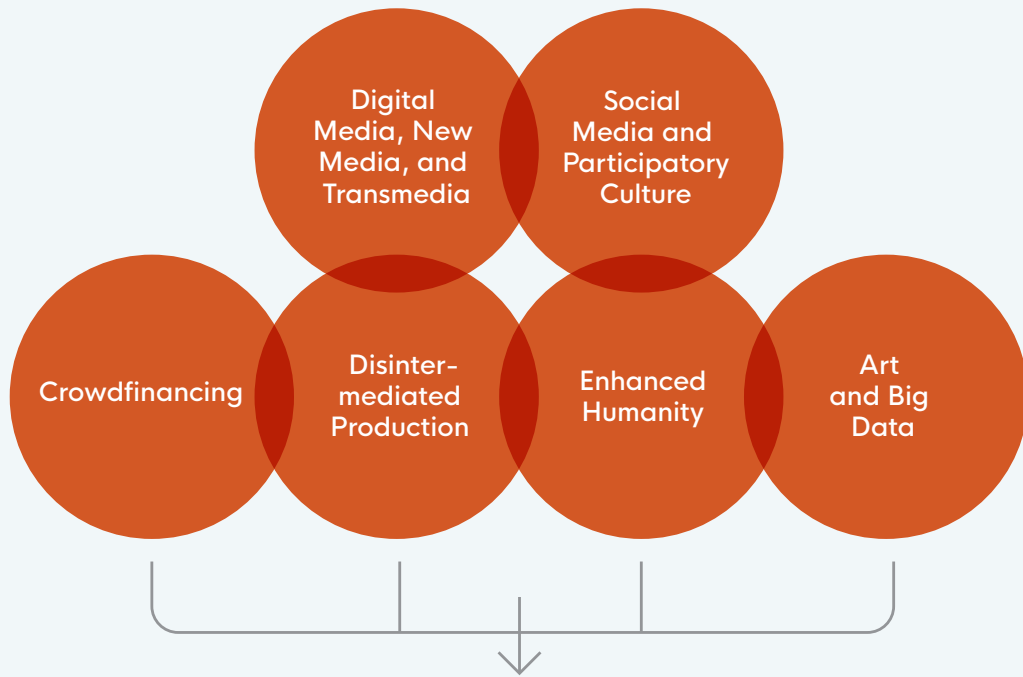
—— WHY IS THIS SIGNIFICANT ——
IN 10-15 YEARS?

These trends and emerging changes are allowing audiences to become artists, replacing the wealthy patron with thousands of micro-patrons; they can broadcast artworks to the world, and amplify artists' potential impact on social, cultural, and political issues. Closing the distance between audience and artist helps audience participants learn to appreciate, critique, and create art themselves, often by extending an original artwork with transmedia storytelling. New immersive media will tap an augmented and enhanced human sensorium, creating aesthetic experiences that transcend the merely real. This in turn will expand opportunities to experience the full spectrum of human experience, reflecting diverse cultural expressions and truths to a worldwide audience.

- **Diversity of ideas and voices.** Digital globalization reduces barriers that exclude cultures, communities, perspectives, ideas, and materials in art, creating new narrative spaces and art forms. It also expands the complexity of global culture by including all voices. Future curators will be trained to consider how art collections and institutions can better engage with their audiences, and "how curation can spark a conversation or make meaningful change to our understanding." New media, including virtual reality, augmented reality, and expanded sensory reality, magnified by applied advances in neuroscience, could improve how others experience the world, and enhance empathy through virtually shared narratives.
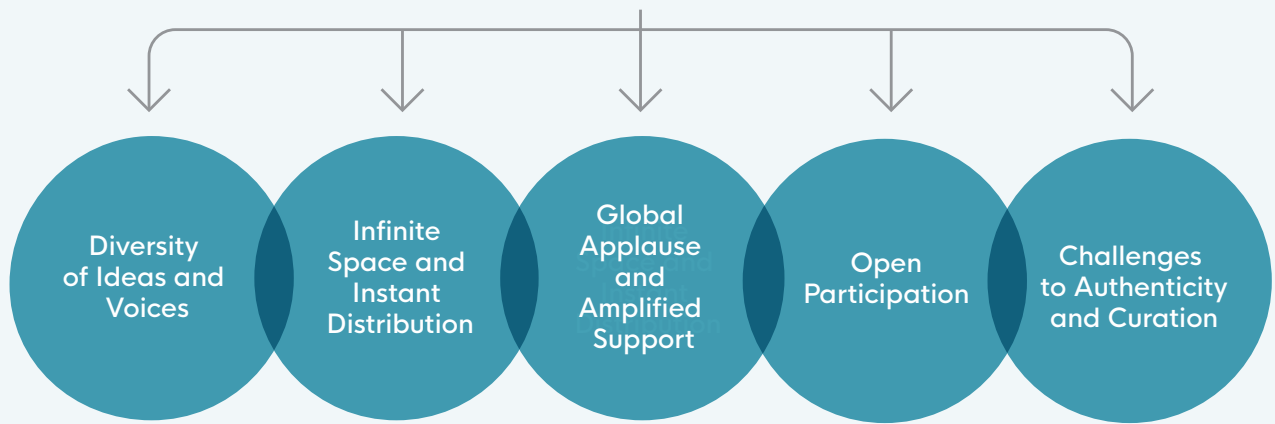
- **Infinite space and instant distribution.** With galleries extending to the digital space, exhibit and performance space becomes infinite and malleable; distribution is instantaneous and global.

- **Global applause and amplified support.** Expansion is going beyond local to global as fan communities emerge and self-organize online in celebration and support of artists. This in turn amplifies support via crowdsourcing sites like Kickstarter, Indiegogo or Fundit. Far from labouring in obscurity, artists can amplify both audience size and patronage globally via digital networks. This could expand the political and social impact of art, and its power to shape issues across nations and markets.

- **Open participation.** Open participation changes artists' capacity to create new works, and increases fans' opportunities to access, critique, mimic, and learn art. This eases the transition from audience to amateur to professional, and boosts diverse perspectives.

- **Challenges to authenticity and curation.** Easy digital dissemination and the rise of remix/transmedia storytelling and art could create Intellectual Property Rights (IPR) and authenticity issues, and could mean a collapse of bricks-and-mortar museums and galleries, balanced by a heightened appreciation of the 'live' experience.

The opportunities for new art forms and integration of art production, critique and consumption into daily life are considerable – as are potential challenges to IPR and royalties, artistic authenticity, and the roles of museums in an age of scanning, digital archives, and 3D printers. Potential evolution of art into new spaces (undersea or in deep space), or as new media (living art or genetic design), suggest that arts may be the new strategic literacy.

CHANGE DRIVERS

Digital Media, New Media, and Transmedia

Social Media and Participatory Culture

Crowdfinancing

Disinter-mediated Production

Enhanced Humanity

Art and Big Data

– – –
THE ARTS TRANSFORMED
– – –

Diversity of Ideas and Voices

Infinite Space and Instant Distribution

Global Applause and Amplified Support

Open Participation

Challenges to Authenticity and Curation

IMPLICATIONS

81

EROSION OF CULTURE AND HISTORY

Languages, traditions, artifacts, and world views are fading from existence and memory in many parts of the world, pointing to a weaker social fabric, damaged potential for innovation and solutions, and cases of lost or forgotten identity.

—— SUMMARY ——

In many parts of the world, the essential elements that make up human cultures as we know them could be destroyed, lost, or forgotten. These elements include people, artifacts, and geography, as well as less tangible elements such as language, customs, mythology, and perspectives. Cultural and historical degradation of many peoples can be attributed to forgotten languages, the deliberate and accidental destruction of artifacts, geography, and cultures as a whole, and a sense of cultural homogenization driven by globalization. To many, the acceleration of cultural loss is alarming. In a world where a significant number of cultures have been forgotten, humanity suffers by losing access to perspectives and world views that could otherwise help solve our great challenges.

—— WHAT IS CHANGING? ——

- **Languages are dying.** There are approximately 7,000 languages spoken in the world today, yet over forty percent are at risk of disappearing. This is occuring at a far greater rate than ever before. In some cases, conflict and natural disasters can destroy all the speakers of an uncommon language; but more often, the cause is that societies drop uncommon languages in favour of a more commonly spoken tongue for economic and social advantages. With the loss of a language comes the loss of a unique way of knowing the world, and the insight that accompanies it.

- **Artifacts and history are being destroyed.** Drivers such as conflict, climate change, and environmental disasters erase many of the tangible artifacts that represent a culture's history and ideas. This can include the geographic landscapes to which some cultures are economically, historically, and mythologically connected. Rising geopolitical tensions and the carrying capacity of the planet under strain puts many vulnerable pieces of the past and present at risk.

- **Cultural homogenization.** The globalization of economies, politics, and culture contributes to the erosion of vulnerable cultures worldwide by incentivizing homogeny and monoculture. Nation states that lack the cultural fortitude of the more dominant cultures are flooded with ideas and products that can suffocate local values and customs. The debate surrounding the overall cultural impact of globalization is complex, but many cultures are threatened by globalization's deluge of new cultural influences.
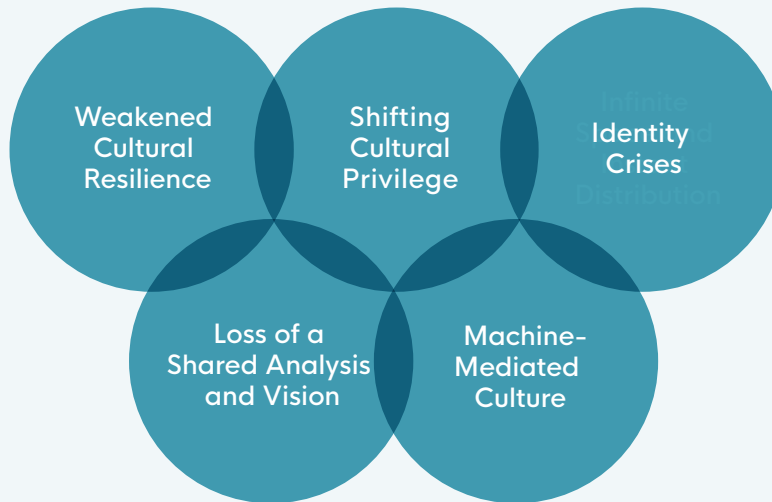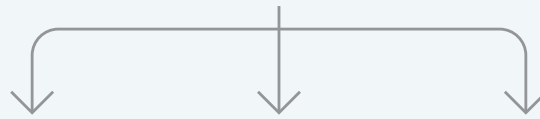

—— WHY IS THIS SIGNIFICANT —— IN 10–15 YEARS?

- **Weakened cultural resilience.** Just as our natural biosphere protects against environmental shock through its diversity of life forms and systems, the ethnosphere acts as a web of diverse cultures and worldviews that provides social resilience against instability and disaster. Having fewer ways of seeing and knowing the world impairs our ability to cooperatively cope with calamity. Diverse perspectives and ideas also foster innovation and the ability to create solutions. In the face of myriad future challenges, a limited scope of ideas will hinder humanity's capacity to react, persevere, and overcome.

- **Shifting cultural privilege.** A significant drop in languages spoken, perspectives shared, and narratives told could strengthen more dominant cultures, and weaken those cultures that still cling to existence. This could snowball, perhaps ultimately resulting in a global monoculture. While culture does not have to be conceived of in zero-sum terms, the aggressive stance that some dominant cultures have taken runs the risk of stamping local traditions out of existence.

- **Identity crises.** A sense of belonging and identity is important for the human condition. A weakened sense of culture can adversely affect conceptions of identity, both at an individual and community level. An increase in substance abuse and suicide could accompany a future where more people lose their cultural identity, threatening to fracture families and communities as well as strain health care systems.

- **Loss of a shared analysis and vision.** A rich and diverse appreciation of history and culture helps us understand where we are and how we got here. The absence of this shared analysis will make it harder to develop a robust societal vision that has broad support.

- **Machine-mediated cultures.** New technologies offer inexpensive and increasingly sophisticated ways to translate text and speech. While this presents opportunities for easier communication across language barriers, questions still remain regarding how machine learning and artificial intelligence will affect the experience of living in a language or culture.

In the face of myriad future challenges, a limited scope of ideas will hinder humanity's capacity to react, persevere, and overcome.

CHANGE DRIVERS

Languages are Dying

Artifacts and History are Being Destroyed

Cultural Homogenization

EROSION OF CULTURE & HISTORY

Weakened Cultural Resilience

Shifting Cultural Privilege

Identity Crises

Infinite Distribution

Loss of a Shared Analysis and Vision

Machine-Mediated Culture

IMPLICATIONS

APPPENDIX A

AUTHORS

Katherine Antal

Lisa Dixon

Sarah Evans

Deanna Jamieson

Jennifer O'Rourke

Peter Padbury

Kurt Richardson

Wendy Schultz

Sven Schirmer

Jason Steeves

OTHER CONTRIBUTORS

Maryam Alam

Marcus Ballinger

Ian Lambert

Nelly Leonidis

Alain Piquette

Eric Ward

Nadia Zwierzchowska

PARTNERS

Horizons appreciated the opportunity
to collaborate with SSHRC on this project.
We thank the following for their
excellent guidance:

Rachel Conlon

Thérèse De Groote

Ursula Gobel

APPPENDIX B

FUTURESCAPER CROWDSOURCING MATERIALS

English email message

Greetings from Policy Horizons Canada

Policy Horizons Canada (www.horizons.gc.ca) is a strategic foresight organization within the Federal Government of Canada. At Horizons, we seek to identify emerging issues that could shape the public policy landscape by understanding where transformative change may occur in the future.

Horizons is collaborating with the Social Sciences and Humanities Research Council as SSHRC seeks to advance, through its Imagining Canada's Future initiative, the contributions of the social sciences and humanities towards Canada's future long-term societal challenges and opportunities, in a global context.

We would like to tap into the collective knowledge of a broad swath of experts, and we invite you to share your ideas with us through a rapid Futurescaper crowdsourcing tool at the link below:

https://ftr.sc/engdirChallenges

The tool will ask you to identify a significant emerging global challenge the world will face in 15 years, and its potential consequences. It will then help push your thinking out further by asking you to consider challenges entered by other people, as well. At the end you will be asked to help us consider appropriate research questions regarding these challenges.

It should just take approximately five minutes to complete this exercise. There is also the option of repeating the exercise at the end if you wish to add more challenges. Embedded in the exercise is an option to forward it to colleagues via social media, and we would encourage you to do so.

At the end of the exercise, you will have the option of requesting a copy of a related report. Rest assured that your responses will remain confidential, and will not be linked to any personal contact information you may provide when requesting a copy of the report.

Thank you! We recognize that your time is valuable and we appreciate your effort. We look forward to discovering the results!

Sincerely,

Policy Horizons Canada

English Questionnaire – Introductory text

Policy Horizons Canada, a foresight centre in the Government of Canada, is trying to identify the global challenges the world will confront in the future. We want to move beyond the well-known challenges of today (e.g. climate change) to identify what could plausibly occur 10-15 years from now.

Horizons is collaborating with the Social Sciences and Humanities Research Council as SSHRC seeks to advance, through its Imagining Canada's Future initiative, the contributions of the social sciences and humanities towards Canada's future long-term societal challenges and opportunities, in a global context. Together, we are using Futurescaper.com as a crowdsourcing tool that can push your thinking. You will be asked to identify one emerging challenge (weak signal or emerging trend), note its potential consequences, and then explore the potential interactions with challenges proposed by other people.

We are looking for short and provocative answers (60 characters or less). As you start to fill in any box, answers that others have offered will appear in a drop down box. If your answer is not on the list, click "add" to add your answer to the database. If your answer already appears in the list, click that instead.

It will take about 5 minutes to complete the exercise. On the last slide you have the option of starting again and adding another challenge. Responses are anonymous and survey results will be aggregated to ensure anonymity. On the final page we provide a mail-to link for you to request a copy of the final report. Embedded in throughout the exercise is an option to forward it to colleagues via social media, and we would encourage you to do so.

Thank you for your contribution!

Questionnaire

1: GLOBAL CHALLENGE

If you were to ask your colleagues what single most significant global challenge they think the world will face in 15 years, what would they say?

Look past current challenges and search for the challenges as yet unknown today. Enter the single most significant challenge.

2: CROSS-IMPACTING FIRST ORDER CONSEQUENCES

Here is a list of consequences that you and others have suggested could be transformative.
Select two consequences that, when combined, will be the most disruptive in the future.
You may select a consequence that you previously entered.

What will happen when the 2 items below interact?

3. CHOOSE TWO CHALLENGES

The purpose of this step is to extend your thinking beyond the challenge and associated consequences that you previously identified. Reflecting on what you've just done, now pick the two most significant challenges for the world in 15 years. The list below combines your input with that of many others and you are asked to select a combination of two challenges that may produce disruptive change.

4. SOLUTION

Looking ahead 15 years, in a future where these two challenges combine...what research questions should we ask today to help us prepare for the challenges above and other challenges you have identified in this exercise?

Thank you for completing this exercise. We appreciate the time you've taken to suggest these changes and their impacts, and contribute your ideas. Please email global@horizons.gc.ca to request a copy of the final report, or to offer any additional comments.

You can hit the Restart button below to share another challenge. All responses will remain confidential and no personal information will be shared or linked to your email address.

Public Invitation

I just took part in this fun exercise to identify emerging global challenges – join me, share your own ideas, and combine them with others!

APPPENDIX C

BIBLIOGRAPHY

1. WORKING IN THE DIGITAL ECONOMY

"3D Printing News." *All3DP*. https://all3dp.com/3d-printing-news/.

"IBM Watson Health." *IBM*. https://www.ibm.com/watson/health/.

"Synthetic Biology Explained." Biotechnology Innovation Organization. https://www.bio.org/articles/synthetic-biology-explained.

Bloomberg. "The Rise of the Platform Economy." Sooner Than You Think Paris. Video. May 22, 2018. https://www.bloomberg.com/news/videos/2018-05-22/the-rise-of-the-platform-economy-video.

Brundage, Miles and John Danaher. "Cognitive Scarcity and Artificial Intelligence: How Assistive AI Could Alleviate Inequality." Institute for Ethics and Emerging Technologies. July 23, 2017. https://ieet.org/index.php/IEET2/more/Danaher20170623.

Farber, Madeline. "Consumers Are Now Doing Most of Their Shopping Online." Fortune. June 8, 2016. http://fortune.com/2016/06/08/online-shopping-increases/.

Gardner, Sarah. "'Wall Street does not value having employees' and that's changing everything about the US workplace." Business Insider. June 25, 2016. http://www.businessinsider.com/companies-dont-like-having-full-time-employees-2016-6.

Hanna, Holly Reisem. "18 Short Task Sites for Making Money from Home." The Work at Home Woman. April 9, 2014. https://www.theworkathomewoman.com/short-task-sites/.

International Monetary Fund. World Economic Outlook 2017. https://books.google.ca/books?id=DLIADwAAQBAJ&pg=PT358&lpg=PT358&dq=the+rise+of+part-time+employment+and+temporary+contracts+challenges+the+current+structure+of+social-insurance+systems.&source=bl&ots=PFqTMsos-Y&sig=MLTd9uP3j05UwBBdxIXuyOZKiP8&hl=en&sa=X&ved=0ahUKEwifv6vz18XbAhWr7IMKHeK-nDa4Q6AEISDAE#v=onepage&q=the%20rise%20of%20part-time%20employment%20and%20temporary%20contracts%20challenges%20the%20current%20structure%20of%20social-insurance%20systems.&f=false.

Mason, Paul. "The end of capitalism has begun." The Guardian. July 17, 2015. https://www.theguardian.com/books/2015/jul/17/postcapitalism-end-of-capitalism-begun.

McGuire, Robert. "Ultimate guide to gig economy data: a summary of every freelance survey we can find." Nation 1099. January 29, 2018. https://nation1099.com/gig-economy-data-freelancer-study/.

McKinsey. "Skill shift: automation and the future of the workforce." May 2018. https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Future%20of%20Organizations/Skill%20shift%20Automation%20and%20the%20future%20of%20the%20workforce/MGI-Skill-Shift-Automation-and-future-of-the-workforce-In-brief-May-2018.ashx.

Murthy, Vivek. "Work and the loneliness epidemic." Harvard Business Review. September 2017. https://hbr.org/cover-story/2017/09/work-and-the-loneliness-epidemic.

Policy Horizons Canada. "The Changing Nature of Work." June 1, 2016. http://www.horizons.gc.ca/en/content/changing-nature-work.

Randstad. "randstad US study projects massive shift to agile employment and staffing model in the next decade." randstadUSA. December 12, 2016. https://www.randstadusa.com/about/news/randstad-us-study-projects-massive-shift-to-agile-employment-and-staffing-model-in-the-next-decade/.

2. GLOBAL HEALTH AND WELLNESS FOR THE 21ST CENTURY

"Flu Near You." Flu Near You. https://flunearyou.org/#!/.

"Patients Like Me." https://www.patientslikeme.com/.

Barrett, Meredith A., Olivier Humblet, Robert A. Hiatt, and Nancy E. Adler. "Big Data and Disease Prevention: From quantified Self to Quantified Communities." Big Data 1, no.3 (2013): https://doi.org/10.1089/big.2013.0027.

Bhatti, Yasser A., Matthew Prime, Matthew Harris, Hester Wadge, Julie McQueen, Hannah Patel, Alexander W. Carter, Gregory Parston, and Ara Darzi. "The search for the holy grail: frugal innovation in healthcare from low-income or middle-income countries for reverse innovation to developed countries." BMJ Innovations 3, no.4 (2017): 212-220. http://innovations.bmj.com/content/bmjinnov/3/4/212.full.pdf.

Carson, Erin. "A one-stop smart home shop to help you care for mom and dad." c|net. April 3, 2017. https://www.cnet.com/news/smart-homes-technology-eldercare-seniors/.

Crossley, Merlin. "What is CRISPR gene editing, and how does it work?." The Conversation. January 31, 2018. https://theconversation.com/what-is-crispr-gene-editing-and-how-does-it-work-84591.

Dora, Sumit, Dinesh Khanna, Ying Luo, Lillian Poon, and Christoph Schweizer. "Medtech May Be Emerging Markets' Next New Thing." Boston Consulting Group. March 2, 2017. https://www.bcg.com/publications/2017/globalization-medical-devices-technology-medtech-may-be-emerging-markets-next-new-thing.aspx.

Future Market Insights. "Medical Tourism Market Is Expecting Worldwide Growth by 2020." Digital Journal. May 30, 2018. http://www.digitaljournal.com/pr/3794904.

Government of South Australia, and WHO. "Progressing the Sustainable Development Goals through Health in All Policies." World Health Organization. 2017. http://www.who.int/social_determinants/publications/Hiap-case-studies-2017/en/.

Halamka, John D., Andrew Lippman, and Ariel Ekblaw. "The Potential for Blockchain to Transform Electronic Health Records." Harvard Business Review. March 3, 2017. https://hbr.org/2017/03/the-potential-for-blockchain-to-transform-electronic-health-records.

Harvard Global Health Institute. Global Monitoring of Disease Outbreak Preparedness: Preventing the Next Pandemic. Cambridge, MA: Harvard University Press, 2018. https://globalhealth.harvard.edu/files/hghi/files/global_monitoring_report.pdf.

Haskins, Caroline. "Your immune system is in charge of how quickly you age." The Outline. April 26, 2018. https://theoutline.com/post/4288/stanford-immune-system-epigenetics-aging-cancer-autoimmune-diabetes-research?zd=5&zi=3hrk4rpd.

Hwany, Young, Elvin Koh, Adison Wong, John C. March, William E. Bentley, Yung Seng Lee and Matthew Wook Chang. "Engineered probiotic Escherichia coli can eliminate and prevent Pseudomonas aeruginosa gut infection in animal models." Nature Communications 8 (2017): 15028. https://www.nature.com/articles/ncomms15028.

Kraft, Daniel. "Future of Medicine." Singularity University Japan Summit. Youtube. October 26, 2017. https://www.youtube.com/watch?v=dxEus6cRqb8.

Martin, Emily Toth. "Genetic detectives: how scientists use DNA to track disease outbreaks." The Conversation. April 29, 2016. https://theconversation.com/genetic-detectives-how-scientists-use-dna-to-track-disease-outbreaks-57462.

McQueen, David V.. "Three challenges for social determinants of health pursuit. International Journal of Public Health 54 (2009): 1-2. https://link.springer.com/content/pdf/10.1007%2Fs00038-008-8167-x.pdf.

Partridge, Brad, and Wayne Hall. "The search for Methuselah." EMBO reports 8, no.10 (2007): 888-891. http://embor.embopress.org/content/8/10/888.

Payne, Elizabeth. "Why robots are the way of the future, especially for the elderly. Ottawa Citizen. July 31, 2017. http://ottawacitizen.com/news/local-news/why-robots-are-the-way-of-the-future-especially-for-the-elderly.

Seil, Justin T., and Thomas J. Webster. "Antimicrobial applications of nanotechnology: methods and literature." International Journal of Nanaomedicine no. 7 (2012): 2767-2781. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3383293/.

Sweeney, Evan. "CDC eyes blockchain for public health surveillance." Fierce Healthcare. October 2, 2017. https://www.fiercehealthcare.com/mobile/cdc-blockchain-public-health-surveillance-data-sharing.

Tannoury, Maya, and Zouhair Attieh. "The Influence of emerging Markets on the Pharmaceutical Industry." Current Therapeutic Research 86 (2017): 19-22. https://www.sciencedirect.com/science/article/pii/S0011393X16300984.

Tirrell, Meg. "FDA moves to encourage A.I. in medicine, drug development." April 26, 2018. https://www.cnbc.com/2018/04/26/fda-moves-to-encourage-a-i-in-medicine-drug-development.html.

Wood, Dr. Fred. "Health Disparities: Big Data to the Rescue?." U.S. Department of Health & Human Services. May 16, 2017. https://nlmdirector.nlm.nih.gov/2017/05/16/health-disparities-big-data/.

Zhen, Fan, Peter P. Fu, Hongtao Yu, and Paresh C. Ray. "Theranostic nanomedicine for cancer detection and treatment." Journal of Food and Drug Analysis 22, no.1 (2014): 3-17. https://www.sciencedirect.com/science/article/pii/S1021949814000027.

3. THE EMERGING ASOCIAL SOCIETY

@DeoTasDevil. "How White Nationalism Courts Internet Nerd Culture." Medium. November 22, 2017. https://medium.com/@DeoTasDevil/how-white-nationalism-courts-internet-nerd-culture-b4ebad07863d.

"Aging World." Radio Free Europe. https://www.rferl.org/a/oldest-population/26615160.html.

"Families, households and marital status: Key results from the 2016 Census." Statistics Canada. August 2, 2017. http://www.statcan.gc.ca/daily-quotidien/170802/dq170802a-eng.htm?HPA=1.

Beaton, Caroline. "Why Millenials Are Lonely." Forbes. February 9, 2017. https://www.forbes.com/sites/carolinebeaton/2017/02/09/why-millennials-are-lonely/#3514dbe47c35.

Burke, Jason. "Talking to the Enemy by Scott Atran – review." The Guardian. October 24, 2010. https://www.theguardian.com/books/2010/oct/24/scott-atran-talking-to-the-enemy-review.

Chamie, Joseph. "The Rise of One-Person Households." Global Issues. February 22, 2017. http://www.globalissues.org/news/2017/02/22/22900.

Chatterjee, Rhitu. "Americans Are A Lonely Lot, And young People Bear The Heaviest Burden." National Public Radio. May 1, 2018. https://www.npr.org/sections/health-shots/2018/05/01/606588504/americans-are-a-lonely-lot-and-young-people-bear-the-heaviest-burden.

Craig, Carol. "How business and the media fuel loneliness." Sceptical Scot. January 3, 2018. http://sceptical.scot/2018/01/business-media-fuel-loneliness/.

Faiola, Anthony, and Souad Mekhennet. "What's happening to our children?." The Washington Post. February 11, 2017. http://www.washingtonpost.com/sf/world/2017/02/11/theyre-young-and-lonely-the-islamic-state-thinks-theyll-make-perfect-terrorists/?utm_term=.5261d3d6487c.

Futrelle, David. "Can the radicalization of 'incels' be stopped?." The Globe and Mail. April 27, 2018. https://www.theglobeandmail.com/opinion/article-can-the-radicalization-of-incels-be-stopped/.

Galloway, Gloria. "Census 2016: More Canadians than ever are living alone, and other takeaways." The Globe and Mail. August 2, 2017. https://www.theglobeandmail.com/news/national/census-2016-statscan/article35861448/.

Griffin, Sarah C.. "Loneliness, cynical hostility, and cognitive decline in Americans above age 50." Graduate School at Virginia Commonwealth University Scholars Compass. 2016. https://scholarscompass.vcu.edu/cgi/viewcontent.cgi?article=5270&context=etd.

inKin. "Social Fitness." https://www.inkin.com/.

Matthews, Tony. "Many people feel lonely in the city, perhaps 'third places' can help with that." Phys Org. March 22, 2018. https://phys.org/news/2018-03-people-lonely-city.html.

Morin, Amy. "Is Technology Ruining Our Ability to Read Emotions? Study Says Yes." Forbes. August 26, 2014. https://www.forbes.com/sites/amymorin/2014/08/26/is-technology-ruining-our-ability-to-read-emotions-study-says-yes/#1d6ccdf946a5.

Murthy, Vivek. "Work and the loneliness epidemic." Harvard Business Review. September 2017. https://hbr.org/cover-story/2017/09/work-and-the-loneliness-epidemic.

P., Aronin. "Telepresence Robots: The Future of Work and Education." Published on LinkedIn. September 26, 2017. https://www.linkedin.com/pulse/telepresence-robots-future-work-education-aronin-p/.

Policy Horizons Canada. "The Changing Nature of Work." June 1, 2016. http://www.horizons.gc.ca/en/content/changing-nature-work.

Seppälä, Emma. "Our need to feel special is making us lonely." Quartz. April 19, 2017. https://qz.com/963430/our-need-to-feel-special-is-making-us-lonely/.

Waber, Ben. "Japan's overwork culture is famous, but the US version may be just as bad." Quartz. October 30, 2017. https://work.qz.com/1115107/workers-in-japan-and-the-us-overwork-in-different-ways/.

Walton, Alice G. "New Study Links Facebook To Depression: But Now We Actually Understand Why." Forbes. April 8, 2015. https://www.forbes.com/sites/alicegwalton/2015/04/08/new-study-links-facebook-to-depression-but-now-we-actually-understand-why/#474cb2791e6d.

WeDo. "Features." https://www.wedo.com/features.

4. SHIFTING DYNAMICS OF PRIVILEGE AND MARGINALIZATION

"Should we redesign humans?." TED Talks Playlist. https://www.ted.com/playlists/144/should_we_redesign_humans.

Berlatsky, Noah. "The Trump effect: New study connects white American intolerance and support for authoritarianism." NBC News. May 27, 2018. https://www.nbcnews.com/think/opinion/trump-effect-new-study-connects-white-american-intolerance-support-authoritarianism-ncna877886.

Bohan, Elise. "10 Human Body Modifications You Can Expect in the next Decade." Big Think. March 15, 2017. http://bigthink.com/articles/10-human-body-modifications-you-can-expect-in-the-next-decade.

Brey, Philip. "Human Enhancement and Personal Identity." In New Waves in Philosophy of Technology, edited by Jan Kyrre Berg Olsen, Evan Selinger, and Søren Riis, 8. New York: Palgrave Macmillan, 2008.

Bulman, May. "Brexit vote sees highest spike in religious and racial hate crimes ever recorded." The Independent. July 7, 2017. https://www.independent.co.uk/news/uk/home-news/racist-hate-crimes-surge-to-record-high-after-brexit-vote-new-figures-reveal-a7829551.html.

Dastagir, Alia E. "The state of hate in America." USA Today. July 9, 2017. https://www.usatoday.com/story/news/2017/07/09/kkk-racist-rants-religious-vandalism-us-vs-them-mentality-escalates-leaving-dark-corners-interne/418100001/.

Estrada, Daniel. "Every time Boston Dynamics has abused a robot." Youtube Video. May 17, 2017. https://www.youtube.com/watch?v=4PaTWufUqqU.

Gaither, Sarah E. "I study biracial identity in America. Here's why Meghan Markle is a big deal." Vox. May 18, 2018. https://www.vox.com/first-person/2018/5/14/17345162/meghan-markle-royal-wedding-2018-race.

Gollwitzer, Anton, and John Bargh. "Why are people so prejudiced? The answer is not what you think." CNN. January 29, 2018. https://edition.cnn.com/2018/01/29/opinions/prejudice-broken-patterns-opinion-gollwitzer-bargh/index.html.

Jacobs, Sarah. "10 American cities that have fallen into decline." Business Insider. January 14, 2018. http://uk.businessinsider.com/us-census-data-population-decrease-shows-american-cities-in-decline-2018-1?r=US&IR=T/#10-dayton-ohios-population-has-declined-from-its-peak-by-461-1.

Juang, Mike. "Next-gen robots: The latest victims of workplace abuse." CNBC Disruptor 50. August 9, 2017. https://www.cnbc.com/2017/08/09/as-robots-enter-daily-life-and-workplace-some-face-abuse.html.

Koski, Jessica, and Hongling Xie, and Ingrid R. Olson. "Understanding Social Hierarchies: The Neural and Psychological Foundations of Status Perception." Social Neuroscience 10 no.5 (2015): 527-550. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5494206/.

Kranz, Maciej. "The Internet of Things: 5 Predictions for 2018." Cisco Blogs. January 25, 2018. https://blogs.cisco.com/innovation/the-internet-of-things-5-predictions-for-2018.

Margolis, Jonathan. "I am microchipped and have no regrets." Financial Times. May 30, 2018. https://www.ft.com/content/6c0591b4-632d-11e8-bdd1-cc0534df682c.

Masci, David. "Human Enhancement. The Scientific and Ethical Dimensions of Striving for Perfection." Pew Research Center. July 26, 2016. http://www.pewinternet.org/essay/human-enhancement-the-scientific-and-ethical-dimensions-of-striving-for-perfection/.

Miah, Andy. "The Ethics of Human Enhancement." MIT Technology Review. September 8, 2016. https://www.technologyreview.com/s/602342/the-ethics-of-human-enhancement/.

Newman, Jared. "Eight Trends That Will Define The Digital Assistant Wars In 2018. Fast Company. January 4, 2018. https://www.fastcompany.com/40512062/eight-trends-that-will-define-the-digital-assistant-wars-in-2018.

Pitel, Laura, and Asser Khattab and Erika Solomon. "Syrian refugees under pressure as neighbours' goodwill runs out." Financial Times. March 5, 2018. https://www.ft.com/content/bf696a82-1d47-11e8-956a-43db76e69936.

Resnick, Brian. "After a terrorist attack, we grow fearful. Here's what that does to our brain." Vox. September 10, 2016. https://www.vox.com/2016/9/10/12861036/terrorist-psychology-fear-9-11-anniversary.

Schaefer, G. Owen. "China may be the future of genetic enhancement." The Conversation. August 1, 2016. https://theconversation.com/the-future-of-genetic-enhancement-is-not-in-the-west-63246.

Schrage, Michael. "Why You Shouldn't Swear at Siri." Harvard Business Review. October 21, 2016. https://hbr.org/2016/10/why-you-shouldnt-swear-at-siri.

Sparks & Honey Cultural Strategists. "Are Cyborgs the Next Step in Human Evolution?." Big Think. July 17, 2013. http://bigthink.com/amped/are-cyborgs-the-next-step-in-human-evolution-2.

Szlyk, Hannah. "Is anomie the enemy? Another perspective on the increase of school shootings." The Menninger Clinic. September 30, 2014. http://saynotostigma.com/2014/09/is-anomie-the-enemy-another-perspective-on-the-increase-of-school-shootings/.

Thobo-Carlsen, Mik. "How Tattoos Went From Subculture to Pop Culture." Huffington Post. December 27, 2014. https://www.huffingtonpost.com/mik-thobocarlsen/how-tattoos-went-from-sub_b_6053588.html.

Whitman, Debra, Jeffrey Love, G. Rainville, Laura Skufca, Simone Schuerle, Daphne Bavelier, and Corinna Lathan. "What Americans Think of Human Enhancement Technologies." Scientific American. January 16, 2018. https://blogs.scientificamerican.com/observations/what-americans-think-of-human-enhancement-technologies/.

Wong, Julia Carrie. "Rage against the machine: self-driving cars attacked by angry Californians." The Guardian. March 6, 2018. https://www.theguardian.com/technology/2018/mar/06/california-self-driving-cars-attacked.

5. BUILDING BETTER LIVES ACROSS THE GENDER SPECTRUM

"Female politicians speak out about sexist, violent cyberbullying." CBC Radio. Podcast. February 14, 2017. http://www.cbc.ca/radio/thecurrent/the-current-for-february-14-2017-1.3981592/female-politicians-speak-out-about-sexist-violent-cyberbullying-1.3981651.

"Forum endorses recommendations on women's political participation." The Commonwealth. April 16, 2018. http://thecommonwealth.org/media/news/forum-endorses-recommendations-womens-political-participation.

"Millennial Women Are Afraid to Invest." Bank News. April 5, 2018. https://www.banknews.com/blog/millennial-women-are-afraid-to-invest/.

"Religion and Reproductive Rights." American Civil Liberties Union. https://www.aclu.org/issues/reproductive-freedom/religion-and-reproductive-rights.

"The Future of Gender." The more accurate guide to the future. February 14, 2014. https://timeguide.wordpress.com/2014/02/14/the-future-of-gender-2/.

"The Global Gender Gap Report 2017." World Economic Forum. November 2, 2017. https://www.weforum.org/reports/the-global-gender-gap-report-2017.

"The Moose Hide Campaign in Your Community." Moose Hide Campaign. https://www.moosehidecampaign.ca/about-us.

"UN Women and partners to pilot blockchain technology in humanitarian action." United Nation Women. February 2, 2018. http://www.unwomen.org/en/news/stories/2018/2/news-event-blockchain-technology-and-humanitarian-action.

"Why some 'incels' are celebrating accused in Toronto van attack." CBC Radio. Podcast. April 25, 2018. http://www.cbc.ca/radio/asithappens/as-it-happens-tuesday-full-episode-1.4633051/why-some-incels-are-celebrating-accused-in-toronto-van-attack-1.4633057.

"Women Working Together for the Africa We Want: African Women Leaders Network convene for a second forum." United Nations Women. April 24, 2018. http://www.unwomen.org/en/news/stories/2018/4/announcement-african-women-leaders-network-second-forum.

Arekapudi, Nisha. "Why gender equality starts with a change in the law." World Economic Forum. May 14, 2018. https://www.weforum.org/agenda/2018/05/over-100-countries-still-bar-women-from-working-in-specific-jobs.

Basu, Moni and Curt Merrill. "A girl gets married every 2 seconds somewhere in the world." CNN. March 15, 2018. https://www.cnn.com/2018/01/29/health/child-marriage-by-the-numbers/index.html.

Beaumont, Peter. "Further arrests of Saudi women's rights activists in escalating crackdown." The Guardian. May 21, 2018. https://www.theguardian.com/global-development/2018/may/21/further-arrests-saudi-arabia-womens-rights-activists-driving-ban.

Begum, Rothna. "The Middle East's Women Are Championing Their Own Change." The New Arab. March 3, 2018. https://www.alaraby.co.uk/english/Comment/2018/3/7/The-Middle-Easts-women-are-championing-their-own-change.

Bilsker, Dan and Jennifer White. "The silent epidemic of male suicide." BC Medical Journal 53, no.10 (2011): 529-534. http://www.bcmj.org/articles/silent-epidemic-male-suicide.

Bloom, Ester. "Millennial women are 'worried,' 'ashamed' of out-earning boyfriends and busbands." CNBC. April 19, 2017. https://www.cnbc.com/2017/04/18/millennial-women-worry-about-out-earning-boyfriends-and-husbands.html.

Boffey, Daniel. "EU to push for 40% quota for women on company boards." The Guardian. November 20, 2017. https://www.theguardian.com/world/2017/nov/20/eu-to-push-for-40-quota-for-women-on-company-boards.

Carpenter, Kitt. "Gay Men Used to Earn Less than Straight Men; Now They Earn More." Harvard Business Review. December 4, 2017. https://hbr.org/2017/12/gay-men-used-to-earn-less-than-straight-men-now-they-earn-more.

Crosson Gilpin, Caroline and Natalie Proulx. "Boys to Men: Teaching and Learning About Masculinity in an Age of Change." New York Times. April 4, 2018. https://www.nytimes.com/2018/04/12/learning/lesson-plans/boys-to-men-teaching-and-learning-about-masculinity-in-an-age-of-change.html.

Dave, Paresh. "Exclusive: Google employees organize to fight cyber bullying at work." Reuters. March 30, 2018. https://www.reuters.com/article/us-alphabet-google-diversity-exclusive/exclusive-google-employees-organize-to-fight-cyber-bullying-at-work-idUSKBN-1H61QR.

Denyer, Simon, and Annie Gowen. "Too Many Men." Washington Post. April 18, 2018. https://www.washingtonpost.com/graphics/2018/world/too-many-men/?utm_term=.1a8c8f15212d.

Follows, Tracey. "The future of gender marketing." Campaign Live. August 16, 2017. https://www.campaignlive.co.uk/article/future-gender-marketing/1442147.

Garland, Susan B. "Single? No kids? Don't Fret: How to Plan Care in Your Later Years." New York Times. March 23, 2018. https://www.nytimes.com/2018/03/23/business/elder-orphans-care.html.

Gaudiano, Paolo, and Ellen Hunt. "what's The Next Trend In Leadership? Black Women." Forbes. May 15, 2017. https://www.forbes.com/forbes/welcome/?toURL=https://www.forbes.com/sites/gaudianohunt/2017/05/15/28-awesome-black-women/&refURL=&referrer=#293f27328914.

Gayle, Damien. "Benedict Cumberbatch urges film industry to make equal pay pledge." The Guardian. May 8, 2018. https://www.theguardian.com/culture/2018/may/08/benedict-cumberbatch-urges-film-industry-make-equal-pay-pledge.

Hassan, Sarah. "Saudi women join the workforce as country reforms." CNN. February 7, 2018. https://www.cnn.com/2018/02/06/middleeast/saudi-women-in-the-workforce/index.html.

Hennessy, Angela. "'Problem for an entire gender': Boys, men not adapting to changing job market." CBC. February 7, 2017. http://www.cbc.ca/news/business/men-boys-falling-behind-1.3962316.

Iantorno, Peter. "Why the Women's Leadership Forum in Saudi Arabia this year is important." Arabian Business. March 8, 2018. http://www.arabianbusiness.com/business/391736-why-the-womens-leadership-forum-in-saudi-arabia-this-year-is-important.

Jahanath, Suloshini. "16 Ideas for Using Technology to Prevent and Stop Violence against Women." The Pixel Project. December 1, 2017. http://16days.thepixelproject.net/16-ideas-for-using-technology-to-prevent-and-stop-violence-against-women/.

King, Barbara J.. "A Cultural Moment For Polyamory." National Public Radio. March 23, 2017. https://www.npr.org/sections/13.7/2017/03/23/521199308/a-cultural-moment-for-polyamory.

King-Miller, Lindsay. "The Reproductive Justice Movement Has A Gender Inclusion Problem." The Establishment. August 2, 2017.

Llewellyn, Jennifer. "Realizing the full potential of restorative justice." Policy Options. May 2, 2018. http://policyoptions.irpp.org/magazines/may-2018/realizing-the-full-potential-of-restorative-justice/.

Marcus, Jon. "Why Men Are the New College Minority." The Atlantic. August 8, 2017. https://www.theatlantic.com/education/archive/2017/08/why-men-are-the-new-college-minority/536103/.

Molteni, Megan. "A patient gets the new transgender surgery she helped invent." Wired. September 11, 2017. https://www.wired.com/story/a-patient-gets-the-new-transgender-surgery-she-helped-invent/.

Moreau, Julie. "Global LGBTQ acceptance more polarized, new research finds." NBC News. May 3, 2018. https://www.nbcnews.com/feature/nbc-out/global-lgbtq-acceptance-more-polarized-new-research-finds-n871106.

Nagle, Angela. "The Lost Boys." The Atlantic. December 2017. https://www.theatlantic.com/magazine/archive/2017/12/brotherhood-of-losers/544158/.

Nelson, Eshe. "Job automation will hurt women first – but will ultimately hurt men more." World Economic Forum. February 9, 2018. https://www.weforum.org/agenda/2018/02/job-automation-will-hurt-women-first-but-will-ultimately-hurt-men-more.

Osborne, Samuel. "Pakistan passes law guaranteeing transgender rights." The Independent. May 9, 2018. https://www.independent.co.uk/news/world/asia/pakistan-transgender-rights-lgbt-national-assembly-law-drivers-license-passport-a8343321.html.

Park, Madison. "Child marriages on decline but 12 million girls still married every year." CNN. March 6, 2018. https://www.cnn.com/2018/03/06/health/unicef-child-marriage/index.html.

Sengupta, Somini. "One by One, Marry-Your-Rapist Laws Are Falling in the Middle East." New York Times. July 22, 2017. https://www.nytimes.com/2017/07/22/world/middleeast/marry-your-rapist-laws-middle-east.html.

Shaer, Matthew. "Why "Atlanta" Creator Donald Glover Is One Of The Most Creative People In Business In 2017." Fast Company. May 17, 2017. https://www.fastcompany.com/40412346/why-atlanta-creator-donald-glover-is-one-the-most-creative-people-in-business-2017.

Soupcoff, Marni. "Why putting a price on a baby would not be so bad." National Post. May 31, 2018. http://nationalpost.com/opinion/marni-soupcoff-why-putting-a-price-on-a-baby-would-not-be-so-bad.

Stenberg, Laura. "Learning from Canada's Aboriginal Women Leaders." Canadian Women's Foundation. January 26, 2016. https://www.canadianwomen.org/blog/learning-from-canadas-aboriginal-women-leaders/.

Tatum, Sophie. "Planned Parenthood gears up for new battles over abortion rights." CNN. May 7, 2018. https://www.cnn.com/2018/05/07/politics/planned-parenthood-power-of-pink-training/index.html.

Tedesco, Kate. "'Let's be honest: work is not working for women'." Women In The World. April 14, 2018.
https://womenintheworld.com/2018/04/14/lets-be-honest-work-is-not-working-for-women/.

Wafula Strike, Anne. "Disabled women see #MeToo and think: what about us?." The Guardian. March 8, 2018.
https://www.theguardian.com/commentisfree/2018/mar/08/disabled-people-metoo-womens-movement-inclusion-diversity.

Yang, Jennifer. "On first International Women's Day since #MeToo went viral, survey asks: Has anything really changed?." The Star.
March 7, 2018. https://www.wired.com/2014/11/hacker-lexicon-homomorphic-encryption/.

6. INHABITING CHALLENGING ENVIRONMENTS

"Aquarius Undersea Laboratory." Florida International University.
https://aquarius.fiu.edu/dive-and-train/facilities-and-assets/aquarius-undersea-laboratory/index.html.

"Floating City Project." The Seasteading Institute. https://www.seasteading.org/floating-city-project/.

"Mission." Mars One. https://www.mars-one.com/mission.

"SeaOrbiter." SeaOrbiter. http://www.seaorbiter.com/.

Clarke, Chandra. "Launch a Balloon for Science." Popular Science. February 20, 2014.
https://www.popsci.com/blog-network/do-try-home/launch-balloon-science.

CNT Editors. "11 Coolest Underwater Hotels in the World." CN Traveler. July 9, 2016.
https://www.cntraveler.com/galleries/2016-07-09/11-coolest-underwater-hotels-in-the-world.

Demontis, Gian C., Marco M. Germani, Enrico G. Caiani, Ivana Barravecchia, Claudio Passino, Debora Angeloni. "Human Pathophysio-
logical Adaptations to the Space Environment." Frontiers in Physiology 8 (2017): Article 547.
https://www.frontiersin.org/article/10.3389/fphys.2017.00547.

Dill, Tiffany. "Extreme Diver community Evolved Spleens Similar to Seals." PBS Nova Next. April 24, 2018.
http://www.pbs.org/wgbh/nova/next/evolution/extreme-diver-community-evolved-spleens-similar-to-seals/.

Flanigan, Colleen. "Living Sea Sculpture: contemporary art as coral refuge." Kickstarter.
https://www.kickstarter.com/projects/livingseasculpture/living-sea-sculpture-contemporary-art-as-coral-ref/description.

Helmore, Edward. "'First luxury space hotel' plans to offer zero gravity living – for $792,000 a night." The Guardian. April 7, 2018.
https://www.theguardian.com/science/2018/apr/07/luxury-space-hotel-orion-span-aurora-station.

Jozuka, Emiko. "Underwater Agriculture: The Scuba Divers Growing Crops in Bubbles Under the Sea." Motherboard. August 11, 2015.
https://motherboard.vice.com/en_us/article/d73baq/underwater-agriculture-scuba-divers-are-growing-crops-in-bubbles-
under-the-sea.

Kildall, Scott. "Art in Space: the First Art Exhibition in Space." New Media Art and Research. February 9, 2016.
https://kildall.com/art-in-space-the-first-art-exhibition-in-space/.

Schawinski, Kevin. "Beyond today's crowdsourced science to tomorrow's citizen science cyborgs." The Conversation. March 17, 2016.
https://theconversation.com/beyond-todays-crowdsourced-science-to-tomorrows-citizen-science-cyborgs-53904.

Senthilingam, Meera. "The closest thing on Earth to a mission to Mars." CNN. December 9, 2015. https://edition.cnn.com/2015/12/09/
health/white-mars-antarctica-concordia/index.html.

Suedfeld, Peter, Katya Legkaia, and Jelena Brcic. "Changes in the Hierarchy of Value References Associated With Flying in Space."
Journal of Personality 78 (2010): 1411-1436. doi:10.1111/j.1467-6494.2010.00656.x.

Szondy, David. "Zero-gravity champagne caters for out-of-this-world celebrations." New Atlas. June 10, 2018.
https://newatlas.com/mumm-zero-gravity-champagne/54965/.

Wall, Mike. "3D-Printed 'Laugh' Is 1st Major Artwork to Be Made in Space." Space. February 16, 2017.
https://www.space.com/35723-first-3d-printed-art-space-station.html.

Wong, Julia Carrie. "Seasteading: tech leaders' plans for floating city trouble French Polynesians." January 2, 2017.
https://www.theguardian.com/technology/2017/jan/02/seasteading-peter-thiel-french-polynesia.

7. BALANCING RISKS AND BENEFITS IN THE EMERGING SURVEILLANCE SOCIETY

"City partners with Shaw to expand public's access to free WiFi." City of Vancouver. January 19, 2018. http://vancouver.ca/news-calendar/city-partners-with-shaw-to-expand-publics-access-to-free-wi-fi.aspx.

"Fragen & Antworten". Feinstaub-Stuttgart.info. https://feinstaub-stuttgart.info/fragen-antworten/.

"Governor Cuomo Unveils Design of Reimagined MTA Subway Cars and Details Ambitious Plan to Enhance Subway Stations." Press Office for New York State Governor Andrew M. Cuomo. July 18, 2016. https://www.governor.ny.gov/news/governor-cuomo-unveils-design-reimagined-mta-subway-cars-and-details-ambitious-plan-enhance.

"Many Smart Ideas One Smart Nation." Smart Nation Digital Government Office, Singapore. https://www.smartnation.sg/.

Bartlett, Jamie. "Will 2018 be the year of the neo-luddite?." The Guardian. March 4, 2018. https://www.theguardian.com/technology/2018/mar/04/will-2018-be-the-year-of-the-neo-luddite.

Beall, Abigail, and Matt Reynolds. "What are quantum computers and how do they work? WIRED explains." Wired. February 16, 2018. http://www.wired.co.uk/article/quantum-computing-explained.

Bohn, Dieter. "Intel made smart glasses that look normal." The Verge. February 5, 2018. https://www.theverge.com/2018/2/5/16966530/intel-vaunt-smart-glasses-announced-ar-video.

Cave, Andrew. "What Will We Do When The World's Data Hits 163 Zettabytes in 2025?." Forbes. April 13, 2017. https://www.forbes.com/sites/andrewcave/2017/04/13/what-will-we-do-when-the-worlds-data-hits-163-zettabytes-in-2025/#629ef85349ab.

Clark, Bryan. "Facebook tracks scary-specific details about your life. Here's how to find what it knows." The Next Web. October 10, 2017. https://thenextweb.com/facebook/2017/10/10/ever-wonder-what-facebook-knows-about-you-heres-how-to-find-out/.

Dezeen. "Elevation – how drones will change cities." May 21, 2018. Youtube. https://www.youtube.com/watch?v=Z0osJnSWxt8.

Digital Trends. Starship Technologies Delivery Drone. Video. YouTube. June 8, 2016. https://www.youtube.com/watch?v=SFxCJJVXPFo.

Dillet, Romain. "Facebook knows literally everything about you." Tech Crunch. March 23, 2018. https://techcrunch.com/2018/03/23/facebook-knows-literally-everything-about-you/.

Google. Talk to Books. https://books.google.com/talktobooks/.

Greenberg, Andy. "Hacker Lexicon: What is Homomorphic Encryption?." Wired. November 3, 2014. https://www.wired.com/2014/11/hacker-lexicon-homomorphic-encryption/.

Hill, Kashmir, and Surya Mattu. "The House That Spied on Me." Gizmodo. February 7, 2018. https://gizmodo.com/the-house-that-spied-on-me-1822429852.

Horcher, Gary, "Amazon Alexa recorded private conversation, sent it to random contact, woman says." KIRO 7 News. May 24, 2018. https://www.kiro7.com/news/local/woman-says-her-amazon-device-recorded-private-conversation-sent-it-out-to-random-contact/755507974.

IBM. IBM Watson Health. https://www.ibm.com/watson/health/.

King, Ian, and Scott Moritz. "5G Networks Will Do Much More Than Stream Better Cat Videos." Bloomberg. May 2, 2016. https://www.bloomberg.com/news/articles/2016-05-02/5g-networks-will-do-much-more-than-stream-better-cat-videos.

Lawson, Philippa. "Moving Towards a Surveillance Society – Proposals to Expand "Lawful Access" in Canada." British Columbia Civil Liberties Association. March 2012. https://bccla.org/wp-content/uploads/2012/03/2012-BCCLA-REPORT-Moving-toward-a-surveillance-society.pdf.

Mims, Christopher. "Who Has More of Your Personal Data Than Facebook? Try Google." The Wall Street Journal. April 22, 2018. https://www.wsj.com/articles/who-has-more-of-your-personal-data-than-facebook-try-google-1524398401.

Ministry of Communications and Information, Singapore. What makes a Smart Nation?. Video. YouTube. August 18, 2017. https://www.youtube.com/watch?v=DJmoy41mWDQ.

O'Connor, Mary Catherine. "Dumpster Diving Robots: Using AI for Smart Recycling." iQ by Intel. July 5, 2017. https://iq.intel.com/dumpster-diving-robots-using-ai-for-smart-recycling/.

Robitzski, Dan. "The LAPD's Terrifying Palantir-Powered Policing Algorithm Was Just Uncovered and Yes It's Basically 'Minority Report.'" Futurism. May 10, 2018. https://futurism.com/lapd-documents-show-their-policing-algorithms-continue-to-target-minorities-and-past-offenders/.

United Postal Service. UPS Tests Residential Delivery Via Drone. Video. YouTube. February 21, 2017. https://www.youtube.com/watch?v=xx9_6OyjJrQ.

What If: Privacy Becomes a Luxury Good?. Panel Discussion. World Economic Forum. January 19, 2017. https://www.weforum.org/events/world-economic-forum-annual-meeting-2017/sessions/what-if-privacy-becomes-a-luxury-good-davos-2017.

8. HUMANITY+

"Genome Editing." National Human Genome Research Institute. August 3, 2017.
https://www.genome.gov/27569225/what-are-the-ethical-concerns-about-genome-editing/.

"Software Update Issued by Abbott Amid Risk of Pacemaker Hacking." Healthcare Analytics News. August 29, 2017.
http://www.hcanews.com/news/software-update-issued-by-abbott-amid-risk-of-pacemaker-hacking.

Abbott, Melanie. "Cybathlon: World's first 'bionic Olympics' gears up." BBC. September 12, 2016.
http://www.bbc.com/news/technology-37196860.

Chayka, Kyle. "Style is an Algorithm." Racked. April 17, 2018.
https://www.racked.com/2018/4/17/17219166/fashion-style-algorithm-amazon-echo-look.

Crow, David. "crispr gene editing ready for testing in humans." Financial Times. March 5, 2018.
https://www.ft.com/content/d6a773a0-cece-11e7-947e-f1ea5435bcc7.

Grossman, David. "People Are Treating Themselves With DIY Gene Therapies and the Government Is Getting Worried." Popular Mechanics. February 8, 2018. https://www.popularmechanics.com/science/health/a16691487/fda-gene-therapy-concern-crispr/.

Kleeman, Sophie. "An Australian Cyborg Was Fined for Using His Hand to Pay for the Train." Motherboard. March 16, 2018.
https://motherboard.vice.com/en_us/article/d35g9q/australian-cyborg-bio-hacker-fined-for-using-his-hand-to-pay-for-the-train.

McKelvey, Cynthia. "The neuroscientist who's building a better memory for humans." Science. December 1, 2016.
https://www.wired.com/2016/12/neuroscientist-whos-building-better-memory-humans/.

Motherboard. The Mind-Controlled Bionic Arm With a Sense of Touch. August 18, 2016. YouTube.
https://www.youtube.com/watch?v=F_brnKz_2tl.

Regalado, Antonio. "A startup is pitching a mind-uploading service that is "100 percent fatal"." Technology Review. March 13, 2018.
https://www.technologyreview.com/s/610456/a-startup-is-pitching-a-mind-uploading-service-that-is-100-percent-fatal/.

Schaefer, G. Owen. "China may be the future of genetic enhancement." BBC Future. August 8, 2016.
http://www.bbc.com/future/story/20160804-china-may-be-the-future-of-genetic-enhancement.

Thompson, Michael. "How Brain-Computer Interfaces Can Deliver On VR's Promises." UploadVR. February 4, 2017.
https://uploadvr.com/brain-computer-interfaces-can-deliver-vrs-promises/.

Vold, Karina. "Is Your Smartphone an Extension of Your Mind?." Motherboard. March 2, 2018.
https://motherboard.vice.com/en_us/article/qvemgb/is-your-smartphone-an-extension-of-your-mind.

9. THE EVOLVING BIO AGE

"Biotech frontiers." The Futures Centre. October 20, 2015. https://thefuturescentre.org/trend-cards/127/biotech-frontiers.

"Introduction to Complexity." Complexity Explorer Santa Fe Institute.
https://www.complexityexplorer.org/courses/89-introduction-to-complexity.

"Main Page." International Genetically Engineered Machine Competition. http://igem.org/Main_Page.

"What is biomimicry?." Biomimicry Institute. https://biomimicry.org/what-is-biomimicry/.

"What is MEMS Technology?." MEMS & Nanotechnology Exchange. https://www.mems-exchange.org/MEMS/what-is.html.

Agarwal, Pradeep, Pushp Shukla, Kapil Gupta, and Bhavanath Jha. "Bioengineering for Salinity Tolerance in Plants: State of the Art." Molecular Biotechnology 54, no.1 (May 2012). 10.1007/s12033-012-9538-3.

Bell, John, KA Garson, BD Lichty, and DF Stojdl. "Oncolytic Viruses: Programmable Tumour Hunters." Current Gene Therapy 2, no.2 (May 2002): 243-254. https://doi.org/10.2174/1566523024605582.

Cohen, Jon. "CRISPR." Science. http://www.sciencemag.org/topic/crispr.

Crow, James Mitchell. "Life 2.0: inside the synthetic biology revolution." Cosmos. April 17, 2018.
https://cosmosmagazine.com/biology/life-2-0-inside-the-synthetic-biology-revolution.

Gent, Edd. "4 Ways Scientists Hope Nanaobots Will Make You Healthier." SingularityHub. March 7, 2017. https://singularityhub.com/2017/03/07/4-ways-scientists-hope-nanobots-will-make-you-healthier/#sm.0000fuq1o4f87dkvxl513ehhz2rd2.

Hobson, Ben. "'Growing a city from the bottom up' could save the human race." Dezeen. May 25, 2016.
https://www.dezeen.com/2014/05/25/movie-rachel-armstrong-living-architecture-project-persephone/.

Kavita V. "DNA Biosensors-A Review." Journal of Bioengineering & Biomedical Science 7, no.2 (2017).
https://www.omicsonline.org/open-access/dna-biosensorsa-review-2155-9538-1000222.pdf.

Molteni, Megan. "Biology will be the next great computing platform." Wired. May 3, 2018.
https://www.wired.com/story/biology-will-be-the-next-great-computing-platform/.

Sarchet, Penny and Michael Le Page. "Human Gene Editing has arrived – Here is why it matters." New Scientist. April 29, 2015.
http://www.newscientist.com/article/mg22630194.200-human-gene-editing-has-arrived--heres-why-it-matters.html/.

Vavitsas, Konstantinos. "Custom-built DNA could be used as a sensor probe." The Conversation. May 6, 2018.
https://theconversation.com/custom-built-dna-could-be-used-as-a-sensor-probe-95226.

Wyss Institute at Harvard University. "CRISPR-Cas9: Gene Drives." Video. https://wyss.harvard.edu/media-post/crispr-cas9-gene-drives/.

10. LIVING WITHIN THE CARRYING CAPACITY OF THE PLANET

Furman, Jason, Rod Shadbegian, and Jim Stock. "The cost of delaying action to stem climate change: A meta analysis." VoxEU.org.
February 25, 2015. https://voxeu.org/article/cost-delaying-action-stem-climate-change-meta-analysis.

Hamer, Ashley and Samuel Hall Research Team. "Somalia's 'Climate Refugees' Can't Wait for Global Action Much Longer." News Deeply.
July 6, 2017. https://www.newsdeeply.com/refugees/community/2017/07/06/somalias-climate-refugees-cant-wait-for-global-action-much-longer.

Hanley, Steve. "410 PPM & Rising – CO2 Levels Reach Dangerous Levels." Clean Technica. May 5, 2018.
https://cleantechnica.com/2018/05/05/410-ppm-rising-co2-levels-reach-dangerous-levels/.

Jones, Nicola. "How the World Passed a Carbon Threshold and Why It Matters." YaleEnvironment360. January 26, 2017.
https://e360.yale.edu/features/how-the-world-passed-a-carbon-threshold-400ppm-and-why-it-matters.

King, Marcus, and Chelsea Spangler. "Water Stress, Instability and Violent Extremism in Nigeria." New Security Beat. August 22, 2017.
https://www.newsecuritybeat.org/2017/08/water-stress-instability-violent-extremism-nigeria/.

Kubiszewski, Ida. "Beyond GDP: are there better ways to measure well-being?." The Conversation. December 1, 2014.
https://theconversation.com/beyond-gdp-are-there-better-ways-to-measure-well-being-33414.

Met Office Hadley Centre. Food Insecurity & Climate Change. https://www.metoffice.gov.uk/food-insecurity-index/.

Policy Horizons Canada. "Canada in a Changing Global Energy Landscape." June 1, 2016. http://horizons.gc.ca/en/content/canada-changing-global-energy-landscape.

Rathi, Akshat. "Humanity's fight against climate change is failing. One technology can change that." Quartz. December 4, 2017.
https://qz.com/1144298/humanitys-fight-against-climate-change-is-failing-one-technology-can-change-that/.

Robertson, Holly. "What Happens Once the Global South's Youth Bulge Grows Old?." Next City. February 8, 2018.
https://nextcity.org/daily/entry/global-south-youth-bulge-older-people.

Simon, Matt. "Sea level rise will imperil humanity's future and its past." Wired. November 29, 2017.
https://www.wired.com/story/sea-level-rise-will-imperil-humanitys-future-and-its-past/.

Simon, Matt. "So you want to geoengineer the planet? Beware the hurricanes." Wired. November 14, 2017.
https://www.wired.com/story/so-you-want-to-geoengineer-the-planet-beware-the-hurricanes/.

Symons, Jonathan. "Geoengineering Justice." The Breakthrough. March 1, 2018.
https://thebreakthrough.org/index.php/journal/no.-8-winter-2018/geoengineering-justice.

Talbot, David. "Megascale Desalination." MIT Technology Review.
https://www.technologyreview.com/s/534996/megascale-desalination/.

Temple, James. "The Growing Case for Geoengineering." Technology Review. April 18, 2017.
https://www.technologyreview.com/s/604081/the-growing-case-for-geoengineering/.

UNChronicle. "Coming to Grips with Water Security in the Face of Climate Change." March 2018.
https://unchronicle.un.org/article/coming-grips-water-security-face-climate-change.

United Nations Environmental Programme. Global Environmental Outlook-5. 2012.
http://web.unep.org/geo/sites/unep.org.geo/files/documents/geo5_report_full_en_0.pdf.

World Health Organization. Global Health and Aging. October 2011. http://www.who.int/ageing/publications/global_health.pdf.

World Nuclear Association. "Generation IV Nuclear Reactors." December 2017.
http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/generation-iv-nuclear-reactors.aspx.

11. THE PERVASIVE CONTAMINATION OF THE 'NATURAL'

"Pollution." World Wildlife Fund. https://www.worldwildlife.org/threats/pollution.

Abbot, Lucy. "External Medicine: Discarded Drugs May Contaminate 40 Million Americans' Drinking Water." Scientific American. September 16, 2011. https://www.scientificamerican.com/article/pharmaceuticals-in-the-water/.

Armstrong, Martin. "Down the Drain. Wastewater with the Most Cocaine." Statista. April 13, 2018. https://www.statista.com/chart/6951/down-the-drain_-wastewater-with-the-most-cocaine/.

Bienkowski, Brian. "Bacteria May Be Remaking Drugs in Sewage." Scientific American. May 14, 2015. https://www.scientificamerican.com/article/bacteria-may-be-remaking-drugs-in-sewage/.

Brunel University. "Cocktail of common chemicals may trigger cancer: Fifty chemicals the public is exposed to on a daily basis may trigger cancer when combined." ScienceDaily. June 23, 2015. www.sciencedaily.com/releases/2015/06/150623072237.htm.

Buxton, Rachel. "Human noise pollution is disrupting parks and wild places." The Conversation. July 17, 2017. https://theconversation.com/human-noise-pollution-is-disrupting-parks-and-wild-places-78074.

Carrington, Damian. "Honey tests reveal global contamination by bee-harming pesticides." The Guardian. October 5, 2017. https://www.theguardian.com/environment/2017/oct/05/honey-tests-reveal-global-contamination-by-bee-harming-pesticides.

Crane, Adam, and Maud Ferrari. "Underwater noise pollution stresses aquatic animals." EarthSky. April 17, 2018. http://earthsky.org/earth/underwater-noise-pollution-whales-fish.

Good, Kate. "The Disturbing Environmental and Health Impact of Pouring Personal Care Products Down the Drain." One Green Planet. January 30, 2015. http://www.onegreenplanet.org/environment/why-you-shouldnt-pour-personal-care-products-down-the-drain/.

Gordon, Amie M.. "Up All Night: The Effects of Sleep Loss on Mood." Psychology Today. August 15, 2013. https://www.psychologytoday.com/us/blog/between-you-and-me/201308/all-night-the-effects-sleep-loss-mood.

Inkpen, Rob. "Atmospheric Pollution, Climate Change and Historic Buildings." Building Conservation. 2004. http://www.buildingconservation.com/articles/atmospheric/atmospheric.htm.

Inter Press Service. "UN Warns Human-Caused Soil Contamination Threatens Global Food Security." Organic Consumers. June 26, 2017. https://www.organicconsumers.org/news/un-warns-human-caused-soil-contamination-threatens-global-food-security.

Lant, Karla. "Scientists Unravel The Mysterious Effects Of Thousands Of Toxic Chemicals." Fondriest. October 30, 2017. http://www.fondriest.com/news/scientists-unravel-mysterious-effects-thousands-toxic-chemicals.htm.

McKenna, Maryn. "As Global Food Chain Grows, So Does Risk of Illness." National Geographic. April 7, 2015. https://www.nationalgeographic.com/people-and-culture/food/the-plate/2015/04/07/as-global-food-chain-grows-so-does-risk-of-illness/?beta=true.

Medic, Goran, Micheline Wille, and Michiel EH Hemels. "Short- and long-term health consequences of sleep disruption." Nature and Science of Sleep 9 (2017): 151-161. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5449130/.

Metcalfe, Chris. "Persistent Organic Pollutants in the Marine Food Chain." United Nations University. March 5, 2012. https://ourworld.unu.edu/en/persistent-organic-pollutants-in-the-marine-food-chain.

Metcalfe, John. "China Keeps It Classy With Designer Smog-Filtration Masks." City Lab. November 22, 2013. https://www.citylab.com/design/2013/11/china-keeps-it-classy-designer-smog-filtration-masks/7673/.

Pells, Rachael. "Fashionable anti-pollution masks make their debut in the UK." The Independent. September 26, 2015. https://www.independent.co.uk/life-style/fashion/news/fashionable-anti-pollution-masks-make-their-debut-in-the-uk-a6668436.html.

Phillips, Tom. "'Forest cities': the radical plan to save China from air pollution." The Guardian. February 17, 2017. https://www.theguardian.com/cities/2017/feb/17/forest-cities-radical-plan-china-air-pollution-stefano-boeri.

Rao, Joe. "Light Pollution Is a Big Problem, But You Can Help." Space. February 23, 2018. https://www.space.com/39787-light-pollution-problem-you-can-help.html.

Relyea, Rick A.. "A cocktail of contaminants: how mixtures of pesticides at low concentrations affect aquatic communities." Oecologia 159, no. 2 (2009): 363-376. https://link.springer.com/article/10.1007%2Fs00442-008-1213-9.

Schiffman, Richard. "A cheap pollution sensor will keep you off the dirtiest roads." New Scientist. September 26, 2017. https://www.newscientist.com/article/2148503-a-cheap-pollution-sensor-will-keep-you-off-the-dirtiest-roads/.

Shephard, Don. "Food Chains and How They Are Affected by Water Pollution." Sciencing. March 13, 2018. https://sciencing.com/food-chains-affected-water-pollution-7712.html.

Shouse, Ben. "Air Pollution Linked to Mutations." Science. December 11, 2002. http://www.sciencemag.org/news/2002/12/air-pollution-linked-mutations.

Siegle, Lucy. "Let's face it – too much of the food chain is broken." The Guardian. August 13, 2017. https://www.theguardian.com/commentisfree/2017/aug/12/too-much-of-the-food-chain-is-broken.

Silcoff, Mireille. "Organic or GMO-free, health food is a luxury that requires wealth." National Post. May 25, 2013. http://nationalpost.com/life/organic-or-gmo-free-health-food-is-a-luxury-that-requires-wealth.

Thompson, Richard C.. "Future of the sea: plastic pollution." Government Office for Science, Government of the United Kingdom. August 3, 2017. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/634433/Future_of_the_sea_-_plastic_pollution_final.pdf.

Vlastis, Anna. "The Growing Diet divide Between Rich And Poor In America." Huffington Post. June 22, 2016. https://www.huffingtonpost.com/stat/the-growing-diet-divide-b_b_10613262.html.

"The diet divide." BBC News. September 6, 2001. http://news.bbc.co.uk/2/hi/uk_news/1528344.stm.

12. ENVISIONING GOVERNANCE SYSTEMS THAT WORK

"What is digital economy?." Deloitte. https://www2.deloitte.com/mt/en/pages/technology/articles/mt-what-is-digital-economy.html.

Bitnation. Refugee Emergency Response. https://refugees.bitnation.co/.

E-Estonia. Healthcare. https://e-estonia.com/solutions/healthcare/e-health-record/.

E-Estonia. Interoperability Services. https://e-estonia.com/solutions/interoperability-services/x-road/.

Fatás, Antonio and Beatrice Weder di Mauro. "As Cryptocurrencies Rise, Who Needs Banks?." Harvard Business Review. May 7, 2018. https://hbr.org/2018/05/as-cryptocurrencies-rise-who-needs-banks.

Frum, David. "If America's Democracy Fails, Can Other Ones Survive?." The Atlantic. March 4, 2018. https://www.theatlantic.com/international/archive/2018/03/yascha-mounk-democracy/554786/.

Mavroidis, Petros C.. "Trade Regulation, and Digital Trade." Working Paper 2017 Global Digital Futures Forum. Columbia University School of International and Public Affairs. May 5, 2017. https://sipa.columbia.edu/sites/default/files/Mavroidis_Trade_Regulation_and_Digital_Trade_0502.pdf.

Statt, Nick. "FCC approves SpaceX's ambitious satellite internet plans." The Verge. March 29, 2018. https://www.theverge.com/2018/3/29/17178126/spacex-satellite-broadband-internet-fcc-approval-license-starlink-spectrum.

X.Company. Project Loon. https://x.company/loon/.

Zuckerberg, Mark. "The technology behind Aquila." Facebook. July 21, 2016. https://www.facebook.com/notes/mark-zuckerberg/the-technology-behind-aquila/10153916136506634/.

13. THE CHANGING NATURE OF SECURITY AND CONFLICT

"May 2, 2018: Emmanuel Macron's "Delicious" Gaffe." The Daily Show. May 2, 2018. http://www.comedycentral.com.au/the-daily-show-with-trevor-noah/videos/may-2-2018-emmanuel-macrons-delicious-gaffe.

Adams, Eric. "The Navy's new robot boats swarm the enemy on their own." Wired. January 8, 2017. https://www.wired.com/2017/01/navys-new-robot-boats-swarm-enemy/.

Bohn, Dieter. "Intel made smart glasses that look normal." The Verge. February 5, 2018. https://www.theverge.com/2018/2/5/16966530/intel-vaunt-smart-glasses-announced-ar-video.

Brown, Jennings. "The Army Wants To Implant Body Sensors Into Combat Soldiers." Vocativ. July 20, 2016. http://www.vocativ.com/342014/army-body-sensors/index.html.

Cadwalladr, Carole. "The great British Brexit robbery: how our democracy was hijacked." The Guardian. May 7, 2017. https://www.theguardian.com/technology/2017/may/07/the-great-british-brexit-robbery-hijacked-democracy.

Danna, Tony. "Three Square Market microchips employees company-wide." PRLOG. July 20, 2017. https://www.prlog.org/12653576-three-square-market-microchips-employees-company-wide.html.

Dvorsky, George. "What You Need to Know About Getting Magnetic Finger Implants." Gizmodo. July 17, 2013. https://io9.gizmodo.com/what-you-need-to-know-about-getting-magnetic-finger-imp-813537993.

Emmott, Robin. "NATO mulls 'offensive defense' with cyber warfare rules." Reuters. November 30, 2017. https://www.reuters.com/article/us-nato-cyber/nato-mulls-offensive-defense-with-cyber-warfare-rules-idUSKBN1DU1G4.

Erwin, Sandra. "U.S. intelligence: Russia and China will have 'operational' anti-satellite weapons in a few years." Space News. February 14, 2018. http://spacenews.com/u-s-intelligence-russia-and-china-will-have-operational-anti-satellite-weapons-in-a-few-years/.

Fingas, Jon. "Chinese scientists unveil plan to zap space junk with orbital lasers." Engadget. January 16, 2018. https://www.engadget.com/2018/01/16/chinese-scientists-unveil-orbital-space-junk-laser/.

Finkelstein, Dr. Robert. "Tutorial: Military Memetics." Presentation at Social Media for Defense Summit, Alexandria, VA, October 24-26, 2011. https://robotictechnologyinc.com/images/upload/file/Presentation%20Military%20Memetics%20Tutorial%2013%20Dec%2011.pdf.

Grego, Laura. "A history of anti-satellite programs." Union of Concerned Scientists. January 2012. https://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/a-history-of-ASAT-programs_lo-res.pdf.

International Committee of the Red Cross. "Views of the International Committee of the Red Cross (ICRC) on autonomous weapon system." United Nations Convention on Certain Conventional Weapons 2016. April 11, 2016. https://www.unog.ch/80256EDD006B8954/(httpAssets)/86748714E19ABC52C1257F930057E50B/$file/2016_LAWS+MX_Towardaworkingdefinition_Statements_ICRC.pdf.

Lamkin, Paul. "Connected cooking: The best smart kitchen devices and applications." March 29, 2018. https://www.the-ambient.com/reviews/best-smart-kitchen-devices-469.

Lin, Patrick. "More Than Human? The Ethics of Biologically Enhancing Soldiers." The Atlantic. February 16, 2012. https://www.theatlantic.com/technology/archive/2012/02/more-than-human-the-ethics-of-biologically-enhancing-soldiers/253217/.

Morgan, Jacob. "A Simple Explanation Of 'The Internet Of Things'." Forbes. May 13, 2014. https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#72a41f591d09.

Rao, Rajesh P.N., Andrea Stocco, Matthew Bryan, Devapratim Sarma, Tiffany M. Youngquist, Joseph Wu, and Chantel S.Prat. "A Direct Brain-to-Brain Interface in Humans." PLOS ONE 9, no. 11 (2014): e111332. https://doi.org/10.1371/journal.pone.0111332.

Reuters. "Autonomous armed 'robot tanks' displayed in London." Reuters. Video. September 14, 2017. https://www.reuters.com/video/2017/09/14/autonomous-armed-robot-tanks-displayed-i?videoId=372531667.

Rosenberg, Matthew, and John Markoff. "The Pentagon's 'Terminator Conundrum': Robots That Could Kill on Their Own." New York Times. October 25, 2016. https://www.nytimes.com/2016/10/26/us/pentagon-artificial-intelligence-terminator.html?_r=0.

Russell, Stuart. "Lethal Autonomous Weapons Systems." UC Berkley. https://people.eecs.berkeley.edu/~russell/research/LAWS.html.

Schmidle, Nicholas. "The Digital Vigilantes Who Hack Back." The New Yorker. May 7, 2018. https://www.newyorker.com/magazine/2018/05/07/the-digital-vigilantes-who-hack-back.

Singer, Ernesto. "How the city bus will become autonomous." Mercedes-Benz. September 22, 2016. https://www.mercedes-benz.com/en/mercedes-benz/next/automation/how-the-city-bus-will-become-autonomous/.

The Economist. "The world's most valuable resource is no longer oil, but data." The Economist. May 6, 2017. https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data.

Wakefield, Jake. "'Future city' to be built in Canada by Alphabet company." BBC. October 18, 2017. http://www.bbc.com/news/technology-41665670.

Welsh, Sean. "Machines with guns: debating the future of autonomous weapons systems." The Conversation. April 12, 2015. https://theconversation.com/machines-with-guns-debating-the-future-of-autonomous-weapons-systems-39795.

14. TRUTH UNDER FIRE IN A POST-FACT WORLD

Bilton, Ricardo. "Why don't people trust the news and social media? A new report lets them explain in their own words." NiemanLab. November 30, 2017. http://www.niemanlab.org/2017/11/why-dont-people-trust-the-news-and-social-media-a-new-report-lets-them-explain-in-their-own-words/.

Bloomberg News. "China Uses Facial Recognition to Fence In Villagers in Far West." Bloomberg. January 1, 2017. https://www.bloomberg.com/news/articles/2018-01-17/china-said-to-test-facial-recognition-fence-in-muslim-heavy-area.

Edelman, Richard. "The Battle for Truth." January 21, 2018. https://www.edelman.com/post/the-battle-for-truth.

Edelman. "2018 Edelman Trust Barometer Canada." 2018. https://www.edelman.ca/sites/default/files/2018-02/2018-Edelman-Trust-Barometer-Canada_ENGLISH.PDF.

Funk, Cary. "Mixed Messages about Public Trust in Science." Pew Research Center." December 8, 2017. http://www.pewinternet.

org/2017/12/08/mixed-messages-about-public-trust-in-science/.

Houser, Kristin. "The Public Doesn't Trust Science. It's 2017. We Need to Fix This." Futurism. June 29, 2017. https://futurism.com/still-writing-expert-the-public-doesnt-trust-science-heres-how-we-could-change-that/.

Kofman, Ava. "Taser will use police body camera videos "to anticipate criminal activity"." The Intercept. April 30, 2017. https://theintercept.com/2017/04/30/taser-will-use-police-body-camera-videos-to-anticipate-criminal-activity/.

Mak, Tim. "Technologies To Create Fake Audio And Video Are Quickly Evolving." National Public Radio. April 2, 2018. https://www.npr.org/2018/04/02/598916380/technologies-to-create-fake-audio-and-video-are-quickly-evolving.

Matthews, Dylan. "Donald Trump has tweeted climate change skepticism 115 times. Here's all of it." Vox. June 1, 2017. https://www.vox.com/policy-and-politics/2017/6/1/15726472/trump-tweets-global-warming-paris-climate-agreement.

Ng, Yi Shu. "China is using AI to predict who will commit crime next." Mashable. July 24, 2017. https://mashable.com/2017/07/24/china-ai-crime-minority-report/#fyL2nhUyqqqj.

Niessner, Matthias. Face2Face: Real-time Face Capture and Reenactment of RGB Videos. March 17, 2016. YouTube. https://www.youtube.com/watch?v=ohmajJTcpNk.

Public Policy Forum. "The Shattered Mirror." Shatteredmirror.ca. https://shatteredmirror.ca/.

The Guardian. "From ale to jail: facial recognition catches criminals at China beer festival." The Guardian. September 1, 2017. https://www.theguardian.com/world/2017/sep/01/facial-recognition-china-beer-festival.

Thies, Justus, Michael Zollhöfer, Marc Stamminger, Christian Theobalt, and Matthias Nießner. "Face2Face: Real-time Face Capture and Reenactment of RGB Videos." March 2016. http://niessnerlab.org/papers/2016/1facetoface/thies2016face.pdf.

Winston, Ali. "Palantir has secretly been using New Orleans to test its predictive policing technology." The Verge. February 27, 2018. https://www.theverge.com/2018/2/27/17054740/palantir-predictive-policing-tool-new-orleans-nopd.

Xiao, Eva. "Tencent's new credit system to use payments, social data." TechInAsia. January 31, 2018. https://www.techinasia.com/tencent-credit-launch.

15. THE ARTS TRANSFORMED

"Art Happens." Art Fund. https://www.artfund.org/get-involved/art-happens.

"How Social Media is Changing Our Art Experience." Artwork Archive. https://www.artworkarchive.com/blog/how-social-media-is-changing-our-art-experience.

Barnett, David. "Women in science fiction: If Mary Shelley invented the genre why are so few female sci-fi writers household names?." The Independent. January 25, 2018. https://www.independent.co.uk/news/long_reads/women-science-fiction-authors-mary-shelley-frankenstein-200-ursula-k-le-guin-sci-fi-writers-female-a8177556.html.

Buffenstein, Alyssa. "These Artists Foretell Our Cyborg Future." Artnet News. August 19, 2016. https://news.artnet.com/exhibitions/posthuman-artists-anticipated-newest-body-modifying-tech-612869.

De Filippi, Primavera. "Blockchain-Based Crowdfunding: What Impact on Artistic Production and Art Consumption?." Observatório Itaú Cultural 19 (2015). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2725373.

Eatough, Matthew. "African Science Fiction and the Planning Imagination. Cambridge Journal of Postcolonial Literary Inquiry 4, no.2 (2017). https://www.cambridge.org/core/journals/cambridge-journal-of-postcolonial-literary-inquiry/article/african-science-fiction-and-the-planning-imagination/481B104305F6F3DAADF1A209D370E8F0.

Evans, Scarlett. "Technology is bringing museums back to life." Verdict. December 13, 2017. https://www.verdict.co.uk/technology-museums-back-to-life/.

Furness, Hannah. "Art galleries 'must embrace digital technology' as the battle against phones is lost." The Telegraph. March 7, 2018. https://www.telegraph.co.uk/news/2018/03/07/art-galleries-must-embrace-digital-technology-battle-against/.

Hauser, Jens. "Art Between Synthetic Biology and Biohacking: Searching for Media Adequacy in the Epistemological Turn." Leonardo Electronic Almanac 22, no. 1, edited by Lanfranco Aceti, Paul Thomas, and Edward Colless. Cambridge, MA: LEA / MIT Press, 2017. https://contemporaryarts.mit.edu/pub/artbetweensyntheticbiology.

Hickins, Michael. "Miley Cyrus And The Future Of Disintermediation." Forbes. September 2, 2015. https://www.forbes.com/sites/oracle/2015/09/02/miley-cyrus-and-the-future-of-disintermediation/#48fe5ebd2513.

Javelosa, June. "Could We Hack Our Brains to Gain New Senses?." Futurism. December 25, 2016. https://futurism.com/could-we-

hack-our-brains-to-gain-new-senses/.

Jenkins, Henry. "Transmedia Storytelling." MIT Technology Review. January 15, 2003. https://www.technologyreview.com/s/401760/transmedia-storytelling/.

Morse, Trent. "All Together Now: Artists and Crowdsourcing." ArtNews. September 2, 2014. http://www.artnews.com/2014/09/02/artists-and-crowdsourcing/.

Serota, Nicholas. "A taste of the digital future for museums." Tate. February 2, 2011. http://www.tate.org.uk/context-comment/blogs/taste-digital-future-museums.

Thaddeus-Johns, Josie. "Meet the first humans to sense where north is." The Guardian. January 6, 2017. https://www.theguardian.com/technology/2017/jan/06/first-humans-sense-where-north-is-cyborg-gadget.

16. EROSION OF CULTURE AND HISTORY

"10 Arab Historical Sites Destroyed by 'Daesh'." The World Around Us. May 2018. http://www.the-wau.com/post/blog/10-arab-historical-sites-destroyed-by-daesh/16151.

"Culture for Sustainable Development." United Nations Educational, Scientific and Cultural Organization. http://www.unesco.org/new/en/culture/themes/culture-and-development/the-future-we-want-the-role-of-culture/globalization-and-culture/.

Abdel-Hadi, Aleya. "Culture, Quality of Life, Globalization and Beyond." Procedia – Social and Behavioral Sciences 50 (2012): 11-19.

Awe, Bolanle. « Globalization : Acculturation or Cultural Erosion ? A Historical Reflection." Journal of Global Initiatives: Policy, Pedagogy, Perspective 3, no.2 (2008): 111-122.

Balko, Radley. "Globalization & Culture." Global Policy Forum. April 2003. https://www.globalpolicy.org/component/content/article/162/27607.html.

Barlow, Maude. "The Global Monoculture." Global Policy Forum. Fall 2001. https://www.globalpolicy.org/component/content/article/162/27553.html.

Directorate-General for Internal Policies of the Union. "Protecting the cultural heritage from natural disasters." European Parliament. February 2007. http://www.europarl.europa.eu/RegData/etudes/etudes/join/2007/369029/IPOL-CULT_ET(2007)369029_EN.pdf.

Foltz, Anouschka. "How Languages Die." The New Republic. December 10, 2015. https://newrepublic.com/article/125501/languages-die.

Simon, Matt. "Sea level rise will imperil humanity's future and its past." Wired. November 29, 2017. https://www.wired.com/story/sea-level-rise-will-imperil-humanitys-future-and-its-past/.

Weed, Julie. "Catering to 'Last Chance" Travelers Who Seek Disappearing Marvels. The New York Times. 5 March, 2018. https://www.nytimes.com/2018/03/05/business/catering-to-last-chance-travelers-who-seek-disappearing-marvels.html.

World Economic Forum. "Geopolitical Power Shifts." The Global Risks Report 2018 – World Economic Forum. 2018.

http://reports.weforum.org/global-risks-2018/geopolitical-powershift/.