Future of Workforce (FoW)

Martin Arlitt, Tom Coughlin, Paolo Faraboschi, Eitan Frachtenberg, Phil Laplante, Dejan Milojicic, Nita Patel, and Roberto Saracco

Final Report, September 2022

Table of Contents

Future of Workforce Report (~50 slides)

Why this Discussion?

- The pandemic has created STRESS on current existence, values, and daily lives
    - global work organization
    - privacy vs. societal benefits
    - supply chain logistics
    - Acceleration of the Digital Transformation was forced upon work, education, and private life
    - In many cases, it was not an acceleration, rather a Digital Crutch that will be discarded as soon as conditions allow
    - In other cases, change will stay with us well beyond the pandemic. We need to differentiate these
- Technologies increasingly play a crucial role and are becoming essential for our survival
- Predicting Future of Workforce (FoW) will help address the pandemic, it goes well beyond hypothetical exercise
    - Addressing the pandemic directly
    - Rebalancing the workforce demand and supply
    - Remote vs. in-person location, ….
    - ….. and much more

Hypothesis

Combination of many economical, ecological, technological and societal factors and enabling technological innovations will result in a major shift in the Future of Workforce which is here to stay beyond the pandemic

To better address these changes will require educating and influencing global industries, academia, and governments through recommendations to better adjust. This is the goal of this document!

Goal, Process, Disclaimers

- Goal
  - We held a series of ten FoW events around the world that lead to a comprehensive global report
  - Each of the events resulted in a regional summary that we aggregated into an overall report
  - IEEE will broadly share this report with global industries, governments, and academia
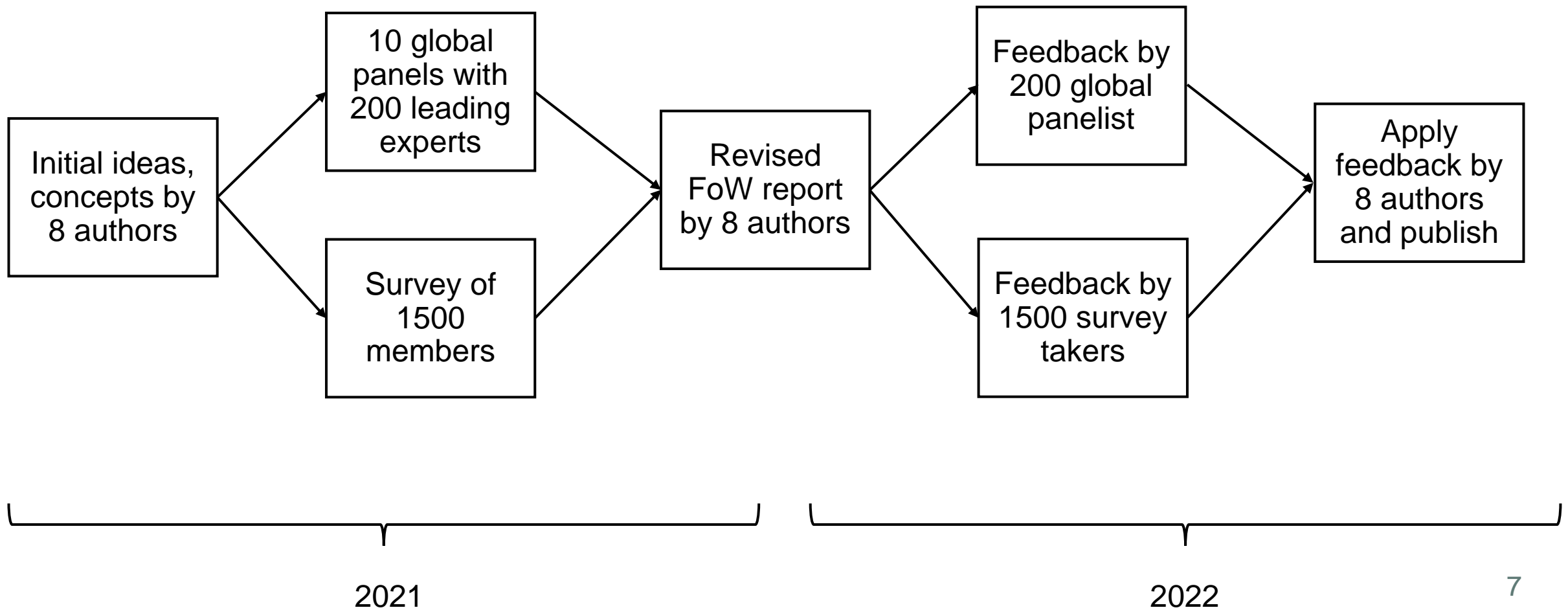
- Process
  - The report is only successful because of individual panels resulting in insights
  - Together we can contribute to an important and globally comprehensive, insightful and useful report
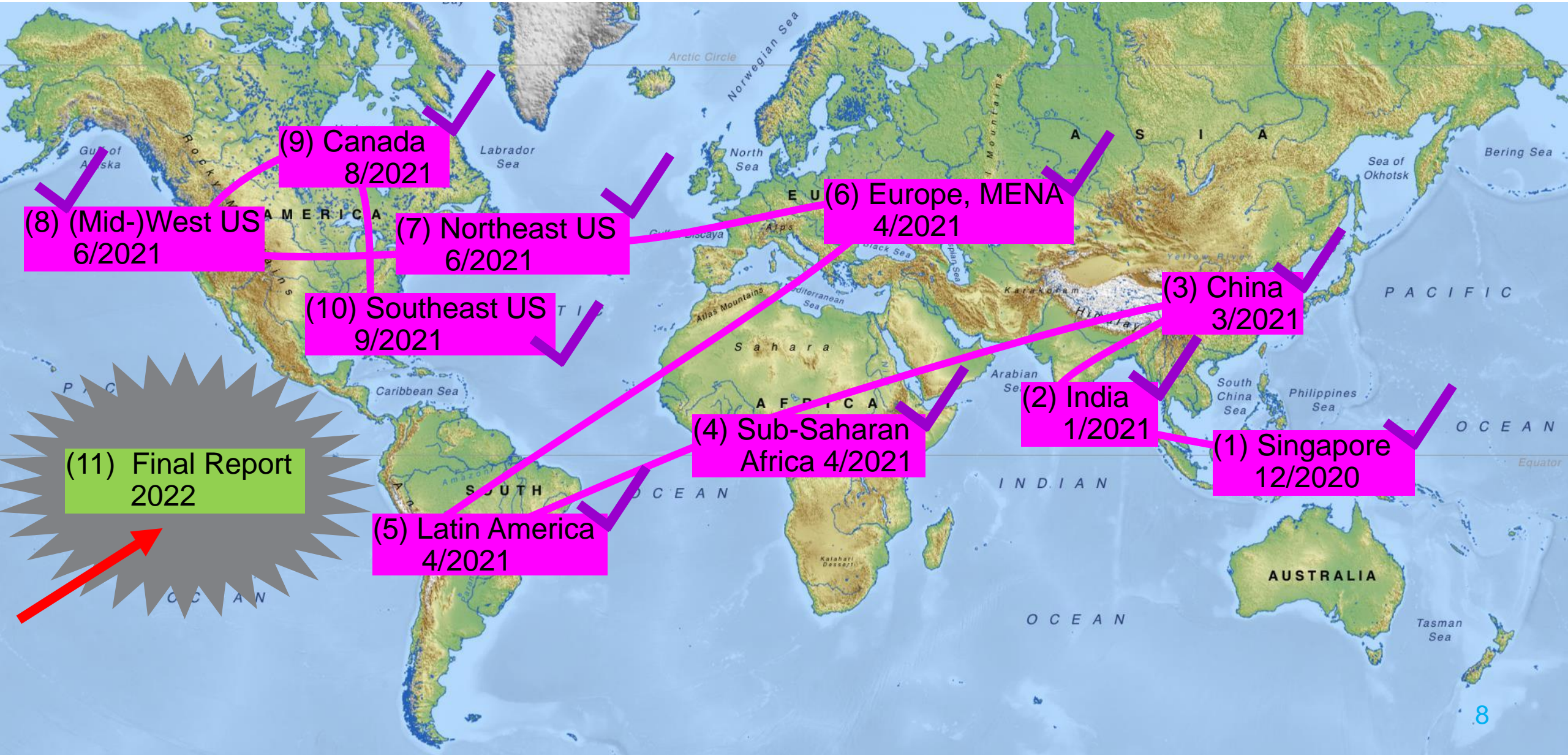 - Intent is to influence industry, legislators, academia, and IEEE to better adapt to the Future of Workforce

- Disclaimers
  - Events were held during a span of 9 months and circumstances changed dramatically
  - While we tried to invite diverse attendees, the ultimate insights were tied to those who attended
  - Final recommendations were distilled by authors and may not reflect original input entirely

Process

Future of Workforce

(9) Canada 8/2021

(8) (Mid-)West US 6/2021

(7) Northeast US 6/2021

(6) Europe, MENA 4/2021

(10) Southeast US 9/2021

(3) China 3/2021

(11) Final Report 2022

(4) Sub-Saharan Africa 4/2021

(2) India 1/2021

(1) Singapore 12/2020

(5) Latin America 4/2021

Future of Workforce Report

Status

– December 2020 through September 2021

- A team of 8 volunteers and 6 staff held 10 2-hour panels with 184 attendees, CxO, YPs and some life members
- We discussed insights based on 15 factors and 15 technologies among academia, industry, governments
- We created 350 slides in preparation for events and after reporting from events
- 4 external presentations (SWITCH'20, CS DV, ASPIPA, CNSV) and a panel at IEEE COMPSAC conference

– Worked with IEEE Computer Society to plan report

– Solicited input from all MOUs to contribute relevant marketing materials to include

– We conducted 15,000+ member survey on ranking the factors/technologies

Next Steps

– October 2021 through September 2022, we

- derived insights from the survey
- completed report
- made it available to all panelists and survey takers
- applied all the feedback

– Ambitious publications plans in addition to report

- a summary paper submitted to IEEE Computer
- blog planned for Forbes
- Exploring other options

– A tour presenting results is under consideration

– Plan other post-report activities

Early Insights

Workforce, Regional View

- US workforce at the lowest growth

- Europe workforce is decreasing by 0.5% in this decade

- Push towards Automation increase also to counteract the decreasing workforce requiring high investment capital, leading to a decrease in wages in several sectors
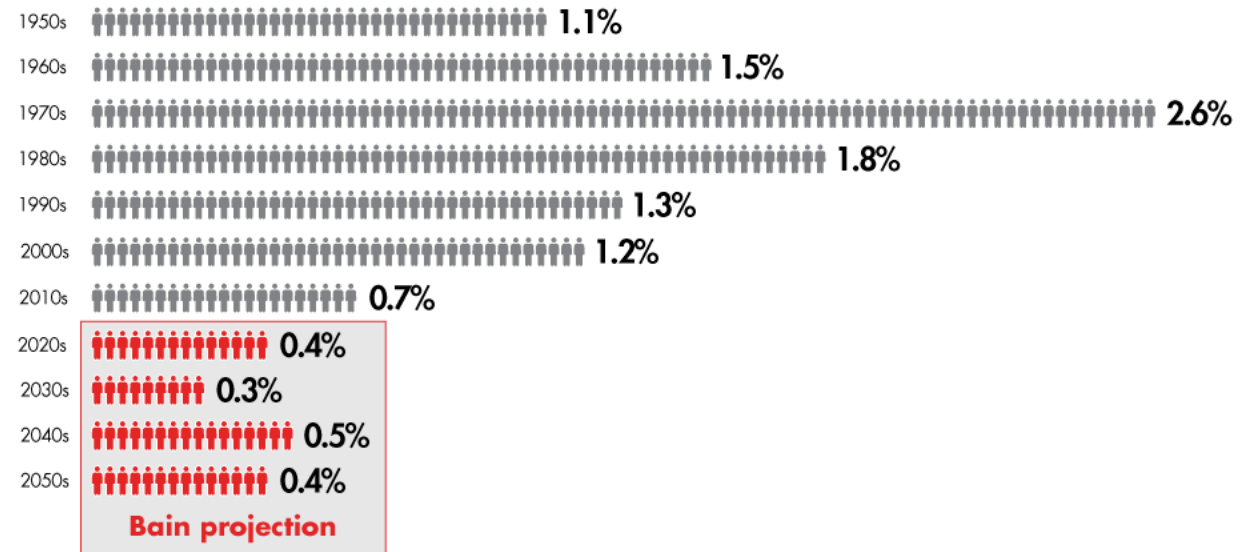
- Inequality increases

US labor force growth will remain low for the foreseeable future

US labor force average annual growth, by decade

Decade	Growth
1950s	1.1%
1960s	1.5%
1970s	2.6%
1980s	1.8%
1990s	1.3%
2000s	1.2%
2010s	0.7%
2020s	0.4%
2030s	0.3%
2040s	0.5%
2050s	0.4%

Bain projection

Sources: US Bureau of Labor Statistics; US Census Bureau; Bain Macro Trends Group analysis, 2017

What can countries do?
- Invest massively in remote-work infrastructure: broadband, wireless, wifi; reliable power grid; provide supporting services to remote communities, locally or online.
- Revamp legislation around equity in a hybrid/remote-work economy

https://www.bain.com/insights/labor-2030-the-collision-of-demographics-automation-and-inequality/

11

Workforce, Corporate View

A permanent transition to remote and hybrid workforce models could have dramatic effects on corporates:

- Larger potential pool of available talent, not limited to company's geographical location

- On the flip side, higher workforce mobility and increased competition for talent

- A shift of capital resources from centralized facilities to supporting remote workforce

- Potential for increased worker productivity from the savings in commute time

- Many new challenges:

  - How can you make sure that everyone is equally included in meetings, whether local, remote, or in a different time zone altogether?

  - How do you shift to evaluate employees' contribution without actually seeing them at work?

  - How do you instill a shared sense of mission in team spirit when the human experience of social interactions is predominantly local?

What can companies do?
- Adopt and adapt advanced remote-work tech beyond Zoom, such as: AR/VR; asynch workflows; AI-assisted communication; digital twins.
- Review, rewrite, and reboot major company policies, e.g., performance evaluation; attracting remote-first & global talent; interviewing, hiring, training; DEI; meeting scheduling, participation, format; employee retention;

Workforce, Individual View

– Theories about individual's skills, applicable to organizations too

broad	deep	T-shaped	Π-shaped	organization
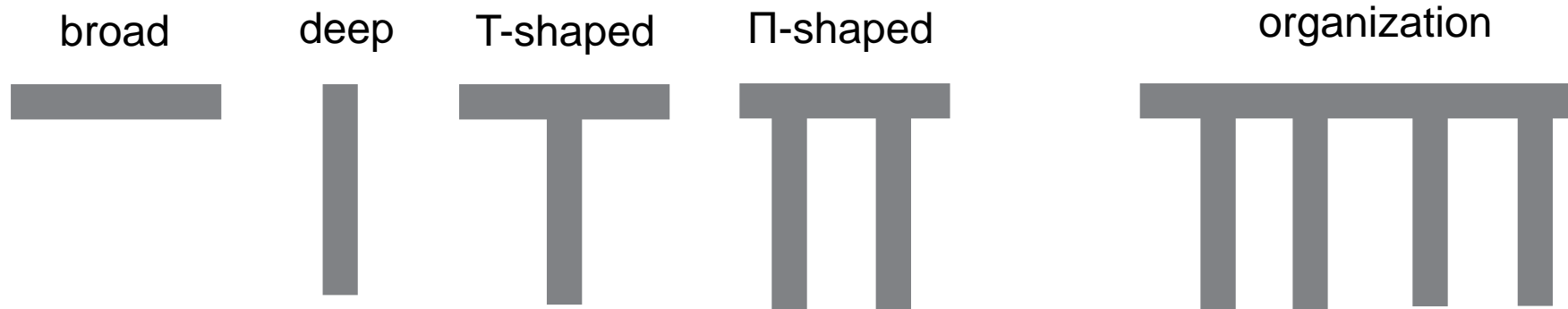
– An additional potential is increased diversity and inclusion because a hybrid/remote workplace is more flexible

What can individuals do?
- Invest in customizing remote work environment to own needs/abilities: equipment, infrastructure, environment.
- Embrace the new work modalities. Sticking to the old models makes you less competitive.

Putting it all Together Technology Curves

Hands-free voice control

25% acceleration in:
- **remote work**
- **e-commerce**
- **automation**

Telepresence, work from home, AR/VR

AI

New era of distributed offices

Transportation, autonomous driving

Robotics

AI/ML applied to cybersecurity

Selective technology during pandemics (increased speed of maturity)

Computing @Edge

Smart buildings, Smart cities

BYOT, IoT continuum

Telecommunication 5G

Extreme Data Centers

Education, training, and accreditation

Traditional technology curve

Selective technology during recovery (reduced speed of maturity)

14

Technology Curves: Where do we Want to End?
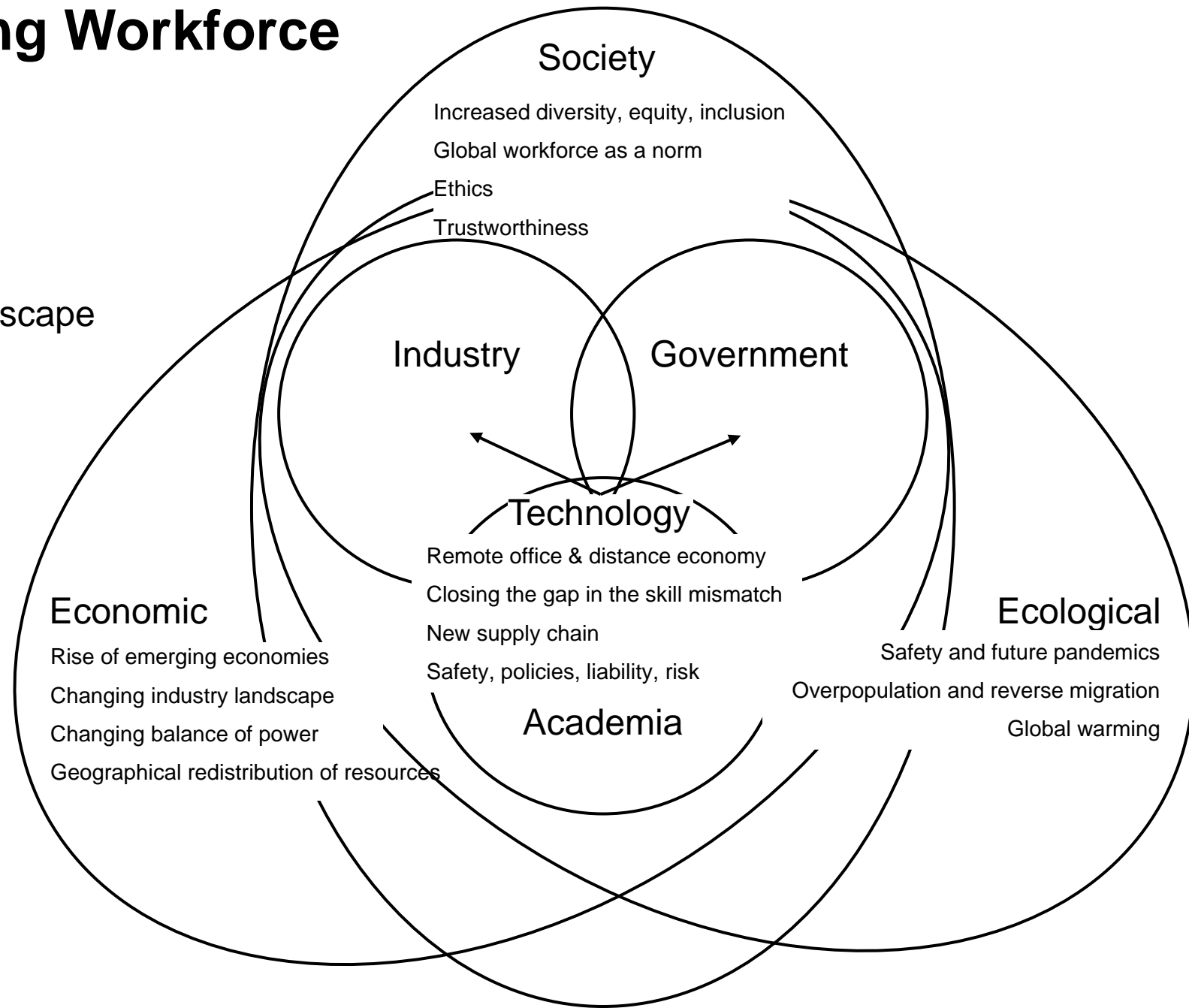

Thriving technology

Building back better

Typical technology curve

Affected technology
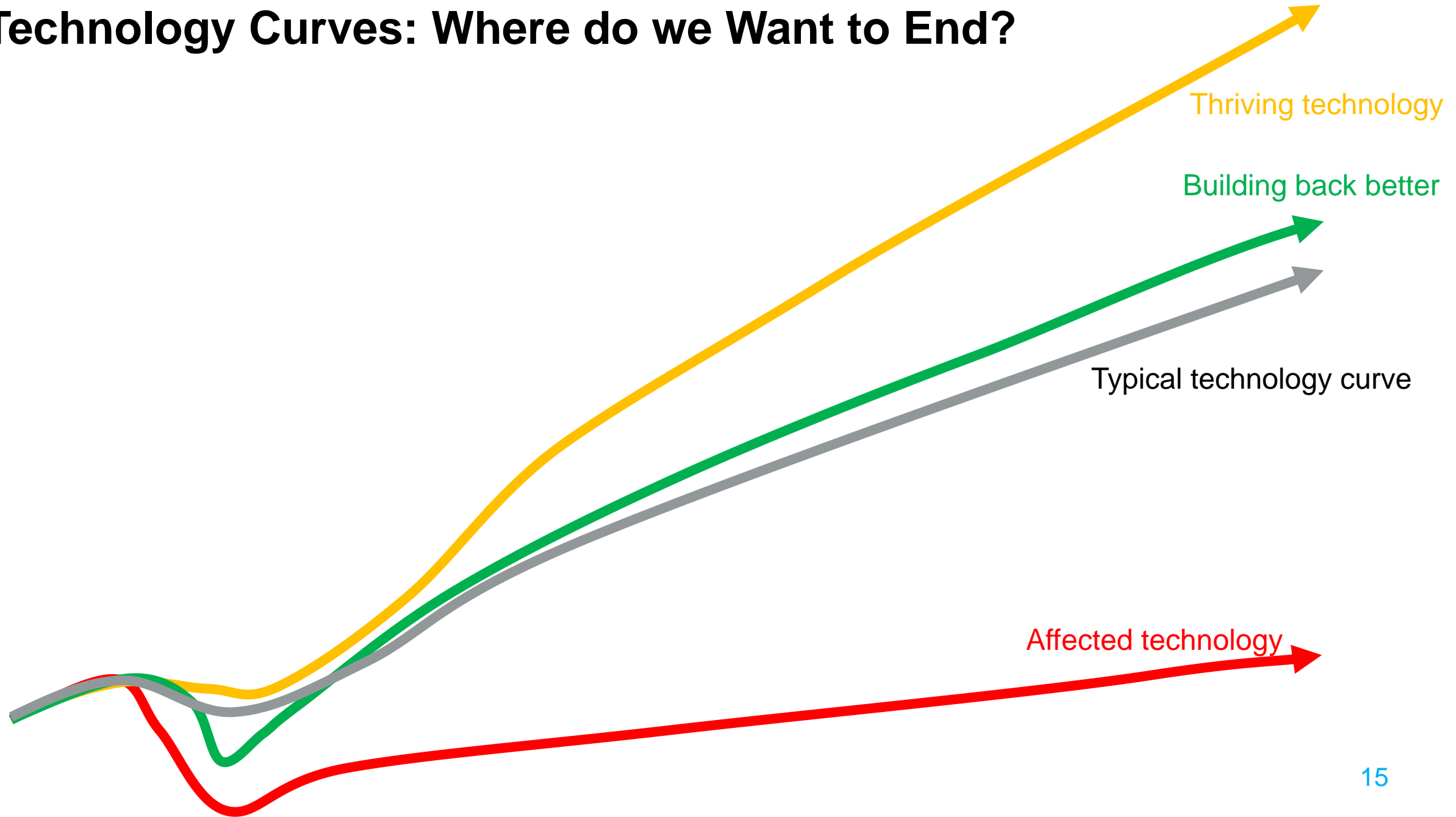
Factors impacting Workforce Septuple Helix

This is a very complex landscape with a lot of interplay!

Society
Increased diversity, equity, inclusion

Global workforce as a norm

Ethics

Trustworthiness

Industry

Government

Technology
Remote office & distance economy

Closing the gap in the skill mismatch

New supply chain

Safety, policies, liability, risk

Academia

Economic
Rise of emerging economies

Changing industry landscape

Changing balance of power

Geographical redistribution of resources

Ecological
Safety and future pandemics

Overpopulation and reverse migration

Global warming

16

Enabling Technologies that Will Impact the Future of Workforce

1. BYOT, IoT continuum
2. Education, training, and accreditation
3. Computing@Edge

personal

⬇

automation

4. Telepresence, work from home, AR/VR
5. AI as Knowledge / Skill provider
6. Robotics
7. Hands-free voice control

⬇

8. Transportation, autonomous driving
9. Telecommunication 5G
10. Extreme Data Centers
11. Quantum computing
12. Blockchain

infrastructure

⬇

security

13. AI/ML applied to cybersecurity
14. Cybersecurity
15. Smart buildings Smart cities

17

Risk vs Benefit

- Transition to remote work isn't new, two things are: urgency & totality of pandemic transition, and renewed drive for diversity, equity, inclusion

- Combined with technological factors, remote work and social justice, we have a chance to "reboot work" since the information revolution, into a more human-centered model

- There are many stakeholders with conflicting interests: social justice, profit, welfare, politics, privacy, etc.

- There are many risks that remote-work technologies could be used to further inequities and disempower employees (intentionally or not).

- It is our responsibility as society and stakeholders (regulators, corporate, researchers, employees) to drive the benefits while carefully balancing the risks.

- We cannot just be passive passengers in the winds of change, we must navigate our way forward.

18

Insights from 10 Panels with ~200 Participants

(9) Canada (8/2021)
- The pandemic augmented strains already being felt due to the aging population. The solutions are complex
- Top three challenges for employees are dealing with work-life balance, maintaining productivity and communicating without in-person interactions
- COVID-19 has accelerated automation and digitization while forcing society to rethink how we work and learn, and our socioeconomic structures and systems

(6) Europe, Middle East, North Africa 4/2021
- Regulations, standards & certifications have become more critical as technology is adopted widely and broadly.
- A single approach in education, shaping and managing the Future of Workforce will not work. Localization is critical.
- Technology needs to be human- and user-centric to be meaningful and impactful.
- Legislation and policies need to be more futuristic to accommodate remote workers around the world

(3) China (3/2021)
- Pandemic highlighted mismatch between industry and education, supply and demand are not meeting together.
- Strengthen cybersecurity, data security, and personal information protection
- Focus on future technologies to support social distancing and prevent future pandemic

USA: (7) Northeast 6/'21; (8) (Mid-)West 6/'21; (10) Southeast 9/'21
- Pandemic highlighted a trend the workforce. There's been a disappearance of middle-skilled jobs resulting in growing polarization in the workforce.
- The pandemic has changed people's priorities, which has resulted in a seismic shift within the workforce and its expectations.
- Education of technology and STEM-related subjects is critical, not only for the next-generation workforce but also for the educators.
- The blend of remote, hybrid and in-person workforces has created new dynamics that will take time to understand and stabilize.
- Increased work mobility is an opportunity and a threat for talent acquisition and retention and should be considered in re-evaluating company policies
- Migration trends have been accelerated and impacted due to increased work mobility; this is shifting cultural norms across the country

(2) India 1/2021
- Concerns about challenges with language, local/rural infrastructures, skills of educators, and processes within industry.
- Investigation of emotional health and technological intervention to handle stress of pandemic
- Concern about focus on work-life balance the inappropriate burden on women during this time

(1) Singapore 12/2020
- Emphasis on businesses agility introducing new initiatives, practices and measures to adapt and transform the way we work
- We all want digital technologies, but also employee engagement, empowerment. Workplace, workforce, technology coming together
- Shifting from "people ready 4 tech" to "tech-ready people". How do we bridge the gap of those who can/cannot embrace digital tools
- Reinforce mental agility and metal wellness of individuals, advocate globally

(5) Latin America 4/2021
- The region will likely undergo a more accelerated timeline towards digital transformation, innovation and technology adoption
- Concerns about challenges with language, local/rural infrastructures, skills of educators, and processes within industry.
- Incorporating technological tools in schools is necessary to reduce the gaps in access to technology, modernize the educational system and encourage students to develop skills such as critical thinking, teamwork and creativity.

(4) Sub-Saharan Africa 4/2021
- COVID-19 has had a debilitating impact on African economies, particularly due to a decline in informal employment, which accounts for 80-90% of total employment in African countries
- Following the outbreak, the share of working women shrank in all four countries. In Uganda and Ethiopia, more women lost their job due to Covid-19 than men. This deepens the already wide gender gap in employment.
- Language challenges, poor local/rural infrastructure, and an inadequate education framework are critical concerns

Geo Insights

– Regional

1. Asia (Singapore, India, China): care for individuals at times of pandemics; focus on general workforce, not just IT and white/blue collar; need for practical education of the graduates in addition to what they learn in school

2. Sub-Saharan Africa: focus on broadband, Africa-made devices, and bias in AI (black vs white, female vs male)

3. Latin America: access to Internet only for mid class and up, difference between cities and rural, need for practical education

4. Europe & MENA: purpose is increasingly more important; new-collars; ecosystems supplementing corporations, one size does not fit all; processes did not accelerate

5. North America: US (Northeast, Midwest/West, Southeast/Central) and Canada: it is all about people; education is key; transformation of the workforce, priorities and loyalties

– Global

– Border and Sovereignty Issues

– The pandemic has brought the issues of workforce mobility, equity, and more to the fore; Controlling and tracking COVID

– Climatic, political, and socioeconomic forces are changing the dynamics

– Schengen agreement (revisited), Brexit, many worldwide agreements on arms, climate, etc are changing

– (Re-)Education is needed globally even after school to get ready for the work

– We are really starting the see the frustration and negative effects of forced online or partial online delivery

– There are a lot of losers (and some winners) and this will become very obvious to the public

– Rural divide has evolved and amplified across all regions of the world

– This is exemplified at different levels subject to population density and at different levels of wealth

– This took place in Asia, Africa, US, Latin America, Canada, and Europe

Some General Observations

Some industries are severely impacted by pandemics, dramatically reducing demand.
Technology can help their workforce, but nothing can substantially reverse lack of demand. For example,
– Transportation, especially air, cruises, taxis/lyft/uber, etc.
– Oil and gas, lack of travel drove down demand for oil (oil future contract went negative)
– Tourism, hospitality, accommodation industry (hotels, AirBnB)

Some of the technologies and approaches are applicable across many fields
– AI/ML/DL techniques can be applied across all other technologies
– Cybersecurity is essential to protect against malicious behavior which is especially concerning in critical times
– Digital transformation is taking place in general and broadest sense
– Disaster recovery of manufacturing and supply chain very similar to data centers

Healthcare, is one of the sectors most impacted by Covid-19 in terms of workforce/resources.
– Amazing speed in vaccine creation, set up of data analytics and need for much more interoperability
– increase use (need for) of robots, digital health passport, digital twin to control people/generate awareness
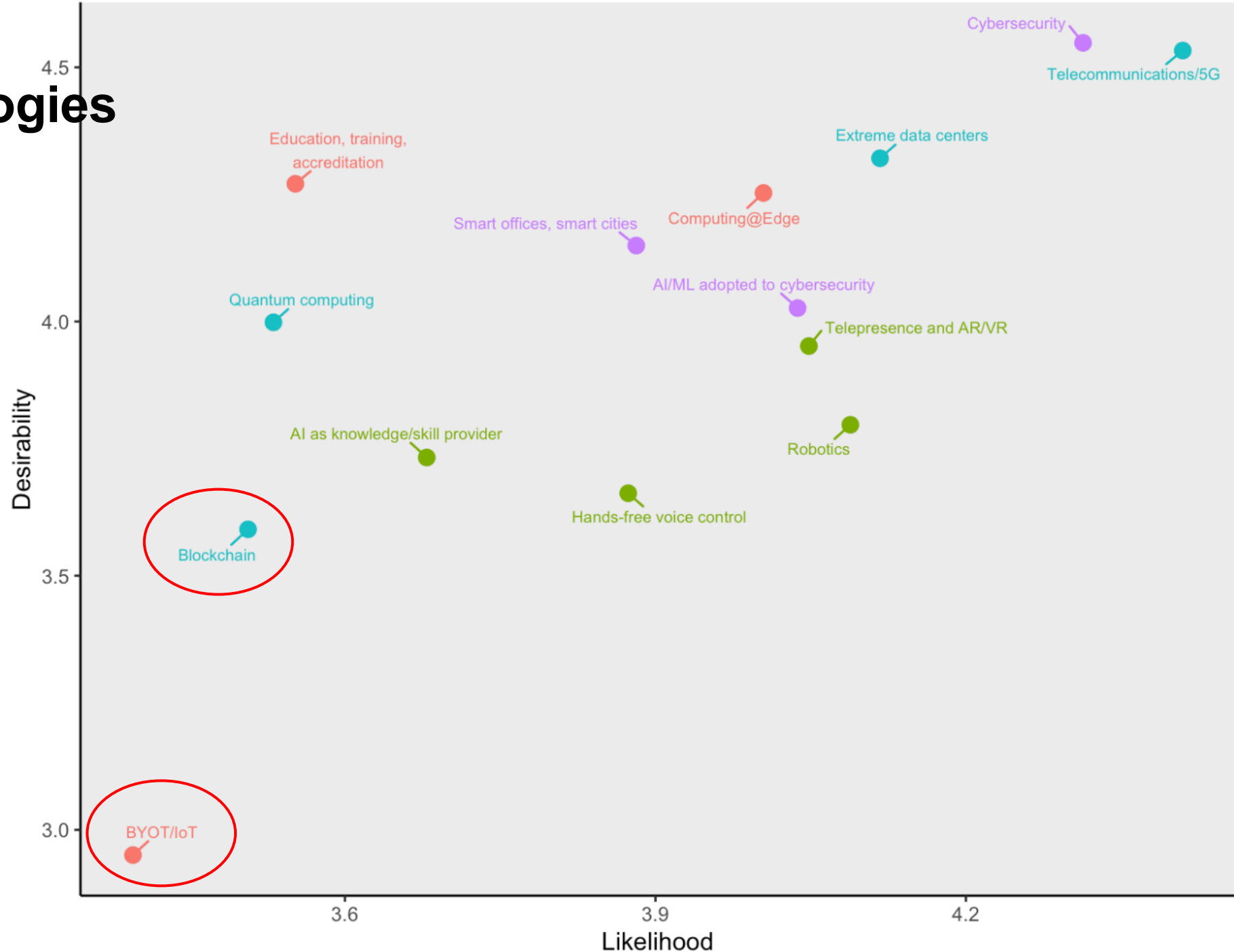– Sharp increase of telemedicine (400% increase in the US, 450% in Europe)

Survey Results

Factors

Safety, policies, liability, risk

Closing gap in skills mismatch

Ethics

Transparency

Changing industry landscape

More diversity in workforce/ DEI

Normalization of global workforce

Remote work/Remote office and distance economy

Safety/pandemics

Migration patterns/density

Climate change/Transportation (Technology)

New supply chain

Geo dist. of resources/ overpopulation/reverse migration

Rise of emerging economies

Changing balance of power

Desirability

Likelihood

4.5

4.0

3.5

3.0

3.4

3.6

3.8

4.0

Category

Economic

Societal

Ecological

Technological

Technologies

Factors Correlation

– Bias in correlation between societal and technical

– Most Survey takers are IEEE members

    – IEEE's tagline: Advancing Technology for the Benefit of Humanity
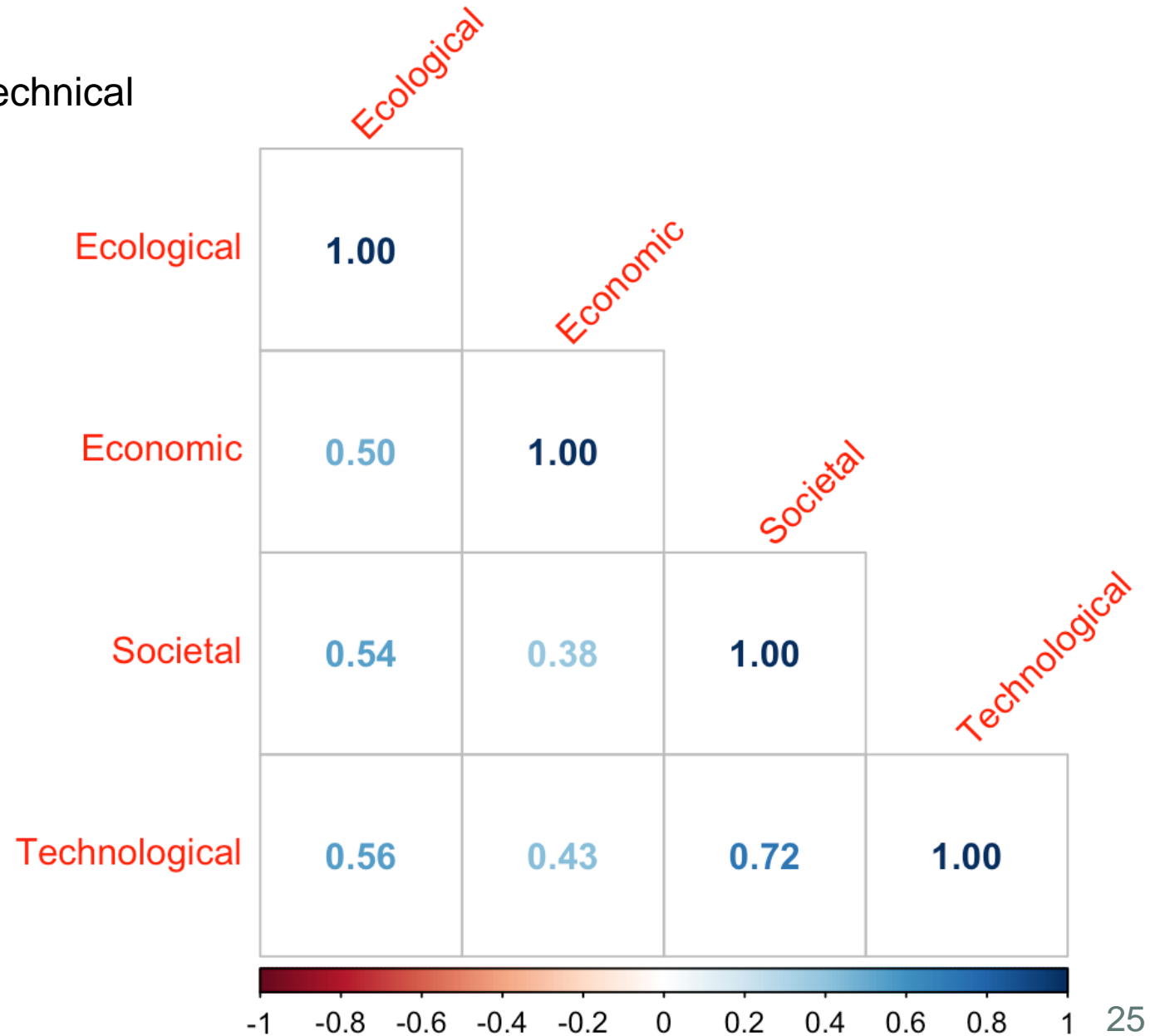
Tangled web of relationships

– Technology impacts:
  - workforce sizing
  - skills needed/required
  - way of working

– Economic impacts:
  - investment in tech
  - demand for specific skills
  - structure on Industry

– Societal factors impact:
  - availability of workforce (quantity/quality)
  - expectation of workforce

– Ecological aspects have more limited impact
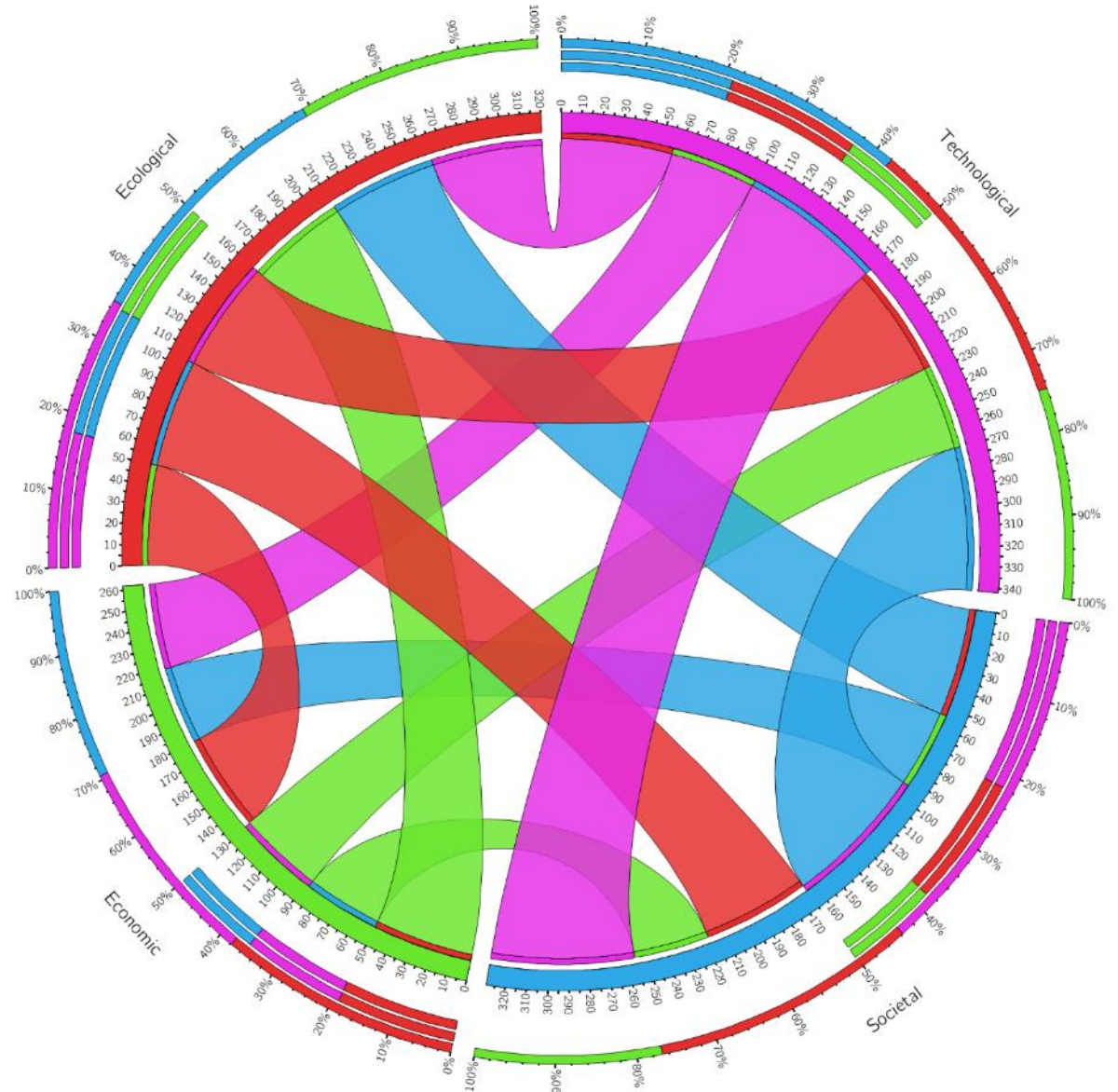
Factors, Correlation

- The minimum correlation between a pair is between ChangingBalanceOfPower and SafetyPoliciesLiabilityRisk

- The largest correlation is between DiversityInWorkforceDEI and RemoteWorkDistanceEconomy
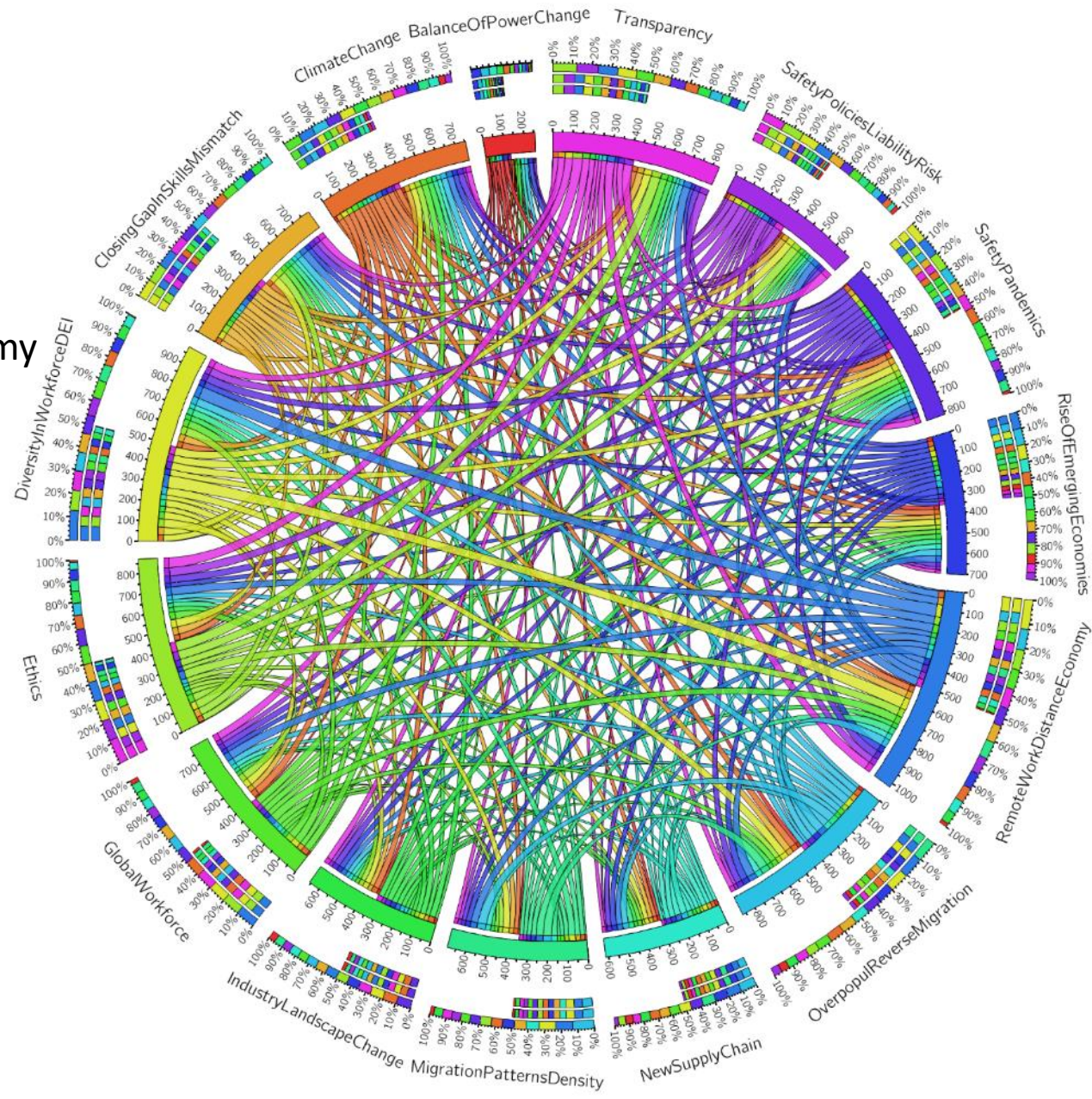
Technologies Correlation

- The largest correlation between a pair is for SmartofficeCity and ExtremeDataCenters;

- The minimum correlation between a pair is for Cybersecurity and BYOTIoT (surprising!)
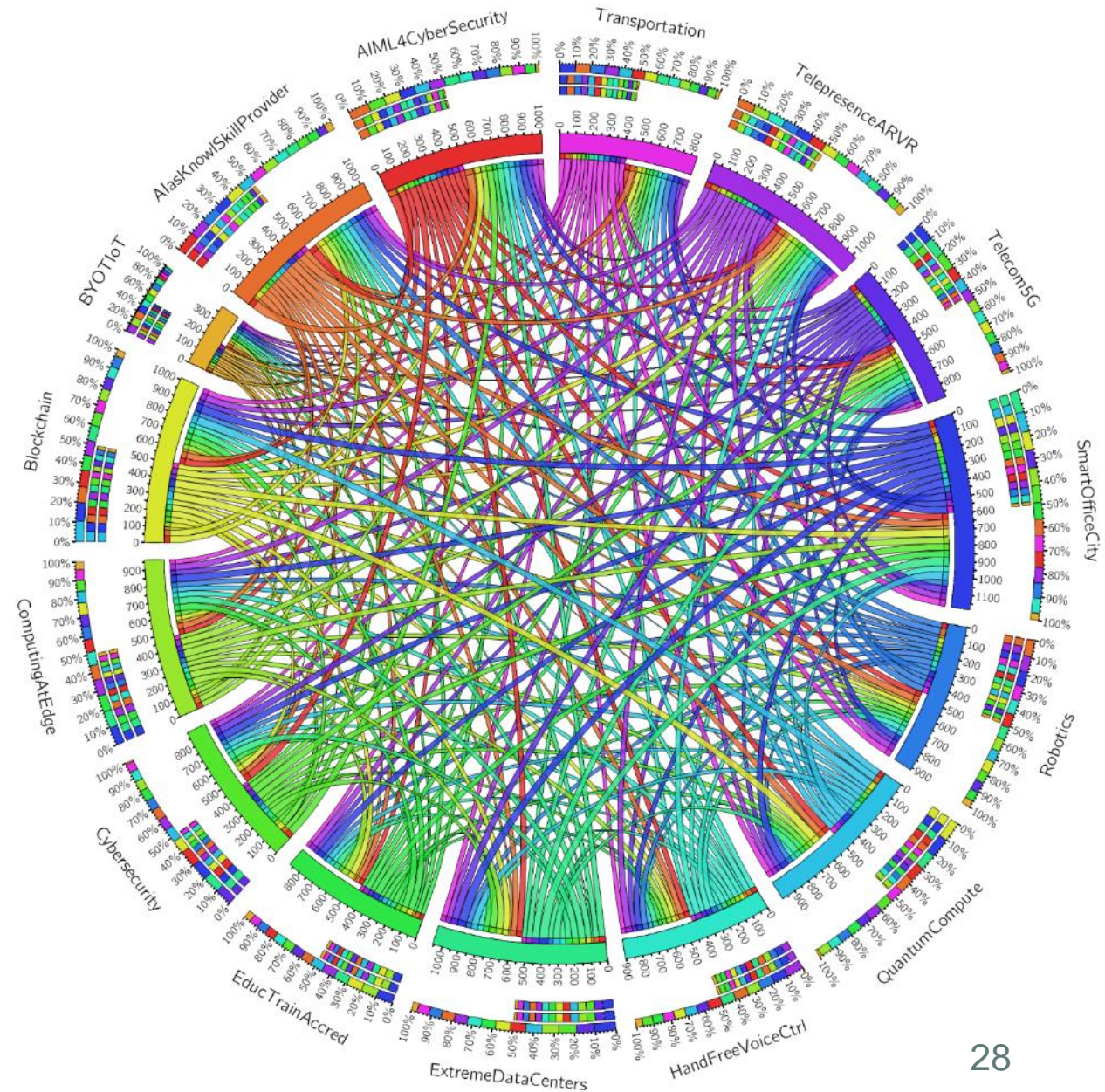
Summary from Unstructured Feedback from Survey (~1500 people)

- Climate change was not addressed. IEEE should encourage investments, motivate world leaders.
- Nobody can predict future, if there will be war or climate change that will change priorities
- Global society is not growing in a culture of ethics, respect. This should be a major debate.
- Quantum computing will become more prevalent in 10+ years in industry and governments.
- Certification of knowledge toward global consistency
- Businesses are thinking multiplanetary, but healthcare, environmental are still in basic stages! Some questions may have vastly different answers in different parts of the world.
- Business, governments to help underdeveloped regions. Technology to 'bring the world together'.
- Diversity and Kindness are two core concepts in all interactions and rooted in respect.
- Will electrical stations be ready for high-volume transportation. How to recycle car batteries.
- Flattening of world will continue. Nations allowing free innovation will exceed centrally planned.
- Businesses should engage in beneficial exchange, regardless of borders.

- Flooding of inexperience in all positions. Replacements for the experienced aging retiring workforce
- Workforce changes not uniform around Globe. E.g. DEI a high priority in some but not all countries.
- People will tend to work for projects rather than for companies/employers. Increase in contractors.
- Early retirements as technology becomes an added stress to work life balance. Shortage of workers.
- People working to older ages (>70 to 75 cohort engagement in remunerated employment)
- Skill based workforce will be more in demand than college acquired knowledge or degree.
- 24/7 work through globalization. The work follows the Sun. Shift to the 4-day work week.
- Use of AI assistants as part of the workflow. AI everywhere. Need for standards/protocols for AI/ML.
- Retirement of baby boomers, significant amount of engineering experience lost.
- Politically driven changes in workforce demographics. Affirmative Action driven by the market.
- The definition of money is going to change in near future.
- Move from fossils to renewables with urgency of climate threat, need to retrain energy work force
- Decentralized electricity generation, improvements to power grid to support cleaner energy.

Q1: Other workforce trends?
Q5: Additional comments? **Q2**: Other technological trends?
Q4: How can IEEE assist? **Q3**: How can your area assist?

- IEEE must be more valuable to industry.
- Make knowledge accessible to the community of adopters, implementors & decision makers.
- Update policy (government/law), law (IP internationally), and business and innovation.
- Help executives understand value of changes.
- Help experienced engineers keep their jobs.
- Incorporate Business Ethics, collaborate with ECI. Develop Ethics in Engineering.
- Ethics as technology speeds past our ability to curb it. Understand new technologies.
- Remain the World's pre-emanate Standards organization.
- Supply employers with information to make workplaces more efficient.
- Become a catalyst for technological change, advance technology at the edge of science.
- Provide high-level roadmap for technology evolution and adoption
- Understand trends and future research.
- IEEE closed to those w/o degree, a lot of people understand theory, but not practice.

- Identify steps (large, small) to drive current technology to support better human behavior.
- Make computing foundations/cybersecurity robust through proof and automated reasoning.
- Ensure ethical use of technology, from hardware up, push for equity in access to resources
- We instill values of collaboration, inclusion, innovation and environmental responsibility
- Influence companies to provide quality products while maintaining a happy work force.
- Continue investing in satellite RF communication programs that push the envelope.
- The improvement of underwater networks, can restore oceans and new green energies
- Assist with the automatic and accurate diagnosis of disease using AI
- Biotech instrumentation makes infectious disease testing faster, reliable, and lower cost.
- Net neutrality, and access to adequate bandwidth considered a modern but essential right.
- Closer coupling of technology to business outcomes.
- Invest in employee education/training, filling the gaps left by educational institutions
- Provide cost effective solutions for transportation electrification
- Carbon reduction in transportation; Electrification - power conversion
- Drive technologies to increase green harvesting and efficiency of energy/power conversion.
- Green energy is not as green. We need diverse sources for national security and reliability.
- Power efficiency w/ motors. Better charging, longer energy store. Green energy adoption .

- AI based decision making. AI will be used to design.
- Massive adoption of AI for increased surveillance
- Autonomous mass transport. Increase in green vehicles.
- Increased drone usage including for personal transport
- Highways will be in maintenance mode. No expansion.
- Robots for domestic use, advancement of aerospace.
- Outer space technology becoming common.
- Fast field-deployable virus detection for future pandemics
- Cryptography protect against quantum computer attacks
- Holographic displays, hand/ face gesture, for computer IF
- Adoption of digital avatars (digital universe)
- Responsible AI/ML in civilian applications;
- AR glasses, direct brain I/F instead of traditional I/F
- Renewables 100%
- Wide range of sensors and sensor networks
- More efficient battery storage and solar converters
- Electrical products shrink, battery capacity increases.
- Microgrids for power generation and storage.
- Pervasive energy efficiency accelerating automation.
- Home energy systems, prosumers w/ rooftop PV/storage

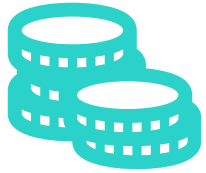**Recommendations**
(aggregate from panels, survey, and authors)
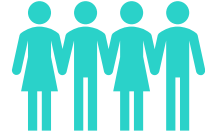
Transformation, Factors

Economic

Regional WF Market→
Global WF Market

Office WF → Hybrid WF

Benefits → Purpose

Corporate → Ecosystem

Innovation hubs (Silicon Valley)
→ Low tax regions (Austin)

Societal

Continued education →
Perpetual education

White/Blue Collar →
New Collars

Diversity →
Diversity, Equity, Inclusion

Work as a means of living →
Work as a means of fulfilment

One employer for life →
continuous change of jobs

Ecological

Reactive (to COVID, …) →
Preventive

Protect the Planet →
Return to the Planet

Signing the treaties →
act collaboratively

Technological

Automated → Autonomous

Homogeneity (generalization) →
Heterogeneity (specialization)

Social Networks (humans) →
Sensor Networks (machines)

Stove pipes in technology →
Interdisciplinary co-design
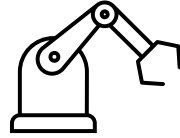
Transformation, Technologies

Personal

Corporate IT, devices → CostShare, Byo*, broadband

Economical divide education → digital divide education
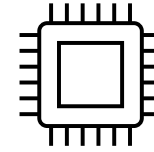
Centralized data analytics → AI@edge

Automation

Telepresence → AR/VR, human-machine I/F, digital twins

AI-assisted → Explainable, mission-critical AIops

Robots in fenced environment → real-time responsive collaboration

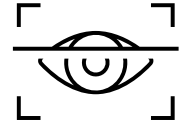Voice recognition → Hands-free Voice Control

Infrastructure

Assisted driving → autonomous driving

5G, WiFi6 → drone satellites communication for rural

Quantum communication → Quantum computing

Security

Privacy-preserving → Privacy-driven

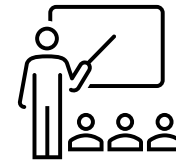AI-assisted cyber analysts → AI/ML replacing analysts

Recommendations: Industry, Governments, Academia, and Professional Organizations

Industry

It is all about people!

Best people bring best people

Industry to do training too

Young people and new tech as attractor for hiring

Offices are useful for junior people to exchange ideas

Governments

Look at technology & society

Goal: Sustainable WF in a well-balanced labour system

System & individual in every sector: biz, gov., academia

Take advantage of remote work for geo-depressed areas

Enable reliable, high-speed communications infrastructure

Inclusive, equitable technology for underserved populations

Academia

Retrain new tech., e.g., AI

Interdisciplinary, global

Learning never ends

Train to learn how to learn

Deep consideration of the human condition

Persuasion, emotional intelligence

Ethical thinking, intercultural awareness & critical thinking

Profess. Organizations

Redefine concepts, hybrid career

Balance properly labor markets

Leverage power of convening, technology predictions & roadmaps

IEEE-USA to educate legislators

Principles, best practices for trust, transparency, accountability, policies

Community responses to issues of safety, security, privacy when exploiting AI & Robotics

IEEE Advancing Technology for Humanity

Recommendations to Industry

– Young employees and new technologies can be used as an attractor of your company, WF and HR related.

– Innovation and creativity will be significantly affected by working from home. Discussion is missed and necessary.

– Offices are particularly useful for entry-level people to exchange ideas. Communication is critical and essential.

– There is a huge surge in talent recruiting. Need for talent.

– Entry-level people change jobs often not understanding employment quality, building career in one company. It is all about people!

– Best people bring best people

Recommendations to Governments

– Policy for payment for teachers to get retrained much better. Demands on our profession has been misplaced, and whole educator class has not been equipped.

– Governments should take a broader look at technology and society

– Government is spending a lot but women are still under 20% of WF, money cannot fix it, it is responsibility of academia and industry

– Mid-career women leave the WF, they are either not understood or not welcome. Hybrid or virtual WF need to be welcoming. We need to have technologies available for these women.

– What is the ideal end point? Sustainable WF in a well-balanced labour system. Well trained, safe healthy, diverse, inclusive, respective, valued

– We need to think about system and individual and every single sector, business, government, academia. Only by collaborating we can reach a solution. What employers may want may be different from individuals and government as well.

– Employers want well trained people. But more than anything else they want right attitudes and right behaviour skills. We have not spent enough resources for behavioral skills. Technologies can be huge beneficiaries. Some schools are teaching ethical behaviour.

– Enable inclusive and equitable technology access for the underserved populations.

Recommendations to Academia
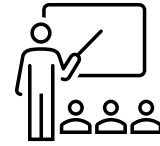
– Educate for jobs in demand, e.g., AI for smart manufacturing

– Develop new classes of interdisciplinary coursers, avoid stove pipes

– Train teachers to teach new tech, e.g., AI, they have so much work, no time to retrain

– Educators should explain that learning never ends

– We need to train kids even before elementary school. Academia has failed them so far!

– We need to tie in academia and industry. In 40-year career, everything will be different. Part will come from universities. But industry can do some of it itself. Industry can identify explainers who are good at that!

– Must also include in equal measure a deep consideration of the human condition, the ways in which new technologies and shifting economic power impact people of all socioeconomic levels

– Favor an interdisciplinary and global curriculum

– Development of intercultural and interpersonal skills

– A strong overlay of ethical thinking, intercultural awareness and critical thinking

– Persuasion, emotional intelligence and capacity for teaching others

Recommendations to Professional Organizations

- IEEE can raise the awareness that knowledge has become free to virtually everybody in the world, that everyone should learn formally or informally. Education can uplift people from different backgrounds. And enrich their lives.
- Volunteers should take the opportunity to learn and educate themselves, their background should not be a factor.
- With tremendous convening power, redefine the concepts. What is the career, do we need to go to school or in and out of school, hybrid careers.
- How to do right signaling to young people. Singapore has done a tremendous thing of signaling.
- Diversity cannot be resolved by committee. We need help from IEEE to balance properly labor markets.
- We need IEEE-USA to educate legislators understand technology, think hype vs reality.

Insights and Summary

Insights, Society-Related

– We have an opportunity and responsibility to be active agents of change. The desire for a positive change is nearly universal among our panelists.

– There is an opportunity to reboot work towards more desirable outcomes, including a more just society and a more sustainable ecology.

– The pandemic created shifts in the dynamics of workplace interactions from how we manage to how we establish relationships with new colleagues.

– Creating a work/life balance was mentioned as an issue by several of the session participants. We need better tools and practices to create this balance which can result in more satisfied and energized workers.

– Similarly, a reboot of work is necessary to improve the standard of living for many workers.

– Encouraging diversity in work is necessary for a better society and for more innovative and productive working environments.

– We are at a fundamental crossroads, in the US and globally, between two very different views of the future of work. One group wants work to return to "normal" with more traditional workstyle with face-to-face communications, meetings, etc. The other group believes that working from home (part or full-time) is a better way forward.

– We need more technically literate young people as legislators and educators, to assist in long-term improvements.

Insights, Technology-Related

– The pandemic accelerated the adoption of technology in many aspects of life, beyond the workplace to include education, healthcare, shopping, and social interactions.

– In many developing countries the majority of work is informal rather than traditional jobs. Technology could be used to help those who need work done and those who are looking for work. Some of the tools used to power the gig economy in more developed regions could help but probably the biggest need in these regions, particularly in rural areas, is access to good internet connectivity.

– The pandemic highlighted the importance of technical literacy (e.g., limited access to health professionals if no knowledge or access to the internet) and showcased the gaps in technical access and literacy (e.g.., limited access to education in rural areas without broadband access).

– Better technology for remote working makes a global talent pool more directly accessible by everyone. This changes priorities for skilled workers and increases the value of specialized skills that can be accessed (and offered) from anywhere. It also changes the balance between a more stable employment and freelance work. Every approach has pros and cons. For the future of work, we want to improve the outlook for workers while not compromising the sustainability of businesses that provide the jobs.

– In areas where "informal work" is dominant (Africa, India), the pandemic has exacerbated several trends such as the gender gap, the lack of IT and telco infrastructure, work-life imbalance, lack of education skills to match the new demands, and so on. Investments are needed to reverse these trends.

– A significant evolution in healthcare is accelerating the uptake of tele medicine. In turns this set up the framework (sensors, self-checking apps, etc.) for preventative healthcare. Both are also generating increasing volumes of data enabling a more personalized medicine and system wide healthcare monitoring, All together this is affecting the work market in healthcare.

Insights, Economy-Related

– There is a very real chance that information work will look substantially different from how it looked before COVID. The emerging winners among employers, employees, and economies will be those that anticipate and prepare for these changes ("skate to where the puck is going to be").

– The remote work experience during COVID is fundamentally changing desk work and working remotely or working from home will be much more common and in some cases be continuous. For many others, they will only be expected in the office 2-3 days a week. This could change many urban areas as commuting and parking requirements will be less, and this could impact the demand for food and other services in downtown areas.

– Remote work could help improve local economies in many geographies, including those where other industries are being phased out due to ecological concerns.

– The pandemic has accelerated the role of technology in work environments, whether it's automation, uses of AI/ML, or remote work ("smart working", as some countries call it). This trend is not going to stop and will cause massive shifts in the workforce, possibly highlighting a digital divide even more (between workers who can access remote technology, and those who can't). The impacts will touch several aspects of society, de-urbanization, reverse migration, transportation, services, home layouts, distributed shared workplaces, etc. with the expectation of a significant fraction of work time not in the office.

– The pandemic has increased the work-from-home. That was a must for companies, and it came to be appreciated by a significant portion of the involved workforce. However, we have seen that as the pandemic relented many companies are resuming the work-on-premises approach. This is already creating conflicts between companies and the workforce.

– The pandemic, by accelerating the digital transformation, is also accelerating the servitization of products.

Insights, Ecology-Related

– When COVID hit and many geographies instituted lockdowns, some immediate ecological benefits were noticed. In particular, a visible reduction in smog in many cities as well as cleaner water in rivers. Noise pollution also diminished noticeably for people living near major roadways or rail lines. These observations should be considered when deciding on FOW policies.

– Business and recreational travel dropped significantly during the pandemic. While detrimental to businesses and economies that depend on travelers, it was another example of how the future of work could be altered in a manner that was more ecologically friendly without significant disadvantage to non-travel businesses.

– The pandemic demonstrated which businesses could quickly reduce their carbon footprints using existing technologies, and which require new technologies (either because more ecologically friendly technologies currently don't exist, or because they are currently cost-prohibitive)

– While the pandemic provided some clear examples of how quickly businesses and societies could adapt to more ecologically-friendly methods, these weren't done with ecology as the main focus. The FOW should consider ecology as a first-class citizen, across metrics that are a current focus (e.g., greenhouse gas emissions) and those that will be in the not-to-distant future (e.g., fresh-water consumption, household or waste generation volumes, etc.)

Next Steps

– Immediate, tactical, throughout 2022

  – Review with panelists and survey takers

  – Apply feedback

  – Distribute report (IEEE Computer Society)

– Tactical, 2023

  – Engage IEEE-USA and equivalent organizations in rest of the world

  – Discuss opportunities with other IEEE MOUs

  – Continue to present, socialize

– Strategic

  – Engage with Industry by visiting specific companies

  – Engage with Government, through IEEE and other organizations

  – Engage with Academia through select universities and organizations

– Broaden and validate research

  – Consider holding panels in a few remaining regions of the world: Australia, Japan, Korea, a couple countries in Europe/MENA, latin America and USA

  – Consider conducting simpler survey with broader focus than IEEE

Overall Summary

Pandemics
– The pandemic has created STRESS on current humankind existence, values, and daily lives
– Technology is critical at times of Pandemics and especially on workforce
– Pandemics also help aggressive technology evolution. *Necessity is mother of invention*

General
– Technology Predictions (or Trends) were always popular, now they are becoming increasingly useful
– We continue to experiment with approaches and delivery models across the regions of the world
– We are becoming more and more systematic and rigorous in our predictions

Seeking Feedback
– What do you think of our predictions for Future of Workforce? What have we missed, what is different?
– Feel free to approach us or our colleagues with feedback, questions, …
– We will keep you in the loop as we progress with the report development

Further Reading

- McKinsey & Company, "Future of Work," https://www.mckinsey.com/featured-insights/future-of-work

- Bain Report, "Labor 2030: The Collision of Demographics, Automation and Inequality," https://www.bain.com/insights/labor-2030-the-collision-of-demographics-automation-and-inequality/

- Yanick Pouffary, HPE Enterprise.nxt: "The new division of labor," https://www.hpe.com/us/en/insights/articles/the-new-division-of-labor-2011.html

- "Work Disrupted"—Deloitte's new book on the accelerated future of work, https://www2.deloitte.com/us/en/pages/human-capital/articles/digital-workforce-transformation-roadmap.html

- Roberto Saracco, Megatrends, https://digitalreality.ieee.org/images/files/pdf/Megatrends1-18-2021.pdf

- OECD, "Building Back Better," http://www.oecd.org/coronavirus/policy-responses/building-back-better-a-sustainable-resilient-recovery-after-covid-19-52b869f5/

- From Spectrum: https://jobs.ieee.org/jobs/content/Will-the-Tech-Workplace-Ever-Be-the-Same-Again-2020-07-07

- McKinsey & Company, "Beyond hiring: How companies are reskilling to address talent gaps," https://www.mckinsey.com/business-functions/organization/our-insights/beyond-hiring-how-companies-are-reskilling-to-address-talent-gaps

- McKinsey Global Institute, "The future of work after COVID-19," February 18, 2021 Report, https://www.mckinsey.com/featured-insights/future-of-work/the-future-of-work-after-covid-19

- Deloitte, "The Future of Work is Here," https://www.libertyglobal.com/wp-content/uploads/2021/03/2021-03-Liberty-Global-Deloitte-Future-of-Work-discussion-paper.pdf

- Hewlett Packard Enterprise, "Future of Digital Work Summit 2021," https://youtu.be/ORJhp7vQxA4

- Harvard Business Review, "The Secrets of Great Teamwork," https://hbr.org/2016/06/the-secrets-of-great-teamwork

- LinkedIn, "Top Companies 2021: The 50 best workplaces to grow your career in the U.S.," https://www.linkedin.com/pulse/top-companies-2021-50-best-workplaces-grow-your-career-us-/

- HPE Pointnext Services, "DIGITAL NOMADS ARE RESHAPING WORK AS WE KNOW IT," https://community.hpe.com/t5/The-Cloud-Experience-Everywhere/Digital-nomads-are-reshaping-work-as-we-know-it-with-the-help-of/ba-p/7130848#.YNOPXOhKguU

- CNN Business, "Reopening plans for offices are complicated by new CDC mask guidelines," https://www.cnn.com/2021/05/14/business-money/cdc-mask-guidelines-employers/index.html

- IEEE- USA Insight, "CYBERSECURITY WORKER DEMAND IS EXPECTED TO DO THIS IN 2021 — AFTER SUFFERING ITS FIRST DROP EVER IN 2020," https://insight.ieeeusa.org/articles/cybersecurity-worker-demand-in-2021/

- Archinect Report, "What Is the Real Threat of Artificial Intelligence to the Architecture Profession?" https://archinect.com/features/article/150258718/what-is-the-real-threat-of-artificial-intelligence-to-the-architecture-profession

- Harvard Business Review "Companies Should Do More to Normalize Career Breaks," https://hbr-org.cdn.ampproject.org/c/s/hbr.org/amp/2021/04/companies-should-do-more-to-normalize-career-breaks

- HPE Enterprise Next, "How learning is changing—and why it matters," https://www.hpe.com/us/en/insights/articles/how-learning-is-changing-and-why-it-matters-2103.html

- Forbes, "Is Your Company 'Future-Ready?' 9 Keys To Building A Resilient Organizational Culture," https://www.forbes.com/sites/nazbeheshti/2021/02/23/is-your-company-future-ready-nine-keys-to-building-a-resilient-organizational-culture/?sh=72e06da927fa

- "The End of Poverty" by Jeffrey D. Sachs, Penguin Books, 2005

- "Little Science Big Science", Derek J. De Solla Price, 1963

Further Reading, IEEE-related

IEEE Computer Society magazines: https://www.computer.org/csdl/magazine/co
- AI/ML/DL - *IEEE Intelligent Systems*
- Cybersecurity - *IEEE Security and Privacy*
- Healthcare - "Digital Healthcare Industry and Technology Trends"

IEEE Standards Association - https://standards.ieee.org/

Technology Predictions – The IEEE Computer Society 2021 Technology Predictions Report focuses on the pandemic's impact on human lives, supply chains, workforces, and the unpredictability of operations and markets. https://www.computer.org/press-room/2020-news/ieee-computer-society-reveals-2021-technology-predictions

Recent IEEE Computer Society articles/papers on Workforce –
- Preparing a Computationally Literate *Workforce*
- A Survey of Educational Efforts to Accelerate a Growing Quantum *Workforce*
- Preparing America's Cyber Intelligence *Workforce*
- Security Awareness Training for the *Workforce*: Moving Beyond "Check-the-Box" Compliance
- Machine Learning *Workforce* Development Programs on Health and COVID-19 Research
- Optimizing Cyber Security Education: Implementation of Bloom's Taxonomy for future Cyber Security *workforce*
- Risk Management of Mobile Workers based on Multiple Viewpoints

Other materials
- https://www.computer.org/publications/tech-news/trends/remote-working-easier-with-ai/
- Preparing a computationally literate workforce
- IEEE Blockchain Initiative - https://blockchain.ieee.org/
- *IEEE Transactions on Quantum Computing* - https://tqe.ieee.org/
- Seamless authentication for online teaching and meeting
- Women in STEM – See the IEEE Computer Society special series of "Women in STEM" interviews - https://www.computer.org/about/diversity-inclusion/#vision
- Top Cybersecurity Issues Faced by Organizations Amidst the Pandemic
- Worlds Apart: Technology, Remote Work, and Equity | IEEE Journals & Magazine | IEEE Xplore

Future of Workforce, Testimonials (email, LinkedIn, twitter)

- Pär Lundström, The Swedish Installation Federation, Senior Policy Advisor, **Sweden**: *Thank you all for yesterdays stimulating discussion on a topic I talk and write about almost every day. You really took this important issue to a whole new level* 😊 *(email, also LinkedIn)*

- Cristiano Radaelli, Anitec, President, **Italy**: *I would like to thank you for the invitation to participate in yesterday's meeting, very interesting and full of "Food for thoughts" (email)*

- Boldr, **Mexico**: *We at Boldr would like to thank everyone at IEEE for inviting us and our President Suneet Bhatt, to participate in the Panel: "Future of Workforce Session-5, dedicated to South and Latin America". It was a great experience and we had the opportunity to share our knowledge. We hope to see you again in future events. (LinkedIn, twitter)*

- Juan Fernando Galindo, Cofundador en VITA Tecnologia para à vida, **Brazil:** *We've got great insights from your participation! Thanks! (Linkedin)*

- Calvain Raoul NANGUE, Cisco Systems, **Senegal**, **Smart Africa**: *Smart Africa is proud to be associated with this initiative and more than ever values the partnership with IEEE and HPE. We are looking forward to the next opportunity.*

Future of Workforce IEEE Staff Team

Overall logistics, US, Canada

Patrick Russoniello
IEEE Corporate Business Development Manager

Survey

Michael Wehrman
Senior Strategic Research Manager at IEEE (past)

Marketing & Production

Katherine Mansfield
Marketing Manager IEEE Computer Soc.

Marketing & Production

Michelle Tubb
Director of Marketing IEEE Computer Soc.

Singapore

Hwa Chiang Leo
Director, Singapore Operations at IEEE

India

Harish Mysore
Director - India Operation at IEEE

China

Steven Deng
China Business Dev. Manager at IEEE

Sub-Saharan Africa

Kathleen Weeks
Senior Corporate Dev. Manager at IEEE

Europe and MENA

Clara Neppel
IEEE, Europe

48

Future of the Workforce Volunteer Team

Martin Arlitt
Microfocus

Tom Coughlin
Coughlin Associates

Paolo Faraboschi
Hewlett Packard Ent.

Eitan Frachtenberg
Reed College

Phil Laplante
Penn State

Dejan Milojicic
Hewlett Packard Ent.

Nita Patel
L3Technologies

Roberto Saracco
IEEE FDC

49

Acronym Definitions

- AI: Artificial Intelligence
- AIOps: Artificial Intelligence Operations
- BYOT (D): Bring Your Own Thing (Device)
- DEI: Diversity, Equity, and Inclusion
- DL: Deep Learning
- EU: European Union
- F2F: Face to Face
- FoW: Future of Workforce
- HCI: Human Computer Interfaces
- HW: Hardware
- ICT: Information and communications technology
- IEEE CS: IEEE Computer Society
- IEEE EAB: IEEE Education Activities Board
- IEEE SA: IEEE Standards Association
- IMF: International Monetary Fund
- IoT: Internet of Things

- ISO: International Organization for Standardization
- ITU: International Telecommunication Union
- MENA: Middle East and North Africa
- ML: Machine Learning
- MLOps: Machine Learning Operations
- MOOC: Massive Open Online Courses
- P2P: Peer to Peer
- R&D: Research and Development
- SME: Subject Matter Expert
- SW: Software
- STEM: Science, Technology, Engineering, Mathematics
- VC: Venture Capitalist
- VR/AR: Virtual Reality / Assisted Reality
- WF: Workforce
- WFH: Work from Home

Thank You!

Questions?

martin.arlitt@microfocus.com
tom@tomcoughlin.com
paolo.faraboschi@hpe.com
etc_26@yahoo.com
pal11@psu.edu
dejan.milojicic@hpe.com
nita.patel@ieee.org
roberto.saracco@gmail.com

https://www.linkedin.com/in/martinarlitt/
www.linkedin.com/in/thomas-coughlin-41a65
https://www.linkedin.com/in/faraboschi
https://www.linkedin.com/in/efrachtenberg/
https://www.linkedin.com/in/phillip-laplante-09973
www.linkedin.com/in/dejanm
www.linkedin.com/in/nitapatel73
https://www.linkedin.com/in/saracco-roberto-8283765/

https://tomcoughlin.com
https://dejan.milojicic.com
http://nitapatel.org

twitter.com/thomascoughlin
https://twitter.com/paolofrb
twitter.com/dejanm
twitter.com/nkpieee

https://www.instagram.com/thomas.coughlin
www.instagram.com/dejanmilojicic

www.facebook.com/thomas.coughlin.908
www.facebook.com/dejan.milojicic
www.facebook.com/DejanHPE
http://www.facebook.com/nitakpatel

IEEE COMPUTER SOCIETY

IEEE

IEEE Industry Engagement Committee