The Millennium Project

WORK/TECHNOLOGY
2050
SCENARIOS AND ACTIONS

JEROME C. GLENN AND THE MILLENNIUM PROJECT TEAM

A PRAGMATIC EXPLORATION OF POSSIBLE FUTURES - CHOICES AND CONSEQUENCES - REALLY EXERCISED MY IMAGINATION.

-VINT CERF
INTERNET PIONEER

VALUABLE INPUT FOR POLICYMAKING TO HELP IDENTIFY THE UNKNOWNS THAT SHOULD BE KNOWN FOR A GOOD ANTICIPATORY THINKING AND STRATEGIC PLANNING.

-EVA KAILI
MEMBER OF THE EUROPEAN PARLIAMENT, CHAIR OF THE PANEL FOR THE FUTURE OF SCIENCE AND TECHNOLOGY (STOA)
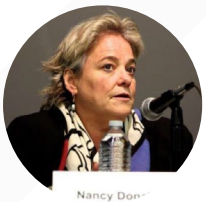
FRESH, IN-DEPTH TAKE ON THE FUTURE OF WORK; THE INSIGHTS OFFERED IN THE THREE FUTURE SCENARIOS ARE BOTH CHILLING AND EXCITING. A DEEP DIVE INTO THIS REPORT IS WELL WORTH THE JOURNEY.

-NANCY DONALDSON
FORMER DIRECTOR, ILO WASHINGTON OFFICE

WE KNOW THAT TECHNOLOGY IS CHANGING HOW WE LIVE AND WORK. WE JUST DON'T KNOW ITS IMPACT. HOWEVER, WE CAN ENVISION ALTERNATIVE FUTURES SO WE CAN BEGIN BUILDING TODAY A PATH TO A PREFERRED FUTURE. THIS REPORT SURVEYS WHAT WE KNOW AND DISTILLS INSIGHTS INTO ACTIONS THAT CITIZENS AND POLICYMAKERS CAN UNDERTAKE TO BUILD THAT PATH.

-JOHN M. KAMENSKY
SENIOR FELLOW, IBM CENTER FOR THE BUSINESS OF GOVERNMENT

IMPORTANT AND RELEVANT TO THE CURRENT GLOBAL DEBATES ON EFFECTS OF THE DIGITAL TAKEOVER OF SO MANY SECTORS OF NATIONAL ECONOMIES, WHICH WE COVER CLOSELY.

-HAZEL HENDERSON
CEO, ETHICAL MARKETS MEDIA,USA

A GREAT DATABASE OF SOLUTIONS AND WEALTH OF IDEAS FOR HOW EVERYONE CAN PLAY THEIR PART IN DEALING WITH AN UNCERTAIN FUTURE.

-BROCK HINZMANN
BUSINESS FUTURES NETWORK (LONDON, SILICON VALLEY, TOKYO)

WITH ITS UNIQUE GLOBAL AND LONG-TERM PERSPECTIVE THE STUDY HELPS US TO UNDERSTAND THE COMPLEXITY OF AN URGENT CHANGE FOR A FUTURE MODEL OF WORK. THE ALTERNATIVE SCENARIOS ILLUSTRATE THE NEED OF A NEW COMMON MIND SET FOR WHAT WE ACTUALLY CALL WORK.

-OLE WINTERMANN
BERTELSMANN STIFTUNG, GERMANY

TABLE OF CONTENTS

TO EDUARD S. CORNISH, FOUNDER, THE WORLD FUTURE SOCIETY (1927-2019), WHO CREATED THE SPACE FOR THE MOST DIVERSE CONVERSATIONS ON THE FUTURE. WE ARE ALL IN YOUR DEBT.

ACKNOWLEDGEMENTS

PREFACE

The potential impacts of artificial intelligence and robotics on the future of work have become a major topic of public conversation and research. Unfortunately, the research and conversations do not make distinctions among artificial narrow intelligence (ANI), artificial general intelligence (AGI), and artificial super intelligence (ASI). The impacts of each are quite different. Just discussing the impacts of AI without these distinctions is like talking about the fax machine and the internet as if they had the same impact in the Information Age. Granted, they are both part of information technology, but their impacts are quite different. Distinctions among ANI, AGI, and ASI are made clear in the future Work/Technology 2050 Global Scenarios section.

We should also not just look at the impacts of these forms of machine intelligence, but the fuller range of new technologies such as synthetic biology and genomics, 3D/4D printing and bio-printing, IoT (Internet of Things), human augmented intelligence, tele-presence and holographic communications, drones (and other autonomous vehicles), nanotechnology, computational science, VR (virtual reality) and AR (augmented reality), blockchain, cloud analytics, quantum computing, collective intelligence, and the extraordinary future synergies among these technologies. All together and with their synergies, we refer to these as "Next Technologies" or NTs.

Not one study on the future of work and technology that we studied at the beginning of this three-year study mentioned synthetic biology once. Yet, synthetic biology could have at least as big an impact on the future of civilization as the steam engine. A few of the other NTs were mentioned. The studies tended to focus on just one industry in one country. Yet the impacts will be global and interactive. The time horizons were usually less than twenty years, not allowing for serious cultural changes and economic systems' evolution. Few recommended what to do about all this beyond improving education by focusing on creativity and STEM (science, technology, engineering, and mathematics). This study looks out to 2050, considering socio-cultural-economic systemic changes due to NTs and suggests 93 actions from three global scenarios and national workshops (STEM being just one of the actions). Each of the 93 actions were assessed by international panels which also suggested an additional 118 actions. The magnitude of foreseeable potential changes is tremendous, requiring far more than STEM. To make all this information more digestible, the 93 actions are divided into sections for relevance to: business and labor; government and governance; culture, arts, and media; education and learning; and science and technology communities.

Many have argued that every technological revolution from the agricultural age to industrial age and on to the information age created more jobs than each replaced. True. So what is different this time? Plenty: 1) the acceleration of technological change; 2) the globalization, interactions, and synergies among NTs; 3) the existence of a global platform—the Internet—for simultaneous technology transfer with far fewer errors in the transfer; 4) standardization of data bases and protocols; 5) few plateaus or pauses of change allowing time for individuals and

cultures to adjust to the changes; 6) billions of empowered people in relatively democratic free markets able to initiate activities; and 7) machines that can learn how you do what you do, and then do it better than you.

And on top of all this, the concentration of wealth is increasing, income gaps are widening, jobless economic growth seems the new norm, and return on investment in capital and technology is usually better than labor. As labor costs go up and AI and robot costs go down, manufacturing and service unemployment rates are expected to increase. So, what do we do about all this? The Millennium Project decided to conduct this three-year study to give greater breadth and depth to considerations for this question.

The Millennium Project is a voluntary global participatory think tank of futurists, scholars, scientists, business planners, and policymakers who work for international organizations, governments, corporations, NGOs, and universities and who volunteer their time. It was selected to be among the top think tanks in the world for new ideas and paradigms as well as for best quality assurance and integrity policies and procedures by the 2013-2018 University of Pennsylvania's GoTo Think Tank Index and was a 2012 Computerworld Honors Laureate for its innovations in collective intelligence systems.

The purposes of The Millennium Project are to assist in organizing futures research, improve thinking about the future, and make that thinking available through a variety of media for consideration in policymaking,

advanced training, public education, and feedback, ideally in order to accumulate wisdom about potential futures. The Project's diversity of opinions and global views is ensured by its 65 Nodes around the world. These are groups of individuals and organizations that interconnect global and local perspectives. They identify participants, conduct interviews, translate and distribute questionnaires, and conduct research and conferences. It is through their contributions that the world picture of this report and indeed all of The Millennium Project's work emerges. The Node Chairs and Co-chairs are listed in the Appendix.

Through its research, publications, addresses at conferences, and Nodes, The Millennium Project helps to nurture an international collaborative spirit of free inquiry and feedback for increasing collective intelligence to improve social, technical, and environmental viability for human development. Feedback on any sections of this report is most welcome at <Jerome. Glenn@Millennium-Project.org> and may help shape future work of The Millennium Project.

Jerome C. Glenn
Executive Director
The Millennium Project

INTRODUCTION

Thought-leaders such as Stephen Hawking, Elon Musk, and Bill Gates are warning the world about the potential dangers of artificial intelligence growing beyond human control. Whether AI can evolve into the nightmares of science fiction or not, it is certain that it and other future technologies (e.g., robotics, synthetic biology, computational science, nanotechnology, quantum computing, 3D and 4D printing, Internet of Things, cognitive science, semantic web, human intelligence augmentation, blockchain, self-driving vehicles, conscious-technology, and synergies among these) will change what we think is possible over the next several decades, but they could also lead to massive unemployment.

To address this, The Millennium Project initiated a multi-year international assessment to see what we can do. The Future Work/Technology 2050 study had seven phases over three years:

- Literature and research review to find what questions were not asked or poorly answered as input to our international Real-Time Delphi survey.
- Over 300 futurists, AI and other technology professionals, economists, and other related experts from over 45 countries shared what should be considered in the construction of alternative future work/tech scenarios.
- Three Work/Technology 2050 Global Scenarios drafts were written and reviewed by over 450 futurists and others via three Real-Time Delphi questionnaires: It's Complicated – A Mixed Bag; Political/Economic Turmoil – Future Despair;

and If Humans Were Free – the Self-Actualization Economy.

- These three scenarios (each about ten pages) were used as inputs to workshops in some 20 countries to identify long-range strategies to address the issues raised in these detailed scenarios.
- The suggestions were distilled and grouped for relevance to government & governance; business & labor; science & technology; culture & arts; and education & learning, and assessed by separate international Real-Time Delphi expert panels.
- Results were analyzed and synthesized, put into separate reports, shared with relevant government departments in over 50 countries, and integrated into a draft final report.
- The above six phases were integrated into this final report.

This report intends to further stimulate a global, systematic, research-based discussion on how to make the transition to a world economy changed by foreseeable future technologies.
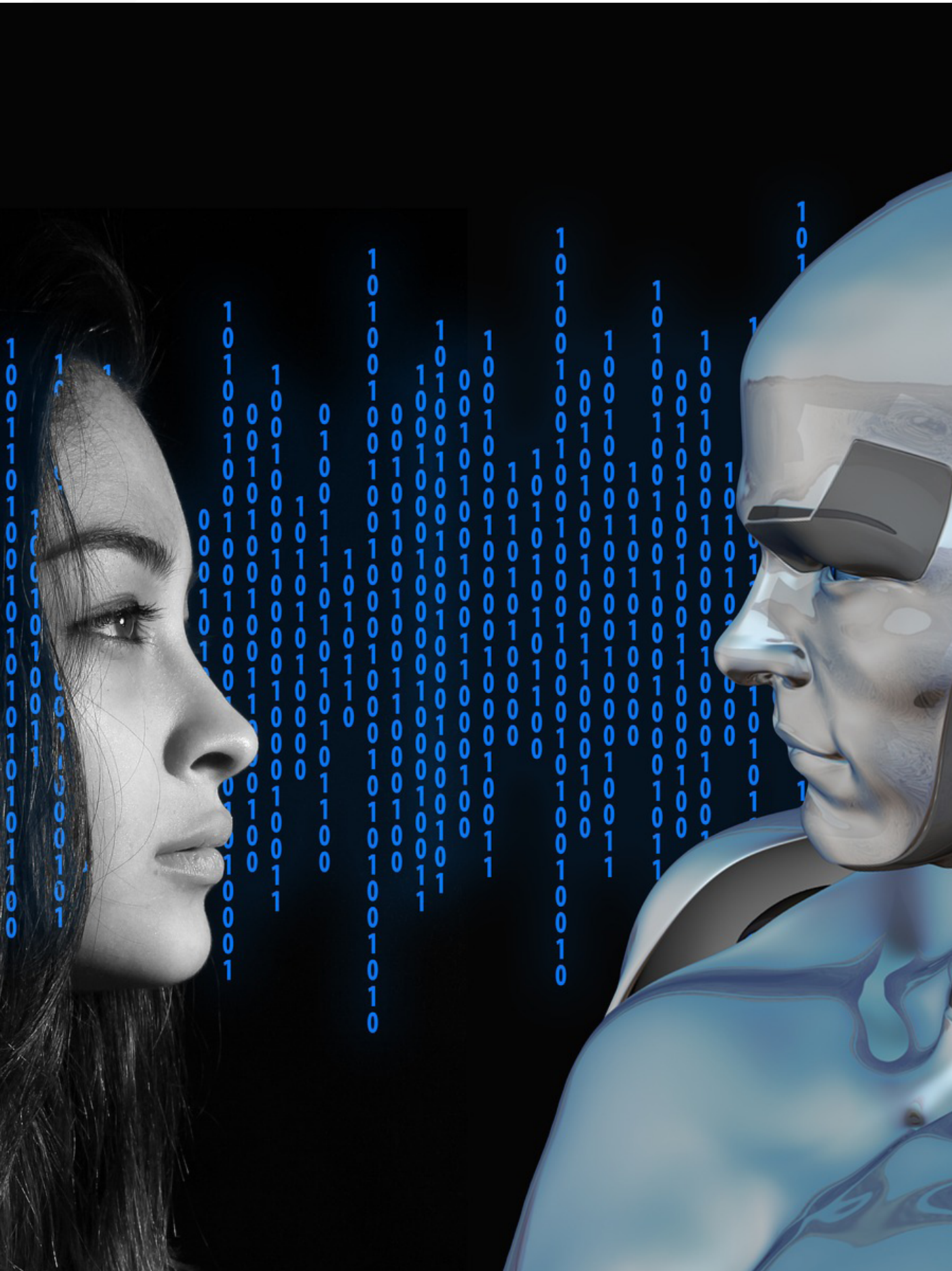
EXECUTIVE SUMMARY

Foreseeable future technologies will not only alter work, they will alter the foundation of cultures worldwide. The world is aware that the concentration of wealth is increasing, income gaps are widening, jobless economic growth seems the new norm, return on investment in capital and technology is usually better than on labor, future technologies can replace much of human physical and mental labor, and long-term structural unemployment is a "business as usual" surprise-free forecast. But the world is not aware of long-range strategies to address these issues, other than focusing education on science, technology, engineering, and mathematics. Improving STEM education is good, but insufficient to address global unemployment due to artificial intelligence, robotics, 3D/4D printing, synthetic biology, drones, nanotechnology, computational science, blockchain, cloud analytics, cognitive science, augmented human intelligence, quantum computing, conscious-technology, and future synergies among these.

The Millennium Project conducted a multi-year, international, multidisciplinary, and trans-institutional study involving panels of experts from around the world to assess concerns and identify actions that could help long-range thinking and strategies to address the work/technology interplay by 2050. The inputs collected over the first phases were used to develop three Work/Technology 2050 Global Scenarios:

Scenario I: It's Complicated – A Mixed Bag.
A business-as-usual trend projection of the increasing acceleration of change with both intelligence and stupidity characterizing decisionmaking. Irregular adoption of advance technology; high unemployment where governments did not create long-range strategies, and mixed success on the use of universal basic income. Giant corporations' powers have often grown beyond government control, in this government-corporate, virtual-3D, multi-polar world of 2050.

Scenario 2: Political/Economic Turmoil – Future Despair. Governments did not anticipate the impacts of artificial general intelligence and had no strategies in place as unemployment exploded in the 2030s leaving the world of 2050 in political turmoil. Social polarization and political grid-lock in many forms have grown. Global order has deteriorated into a combination of nation-states, mega-corporations, local militias, terrorism, and organized crime.

Scenario 3: If Humans Were Free – the Self-Actualization Economy.
Governments did anticipate the impacts of artificial general intelligence, conducted extensive research on how to phase in universal basic income systems, and promoted self-employment. Artists, media moguls, and entertainers helped to foster cultural change from an employment culture to a self-actualization economy.

The detailed scenarios were given as input to national planning workshops organized by Millennium Project Node Chairs around the world. Some workshops are still in planning at the time of this publication. The purpose of the workshops is to recommend strategies to address the issues raised in the scenarios. Thus far, some 30 workshops have been held in about 20 countries and discussions are being held to organize workshops in an additional 20 countries. The outcomes

of the workshops were distilled for further assessment by global panels of experts. Nearly 100 actions were identified and grouped into five categories. They represent a menu of options for different actors around the world from which to choose the most relevant to their situation. International expert panel ratings and commentaries on each action are distilled in the last section of this report. Following is a list of the five actions rated most effective for each category:

Government and Governance

Establish a national independent (as much as possible) technology forecasting and assessment agency to inform legislative, judicial, and executive functions of government about future technology and their impacts (a government Agency for the Future).

The government, employers, and labor unions should cooperate to create lifelong learning models including forecasts of future skills requirements.

Study how to prevent future conflict between technologically augmented humans (via AI, genetics, electronics or other means) and non-augmented citizens.

Training programs for politicians before governing and include prototype governance methodologies.

By 2050, introduce a global system for resource sharing (all kinds: scientific knowledge, technology, labor).

Business and Labor

Develop ways for companies and employees to create ethical, aesthetic, and social value in addition to economic and material value.

Establish labor/business/government NTs, future job skills, and retraining databases.

Define a new social contract of workers' rights

in a transactional and global economy.

Create observatory or horizon scanning online platforms that update employment and technology trends along with discussions of future of employment.

Manage companies like professional networks, rather than as static hierarchies.

Science and Technology

Directors of national science labs and other leaders in the S&T community should devote more effort to making current science and future technology understandable to the general public.

Create national policies and standards for the IoT that stresses future cyber security systems.

Forecast synergies among the full range of NTs and their potential impacts (e.g., artificial intelligence, robotics, synthetic biology, nanotechnology, quantum computing, 3D/4D printing, IoT, drones (and other autonomous vehicles), VR and AR, cloud analytics, conscious-technology, semantic web, holographic communications, blockchain, and tele-presence).

National S&T leaders should be part of the national team that creates, regularly updates, and implements their country's national S&T strategy.

S&T and legal communities should collaborate nationally and internationally to establish legal frameworks and treaties that anticipate future liability requirements that can deter technological hazards and encourage technology befitting humanity.

Education and Learning

Increase focus on developing creativity, critical thinking, human relations, philosophy, entrepreneurship (individual and teams), art, self-employment, social harmony, ethics, and values, to know thyself to build and

lead a meaningful working life with self-assessment of progress on one's own goals and objectives (as Finland is implementing). Include futures as we include history in the curriculum. Teach alternative visions of the future, foresight, and the ability to assess potential futures.

Make Tele-education free everywhere; ubiquitous, life-long learning systems.

Shift education/learning systems more toward mastering skills rather than just mastering a profession.

In parallel to STEM (and/or STEAM - science, technology, engineering, arts, and mathematics) create a hybrid system of self-paced inquiry-based learning for self-actualization; retrain teachers as coaches using new AI tools with students.

Culture, Arts, and Media

Repurpose libraries, old post offices, movie theaters, national parks, museums as well as "maker spaces" as "creative placemaking," hubs for integrating the arts and community building—a nexus for creative contribution, life-long learning, cultural exchange, and Next Tech/digital connection places.

Produce movies, music, TV shows, computer games, and immersive media with more positive storylines that portray how the culture of augmented humans could evolve without prejudice and conflict with non-augmented humans.

Support joint cultural activities with other countries that re-enforce new values to help the transition to the next rapidly changing techno/economic realities.

Establish associations, communities of practice, and/or arts/media alliances to create and help new social movements with themes such as self-employment as

new norm, technology to augment human capacity rather than replace humans, self-actualization economy, invest in what replaces you, eco-empathy, and good news in media about positive actions.

Expand the purpose of work to self-actualization and moving from "my job is my identity, value to society, and source of dignity" to "my identity, value, and dignity is how I invent my life, how I give it purpose."

Taken together, these actions plus the full range of the 93 actions will make the transition to a new economics more humane, peaceful, and equitable.

Actions in each of the five categories re-enforce each other. Focusing on just STEM is not enough. We need actions for business and labor, government, culture and arts, and the S&T community, as well as actions related to education and learning. Comments on all the actions by the international panel give factors to consider in selecting and implementing each action.

A growing body of artificial intelligence experts believes that if socio-political-economic systems stay the same, and technological acceleration, integration, and globalization continue, then half the world could be unemployed by 2050.

There have been many "future of work" studies; why is this unique? This one is an international rather than national study.

It included nine Real-Time Delphi studies four for building the scenarios and five for identifying actions with the participation of more than 450 futurists, AI professionals, economists, artists, educators, scientists, engineers and other related experts from over 50 countries. It also focused on the global socio-economic long-range situation rather than on a specific industry in a specific country, over a shorter period of time.

Most studies looked at the impacts of artificial narrow intelligence and robots on work, not artificial general intelligence, quantum computing, synthetic biology, nanotechnology, and other next technologies (NTs) and the synergies among them. The 2050 horizon was chosen because it helps us look not only at the primary consequences, but also at secondary and tertiary ones. It also allows enough time to talk about cultural changes that can help the transition to new economic/technological conditions. We did not find other future of work studies with detailed future scenarios and their use in national workshops to identify strategies to address long-range issues of work and technology. Hence, the focus of this report is on what we could do, rather than how many people will be unemployed by when.
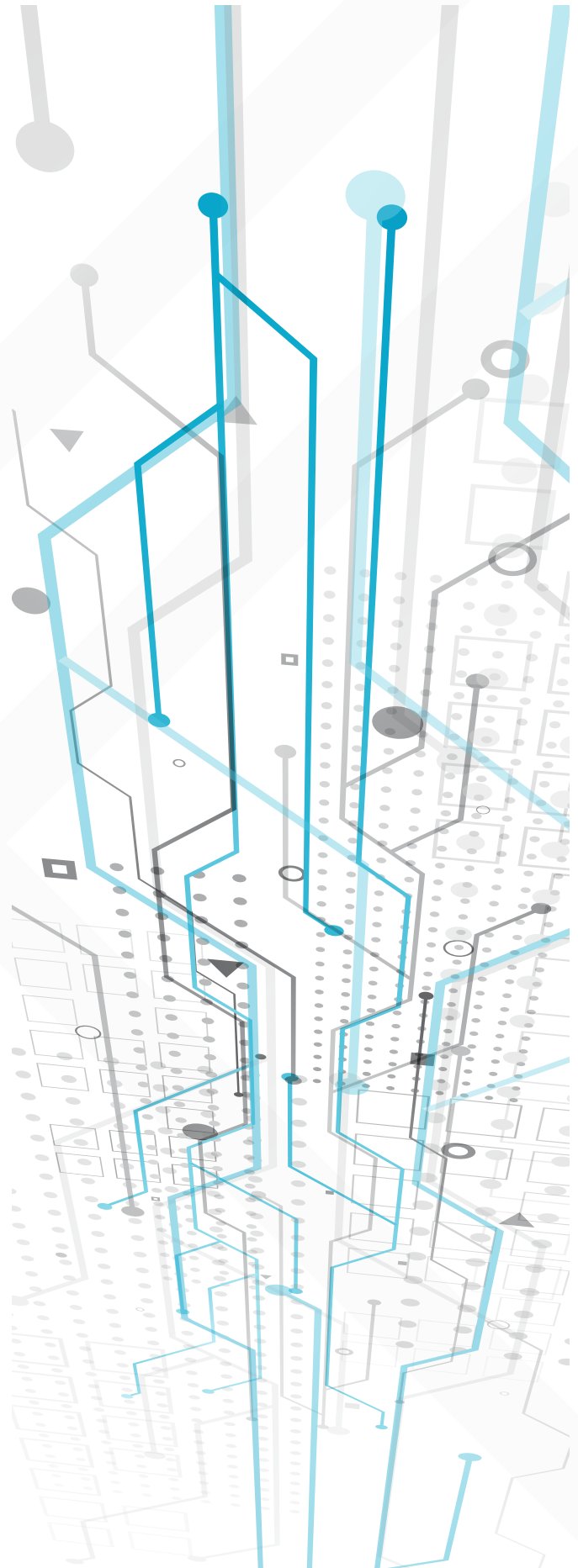
THE MILLENNIUM PROJECT

The Millennium Project is a global participatory think tank established in 1996 under the American Council for the United Nations University that became independent in 2009 and has grown to 65 Nodes around the world (an MP Node is a group of institutions and individuals the connect local and global perspectives).

Purpose: Improve humanity's prospects for building a better future.

Mission: Improve thinking about the future and make that thinking available
through a variety of media for feedback to accumulate wisdom about the future for better decisions today.

Vision: A global foresight network of Nodes, information, and software, building a global collective intelligence system recognized for its ability to improve prospects for humanity. A think tank on behalf of humanity, not on behalf of a government, or an issue, or an ideology, but on behalf of building a better future for all of us.