Future Skills for the 2020s

A New Hope

FALL 2020

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Executive Summary

We are living in a uniquely pivotal moment in time. Structures that bind our society and environment are rupturing, while new pathways are opening for renewal and regeneration. We have a window of opportunity to get things right. Rather than focus on fear, how can we co-create a future that is inspirational and hopeful? What are the skills needed today to build a thriving future for all? The message from hundreds of experts participating in this research is clear, we must:

- **Collaborate, adapt and transform**
- **Embrace future-orientations and technological tools**
- **Embody well-being of people and planet as our primary purpose**

This report is for Vocational Education & Training practitioners & policy shapers, the WorldSkills movement, business people, academia, media and learners of all ages interested in trends and skills. The project aims to identify the impact of transformation of skills across industry sectors, and explore the implications this has on Vocational Education & Training. This has been the focus of the authors team for a decade. Building on prior work in this space,[1] we invite you to explore the critical topic of Future Skills needed to thrive in the 2020s. We co-created 'maps of the future' with hundreds of experts across eight sectors, through explorative 'Rapid Foresight' workshops and surveys.[2] We invite you to the summary of their insights here, and to dive deeper into sectoral details and collaboration opportunities in the full report.

Technological advances have multiplied since the Industrial Revolution, while social change and population growth give rise to ever more cross-pollinating innovators. Each new generation can say the world is changing faster than ever before. As individuals and collectively, we now have greater powers to change our environment and our futures. These powers will soon increase exponentially. Is this the most pivotal decade in our existence?

In our world of increasing change, complexity and uncertainty, we know that skills of the past will not serve us today, or tomorrow. If 20th century market economies were capital-centred, and modern economies become human-centred, then in order to survive and thrive in the 21st century we should create systems that are life-centred and relational. These systems explore our relationships with self, others, places, and other beings. 'Preadaptive'[3] development of skills 'working with future' concerns not only technological progress and its consequences, but also many other issues related to sustainable development and ability to overcome global risks.

This report focuses on factors and skills that are emerging in some shape today. To give insight to direction, timing and relative importance, we asked experts when changes will be significant in the sector i.e. widespread impact, or clearly disrupting sector & transforming roles. This foresight[4] work helps us choose which pieces of potential futures we'd like to keep, change or move away from.

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1 E.g. Atlas of Emerging Jobs, *Future Skills 1.0*, *Kazan Declaration*

2 17 workshops with 302 attendees, 502 survey responses. Experts come from 46 countries and have 6000+ years of sector-specific experience. They are leaders from Business, Academia, Education & Training, NGO & Government officials. This research process took four months in 2020.

3 *A Concept Derived from Evolutionary Biology*

4 Our *Rapid Foresight* methodology was developed with partners such as The International Labour Organisation

Of the megatrends making the world a VUCA place (Volatile, Uncertain, Complex, Ambiguous), Digitalisation is predicted to have the most impact on skills this decade. Other high impact megatrends are Globalisation, Sustainability and Automation. COVID is accelerating change in all elements of work and life today, although later in the decade other trends are predicted to have more impact on skills. There is clearly a need to get ahead of the curve on many of these snowballing megatrends before they avalanche us out of existence. Cyber/AI risks and environmental crises are potentially greater threats than COVID or recession [5]. Self-creating bots are one of many examples of turning points in power and our responsibility this decade. Addressing these complex intertwined challenges of our time requires new fundamental skill sets, holistic ethical application and governance.

How much impact will these Megatrends have on Skills over the next 10 years?

Digitalisation	HIGH	HIGH	Automation
Globalisation	HIGH	MEDIUM	Accelerating Change
Environmentalisation	HIGH	MEDIUM	Demographic Changes

Experts agreed in general that these scenarios are likely this decade:

- Demand for collaborative team skills will be greater than for Individual personal skills
- Customisation & personalisation will continue as we transition away from 1-size-fits-all mass production and education systems
- Life-centred, transformative, regenerative & circular economies come to the fore this decade as we move away from 'business as usual' extractive capital-centred consumerism
- Demand for multi-disciplinary generalists will be greater than for narrow specialists. COVID restrictions, automation, job losses and structural employment shifts are some of the factors driving the trend towards multifunctional roles.

And to a lesser extent:

- Algorithms will control people & behaviour more than people control algorithms
- Skills gap will close
- National self-sufficiency will continue to grow, with borders closed, inward orientation, political & social disruption of global collaboration

5 WEF & Global Challenges Foundation

At a more detailed level, experts predict these factors to impact skills significantly across all sectors:

2020

2030

- Remote Work = New Norm
- Strict Hygiene / Biosecurity
- Unemployment & Reduced Spending
- National Self Reliance & Domestic Supply Chains
- Eco Materials & Production Modes Essential
- Digital Currency replaces Cash
- Personalisation of Manufacturing
- Nationalization of Platforms & Data
- Permanent Loss of Jobs due to Structural Shifts
- Demographic Changes: Workforce becomes increasingly Senior
- Total Digital Monitoring

- Cybersecurity & Privacy Threats
- Industrial Internet: Big Data Analytics & IoT
- 3D Printing
- Supply Chain Transparency
- Mixed / Augmented / Virtual Reality
- AI prediction & Self-learning Machines
- Robotics & Cobots
- New Human-computer Interfaces (Touch/Brain)

Factor Clusters

COVID ACCELERATED

TECHNOLOGY /SMART

GENERAL

Here we see #1 top influencing factor by sector. COVID-19 related factors are indeed shaping the beginning of the decade, while advancements in digitalisation and automation play crucial role towards the end of the decade.

Top Factors affecting Skills *

	ALL SECTORS	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY
2020	Strict Hygiene & Biosecurity Rules	Strict Hygiene & Biosecurity Rules	Strict Hygiene & Biosecurity Rules	Strict Hygiene & Biosecurity Rules	Remote Working = New Norm	Remote Working = New Norm	Remote Working = New Norm	Resource shortages: Soil Degradation, Biodiversity Loss & Malnutritious Food
2030	Robotics & Cobots	AI Prediction & Self-learning Machines / Production Lines	Smart Infastructure Sensing Environmental & Digital Metrics	Unmanned Vehicles	Automated Coding	Customised Services	New Human-computer Interfaces (Touch, Brain)	AI Prediction & Self-learning Machines / Production Lines

Factor Clusters

- COVID ACCELERATED
- TECHNOLOGY /SMART
- GENERAL
- SECTOR SPECIFIC

Source: GEF Expert Surveys, n=350

*** Descriptions and details** of how this picture changes considerably for each sector can be found in Chapters 2, 4 & 5.

Emerging Paradigms of the 2020s

1. **SMART** From inert things to smart environments. Everything is programmable and interconnected. Cybersecurity is critical, and digitalisation drives change. New social classes defined by technological literacy can be seen today.

2. **RELOCALISED** From globalised supply chains and economies of scale to relocalised independently resilient production networks serving local communities and bioregions.

3. **CREATIVE** From standardised produce to creativity-infused products. Human-centred design, personalisation and creativity are becoming the norm across all sectors. As automation increases, technology empowers the rise of the 'creative class' — anyone can be a creator. Mass uniqueness assumes that everyone produces and consumes things that are unique. This uniqueness applies to skill sets and careers. Creativity and uniqueness will be the main value drivers of the decade, for employees and companies alike.

4. **EXPERIENCE-BASED** From alienated consumerism to participative experience-based economy. Prioritising experiences over material consumption helps bridge social, cultural divides, connecting us to the present & our environment. The consumer can become the producer & co-creator. Economic indicators (GDP, shareholder value) are no longer the ultimate goal, but become means to the greater goals of personal and relational well-being.

5. **COMPLEX / NETWORKED** From linear systems to networked complex structures. COVID-19 reminds us that everyone and everything is interconnected. Personal, societal and planetary well-being are inextricably entwined in everyday social ecosystems. Our viewpoints transition from binary, solo and siloed to multidimensional, nuanced networks and ecosystems.

6. **REGENERATIVE** From extractive to regenerative economy. From industrial revolution hierarchical command, control & conquer styles and Take-Make-Use-Lose consumption mindsets to nature-inspired, emergent, distributed, zero waste, life-centred, holistic, long-term, purposeful perspectives and abundance mindsets. Regeneration goes further than sustainable practices by focusing on improvements rather than maintaining status quo. Shifting from transactional outputs to holistic outcomes (e.g. Farming, Construction, Manufacturing) includes focusing on environmental impacts (e.g. soil health, carbon & biodiversity) & social welfare throughout the value chain, as well as traditional economic measures (e.g. yield, productivity, profit margin).

These paradigms weave together interdependently with blurred boundaries. Indeed, integration surfaced as a recurring theme throughout our research e.g. weaving combinations of skills together, and/or across sectors. "*We are now on the verge of shifting into an economic paradigm that is not about communism or capitalism; it is about recalibrating equity and sustainability into a development paradigm.*" — Achim Steiner, UNDP Administrator, 2020[6].

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[6] The Key Role of Mindsets in Human Development, Jürgen Nagler UNDP

Skills to Thrive: Critical Curricula for the 2020s

Our analysis across sectors resulted in a recurrent set of skills that appear to be fundamental, or universally critical:

COGNITIVE & FOUNDATIONAL

Internal skills of self that help an individual adapt and thrive in the increasingly complex & uncertain world. Critical thinking and learning how to learn feature heavily at the top of industry sector skills priorities, as voted for by 350 sector experts. This is echoed by a majority consensus of 120 Education & Training experts surveyed, stating the training focus should be: flexibility & openness; critical & creative thinking; systems thinking & understanding complexity.

SOCIO-ECONOMIC & CULTURAL

Relational skills that support prospering in teams and across communities & networks, catalysing groups and social cohesion. Skills from this cluster (e.g. facilitation, co-creation, social & emotional skills, user-centric approaches) are number 1 in most sectors, both now and in 2030 predictions. In 2020, collaboration is the most significant skill across sectors. E&T expert consensus on key skills: collaboration (multicultural, on/offline) & enhancing team performance (e.g. collective intelligence & AI or building trust); empathy; learning to learn & unlearn.

TECHNICAL & DIGITAL

Skills that connect to the 2020s tech reality and help use the full potential of digitized workplaces. At a general level, digital fitness becomes an essential. Big Data and Cybersecurity are considered significant this decade by all 350 sector experts surveyed across all 7 sectors, the only skills reaching this level of consensus. E&T expert consensus on key skills: mathematical & logical thinking complemented by AI skills, such as content creation, data mining & analysis.

GREEN & UNIVERSAL WELL-BEING

Skills that ensure we are building a thriving future for all life, including future generations. Regenerative,[7] sustainable & well-being skills are some of the most significant in most sectors with the notable exceptions of ICT & Manufacturing & Engineering. E&T expert consensus on key skills: understanding climate change effects & interventions, environmental management theory & technologies, applied to be regionally relevant; well-being skills (mental, physical & digital).

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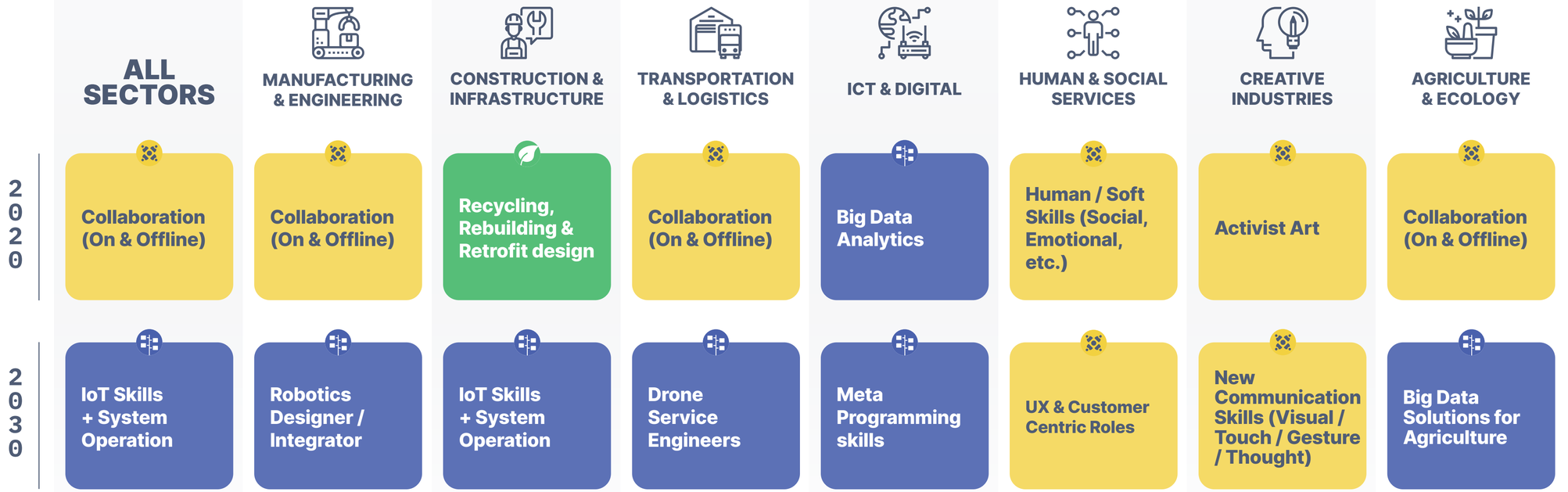
[7] Daniel Christian Wahl's *article contains a treasure trove of regenerative education resources*

Most Significant Skills *



Skills/Roles Clusters

- TECHNICAL & DIGITAL
- SOCIO-ECONOMIC & CULTURAL
- GREEN & UNIVERSAL WELLBEING

2030 skills mentioned here are rising in siginifcance during the decade. They can be seen as additional to siginificant skills in 2020, rather than replacing them.
Source: GEF Expert Surveys, n=350

* **Descriptions and details** of how this picture changes considerably for each sector can be found in Chapters 2, 4 & 5.

Implications for Education & Training 2020s

Which training areas are MOST CRITICAL to prepare for the next 10 years?

	ALL SECTORS	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY	EDUCATION & TRAINING SECTOR
1	**Adaptability, Future Thinking & Navigating Change**	**Adaptability, Future Thinking & Navigating Change**	**Adaptability, Future Thinking & Navigating Change**	**Environmentally Sustainable & Regenerative Practices**	**Cybersecurity**	**Environmentally Sustainable & Regenerative Practices**	**Entrepreneurial Skills, Customer Focus & UX**	**Environmentally Sustainable & Regenerative Practices**	**Adaptability, Future Thinking & Navigating Change**
2	**Environmentally Sustainable & Regenerative Practices**	Robotics & Internet of Things	Environmentally Sustainable & Regenerative Practices	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	AI & Big Data Analytics	Critical & Creative Thinking, Understanding Biases
3	**AI & Big Data Analytics**	Collaboration & Co-Creation (On & Offline)	3D Manufacturing	Cybersecurity	Critical & Creative Thinking, Understanding Biases	Entrepreneurial Skills, Customer Focus & UX	Systems Thinking & Understanding Complexity	Robotics & Internet of Things	Collaboration & Co-Creation (On & Offline)

Source: GEF Expert Surveys, n=502

Training Areas Clusters: TECHNICAL & DIGITAL; COGNITIVE FOUNDATIONAL; SOCIO-ECONOMIC & CULTURAL; GREEN & UNIVERSAL WELLBEING

* **More details** of sectoral differences can be found in Chapter 5.

Education Systems for the 2020s

These are key findings — i.e. majority consensus — from 120 E&T experts, supported by insights from sectors.

❖ **Teaching methods**: Virtual / remote training of practical skills & soft skills, together with simulation, role-play, gamification and team-based learning.

❖ **Teacher development areas**: Design & deliver digital / blended courses; Motivation & empowerment skills (e.g. developing student curiosity).

❖ **Assessments**: Human skills, creative capacity, life skills (e.g. mindfulness, open-mindedness, etc.); Transnational skills assessment (e.g. 'Demonstration Exams' according to WorldSkills standards)

❖ **Frameworks**: Learning ecosystems, including multilocation learning environments, community embodied learning models; VET centres / colleges as 'organisations that learn' (updating their curriculum & approaches constantly).

❖ **Collaboration opportunities to become more future-fit**:

» Global network of 'prototype spaces' to test 'skills of the future' (with Global Industrial Partners & research centres)
— Learning Labs/clubs as hub spaces for life-long learning

» Development of international skills standards & infrastructure (e.g. 'Future Skills' in WorldSkills Competitions, sustainable / regenerative economy skills training)

» Knowledge sharing between teachers, e.g. through inquiry networks, international internships, acceleration programs for VET institution teams to improve curriculum & learning methods

» Development of open and freely accessible educational resources, e.g. MOOCs (Massive Open Online Courses)

» Industry-led challenges to solve industry problems

» Creating partnerships between business & education, e.g. hybrid learning environments (combining classroom-company-outdoors-virtual space), pooling of resources, apprenticeships & internships

Stakeholder-specific Strategies

Please see chapter 6 for the full list of stakeholders, strategies and details. Key recommendations:

Education & Training, Policy

- Support teachers and learners to adopt new pedagogies and tools (e.g. digital) that empower students and encourage collaboration.
- Where possible, deregulate VET institutions to encourage experimentation, e.g. digital badging & blockchain for adaptable distributed assessments.
- Prioritise collaborations between businesses and training institutions in critical areas, e.g. collaborations in Manufacturing & Engineering and ICT, or in Agriculture (which has extreme impact on the well-being of people and planet).
- Catalyze & 'weave' local & national learning ecosystems by facilitating multi-stakeholder alliances & collaborations: learning beyond classrooms; experiential education based on real problems; catalysed by transformative learning community builders.
- Develop knowledge sharing platforms and 'integrator' roles to bridge the knowledgegap between tech developers and users in critical areas, such as sustainable / regenerative practices. Policies & practices are needed to support adoption of existing technologies. Integrators are key roles to bridge gaps.
- Design and promote an integrated approach to measure and manage economic, social and environmental dimensions, e.g. Doughnut Economics.
- Continually monitor the skills gap, e.g. quarterly 'pulse check' with a pool of businesses, educators, learners and workers. Regularly update curricula and assessment frameworks to reflect changing skills landscape (e.g. every 2 years).
- Develop freelancing & entrepreneurship policies & practices to empower those displaced to create their own jobs.
- Create standards to oversee ethical regulation of technology development (such as AI) and their educational applications.

Companies

- Close the skills gap and get closer to pool of fresh talent by forging closer relationships with educational institutions. Identify business problems that can become professional education case studies & opportunities for student problem-solving challenges.
- Foster culture of learning: encourage mentorship and apprenticeship models; cultivate teaching capacity of employees. Typically, it is cheaper to reskill, rather than hire or outsource.
- Promote adoption of advanced technology and future skills by offering employees new skills and growth opportunities.

- Create collaborative ecosystems that build ‘win win wins’ with partnersthrough the value chain/circle.
- For greater growth, communicate how your company’s purpose and culture contributes to thriving people and planet, e.g. consider which Sustainable Development Goal aligns to your mission.

Individual Learners — Students, Parents, Employees, Everyone!

- Master life skills and mindsets that are essential for the 21st century, including learning how to learn, collaboration, empathy, futures literacy and openness.
- Learn about and experiment with new technologies and practices that become mainstream.
- Take responsibility for professional development & career path, rather than expect an employer or government to unlock your full potential, passions and purpose.
- Organise learning circles that help learn skills — engaging in online courses & communities and practising on your own.
- Create student and parent committees that demand changes in education and lead dialogues on necessary changes.

Every person has the potential to shape their world — our world — with every action. To thrive today we must find new ways to listen, collaborate and adapt together. Digital fitness [8] becomes essential, bringing power and opportunity. There is hope that automation can free us to be more purposeful and creative. As our skill sets adapt to the new landscape of the 2020s, so must our mindsets: towards our thriving, regenerative future.

What does this mean for you today?

Please do continue the co-creation of our shared future!
We welcome feedback on this document at partners@globaledufutures.org or rda@worldskills.ru.

[8] We use ‘Digital Fitness’ as a proxy for digital literacy and digital intelligence, because ‘fitness’ implies conscious well-being, rather than just knowledge.

Foreword

Dear friends,

We are happy to present you with a result of a half-year project initiated by WorldSkills Russia and realized by Global Education Futures with a great support of WorldSkills International and WorldSkills member countries and regions.

This report has been contributed to by over 700 experts from 45 countries all over the world.

We started to work on Future Skills in 2015 and from the beginning we tried to make this work as practical as possible. So, the results of the first foresight projects have been implemented in competitions on Future Skills at WorldSkills Russia competitions, and the report “Skills of the Future: how to thrive in the new complex world” (2017) provided a basis and inspiration for the Future Skills zone at WorldSkills Kazan 2019. More importantly, Future Skills started to be implemented in curricula of VET and HE educational institutions.

This report has been provoked by the COVID-19 crisis and following lockdowns. At the edge of the new decade our lives changed dramatically and rapidly. The situation requires that we now live and work in the New Norm. This made us raise this question again: what are the skills we need for the future? How did COVID-19 impact skills supply & demand and how can we be better prepared for the future?

To be as practical as possible we decided to look at the situation through industries’ lenses and invited representatives of all 6 economy sectors represented in WorldSkills official list of skills, plus the crucially important sector of Agriculture and Ecology.

We believe that the outcomes, either sector-related or those that have implications for Education & Training in general, will give us a New Hope. We hope to inspire changes that will help young people (and lifelong learners) to be better prepared for the coming decade.

Ekaterina Loshkareva

Deputy Director General
WorldSkills Russia

Board Member (Strategic Development)
WorldSkills International

Editorials — Voices from Expert Community

Robert Urazov

WorldSkills Russia Director General

The year of 2020 accelerated all the trends we have observed lately and one more time proved that we are to think about the future and get ready for it. Skills and competencies are in the core of one's readiness for tomorrow and it is crucially important to provide relevant education and training for all despite the age and other factors.

Future skills Initiative has been driving changes in Russia since 2015 not only being implemented in WorldSkills projects but also changing the model of educational process in VET and HE by including short-term modules on Future Skills in curricula.

This project proved it once again that future skills are not only those related to high-tech but those demanded by labor market in foreseeable future. What is even more important that cognitive, cultural, socio-emotional and green skills have been finally acknowledge as equal to hard skills.

To possess an up-to-date skills set is important not only for a successful employment but also for self-employment and entrepreneurship. Participation in gig-economy is not only one of the growing trends but also a full-scale sector of economy with 5-45% of employers using online platforms for a job that, in many cases, also leads to new working places.

What can we do? Analyze trends, anticipate skills demand, promote, provide and support relevant educational and training programs with a focus to re- and up skilling for all and encourage change-making in E&T sector.

Editorials — Voices from Expert Community

Carolyn Hayle

Chief Executive Officer at Etalon Global Solutions
Jamaica

The most critical professional or general skills necessary in the 2020s are adaptability and a willingness to learn, unlearn and relearn.

The most important change in the education system would be to integrate skills (an appropriate mix of hard and soft depending on the sector) into the higher education system. This adjustment would result in flexible learning pathways and create a competitive and agible labour market. This adjustment would ultimately create the framework for intellectual humility and new learning.The focus for National Policymakers in professional education should be on teacher education and training, specifically, on learning to learn, unlearning and intellectual humility. This process should result in poly-maths that can create the human capital needed for systems thinking in a circular economy.

Daniel Christian Wahl

International Futures Forum Research & Innovation
Spain

In order to be prepared to meet the future you see coming, in a way that is fundamentally different from the past, we need to redesign human impact on Earth as a transformative response. Of course, there are wonderful technological applications that will be useful to us, but the real skills are actually much more in healing relationships at the local level, relationships with place, relationships to local food, to local watershed, to local ecosystem. The primary need is to bring people back into a deeper relationship with their places. **The only way to rebuild planetary health and create the abundant thriving planet that sustains the future humanity and the rest of life is by human beings becoming the healers of the places they inhabit, rather than exploiters.** Key skills: healing your local ecosystem; developing a deep relationship of custodianship and stewardship to your place, and the community of life in that place. How do you become a chemist and an innovator in the space of your local bio materials economy? Future-orientated policy should enable people and businesses to do so everywhere around the planet. In education, we need to build people's capacity to build resilience in place, and become ecosystems healers in place, deeply localised and adapting to each unique context.

Editorials — Voices from Expert Community

Marc Ian Barasch

Author, Editor, Film & Television Writer-producer

USA

Our planetary civilisation has reached a clear (and harrowing) inflection point: We must transform society's business-as-usual or face unthinkable catastrophe.

A goal of "sustainability," though laudable, is not sufficient. Our educational system now needs a transformative theory and praxis to teach (and learn) how to co-create a Regenerative Society — one based not on heedlessly extracting resources and then trying to offset its direct harms, but purposed toward augmenting the health of people and planet as its central operating principle. It is a principle that iterates across disciplines and domains: developing regenerative finance and "fintech" to flow capital toward enterprises that enhance the mutual thriving of humanity and nature; regenerative industries, whose inputs and outputs, upstream and downstream improve the ecosphere, rather than deplete it; regenerative agriculture, where biodiverse trees and crops produce food, medicine and materials while restoring and maintaining biota-rich, carbon-storing soil; regenerative urban design that increases the well-being of both the human community and the natural one; regenerative architecture and building materials that enhance clean energy, air and water; consumer goods, designed and produced in ways that help renew landscapes and seascapes, not degrade them; regenerative "make-overs" of our systems of transportation, energy, justice, governance, healthcare, and more. It may sound utopian, but in light of the evolutionary bottleneck of the current order, it is urgent pragmatism. We have no choice but to invent and inculcate radically innovative ways to address human needs while remediating the biosphere, and achieve this at a speed and scale with, as a recent IPCC report put it, "no documented historic precedent." We must seize what may be a single generational opportunity to "flip the script" on dystopia and become "solutionaries" for a new era of human and natural thriving.

Editorials — Voices from Expert Community

Shobha Mishra Ghosh

Assistant Secretary General, FICCI

India

The world of work is undergoing major changes that will continue and potentially intensify in the future or in the rapid advent of the exponential technologies like robotics, AI, machine learning, internet of things, blockchain and 3D printing. These changes are leading to the creation of entirely new industries, jobs, goods and services. Industry 4.0 coupled with demographic trends and globalisation will also impact the jobs and the skilling ecosystem.

The global workforce and the citizens will have to constantly keep upskilling and reskilling to stay relevant to the changing modern way of living and working. The skilling ecosystem needs to reinvent itself to keep in sync with this paradigm shift.

Industry 4.0 and related innovations are also creating more opportunities. While there are job losses in traditional manufacturing and services sectors due to automation, there are news jobs that are being created in new age manufacturing and services that need high-order skill sets. In 2018-19 countries like Germany, Korea, Singapore had the highest global density of automation, yet they had high employment rates. Similarly The FICCI Future of Jobs report in 2017 mentioned that in India, although automation created 10% job losses, there were 9% of jobs created in sectors like BFSI, IT& ITES, Textile, Retail and Automobile.

New consumption and production patterns, resource efficiency and emission targets will influence jobs and skills across the world that require hybrid skills such as the green electrician. As per the ILO estimates the net employment effect transitioning to a low-carbon economy will be positive with around 19 million new jobs created globally by 2030 as a result of decarbonisation of energy use and energy efficiency measures.

Due to the current pandemic situation businesses have started thinking about alternative Work from Home Models and leveraging the gig economy to the fullest. Post-covid, digital literacy, coding skills, critical thinking, creativity, problem solving, innovation, etc will be requisites to enter the labor market. The covid pandemic has also brought to the full the need for skills like social intelligence, emotional intelligence, and empathy.

Rapid technological changes, digital transformation, new Edtech skills, global and local socio-economic and environmental challenges have made university and industry collaboration critical and crucial. For building a future foresight and solving present societal challenges, industry-university partnership is the driving force and must be nurtured. For example, universities like Oxford University are collaborating with pharmaceutical and biotechnology companies like AstraZeneca and Serum Institute of India to develop a vaccine for COVID-19. In India Samsung is collaborating with IIT Guwahati and will train students on Internet of Things, embedded systems, AI, Machine learning, to make them industry ready. Industry has always complained about the skill gaps in new recruits. Apprenticeships (including virtual) with industry or social and organizations is a proven method to bridge this gap and provide Learners with real work experience.

1.
Introduction: Why Future Skills?

1. Introduction: Why future skills?

Work, disrupted

Until recently, the world of work was relatively stable. Career decisions would be taken at the beginning of professional life, and a single choice would be preserved consistently, often accompanied by staying with the same employer for decades. Even in the late 20th century, inherited careers were not uncommon, with parents passing vocation onto their children. In the 1980s, Japanese companies were proud of their life-long employment practices that could yield unprecedented productivity and loyalty from their 'salarymen' — while US and European companies were trying to master these 'best HR practices' sometimes considered the 'secret sauce' of Japanese economic miracle. [9]

In the early 21st century, however, things started to change dramatically. Exponential digital technologies, continuous managerial innovations and global hypercompetition have produced a situation where any sector or business model can potentially be disrupted and overthrown. Film photography, morning newspapers, paging telecom, mom & pop stores — these and many other familiar solutions of the recent past were going away one by one, giving way to new shiny products and formats. The rate of change in all sectors accelerated — and so did the transformation of labour markets. Today, a list of most popular jobs in the economy can get completely rearranged in 3-5 years, and whole new economic sectors may emerge, flourish and disappear in just 10-15 years. There are no guarantees that a certain career or job will remain in demand in the foreseeable future. Even the Japanese Business Federation admitted in 2019 that the lifetime employment system is 'no longer sustainable'. [10]

In 2013, Oxford Universities researchers' forecast that 47% of all jobs on our planet (2 billion jobs) could be potentially automated in a technically and economically feasible way before 2030. [11] Yet, as these figures were startling, they provoked a wide discussion, and forecasts by OECD, McKinsey and other groups indicated the range of 15-20% job displacement driven by technologies. However, what is important here is the message: the world of work is fragile, it can be destroyed by upcoming innovations, and the future holds hostage all of us. We hear that machines can be better at many vocations — they can play chess better, drive cars better, diagnose cancer better. We hear that over time humans will become dispensable, that most of the humanity will be a 'useless class'. [12]

We are entering a world that is increasingly complex and uncertain. As many researchers advise, in order to succeed and thrive in this world, we need to enhance our collaboration and our trust with each other, and should do so in ways that are increasingly sophisticated. But if any sector or any job can be disrupted, longer-term strategies become riskier and the reliability of and collaborations is waning away. There are also new challenges on the horizon that could be even more serious than job displacement by automation — humanity needs to overcome threats

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9 E.g. Peter Drucker's essay: *What We Can Learn From Japanese Management – Harvard Business Review*

10 End of Heisei Era and Lifetime Employment, Yumiko Murakami, The Japan Times

11 *The future of employment, Oxford Martin*. Coauthor Carl Frey indicated that 'being feasible' does not mean 'being certain' during WorldSkills forum sessions on 'future skills' in 2017 (Abu Dhabi) and 2019 (Kazan).

12 As described in *Yuval Harari's 'Homo Deus'*

of potential global wars using existentially lethal technologies, address the climate crisis and the unfolding collapse of the biosphere.

This situation is decidedly uncomfortable for businesses, labour markets, and regulators. It also creates new circumstances for the professional and general education & training around the world. In particular:

- Traditional models of qualification, such as diplomas and certificates, may become increasingly irrelevant — even with cutting edge training programs, their validity can only last a few years until skills transform or disappear.
- Secondary education alone will not be able to accomplish adequate vocational training and career preparation (as it was often anticipated in the past), unless it actively collaborates with businesses and research centres.
- Paid education (especially, higher education) may not have guaranteed 'payback' for the individual unless it focuses on skills that increase personal adaptability and allow it to cope with complexity.
- The curriculum of both secondary and tertiary education is also increasingly challenged, in terms of its ability to support personal and global well-being, and prepare learners for life, both now and in the future.

The idea that technological advancements jeopardise our common future and collective well-being is relatively new. Throughout the 19th and most of the 20th century, scientific & technological progress was largely presented as an undeniable 'force of good' that evidently benefited most of the society: electricity, cars, telephones and washing machines served human beings and made the human world more comfortable and reliable. Even the nuclear and bacteriological warfare, while being an existential risk for our civilisation, did not massively affect our daily lives and our lifestyles at the scale that digital technologies did. Furthermore, as the rate of technological change was then still low enough for humans to adapt to upcoming changes. So we could hardly imagine ourselves asking: why do we need humans if technologies are so much more efficient at everything?

But in the last decade the question has been asked [13] — and it demands to be answered. We need to better understand how and why humans will learn and work in the 21st century. We need to create new meanings, to draw new dividing lines between humanity and constantly evolving technology.

These lines cannot be drawn post hoc, as technologies evolve too fast, and their implications become too massive and wide-spread. We need to establish new rules of the game that will allow for a coordinated development of our civilisation, especially in the education & training sector. That is, we need to move from adaptive to pre-adaptive development:

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[13] E.g. see this discussion Do We Need Humans?, TED Radio Hour

- **Adaptive** development assumes that humans create responses to existing situations or problems, gradually moving to consensual solutions;

- **Preadaptive** development [14] assumes that humans need to anticipate possible future situations and prepare beforehand, addressing problems at the point of their emergence and not full manifestation, curbing undesired future scenarios, and generating new opportunities for desirable futures. Preadaptive development holds the idea that we are not simply preparing for the possible future — we are actively shaping the future.

The preadaptive 'working with future' concerns not only technological progress and its consequences, but also many other issues related to sustainable development and ability to overcome global risks.

In 2020 a global pandemic started, a risk forecasted by futurologists at least throughout the last decade [15]. COVID-19 pandemic is not only one of the greatest global threats to public health, it also shapes urban services, transportation, retail, education, and many other sectors. COVID challenges are better addressed by those countries, sectors and organisations that have prepared beforehand, that underwent digital transformation, created agile governance practices, [16] and developed anti-fragility capabilities — in other words, by those who acted in a preadaptive way.

These sectors and organisations are not simply the ones that are most resilient. Right before our eyes, these players start to shape new rules of the game: network-based markets & organisational structures, locally situated economies, flexible employment structures, distributed life-long learning systems, etc. COVID has accelerated change. We should ask ourselves: what is the future that emerges? To what extent this future is already being shaped by key players, such as Big Tech FAANG [17] and global banks — and to what extent it can still be influenced by all of us? What will be the role of education & training systems that can cultivate new skills and mindsets for the changing reality — and help human beings jointly address the global & local challenges they are facing? Sometimes our societies pass the 'scenario forking' or 'bifurcation point', short periods of time when, due to greater social, political or cultural instability, the impact of small groups can shape the global future of the whole civilisation.

Our future is full of fears and threats: we envisage our freedom and privacy taken by corporations and governments, we imagine our jobs, our meaning of life and maybe even our life as such taken by hostile technologies...

How can we co-create the future that is not frightening but inspirational? A future that will work not only for technological and financial elites — but for 100% of humanity [18] — or better, all living beings on Earth?

[14] Preadaptation or exaptation is a concept derived from evolutionary biology: Exaptation The notion of preadaptation in education has been proposed by Alexander Asmolov, a leading Russian expert on developmental psychology.

[15] Global Challenge 8, The Millennium Project

[16] See, e.g. Organisational Speed in the Post-COVID-19 Era, McKinsey and Company

[17] Acronym for Facebook, Amazon, Apple, Netflix, and Google

[18] In words of Buckminster Fuller: 'Make the world work, for 100% of humanity, in the shortest possible time, through spontaneous cooperation, without ecological offense or the disadvantage of anyone.'

Moving into the Hopeful Future of Work

The idea of inspirational futures for workers has been a defining thread through our own work. In 2014, collaborators [19] from SKOLKOVO and Russian Agency of Strategic Initiatives published an Atlas of Emerging Jobs, a 'compendium' of jobs of the future — one of the largest in the world.

This study has been co-created with leading national & international employers, startups, academia, regulators and NGOs — hundreds of organisations from over 30 sectors have been co-defining 'maps of the future', identifying new tasks and job roles, and describing over 200 new careers. This work has exemplified that technological and social changes bring not only threats but also many opportunities. The forecast was becoming a reality before our eyes, and many of the 'emerging' jobs of 2014 list have become regular ones in 2020. What is more important is that the Atlas has become an 'acupuncture intervention' [20] that has catalysed changes in universities, schools and regional education systems, and inspired many projects in complementary education and career advising.

The Atlas offered a positive and inspiring vision of the future: it did not threaten readers with possible unemployment or suggested to hold back the progress, but showed the world full of hopes and possibilities. Job roles described in the Atlas are only examples, there are thousands more possible careers emerging. Through their learning with the Atlas, teenagers, families, teachers, and administrators learn to comprehend and reimagine the future.

The Atlas has instigated WorldSkills inquiries and experiments [21] with 'skills of the future' that aimed at understanding the qualities of future professionals and systems that train them. Skills of the future, the joint study by WorldSkills Russia and Global Education Futures published in 2017, described a massive transition as the traditional world of industrial jobs falls under siege by automation. Standardised products and operations (envisaged as routines or algorithms) are increasingly taken over by artificial intelligence and robotics. At the same time, a whole new world of human-cenred work will flourish, established upon unique human abilities, such as creativity and empathy, that will yield a great multitude of new types of work — and the variety of tasks, skills and jobs will increase manifold. ***(Figure 1)***

The report considered several megatrends that shape the future of work. Technological progress and demographic growth increase the diversity of human occupations, i.e. increase the complexity of our civilisation. The growth of complexity requires new ways of governing, transiting from hierarchy-based to network-based organisational forms. These processes will continue in the next few decades, so a highly probable future is not the one dominated by mega corporations, but the one where complex ecosystems of product & meaning producers exist, pulling together networks of individuals, small, medium & large organisations. Workers operating in such networks are holders of unique blends of competencies and personal traits that establish their unique value propositions to communities they work with.

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19 The group that later established Global Education Futures

20 Jaime Lerner, a Brazilian urbanist, devised the idea of small scale - high impact urban intervention projects he called 'urban acupuncture'

21 Many of these prototypes were created by Ekaterina Loshkareva and WorldSkills Russia team at WorldSkills HiTech competitions in 2014-20, and in FutureSkills zone of WorldSkills 2019 Competition in Kazan.

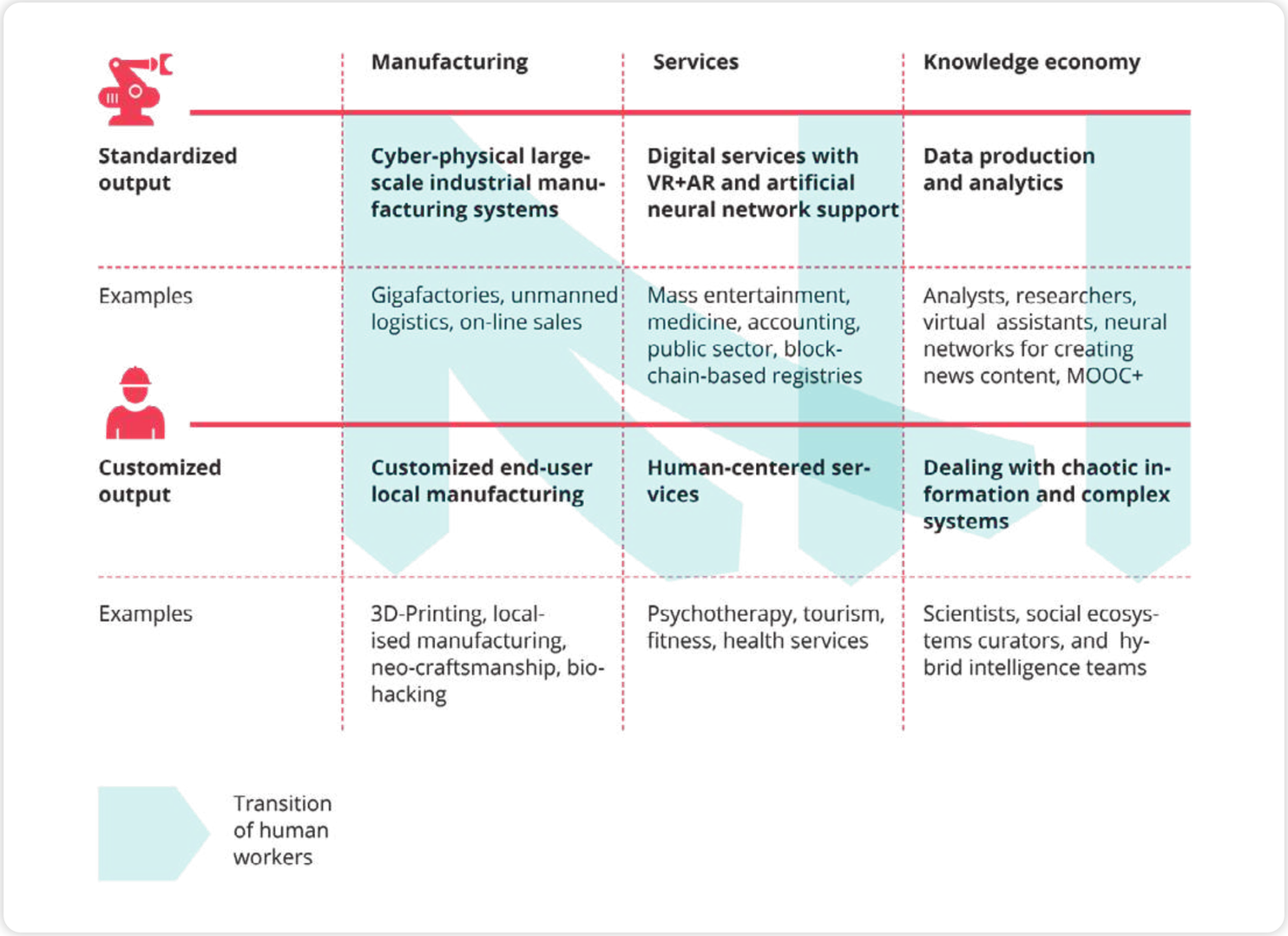


Figure 1: **Transition to Mass Uniqueness of Products and Competencies**

Source: Skills of the Future: How to thrive in the complex new world, WorldSkills Russia & GEF)

In the world where anything that is standard and routinised can be automated, the main value will be provided by products and operations that are non-standardizable — or unique. We are entering the world of 'mass uniqueness'. Specific professional skills (such as software design or machine tooling) become increasingly granulated — and also increasingly short-lived, because technological progress always has a potential to disrupt them. Therefore, the report suggested that it is important to transit from narrow specialisation to the development of 'generalist' skills that can allow one to flexibly adapt, learn and thrive in the new complex world. New skill models should prioritise human skills and existential competencies that establish the foundation for thriving and success — so it needs to become the focus of professional education & training.

The idea of 'mass uniqueness' was further elaborated in Mission: Talent, the joint 2019 report by WorldSkills Russia, Rosatom & BCG. The report estimates that the transition towards a mass uniqueness model will create an additional 0.5-2% annual growth of the world economy. In order to capture this opportunity, a number of systemic policies should be established ***(Figure 2)***, including changes in the labour laws and principles behind VET system organisation. However, a number of important transitions should also occur to the basic competence model of workers. First, every worker should prioritise life-long employability, constantly seeking opportunities for life-long learning in the workplace, within higher and complementary education, etc. Second, professional education & training should focus on developing a fundamental skill set that includes creative and critical thinking, digital skills, etc. Finally, among the most critical skills are those that support professional self-sustainability, such as an ability to establish & navigate a personal career development pathway, to create a personal learning journey, to connect and learn with professional communities of choice, to promote oneself within those communities.

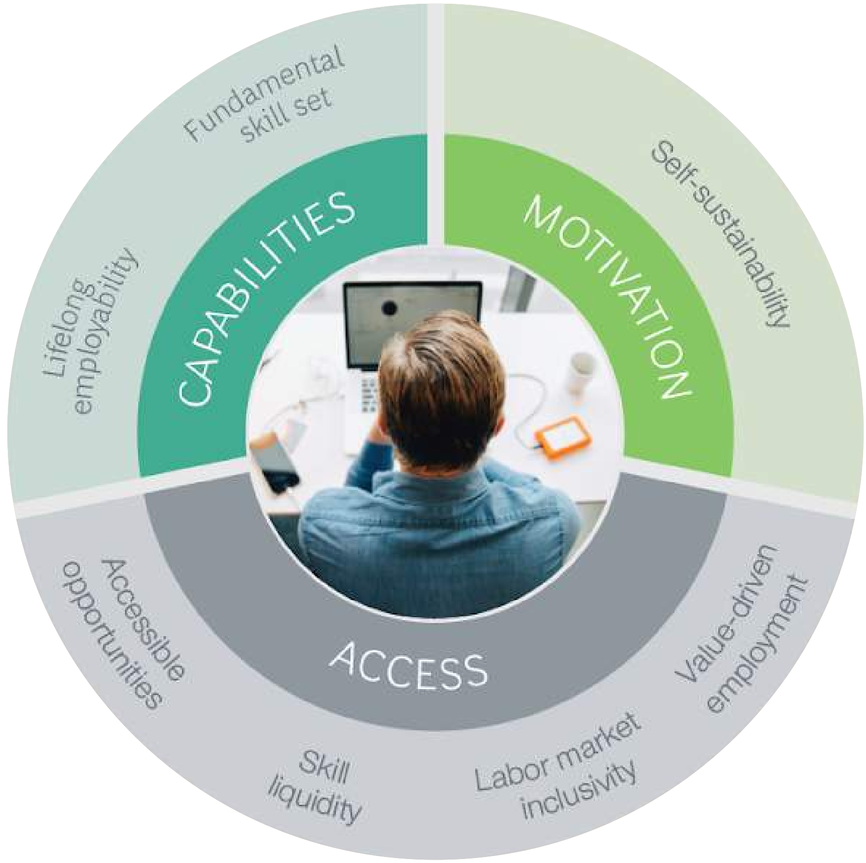


Figure 2: **The Principles of a Human-centric System in service of Mass Uniqueness**

Source:'MISSION TALENT: MASS UNIQUENESS. A Global Challenge for One Billion People', WorldSkills Russia, Rosatom & BCG

The ideas of the 2017 and 2019 reports have evoked the WorldSkills Kazan 2019 Skills Declaration that establishes principles of human-centric talent management system. Kazan Declaration claims the need of 'skills of the future for everyone': that every person should receive a set of competences for employment, including basic and cognitive skills, as well as social, cultural, green and digital competences. Opportunities for personalised development and mobility, and respect for individual traits and values should all become part of the new system. The Declaration suggests that professional development needs to happen in human-centric ecosystems for life-long learning and career opportunities. This report you read now carries forward the main inspiration of these earlier studies, prototypes and visionary statements: we need to explore and materialise the positive future of work and skills. A clear and consolidated vision of the future is required, that includes voices and positions of all key stakeholders. We also recognise that the world is changing right in front of our eyes: the COVID pandemic and its consequences create the 'new world order', and the earlier we begin to explore possible scenarios, the better we can prepare ourselves for these possible futures — as the preadaptive approach suggests. This is why Global Education Futures and WorldSkills Russia with the support of WorldSkills International have brought together hundreds of business and vocational education experts from over 40 countries for the world to participate in visionary sessions that explored the future of skills and learning in the 2020s.

Our study explores sectoral tendencies and processes — and then generalises those to underscape the 'landscape of skills and jobs' that arises. We do not create an overarching set of scenarios for the future of work — instead, we help to 'reveal' the patterns encountered by sectoral experts.

Our purpose is to connect the 'future skills' concept and the idea of preadaptive system development with approaches and frameworks that can be implemented today or in the foreseeable future. We provide specific proposals for action that will help root this new paradigm in 21st century education & training systems. The future emerges right in front of us, and our own actions shape it.

Report Purpose

The COVID-19 crisis has created strategic uncertainty that is anticipated to challenge and disrupt many existing sectors of economy. The impact is expected to be multidimensional: some sectors, such as tourism and passenger air transportation, have diminished, while others, such as digital services, have been rapidly expanding. Digital transformation & automation began to accelerate as businesses tried to recover from pandemic's effects. Companies started to massively revise their business models and their risk management strategies to restore their operations and build up resilience against future risks. The global economy is visibly changing, and so skill standards and skill development strategies have to be revised in accordance with the new reality.

The purpose of this project is to gain insight into the future and reduce uncertainty for the landscape of skills and jobs in the 2020s. We do so by engaging in the co-creative 'future mapping' that helps emerging trends, technologies and business models that reshape the skills needed to thrive through the decade. Our goal is to identify the impact of sectoral transformation on skills — which skills are expected to emerge, transform or disappear — and then define implications of skills demand evolution on sectoral & general professional education.

We aim to answer the following questions:

- How will the megatrends that we have earlier identified as 'drivers of the future' (in our 2017 & 2019 reports) impact the demand for skills in various economic sectors in the 2020s? Which new factors are emerging?
- What is the impact of COVID-19 pandemic on the future of sectors and the future demand for skills in particular?
- What are the main shifts in the 'landscape of skills' that we can see, e.g. new employment scenarios?
- What will be the 'fundamental skill set' model for the next decade?
- What is the future of skills in the 2020s across main sectors of the global economy (e.g. Agriculture, Manufacturing, and Services)? What are some of the most important 'future skills' that will be demanded in those sectors?
- What are the new requirements that the world economy (and specific sectors) set to Education & Training systems? Which areas — such as curriculum, teacher training, assessment systems, etc. — can bring the most significant impact?
- What are the directions of local and global collaboration in order to evolve talent development systems and labour markets to become more future-fit?

This report supports the mission of WorldSkills: ‘to raise the profile and recognition of skilled people, and show how important skills are in achieving economic growth and personal success.’

The WorldSkills movement is currently comprised of 85 member countries and regions who cover two thirds of the world’s population. WorldSkills is one of the largest global movements committed to improve the world through the power of skills. We also hope that facts, ideas and forecasts presented in this report will help the WorldSkills community and partners to lead sectoral, national and global conversations on skills transformation and professional education changes.

WorldSkills Kazan 2019 (Opening Ceremony). 250,000 visitors saw 1,300 competitors taking part in 56 skills.

Source: *WorldSkills.org*

Who is this Report for?

- Vocational Education & Training practitioners, policy shapers, academia and media
- Global and national NGOs in the field of job markets and skills standardisation and policymaking, young people empowerment & career and professional education, including WorldSkills-related National Skills Organisations
- Businesspeople & Sector Experts
- General public of life-long learners

For the purpose of this report, we focus on global economy sectors that are some of the largest in terms of employment and valued added creation, together accounting for more than 90% of the global workforce.[22] The majority of these sectors are also in the scope of WorldSkills competitions and programs. The only sector that is not part of WorldSkills is Agriculture & Ecology — we introduce it because of its scale (over 28% or 1.3 Billion are employed in this sector worldwide), and its critical importance for the 21st century — agriculture is considered one of the main contributors to climate change and biodiversity loss, so changing its practices is vital for our collective futures. Some sectors, such as healthcare, finance and real estate, were not part of our consideration — although a number of relevant trends were considered in human centred services, ICT, and construction, respectively. These sectors are shaped by a number of technological and socio-cultural innovations that are sector-specific and can be explored in later studies.

Sectors Covered in this Research:

- **MANUFACTURING & ENGINEERING**
- **ICT & DIGITAL**
- **CONSTRUCTION & INFRASTRUCTURE**
- **TRANSPORTATION & LOGISTICS**
- **HUMAN-CENTRED & SOCIAL SERVICES** (includes Education, Health, Well-being, Fitness, Retail, Tourism & Hospitality and other services)
- **CREATIVE INDUSTRIES, DESIGN & ART)**
- **AGRICULTURE & ECOLOGY**
- **EDUCATION & TRAINING (E&T)** Professional & Vocational & Higher Education

Full descriptions of each sector can be found at the start of each sectoral chapter.

22 World Employment and Social Outlook: Which sector will create the most jobs?, ILO

Methodology

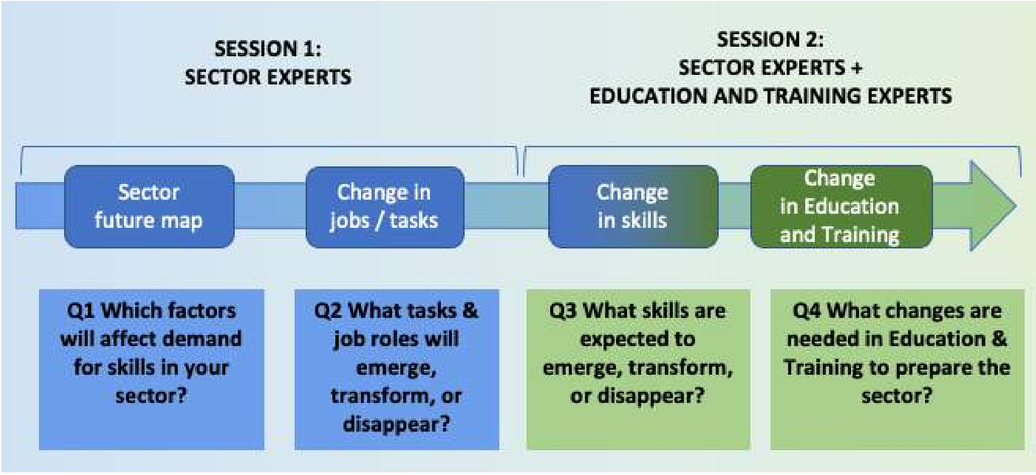
Our study was comprised as the following four-step process:

STEP 1

- **Expert selection and invitation campaign** brought together **302** sector experts from 46 countries into online foresight sessions. The project team refined the Rapid Foresight methodology (in its Skills Technology Foresight version) for online facilitation and ran prototype sessions.

STEP 2

- **17 online 2-hour co-creation sessions** were conducted. Experts (average of 17-20 per session) worked in micro-groups of 3-6, co-creating Google Doc 'future maps'.



STEP 3

- Results of explorative sessions were filtered for relevance & consistency. Key ideas were converted into **8 sectoral online surveys** that helped refine findings and reduce potential biases. **502 experts** completed the surveys. Survey results were **ranked** based on the data provided.

STEP 4

- **Final results were summarised in the present report**, including *sectoral overviews* & *future maps* (Chapter 4), factors influencing future of skills (Chapter 2), '*common denominators*' of *sectoral forecasts*, including key shifts of the economy, main transitions in the skills landscape, the emerging 'fundamental skill set' (Chapter 3), and *strategies for Education & Training sector* and relevant *policies* (Chapter 5&6). Supporting **literature research** was carried throughout the project, crowdsourced from hundreds of experts.

Our choice of Rapid Foresight as a method of future skills research comes from a decade of Global Education Futures practice. The methodology of Skills Technology Foresight that our team has created jointly with the International Labour Organisation has been proven efficient in dozens of projects conducted in over 20 countries of the world. The methodology and this project reflect the principles that we strongly believe in: deriving knowledge from horizontal communication of practitioners that engage in the co-creation of achievable visions of the future.

Future foresight is clearly beneficial when it shines a light on what we don't know. It's less about being predictively accurate, than helping us understand and navigate qualitative changes anticipated in our near and longer-term futures. Whilst we framed our questions to have participants focus on what is likely to happen, this foresight work helps us intentionally choose which pieces of potential futures we'd like to keep & which we'd like to move away from.

All factors and skills mentioned are emerging in some shape today — but many of them may still exist in a very nascent form. We asked experts when they will be significant in the sector, i.e., widespread impact, or clearly disrupting sector & transforming roles. The calculations for 'average year' can be seen in the sectoral tables. This is not intended to be forensically accurate, but can give insight to direction, timing and relative importance. We typically take longer than expected to complete complex tasks (sometimes referred to as Planning Fallacy [23]), therefore estimates here should be taken as a general direction, rather than precise predictions. That said, the rankings of skills and factors of the future can give an accurate estimate of relative sentiment and priority from the audience of experts.

We also recognise that any study like ours will inevitably have its biases. We invite contributions from all parts of the world. Our contributors originate from 46 countries spanning 6 continents. Combined, participants have over 6000 years of sector-specific experience. They represent Academia (Deans, Professors, Researchers), Business (CEOs, Charpeople, Executive Directors, etc.), E&T Practitioners (Education Department Heads, Lecturers & Teachers, WorldSkills Experts), NGO & Government officials, Media and Student learners. Details per sector can be found in the Annex. Our working group includes members from India, Russia, Europe, USA and Canada, with gender and age balance considered. [24] Our sessions aimed to encourage open communication and representation of all voices. However, we acknowledge to have biases imposed on us by our education, our cultural and professional background. We welcome voices that are underrepresented in this report — various professional and cultural communities, political, social and spiritual leaders — to engage in the global conversation to weave together a great tapestry of new skills for the 21st century, for the benefit of all.

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[23] Why do we underestimate how long it will take to complete a task?, The Decision Lab

[24] We use both British and American English in this report, as a nod in the direction of linguistic diversity. We welcome collaborators wanting to translate to other languages.

2.
Key Trends of the 2020s

2. Key Trends of the 2020s

Game-changing trends that necessitate changes in skills and education are careering towards us, faster than we have ever seen in history. Collectively these changes require us to change mindsets, to shift from adaptation to preadaptation, as our futures accelerate.

2.1 The Age of Great Acceleration

We are living in the world that is in the stage of accelerated change — and the reason for that is rooted deeply in the way our society is organised. Over the ages, humans learnt how to convert their accumulated practical knowledge (or 'technologies', both 'hard' ones, such as steamboats and aeroplanes, and 'soft' ones, such as bureaucracy and accounting) into opportunities to expand and proliferate. This process is self-reinforcing: technological development enables further population growth, greater connectivity, and technosphere expansion, which in its turn increases human knowledge and innovations.

This technological and sociocultural development allowed human beings to spread to every corner of our planet, and to adapt to any natural environment from icy Arctic to hot Sahara desert — but until very recently it was fairly slow. Things started to speed up during the Industrial Age, and in the 20th century the world's population surged from 1.6 to over 6 billion. Humanity becomes increasingly connected and empowered, and thanks to its technological advancement, humankind has been able to largely eradicate many of its existential threats, such as famine and many lethal diseases.

Today, the dynamics of a 'permanent' technological revolution continues to shape modern society. Technological revolutions provoked by critical inventions were very uncommon before or at the beginning of the industrial era: an invention, such as the steam engine, could appear once in a quarter or half a century. Today, such inventions appear every 2-3 years: in the last decade, the world saw dramatic progress in machine learning and deep neural networks; the emergence of biotechnology, such as CRISPR[25] that can revolutionise agriculture and biomedicine; and creation of many new materials. Critically, institutions that support scientific research and technological development have become catalysts of change.

However, such power comes at a high cost. Human activity is now one of the prime drivers of change in the Earth System — the sum of our planet's interacting physical, chemical, biological and human processes. ***Figure 3*** shows the exponential growth of human collective capacity and consumption, mirrored by the growth of our ecological footprint. We are living in the Age of Great Acceleration, when all of the key planetary systems — oceans, land, atmosphere and biosphere — are quickly depleted or disrupted at a pace previously unseen. This process presents massive risks for our collective futures.

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25 What Is CRISPR?, Aparna Vidyasagar, Live Science

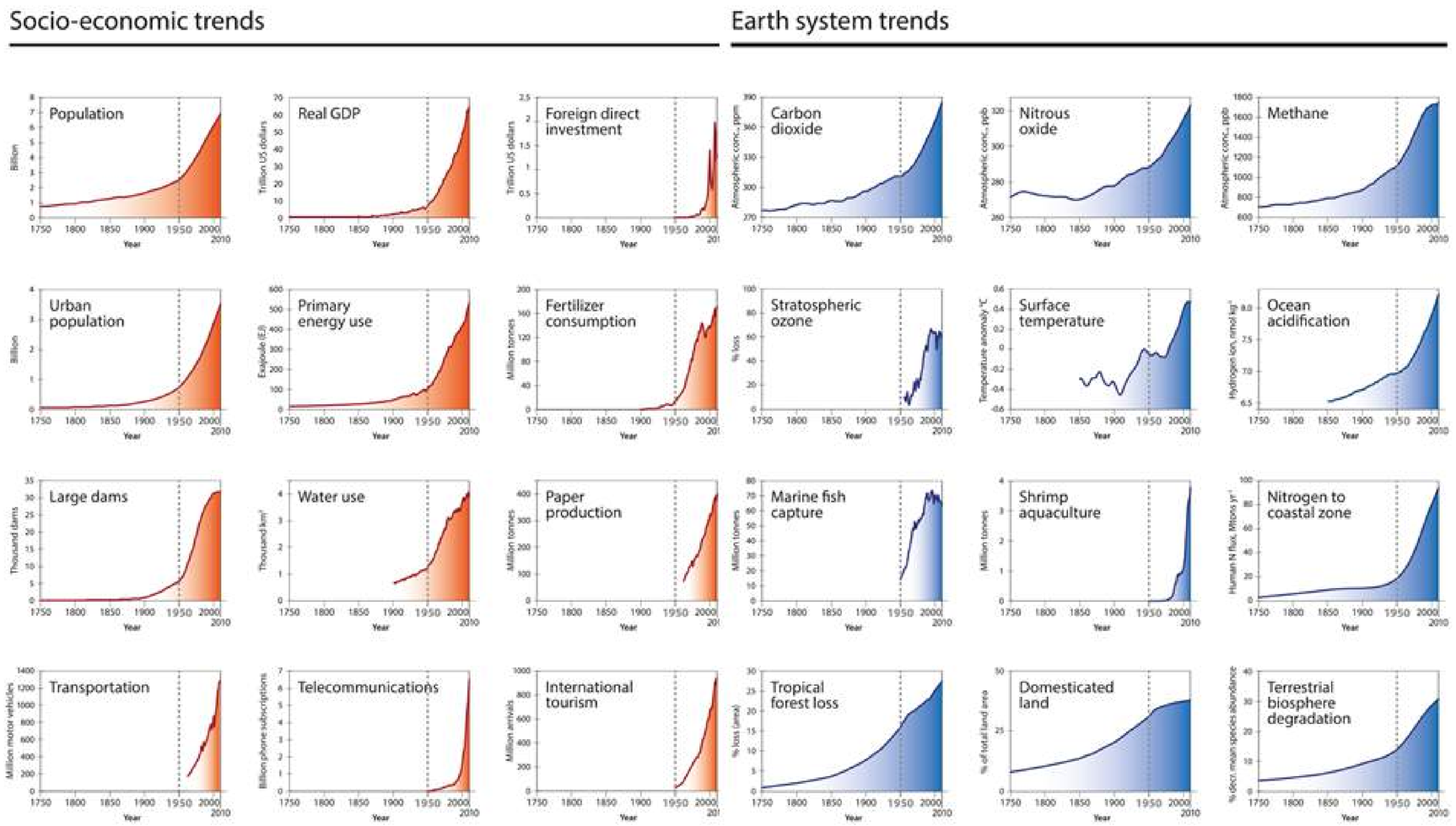

Figure 3: **Indicators of Great Acceleration**

Source: *Planetary Dashboard*

A VUCA World

As changes drive social and environmental tipping points, it also becomes evident that many human systems, including businesses and public policies, evolve at a much slower rate than the technological sector.***(Figure 4)*** Keeping up with the pace of change can be overwhelming, or impossible for some. What emerges as the reality often referred to as VUCA: volatile, uncertain, complex and ambiguous.

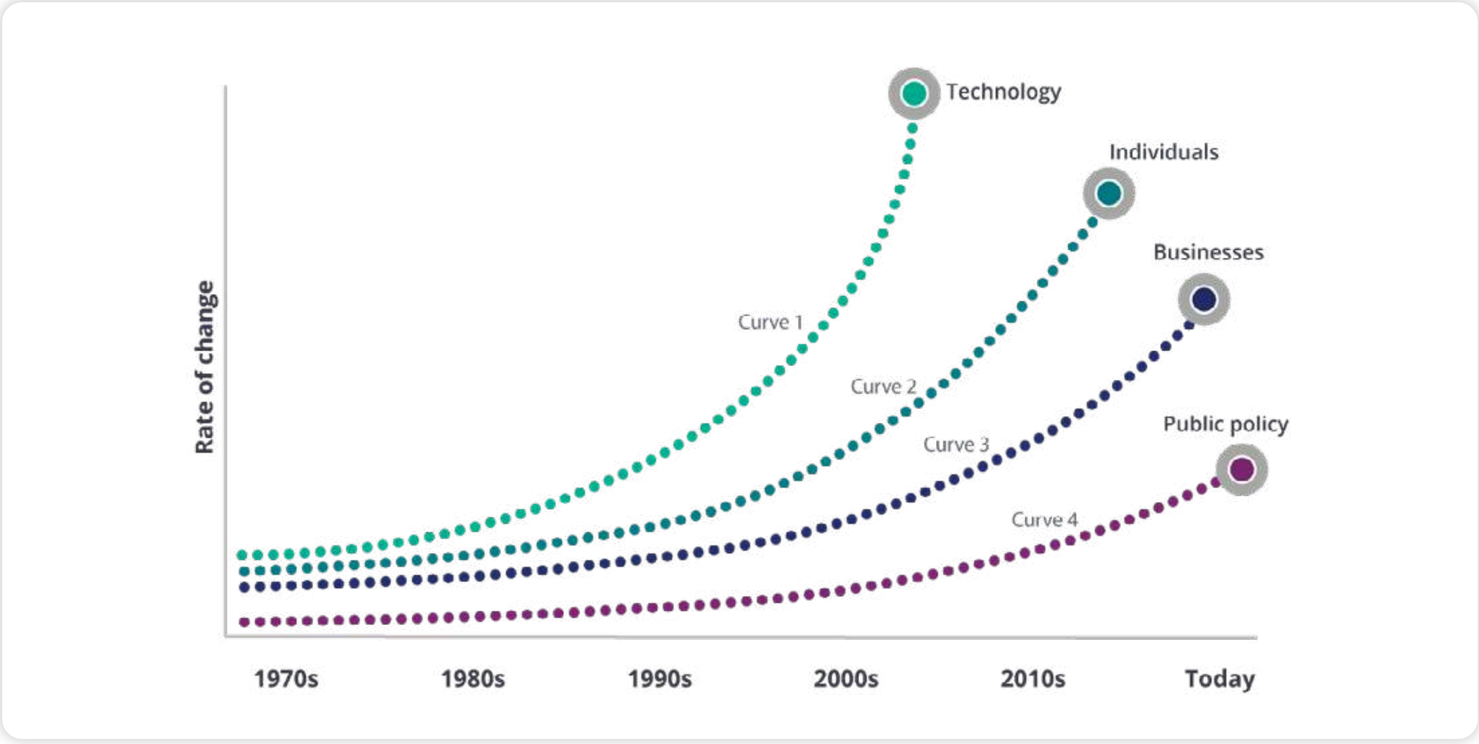

Figure 4: **Comparative Rate of Change in Human Systems**

Source: *Deloitte Insights*

VUCA is a situation of 'fundamental uncertainty' that is particularly problematic for building long term professional development strategies and career pathways. Where once a career and skill set could last a lifetime, in the near future we will all be challenged to reinvent our skill set on an ongoing basis. The very nature of skills, their direction, organisation, the way in which they are learned, form, content and location will all change.

The skills gap affects all of us, from employers, students, families, everyone. Up to 375 million workers (14% of total) may need to change occupational categories and acquire new skills by the year 2030.[26] Closing the skills gap could add $11.5tn to the economy by 2028 according to the World Economic Forum.[27]

Figure 5: **Productivity Loss due to Skills Mismatch in Various Regions of the World**
Source: Mass Uniqueness: A Global Challenge for One Billion Workers, Worldskills Russia, Rosatom and BCG

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26 How will Automation affect Jobs, Skills, and Wages?, McKinsey Global Institute

27 Closing the Skills Gap Accelerators, World Economic Forum

	VUCA	VUCA PRIME	ACTION
V	Volatility	**Vision**	Clarify purpose, focus on desired outcomes, set strategic intent (vs reaction)
U	Uncertainty	**Understanding**	Question and listen, dialogue before deciding
C	Complexity	**Clarity**	Engage with others to make sense of what is occuring, use multiple perspectives to frame a likely story
A	Ambiguity	**Agility**	Rapidly prototype possible solutions, experiment, reflect, learn and iterate (vs plan & cascade)

Figure 6: **VUCA Prime - A solution to VUCA**

Source: *Cornerstoneintegral.com*

Bob Johansen [29] showed there is a positive side to the VUCA world (he calls this VUCA Prime): "We all need some comfort and security in life. In order to thrive, beyond just surviving, people must take on dangers and turn around the uncomfortable VUCA acronym by developing the skills and state of mind that I describe as having Vision, Understanding, Clarity and Agility... We need to call attention to the challenges, but we also need provocative ways to generate believable hope". The proactive version of VUCA shows both the necessary attitude in the VUCA world, and how opportunities can be created from it.

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[29] *Get There Early: Sensing the Future to Compete in the Present*, Bob Johansen

COVID-19: A Trigger for the Next Stage of Acceleration?

The COVID-19 pandemic (hereinafter referred to as COVID) presented itself to the world as a manifestation of the VUCA World. Governments and businesses around the globe turned out to be largely unprepared to deal with the situation. Even though anticipated [30], the pandemic was a highly unlikely event – so businesses preferred to leverage global systems of manufacturing and logistics and to stay lean, rather than to build themselves up with resilience in mind. According to Nasim Taleb, the COVID crisis might not have occurred if the world as a system would have taken in Jacobsen's point. This would involve applying a positive mindset in a VUCA world: understanding possible futures and building a clear, agile vision to thrive.

The pandemic is expected to have a significant and lasting impact on skills. ***Table 1*** below shows these factors by sector. Unsurprisingly, a majority of our respondents indicated that remote working is already the new norm. These and other COVID-related factors increase the acceleration of change — and require companies and economies to be more agile and speedy than ever. [31]

% of Respondents indicating the Factor that will have a significant Impact on Skills in 2020	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORT & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY	ALL SECTORS AVERAGE
Remote Working becoming New Norm	78%	70%	89%	83%	86%	92%	61%	70%
Strict Hygiene / Biosecurity Rules in Production & Delivery	85%	80%	100%	70%	79%	70%	67%	69%
Unemployment, Jobs Disappearing & Reduced Spending	73%	77%	84%	60%	77%	73%	67%	64%
Push to more National Self-reliance & Domestic Supply Chains	50%	67%	79%	46%	60%	42%	50%	49%

Table 1: **Survey Results: COVID Factors affecting Skills.**

Source: GEF expert surveys, n=502

30 Examples: *Millennium Project Challenge 8*, *Johns Hopkins Center for Health Security* and author *Nassim Taleb*

31 Examples: *Heather McGown*, Forbes and *The Great Acceleration*, Mckinsey

Analysts and futurologists have suggested that COVID can also provoke a number of long-term changes, including:

- The speed-up of digitisation in all sectors[32]
- Relocalisation with focus on local markets and technologies that bring manufacturing closer to end consumers
- Online shopping & decline of physical shops
- Large-scale automation accelerates — due to the necessity for sectors to adapt
- Rising competitive intensity — agile & tech-driven winners capture the lion's share of industry value
- Consumers becoming more prudent and health-conscious
- Rising physical and mental health issues (e.g. stress, anxiety, OCD) driving increasing need for economies of care and connection
- Income and health inequalities — people at the bottom of the socioeconomic pyramid suffering most (including people living in poverty, elderly, disabled, youth and indigenous peoples) [33]
- Private and social sectors stepping up (the private sector plays a stronger socio-economic role, while the social sector rises) [34]

COVID also has a huge effect on skills in Education and Training, and drives arguably the most rapid large-scale change in education in history. 1.5 billion learners stayed at home because of COVID in 2020, so many educational institutions had to find ways to move lessons online, almost overnight. We have seen massive reskilling of teachers as well as students to teach and learn online, an ongoing growth-stage process, with tools and methods for online education still under development. To what extent this move online will last in the coming 'COVID-ready' years is yet unclear, but already many schools see the benefit of keeping at least part of their curriculum online, usually in some hybrid form. COVID may drive decreasing funding in many countries, where budgets may well be allocated to other sectors than education.[35] COVID also decreases international student mobility, reducing development of cross-cultural skills. But perhaps most important for education is the necessity to adapt curriculums to the future. Remote working and building digital connections are now key skills for most workers. Other emerging skills accelerated by COVID include the need self-awareness, self-soothing, adaptability, resilience and mindfulness.[36]

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32 See Section 4.4 ICT sector + *Accelerating trends in China since COVID-19*, McKinsey

33 *Everyone Included: Social Impact of COVID-19*, United Nations

34 *A Changed World By 2030: How Covid Accelerates 6 Key Trends*, Dan Bigman chiefexecutive.net

35 *The impact of COVID-19 on education insights from Education at a Glance 2020*, OECD

36 *Staying In The Green Under Covid*, Dominique Dennery

2.2 Megatrends

In our 2017 ‘Future Skills 1.0’ study, we identified five megatrends reshaping the demand for skills: digitalisation, automation, globalisation, environmentalisation & sustainability, and demographic changes. In this present study, we explored the impact these megatrends will have on skills over the next 10 years across sectors (derived from collective assessment by sectoral experts):

	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORT & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY	AVERAGE
Digitalisation	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
Globalisation	HIGH	MEDIUM	HIGH	HIGH	HIGH	MEDIUM	HIGH	HIGH
Environmentalisation	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	HIGH	HIGH	HIGH
Automation	HIGH	HIGH	HIGH	HIGH	HIGH	MEDIUM	HIGH	HIGH
Demographic Changes	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM

Table 2: Estimated Impact of Megatrends on Skills in the 2020s.

Source: GEF Expert Surveys n=350

The effects of these megatrends in the coming decade are intensifying. Digitalisation will have the highest impact on the skills needed in all sectors over the next 10 years. A number of interdependencies are quite obvious, for example, digitalisation reciprocating impact with automation and globalisation.

Digitalisation

Digitalisation, i.e. the transfer of all information types into digital form, changes our approach to almost all aspects of enterprise management, city management and personal life. Opportunities for use of digital data are enormous, as numerical data is discrete, can be stored, copied, analysed and sent practically without any restrictions. Digitalisation means many jobs will change in the coming decades, and that upskilling [37] will be continuously necessary.

Key developments related to digitalisation include:

- Hyperconnectivity: the interconnectedness of humans and digital devices, and proliferation of digital solutions into human life to the degree of omnipresence. Digital connectivity and automation rapidly enable us to connect to everything and everyone, form groups and relationships, with potentially global reach. This requires various levels of and digital fitnes.
- Shift from general digitalisation of the external world to digitalisation of personal space through virtual, augmented or mixed reality.
- Application of various digital solutions with increasing degree of complexity and autonomy, including machine learning and artificial intelligence (AI).
- The Internet of Things and the Internet of Everything (details of key concepts and impact on skills can be found in Section 2.3).
- Network society, characterised by intelligent consumption, game society, blockchain, new approaches to business organisation and hierarchy, and open innovation. Network society requires social skills, responsibility and initiative.

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[37] Upskilling is 'the process of learning new skills or of teaching workers new skills,' while reskilling is 'the process of learning new skills *so you can do a different job*, or of training people to do a different job.' - Cambridge Dictionary. We use upskilling as the umbrella term that includes reskilling.

Automation

Automation can be defined as work performed without the aid of people — hardware machines & software processes running with little or no continuous human input. Relations between humans and technology are changing at an accelerated pace. This is the result of the expansion of automated control technologies and production of material and digital products. Robots can be designed to carry out various physical tasks, and increasingly a significant automation of routine cognitive work through the expansion of systems of 'weak' AI. [38] This transforms most jobs in the 2020s, where in 60% of jobs, 30% of activities could be automated. Fully automated terminals in Rotterdam, Qingdao and Shanghai are examples — as well as some 'lights out' automated plants, such as Japanese FANUC. A kind note to humans: not all tasks can be automated yet. Some physical skills will still be superior to robotic skills this decade, such as precision motor skills, error correction and adaptation. Humans will still be superior for human skills, such as ethics, relationship building and foresight.

While impacting all areas, automation varies greatly by sector and geography. Towards the end of the decade, as robotics advancements unlock more complicated capacities, the physical & mechanical industries (manufacturing & engineering, construction & infrastructure, transportation and logistics, agriculture & ecology) will see further productivity gains and skills transformations.

The 4th industrial revolution that we are experiencing is characterized by universal digitalisation and the blurring of boundaries between physical, digital and biological fields. [39] The changes taking place involve the intersection of several trends with the key focus on automation of processes. See below:

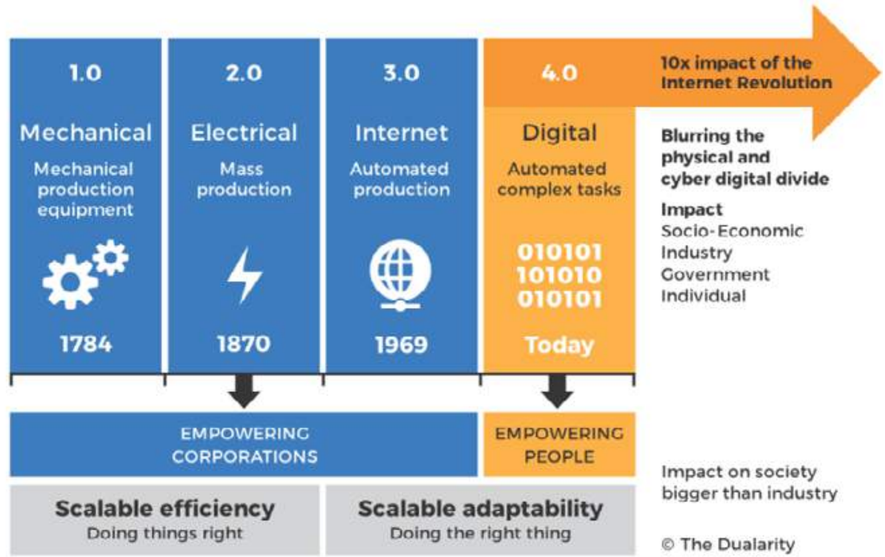

Figure 7: **Stages of the Industrial Revolution**

Source: *Olivier Van Duüren*

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38 *Rethinking Weak Vs. Strong AI*, Kathleen Walch, Forbes

39 *The 4th Industrial Revolution Is Here - Are You Ready?*, Bernard Marr, Forbes

The transition to the new industrial model implies not just an automation of separate conveyor lines of production, where devices act independently, but rather complex production systems connecting physical and digital spaces. Several compound elements lie at the base of the new industrial model:

1. Industrial robotics will allow for replacing manual labour in most routine production operations. This also applies to transport operations, where robot pilots can take over on the road, in the air and everywhere. And to routine cognitive work, like in simple services (e.g. booking and selling airline tickets).

2. Unmanned vehicles will change logistics at micro- and macro-levels.

3. New materials and additive technologies for 3D Printing complex details and elements of construction will enable flexibility and personalisation of manufacturing.

4. New communication protocols will support Internet of Things communication between devices that will enable greater humanless coordination within production facilities and throughout the supply chain (e.g. 'production area - machine - conveyor - supplier').

5. Self-learning computer networks enable constant collaboration between subsystems and interaction with external systems. This means that elements of a production system will become partly or fully self-managing.

This has far-reaching consequences for work and skills. Routine skills will decline in importance, and higher-order, non-routine, cognitive, socio-economic skills will increase in relative importance for new human jobs/tasks. As will the ability and willingness to learn to unlearn and relearn. Whether the decline of jobs by replacing humans with machines will lead to a permanent decline in the overall available number of jobs is not clear yet. New jobs may emerge that will require higher-level cognitive skills, and therefore will unlikely be replaced by further automation. Research also shows that automation is more likely to replace tasks and activities within an occupation, rather than the entire job, that greater demand due to rising incomes is likely to offset job displacement from automation, and that technology adoption may not always be economically feasible, thus, displacement due to automation may not be immediate. [40]

COVID-related automation

Some automation developments are COVID-induced.
They are mainly related to health and safety.
Some examples are:

1. 'Flippy **the burger-flipping-robot'** which helps with food safety.

2. Breezy, a robot that sprays a fog of disinfectant in airports and other highly trafficked spaces. [41]

3. Tug, a robot that that carries medical supplies up and down halls of hospitals while nurses and doctors provide the bedside manner and adaptive medical know-how.

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[40] *The rise of technology and impact on skills*, Sungsup Ra, Unika Shrestha, International Journal of Training Research

[41] Robotics partner, Build with robots

Environmentalisation and Sustainability

Humans are gaining a better understanding of the earth's ecosystem and our role in it. The Limits to Growth publication of 1972 challenged the idea of unconstrained economic growth, and raised the need to transit towards sustainable technologies and circular economies. In the first decades of the 21st century, we have crossed 4 'planetary boundaries' — climate change, biosphere integrity, land-system change and altered biogeochemical cycles (phosphorus and nitrogen). So the world may become a much less hospitable place for humans to exist — risks of soil depletion and biosphere collapse are potentially even more hazardous than the widely discussed climate crisis. This threatens our species' potential to survive on the planet much beyond the end of this century, unless our behaviour changes now. This has an impact on the skills that we need to deal with the situation that we caused: upskilling covers not just technical skills but also core/soft skills, such as environmental awareness, analytical skills, critical thinking, emotional intelligence, teamwork, innovation, communications, leadership, negotiation and influencing.[42] These form the backbone of the cultural evolution required 'to respond to the converging crises we are facing, biological evolution will be too slow, and technological evolution alone will be too full of unintended consequences.'[43]

Our understanding of our environment has also resulted in growing demand from the public/market for 'greening', in most fields of life. Various state and industry environmental policies and standards have been introduced, as have international agreements on sustainability, such as the Paris Agreement. This cooperation is needed in the future to deal with the complex issues that we face as humanity. International and cross-sectoral cooperation is critical, as well as facilitation and peacemaking competencies.

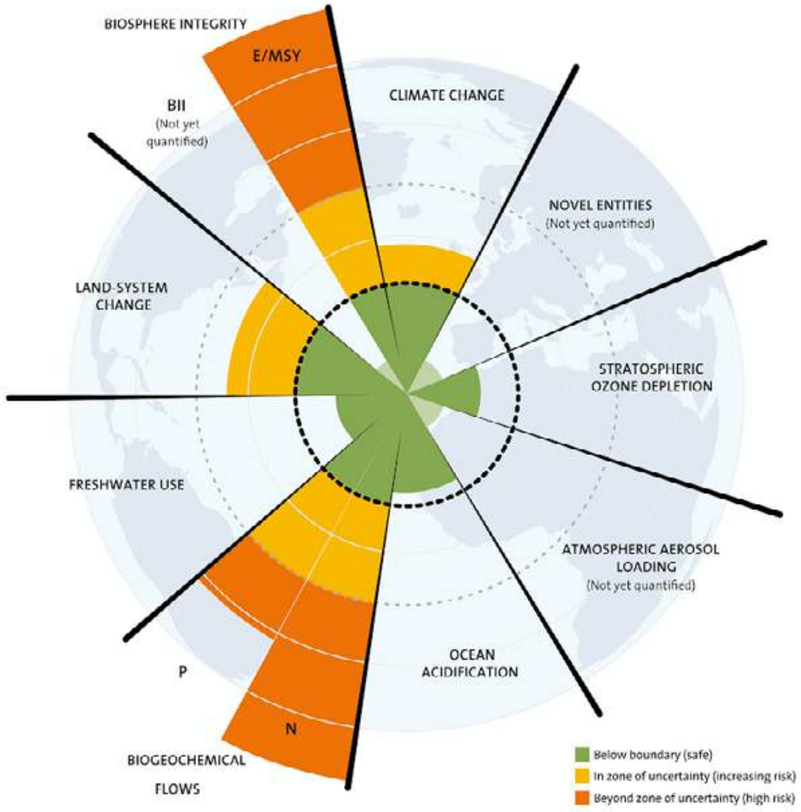

Figure 8: **Planetary Boundaries**

Source: *Stockholm Resilience Centre*

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42 Green employment skills, International Labour Organisation, and Top 5 sustainability skills to survive, NetImpact rbes

43 Green swans regeneration rising, John Elkington & Daniel Wahl.

We can already see a shift in ecological paradigms toward positive concepts.[44] The Doughnut Economy approach suggests there still is a 'safe space' of sustainable long-term operation, taking into consideration both planetary boundaries and basic human needs. The pathway out of our deadly dynamics can be seen in the transition to a regenerative economy. This transition is a paradigm shift that will require both the deployment of new technologies and the transformation of culture.

While sustainable approaches are concentrated on minimising the harm from human activities, regenerative approaches seek to undo this harm and restore all forms of natural (and sociocultural) 'capital', including biodiversity, soil, clean air and water. The regenerative economy therefore invites us to think from a different perspective: how can we act as life and begin to create conditions conducive to life? How can we design our technological and social systems to benefit not only humans but the wider tapestry of life that we are part of?

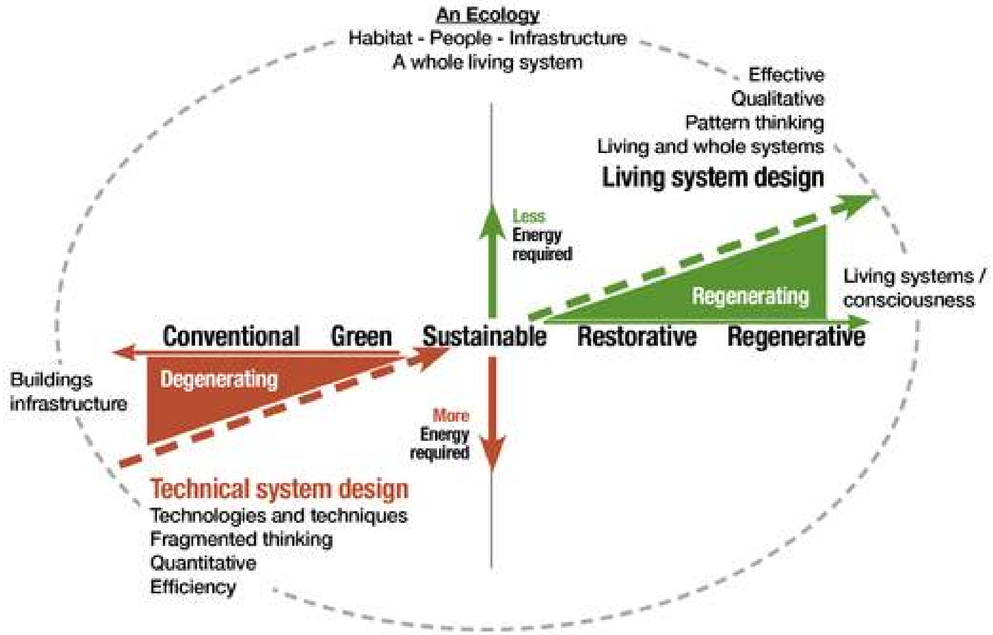

Figure 9: **Conventional, Sustainable, and Regenerative Approaches in System Design**

Source: *Regenesis Group*

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44 *Planetary Boundaries – an update*, Stockholm Resilience Centre

Many technological and organisational strategies have been identified, including:[45]

- **Regenerate.** Moving to renewable energy & materials, retaining & regenerating the health of ecosystems, and returning recovered resources to the biosphere.
- **Share.** Using peer-to-peer sharing, as well as reusing & repairing products that are also designed with durability in mind.
- **Optimise.** Improving performance to remove waste / pollution in supply chains and technological processes.
- **Loop.** Refabricating complex components and reusing / recycling non-renewable materials.
- **Virtualise.** Whenever possible, delivering virtual value instead of a physical one to reduce material consumption (Buckminster Fuller also called this strategy 'ephemeralisation'[46])
- **Exchange.** Applying renewable eco-materials / methods instead of older non-renewable ones.

These methods will inevitably require even greater socio-technical coordination and increased control over supply chains and production processes — so they very likely will be based upon the new digital and automated technologies, including AI.[47] However, regenerative solutions are often found in traditional low-tech setups — indigenous cultures have perfected ways of sustainable living over millennia, and their knowledge is often preserved as a local wisdom that allows for more efficient methods of food production, construction and manufacturing. Harvard University lists 100+ traditional solutions that can be adopted by industry to meet climate change challenges.

Education plays a key role here – learning to become the 'cradle of the future' in prototyping sustainable and regenerative approaches with young people and adults alike. Many skills to be developed are not new, but need to be focused towards economic products that do not hinder our survival as a species — including various skills that support initiating and promoting the change, enabling and delivering the change needed.[48]

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45 *The Circular Economy*, McKinsey

46 *What is Ephemeralisation and Why it Matters*, David Friedlander, Life Edited

47 *Artificial Intelligence And The Circular Economy*, Ellen Macarthur Foundation

48 *A Skills Framework for Regeneration and Planning*, Turok and Taylor, ResearchGate

Globalisation

Globalisation is both a process and an outcome of rapid technological change, escalating cross-border economic activity and liberalisation of foreign economic policies. [49] It is a centuries-old process with reality in various aspects of life, and largely overlaps with the description of hyperconnectivity (described above). Economic integration is increasing through increased flows of goods, capital, knowledge and information, as well as increasingly connected value chains, supply chains and innovation ecosystems. Skills can be enhanced by lessons learnt abroad. Technological and scientific integration requires advanced social skills and higher-level thinking, in order to understand, lead and integrate complex international and cross-sectoral technologies, standards, science/research networks and facilities. Value and supply chains are increasingly subject to international standards, e.g. WTO, ISO or the EU. Standards on logistics, whether applied to routing of physical cargo, mail or air communication, have played a key role in boosting globalisation.

As standards evolve to keep pace with the modern world, changes in the skills are required to comply with these standards. National & international skills policies need to understand where codified tasks are performed in the world / value chain, and understand the shifting nature of economic activity, e.g. offshore trends.

It is yet unclear what COVID will mean for the rate of globalisation in the COVID-ready world. Will it continue at the same pace, or slow down, or even reverse? Globalisation in terms of foreign trade has increased since WWII, but has slightly declined since 2007. [50] In 2020 COVID disrupted trade, with services traded dropping by 30% in Q2 2020. [51] BCG forecasts a significant stagnation and reorganisation of the global trade in the coming years, US-China trade being most negatively affected ***(Figure 10)***.

Our expert panel predicted that globalisation may reverse in the 2020s towards more national self-sufficiency, or towards bio-regions, and/or 'mega-blocks' of countries that have cultural, economic, physical and political proximity (Section 3.1)

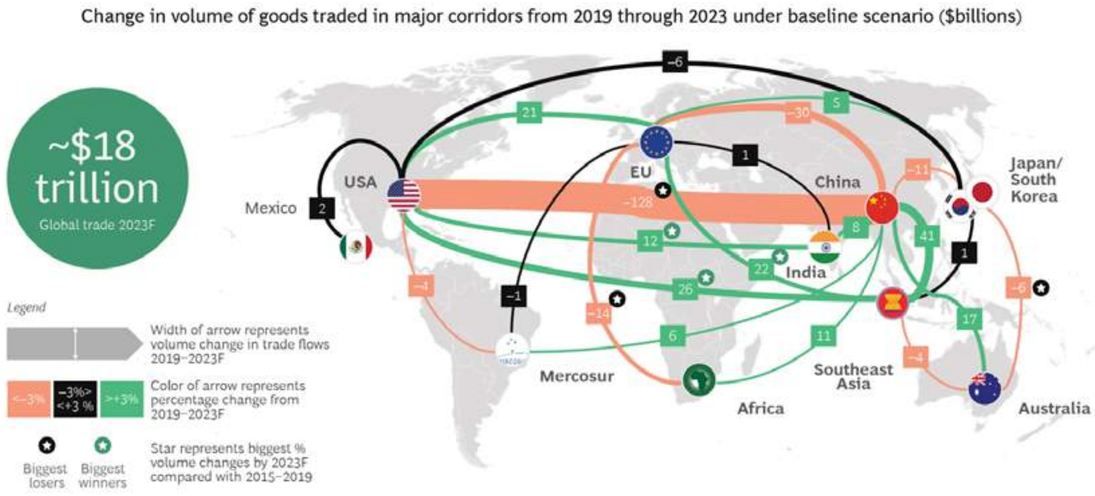

Figure 10: **Forecasted Changes in Global Trade Volumes.**

Source: *Redrawing the Map of Global Trade, BCG*

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49 *Globalisation: Causes and Effects*, David A. Deese, Routledge, May 2017

50 *Globalisation Report 2020*, Dr. Andreas Sachs, Dr. Claudia Funke et al

51 *COVID-19 and world trade*, WTO

Demographic Changes

A new social landscape emerges:

1. **EXPANSION OF POPULATION AND GROWTH OF LIFE EXPECTANCY.** The global population in 2040 is expected to rise from 7.8 billion in 2020 to 9 billion. In a time of declining birth rates across the globe, this is predominantly explained by the projected global average life expectancy rising from 62 years in 1980 to 77 in 2040.[52] This causes retirement ages to increase and pension benefits to decrease.[53] The numbers of workers above 60 will continue to increase globally, increasing the specialised need for reskilling this group. Demand will increase for other elderly service and care skills, nutritional health, digital affairs, and gerontology.

2. **THE ROLE OF WOMEN IN THE ECONOMY EVOLVES AT DIFFERENT RATES.** In OECD countries, attention is focused on women having equal opportunities to reach managerial positions and receive equal wages for the same work. In other countries a transition towards greater gender equality is just starting. Urbanisation and other social changes will lead to a significant increase in the share of women in the labour market in the Global South. This will strongly impact the distribution of skills between males and females towards a more equal distribution. Factors influencing this development are gender focus in national skills development policies and strategies, gender-sensitive training environments, opportunities for men and women in all sectors of the economy and life-long learning for women.[54]

3. In modern psychology and pedagogy, there is a trend shifting away from the **PERCEPTION OF CHILDHOOD** as a period of preparation for 'the real adult life,' towards the perception of this period of life as a self-valuable, meaningful 'here and now'.[55] This trend fits with the idea that education does not merely serve the purpose of qualification, but also of socialisation. In addition, a blurring of childhood boundaries is taking place: also in later phases of life, it will be necessary to constantly learn and relearn. The new generation ends up in a winning position, since for them most technology is a familiar part of the world in which they were born. This enables them to influence the market by creating demand or even becoming co-creators of the digital world even before they finish school. The key relevance for skills is that learning will become normal throughout life. Also, teaching skills now starts to flow from younger generations to older — for example, in training digital skills through a process of 'reverse mentoring'[56] when younger colleagues mentor older colleagues.

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52 *Forecasting Life Expectancy, Years of Life Lost, and All-cause and Cause-specific Mortality*, Global Health Metrics

53 *Pensions at a Glance 2019 - OECD and G20 Indicators*, OECD

54 *The Gender Divide in Skills Development*, ILO

55 *The Future of Childhood: Towards the Interdisciplinary Study of Children*, Prout A,

56 *Cross-Generational Mentorship: Why Age Should Be No Object*, Everwise

2.3 Factors that Drive Change in Skills Demand

Here we build on our prior publications and the preceding Section 2.2 by going into megatrends in more granular detail. In our Rapid Foresight sessions, our expert audience explored the nuances of how these megatrends will affect skills. These discussions informed our survey, the results of which can be found at the end of this section.
The following underlying factors are seen as universal across all sectors (Chapter 4 includes sector-specific trends affecting skills).

Technological Factors

Artificial Intelligence (AI) & Self-Learning Machines

AI & Automation go hand in hand. AI refers to the simulation of intelligent behaviour in computers, allowing software or hardware to perform tasks commonly associated with intelligent beings.

When will AI be ubiquitous? It is currently being developed towards commoditisation by tech giants, democratised & offered as intuitive and accessible meta-code. Programming skills reliant on maths and logic will continue to see huge increases in demand, and will remain at the core of this AI ecosystem. However, through the emergence of modular, automated & visual code, many without traditional technical skills will be able to build programs and software. This will result in organisations and individuals connected in a wider ecosystem, benefiting from this new accessible processing power.

Figure 11 shows Gartners's predictions for various types of AI. Gartner distinguishes a few key trends that boost the development of AI and AI applications. The combination of various types of AI is increasing organisational agility. Algorithmic trust models can ensure the privacy and security of data. New materials for data storage and processing like DNA and biochemistry will enable machines to take a step beyond the physical limits of silicon. Formative AI can dynamically change to respond to a situation and generative AI can create novel content. Finally, digital versions of ourselves can lead to several applications as well as vulnerabilities. Self-creating bots are one of many examples of turning points in power and our responsibility this decade.

As we witness the rise of robots this decade, AI & automation can empower us, freeing us from repetitive manual & clerical rule-based tasks. This pushes most workers further up the value chain to focus on human and cognitive skills, such as relationship-building communications, situational judgment & creative problem-solving. Yet we are probably decades away from AI reaching human levels of conscious intelligence.

Automation also creates work. We can think of automated hardware or software as workers, who need maintenance & performance reviews. Self-learning represents a significant future step for AI. Then the need to supervise machines is expected to decline, when machines will be capable of learning by themselves.

The rise of AI will allow a shift in focus to tie in with another emerging trend: customer-centric approaches across all sectors (the experience economy, design thinking putting human needs first, UX being the primary differentiator).

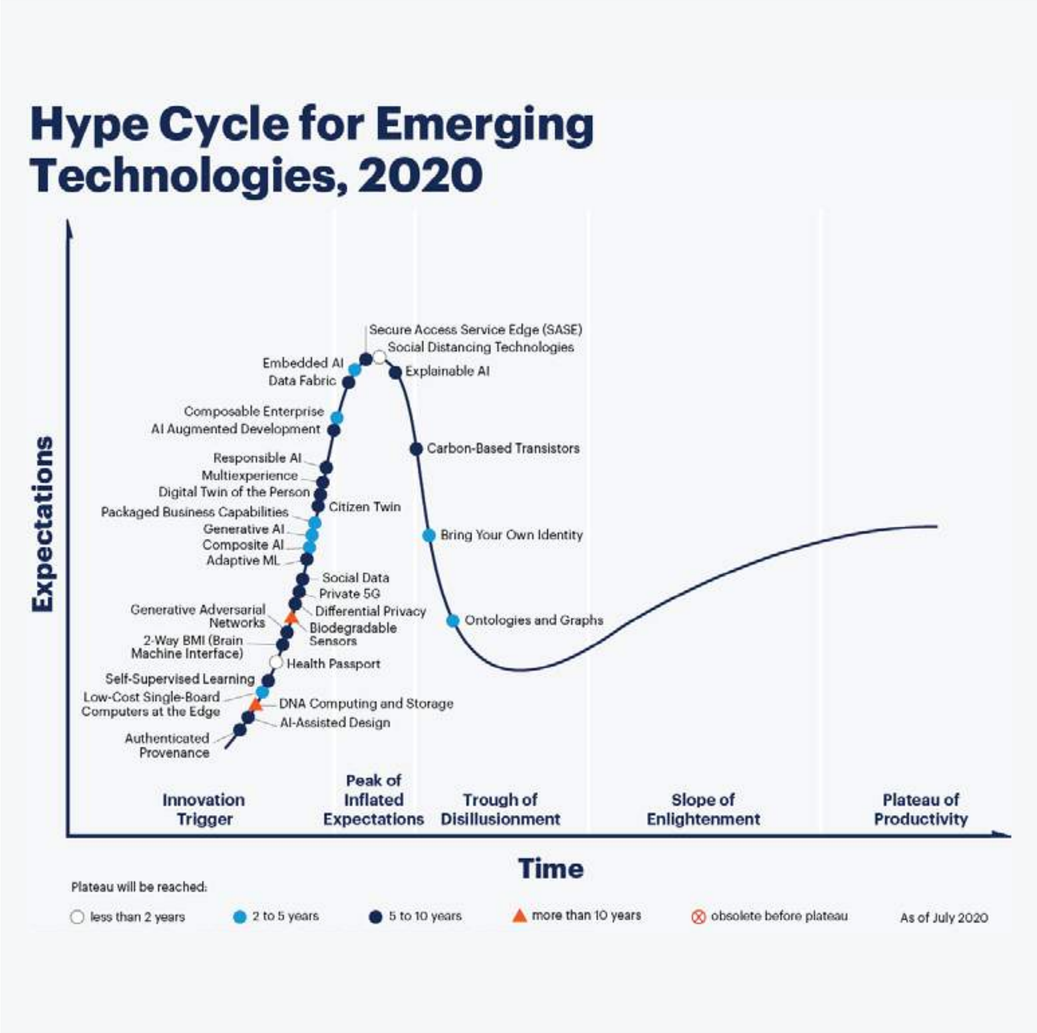

Figure 11: Hype Curve for Emerging Technologies 2020.

Source: *Gartner*

Automated Programming

A type of computer programming where program code is automatically generated. A program that writes more code is written, which then creates more programs. Translation websites may be considered as automatic programs, and the high-level language they are translating into a lower-level language is the specification.

There are currently two categories: [57]

- **Generative Programming**, or meta-programming, where programs automatically create software components, e.g. C++.

- **Source Code Generation** is developed based on a description of the problem, or with a programming tool, such as a template processor or an integrated development environment (IDE), e.g. MIT's App Inventor has drag and drop functions to visually connect software components in order to build an app, without typing any lines of code.

Coding skills are needed to create automated programming, however they will have a different nature — it is more important to understand the principle of programming and to design 'information architecture', while the coding process may be based on meta-programming, e.g. with visual interfaces.

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57 *Automatic Programming*, Techopedia

Robotics and Cobotics (Collaboration of Humans with Robots)

Robotics is the design, construction, and operation of robots. A robot is any automatically operated machine that replaces human effort. In particular, physical robots are beneficial when performing 5 'D' tasks: Dirty, Dangerous, Dear (or Expensive), and Dull or Demeaning. These robots operate every day in manufacturing, warehouse, health care, and other situations. Robots are widely used in such industries as automobile manufacture to perform simple repetitive tasks, and in industries where work must be performed in environments hazardous to humans. Many aspects of robotics involve AI. Robots may be equipped with the equivalent of human senses, such as vision, touch and the ability to sense temperature. Some are capable of simple decision-making, and current robotics research is geared toward more self-sufficiency that will permit mobility and decision-making in an unstructured environment. ***58***

Cobots, or collaborative robots, are designed to share a workspace and tasks with humans. Instead of replacing humans, cobots augment and enhance human capabilities with strength, precision, and data capabilities. Cobots are trained differently than traditional industrial robots. Rather than programmed to a specific set of steps using programming tools, many cobots are trained by humans manipulating the arms and training by example.

Unmanned Vehicles

Unmanned aerial vehicles (UAVs) or drones are the most popular unmanned vehicles currently. Unmanned aircraft systems consist of the aircraft component, sensor payloads and a ground control station. They can be controlled by onboard electronic equipment or via control equipment from the ground. UAVs support a wide range of applications such as shipping, photography, security, inspection, emergency response and environmental monitoring. They can use LIDAR (Light Detection and Ranging) imaging, e.g. surveying in 3D. Skills for use may include team working, hand skills & spatial awareness, programming, engineering & maintenance. ***59***

Industrial Internet: Big Data & IoT

The Industrial Internet of Things (IIoT) refers to the billions of industrial devices — anything from the machines in a factory to the engines inside an aeroplane — that have sensors gathering and sharing data via wireless networks. They form a communication-based ecosystem of devices communicating with cloud-based processes. IIoT refers to a subcategory

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58 *robotics | Definition, Applications, & Facts*, Britannica

59 *A Taxonomy of Skills and Knowledge for Efficient Autonomous Vehicle Operation*, Orfanou, Vlahogianni & Yannis, Semantic Scholar

of the broader Internet of Things. IoT includes IIoT plus things like asset tracking, remote monitoring, wearables and more. IIoT focuses specifically on industrial applications, such as manufacturing or agriculture. Consumer IoT devices can range from smartwatches to smart home speakers (and light bulbs, and door locks, and other smart home devices), and even shoes or clothes. Industrial IoT may have different requirements than Consumer IoT, e.g. security, interoperability, serviceability and more.

The advent of tiny low-cost sensors and high-bandwidth wireless networks now means tiny devices can be connected, given a level of digital intelligence that allows them to be monitored and tracked, and can share data on their status and communicate with other devices. Providing detailed data in real time, the IoT can help companies understand their processes better, give insight into the broader supply chain, and increase B2B coordination. Currently, IoT is of particular interest to the manufacturing, retail, utilities and transport industries. Health care and government will be big IoT adopters this decade.

Big Data Analytics (BDA) examines large amounts of data from connected devices to uncover hidden patterns, correlations and insights. Big data processing is challenging due to limited computational, networking and storage resources at IoT device-end. BDA provides operational and customer-level intelligence in IIoT systems. Manufacturers are using BDA to improve their supply chain, enhance production efficiency and quality, and identify new opportunities.

A next step for IoT is the Internet of Everything, which adds network intelligence and security that allows for convergence, orchestration and visibility across previously disparate systems:

Skills needed include: general digital fitness; data mining; understanding of coding and market intelligence; analytical problem-solving; and creativity for visualising data and finding new applications.

Figure 13: **Model of the Internet of Everything.**

Source: Quiita.com IoE vs. IoT vs. M2M

Blockchain & Supply Chain Transparency

A blockchain is a distributed or decentralised ledger, a digital system for recording transactions among multiple parties in a verifiable, tamperproof way. The ledger itself can also be programmed to trigger transactions automatically. Blockchain can greatly improve supply chains by enabling faster and more cost-efficient delivery of products, enhancing products' traceability, improving coordination between partners, and aiding access to financing. Successful blockchain applications for supply chains will require new permissioned blockchains, new standards for representing transactions on a block, and new rules to govern the system — which are all in various stages of being developed. Supply chains underpin the macroeconomy and global markets. Visibility remains a challenge in large supply chains involving complex transactions.[60]

3D Printing

3D printing, or additive manufacturing, is a process of making solid objects from a digital file. It encompasses many technologies, materials and applications across most industries. Examples include: consumer products (e.g. eyewear, footwear, furniture); industrial products (e.g. tools, prototypes, parts); prosthetics; architectural scale models; movie props, 3D printers and materials are currently expensive for consumers, so rental and sharing businesses emerge. This technology is a key driver of the trends towards relocalisation, environmentalisation, personalisation, customisation and mass uniqueness.[61] To operate a 3D printer today requires technical skills, programming skills and creative/design skills.

Cybersecurity & Privacy

Data security and privacy have a common goal to protect sensitive data. Data security focuses on protecting the data from theft and breaches, whereas privacy governs how data is being collected, shared and used. Both are already key skills for digital fitness. Cyberspace is 'the electronic world created by interconnected networks of information technology and the information on those networks. The term 'cybersecurity' encompasses measures taken to protect online information and secure the infrastructure on which it resides.[62] Businesses that handle data belonging to their customers are being increasingly scrutinised with the arrival of regulatory changes, such as the EU's General Data Protection Regulation (GDPR, 2018), designed to create a level playing field and stipulate adequate security measures to protect consumer privacy and data. Companies will often encrypt information to make it unreadable by unauthorised parties. Data security skills are increasingly important for everyone who interacts online.

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60 *Building a Transparent Supply Chain*, Vishal Gaur and Abhinav Gaiha, Harvard Business Review

61 *3D Printing Playbook*, Richard A. D'Aveni, Harvard Business Review

62 *Privacy and Cyber Security Emphasizing Privacy Protection in Cyber Security A°ctivities*, Office of the Privacy Commissioner of Canada

Mixed, Augmented & Virtual Reality (MR/AR/VR)

- **Virtual Reality (VR)** immerses users in a fully artificial digital environment. It is the most widely known of these technologies. Using a head-mounted display (HMD) or headset, you'll experience a computer-generated world of imagery and sounds in which you can manipulate objects and move around using haptic controllers while tethered to a console or PC. [63] VR can help with remote team meetings and collaboration. VR gives opportunity to build confidence on soft skills, e.g. public speaking, preparing for interviews in a realistic environment that you couldn't otherwise create. It can be combined with AI to measure things that human feedback may not achieve. It can help build personalized learning journeys that respond to the individual, adjusting the learning curve accordingly. It can break down large tasks and skill sets into smaller, more manageable learnings that are measurable. Further enhancements can be unlocked when combining with touch sensitive feedback interfaces. [64]

- **Augmented Reality (AR)** overlays digital information on real-world elements. Pokémon GO is among the best-known examples. Augmented reality keeps the real world central but enhances it with other digital details, layering new strata of perception, and supplementing your reality or environment.

- **Mixed Reality (MR)** allows you to interact with both physical and virtual items and environments, using next-generation sensing and imaging technologies. MR anchors virtual objects to the real world, so you can play a virtual video game, grab your real world water bottle, and smack an imaginary character from the game with the bottle. MR provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place, breaking down basic concepts betweenreal and imaginary, offering an experience that can change the way you game and work today. [65] This provides a way to help construction companies support complex modelling processes and improve opportunities for collaboration across projects. Imagination and reality have never been so intermingled. [66]

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[63] *VR vs AR*, Intel

[64] *Haptic – Adding a New Dimension to Virtual Reality*, FutureBridge

[65] *The difference between VR AR and MR*, Forbes

[66] *Virtual Reality Vs. Augmented Reality Vs. Mixed Reality*, Intel

Digital fitness is increasingly key to stand out in almost any 'non-tech' role, e.g. Data Analytics, Forecasting or CRM skills in Customer Care or Sales roles (#6 & #7 on the LinkedIn list above). We use 'Digital Fitness' as a proxy for digital literacy and digital intelligence, because 'fitness' implies conscious well-being, rather than just knowledge. A comprehensive framework for Digital Intelligence is offered by DQ Institute:
(see Figure 14)

At a general level, everyone now needs to develop ways to cope with information overload, filtering signal from noise, deciding what/who to trust. According to McKinsey Global Institute's Workforce Skills Model, Technological skills are predicted to grow 55% 2016-2030 in terms of hours worked, growing more than double any other skill category.

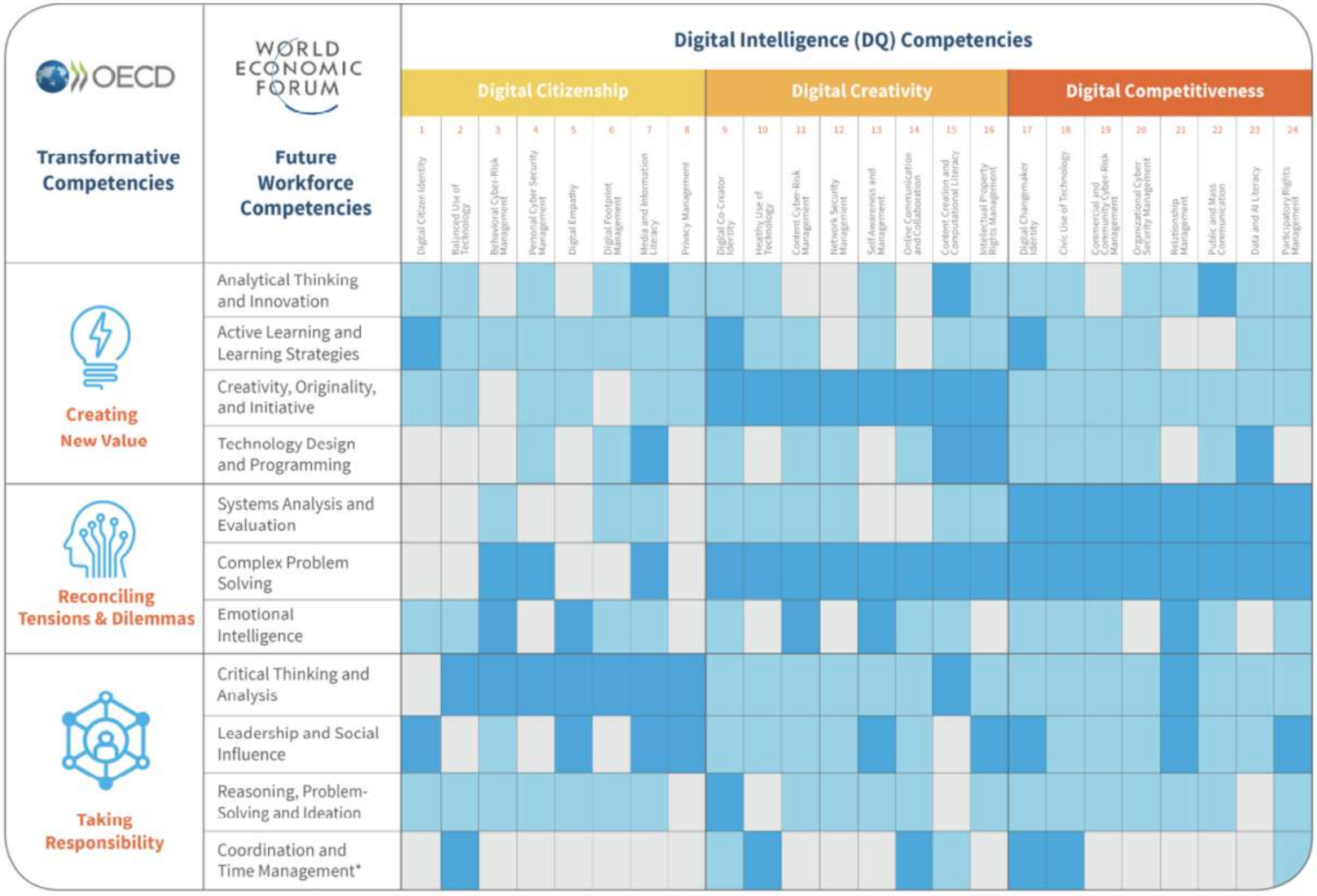

Figure 14: ***Digital Intelligence Framework*****, DQ Institute**

Socio-economic & Political Factors

Personalisation of Production: E-commerce + On-demand Small Batches

We are entering the era of mass personalisation, with increasing focus on customising offers to each individual's wishes. From a storybook with your own child as the star to ear plugs that fit seamlessly in your eardrums from your own 3D printer. This means a paradigm shift from standardised produce to creativity-infused products. The near-ubiquitous presence of the Internet and computing, together with emerging responsive manufacturing systems, such as 3D printing, present an opportunity for a new paradigm of product personalisation. Customers create innovative products and realise value by collaborating with manufacturers and other consumers. This co-design process is enabled by an open product architecture, on-demand manufacturing systems, and responsive cyber-physical system involving user participation in design, product simulation/certification, manufacturing, supply and assembly processes that rapidly meet consumer preferences.[67] Collaborative skills are needed to operate a chain of cooperation between manufacturers, vendors and consumers. Other skills needed are related to personalisation design, on-demand manufacturing systems, open architecture products, and cyber-physical systems.

Rise of Agile / Lean / Horizontal Management Structures

Several management methods have been introduced in the last few decades with the purpose of increasing productivity, flexibility and efficiency. Lean methodology involves creating more value for customers, with fewer resources, identifying riskiest assumptions and iterating rapidly through the build-test-learn production cycle. Agile aproaches have similarities, but are more focused on the development process, time-boxing and cooperation. Organisational methods such as sociocracy and holacracy further evolve these movements towards distributed, inclusive collaborations. Analytical, social and communication skills are essential.

Digital Currency replaces Cash

Paper and coin currencies account for 8% of the $90 trillion of money in the world in 2020.[68] It should be noted that paper currency volume has increased in the past 10 years[69] and still has appeal, e.g. anonymity, independence from electricity. Use of credit & debit cards, phone payment systems and online transactions are forecast to increase through the decade. Digital currencies — cryptocurrencies, such as Bitcoin, Ethereum, and the regenerative-economy's SEEDS, virtual currencies, central bank digital currencies (CBDCs) and e-cash — currently account for a fraction of a % of the global money, but are increasingly popular. COVID may accelerate the trend towards contactless payment methods for greater hygiene. While this transition may be complete this decade in only a handful of countries, this trend will increase demand for digital skills globally, cybersecurity and blockchain in particular.

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[67] *Evolving Paradigms of Manufacturing: From Mass Production to Mass Customisation and Personalisation*, S. Jack Hu

[68] All of the World's Money and Markets in One Visualisation, Jeff Desjardins, Visual Capitalist

[69] Will Cash Die Out?, Bank of England

Total Digital Monitoring

The Surveillance state is here,[70] characterised by governmental surveillance of groups of citizens. This has been cited as necessary to fight terrorism, prevent crime and social unrest, protect national security, and control the population. Conversely, mass surveillance has equally often been criticised for violating privacy rights. Digitisation delivers smart cities covered by Closed Circuit TV (CCTV), facial recognition and AI cross-referencing, and smart policing policies.[71] The Social Credit System in China is intended to standardise assessment of citizens economic & social reputation. On the commercial side, people are monitored physically and digitally in many ways, from loyalty cards to browser cookies, phone geolocation and DNA profiling. This is one of the key drivers for cybersecurity and digital privacy becoming part of 'digital fitness' for everyone this decade. See Section 3.2 for further discussion.

Permanent Loss of Jobs due to Structural Shifts

As jobs move from one country to another as a result of globalisation, or from one sector to another as a result of a disruptive innovation, or even from humans to machines, the number of jobs in some places might decrease permanently. In such cases, people need to be creative and entrepreneurial in finding a replacement for their former job, and will need to reskill.

Nationalisation of Platforms and Data

Nationalisation is the transfer of major assets from private to state control. As data becomes the new oil, the nationalisation of data, social media and marketplace platforms is the topic of political discussion in many countries. It is related to cybersecurity and privacy considerations, but also increasing public concerns that platforms manipulate user attention and serve as 'opinion polarisers', disconnecting, rather than joining the social fabric.[72] Some of the largest platforms (e.g. Facebook, Google, Amazon) have become key elements of the social infrastructure, but are in private hands. The discussion is around what access and influence should state, company and individual have over personal data? Similarly, other critical digital infrastructure, such as 5G and smart energy networks, can also potentially become a subject of nationalisation due to their influence on public and national security. The extent, to which data and its operators are nationalised, depends on the country. What this means for skills, is yet fully unknown — but we can certainly see that the present (yet largely unrestricted) development of social media calls for skills such as attention management and personal well-being management, which are frequently jeopardized by platforms' addictive mechanisms.

This study explores the impact on skills from these megatrends and factors described above. The picture is only partially revealed, and requires more collaborative research. For instance, the way in which humans will be assisted or replaced by machines is rapidly changing with every new technological development. Similarly, the way humans interact with nature will also continue to evolve, and we certainly see a transition towards nature-friendly technologies and materials. A number of clear paradigm shifts are explored in the next section.

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70 *The Surveillance State is a Reality*, Karl Maier, Bloomberg

71 *Global Expansion of AI surveillance*, Carnegie Endowment for International Peace

72 *The Social Dilemma.com*

Key Factors impacting Skills 2020

Factor Clusters: COVID ACCELERATED | TECHNOLOGY /SMART | GENERAL | SECTOR SPECIFIC

	ALL SECTORS	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY
1	Strict Hygiene & Biosecurity Rules	Strict Hygiene & Biosecurity Rules	Strict Hygiene & Biosecurity Rules	Strict Hygiene & Biosecurity Rules	Remote Working = New Norm	Remote Working = New Norm	Remote Working = New Norm	Resource shortages: Soil Degradation, Biodiversity Loss & Malnutritious Food
2	Remote Working = New Norm	Cybersecurity & Privacy Threats	Unemployment & Reduced Spending	Remote Working = New Norm	COVID speeds up Digital Transformation & increases Demand for ICT	Strict Hygiene & Biosecurity Rules	Social Media Sensationalism over Competence	Hydroponics
3	Unemployment & Reduced Spending	Remote Working = New Norm	Customisation & Personalisation	Unemployment & Reduced Spending	Strict Hygiene & Biosecurity Rules	Unemployment & Reduced Spending	Affordable Graphic Technologies	Demand for Organic / Sustainable / Fair Trade + Certified
4	National Self Reliance & Domestic Supply Chains	Unemployment & Reduced Spending	Mobile Devices & Apps for Collaboration & Management	National Self Reliance & Domestic Supply Chains	Integrated Providers of IT Service Infrastructure	Cybersecurity & Privacy Threats	Unemployment & Reduced Spending	Strict Hygiene & Biosecurity Rules
5	Cybersecurity & Privacy Threats	3D Printing	Prefabrication & Modular Construction	RFID & GPS Smart Logistics	Unemployment & Reduced Spending	Self Directed & Online & Blended Learning	Social Activism – Demand for Socially Engaged Art / Creative Work	Farm Management Software

Source: GEF + sector expert foresight sessions n=281 + surveys n=350

Rising Factors for the Decade 2021 2030

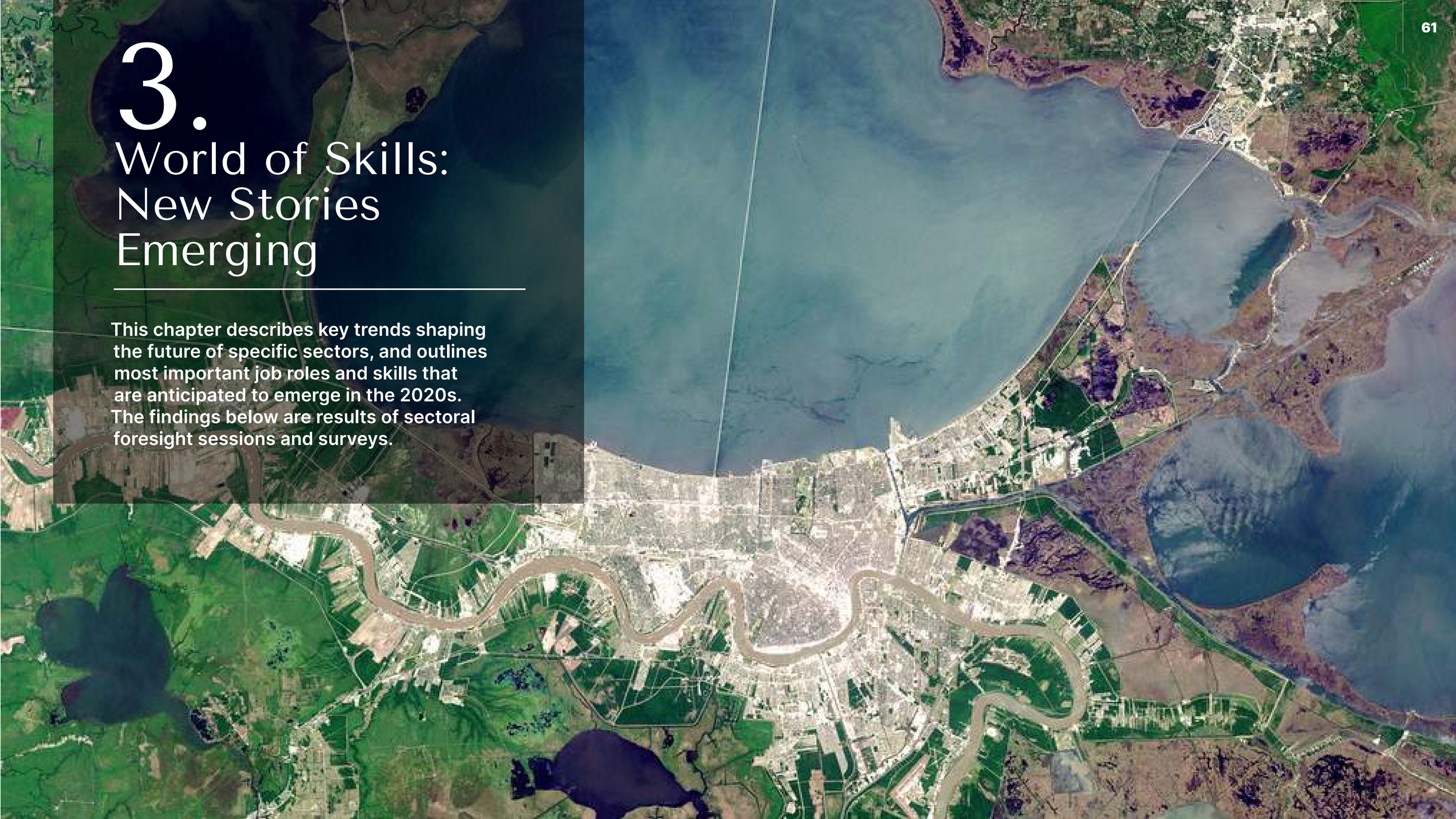
Factor Clusters: COVID ACCELERATED · TECHNOLOGY /SMART · GENERAL · SECTOR SPECIFIC

ALL SECTORS	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY
Robotics & Cobots	**AI Prediction & Self-learning Machines / Production Lines**	**Smart Infastructure Sensing Environmental & Digital Metrics**	**Unmanned Vehicles**	**Automated Coding**	**Personali-sation of Production**	**New Human-computer Interfaces (Touch, Brain)**	**AI Prediction & Self-learning Machines / Production Lines**
AI Prediction & Self-learning Machines	Robotics & Cobots	Smart and Life-cycle Optimizing Equipment	Smart Roads	Robotics & Cobots	Robotics & Cobots	Digital Currency replaces Cash	3D Printing
Supply Chain Transparency	Autonomous Manufacturing & RFID logistics	Smart Wearable Tech increases Safety, Collaboration & Efficiency	Integration of Digital Transport Network & IT	Total Digital Monitoring	Ageing Populations: Assistive Technology & Senior Services	Full Sensory Tech & Wearables in Entertainment Experiences, Clothing & Bodies	Full Year Use of Land (Cover Crops, Multi Season Harvest)
New Human-computer Interfaces (Touch, Brain)	Eco Materials & Production Modes Essential	Ecosystemic Supply Chain Approaches	Robotics & Cobots	New Human-computer Interfaces (Touch, Brain)	New Human-computer Interfaces (Touch, Brain)	Decentralisation & Crowdsourcing democratises Creativity	Gene Editing & Epigenetics
Eco Materials & Production Modes Essential	eCommerce + On Demand Small Batches	3D Printing	Electric Mobility + Battery Tech	AI-created Entertainment	Total Digital Monitoring	AI Prediction & Self-learning Machines / Production Lines	Robotics & Cobots

Source: GEF + sector expert foresight sessions n=281 + surveys n=350

3.
World of Skills: New Stories Emerging

This chapter describes key trends shaping the future of specific sectors, and outlines most important job roles and skills that are anticipated to emerge in the 2020s. The findings below are results of sectoral foresight sessions and surveys.



03. World of Skills: New Stories Emerging

The 2010s was the decade of 'future ripening': building the potential of human and physical capital [73]; countless phenomenal innovations; [74] rising momentum of civic and activist changemakers. [75] It also brought many disillusions regarding unfulfilled hopes of the early 21st century: failed promises of technological transformation; [76] a collective inability to address climate change; [77] rising tides of media mistruth and divisive politics. [78] Since the 2008 global financial crisis, it became apparent that the future of (until-then unchallenged) neo-liberal consumerist capitalism is not so bright. The world began exploring alternative pathways for economic and social development. Sometimes these pathways looked more like backward stepping — for instance, the rise of nationalist authoritarian governments or the religious fundamentalism. In other cases, they looked as far-too-radical attempts to create a better future – such as multiple projects of decentralised economies based on blockchain and cryptocurrencies, or utopian seasteading communities supported by tech billionaires. [79] The 2010s also showed glimpses of a new digitised reality, when everyone stays online 24/7, our gadgets and wearables connect us globally, help us with our daily tasks, and make our lives extremely transparent to technological companies and governments. Yet the institutions and principles of our society, from school systems to democratic elections, remained the same as throughout the 20th century.

The COVID pandemic appears to be not just another global risk factor becoming real. It is a touchstone, a test-case checking the readiness and the willingness of global society to reimagine itself and start living by new principles. And these new principles should not take for granted what has emerged so far — we should not simply assume that the remote work or the surveillance state becomes the new norm. The 2020s is a time of unprecedented risks and opportunities that will likely give a rise to a new global socio-economic model for the decades to come. We still cannot precisely anticipate the precise features of this emerging model, but the emerging trends already reveal some of its shapes and characters.

Ideas presented in this Chapter are generalized from sectoral foresight sessions (more details in Chapter 4). We can describe them as 'emergent' patterns of future skills and labour markets that are 'revealed' as common denominators across sectors.

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73 *The 2010s Have Been Amazing,* Johan Norberg, WSJ

74 *A Decade of Change: How Tech Evolved in the 2010s and What's In Store for the 2020*, Pedro Palandrani, Andrew Little Global X

75 *A Look Back at the 2010s: A Decade of Voices and Choices*, UN Population Fund

76 *The 2010s: The Decade of Disillusion*, Andrés Ortega, The Globalist

77 *The 2010s were a Lost Decade for Climate. We can't afford a Repeat, Scientists warn*, The Washington Post

78 *The Rise of the Populist Authoritarians*, Financial Times and *Post-truth: 2016 Word of the Year*, Oxford Languages

79 *Active Projects*, The Seasteading Institute

The Three Horizons model, created by Bill Sharpe of International Futures Forum, conveys the idea that social or economic system change usually comes in three waves. In the beginning of transition, the existing system or 'business as usual', Horizon 1 (H1) is dominant. As the world evolves, the existing system may increasingly fall out of place. Horizon 2 (H2) is a wave of innovations that rises to mend the shortcomings of H1. These innovations 'fix' the system, but this can be superficial, not necessarily changing the underlying premises upon which the system operates. That is the task of the wave of deep 'operating system' innovations, Horizon 3, that begin to take root as the 'transitory' H2 disrupts the existing system. Horizon 3 (H3) innovations then work their way towards economic viability, and a new system is established.

The Horizon 1 'classical' industrial model, based on mass scale production, standardisation and commodification, has dominated the past 2 centuries, but is now starting to wane. The ongoing revolution of digitalisation & automation aims to create industries that are much more flexible, modularised and consumer-focused. H2 production systems can have a greater degree of autonomy, while humans can focus on more creative and relational aspects of work. These H2 innovations do not typically address some of the more fundamental problems of the existing economic model, i.e. the challenge of operating within planetary boundaries. That challenge is addressed by Horizon 3 approaches and technologies — ecologically-friendly solutions that regenerate nature — our resources — instead of destroying. H3 approaches are in their early stages today but are expected to develop and scale up throughout the 2020s.

The emerging paradigms rising in the coming decade are Smart, Experience-based, Creative, Networked, Relocalized, and Regenerative Economic models. The present and the future are bridged by technological innovations and institutional changes, but most of all, by changes in the fundamental skill set of workers, and new ways in organising labour. Next, we discuss this through the lens of 'jobs & skill landscape paradoxes'.

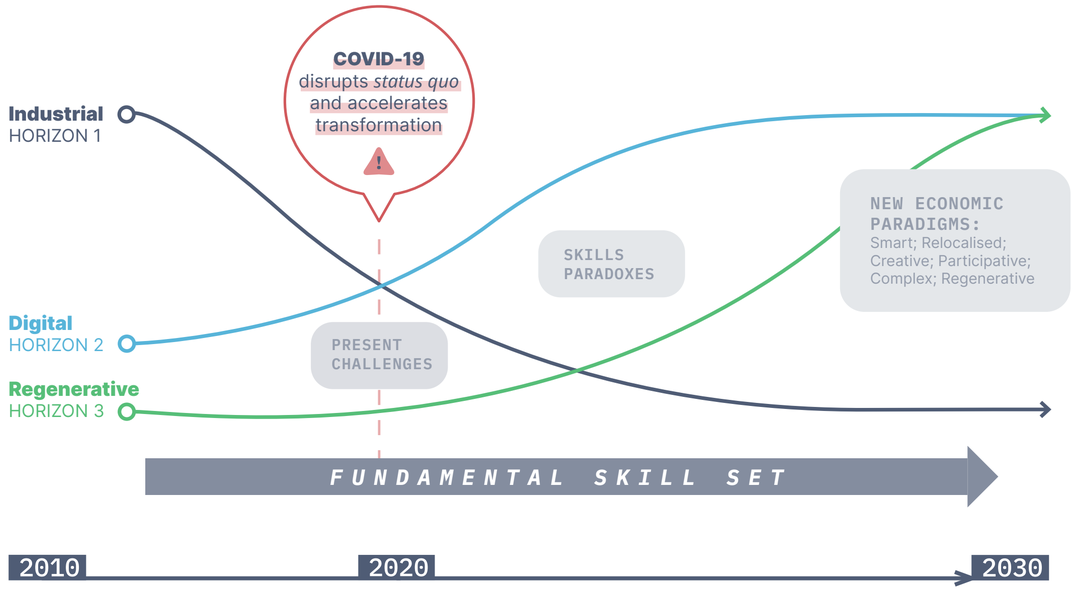
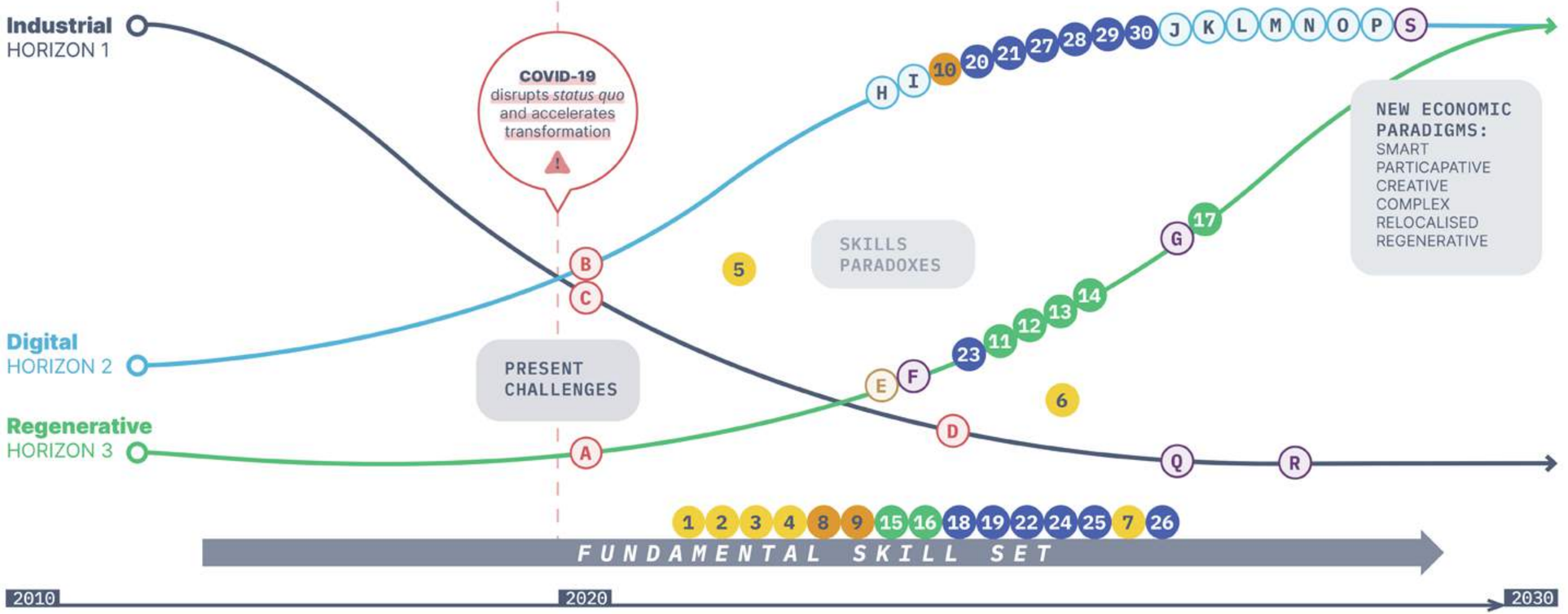


Figure 15: **Three Horizons Simplified Map of The Future**

Map of the Future — Three Horizons

ALL SECTORS



Factor Clusters

- COVID ACCELERATED
- TECHNOLOGY /SMART
- GENERAL
- SECTOR SPECIFIC

- A Strict Hygiene / Biosecurity
- B Remote Work = New Norm
- C Unemployment & Reduced Spending
- D National Self Reliance
- E Resource shortages: Soil Degradation, Biodiversity loss & Malnutritious Food
- F Prioritisation of Wellbeing (Physical / Mental / Emotional / Spiritual)
- G Eco Production Modes Essential
- H Cybersecurity & Privacy Threats
- I Industrial Internet: Big Data & IoT
- J 3D Printing
- K Supply Chain Transparency
- L Mixed / Augmented / Virtual Reality
- M Robotics & Cobots
- N Self-learning Machines & AI
- O Smart Infastructure
- P New Human-computer Interfaces (Touch & Brain)
- Q Customisation & Personalization
- R Permanent Job Loss due to Structural Shifts
- S Total Digital Monitoring

1. Collaboration (On & Offline)
2. Facilitation & Co-creation
3. Human Skills: Social & Emotional
4. Diversity, Equity, Cultural Awareness
5. Multidisciplinary Cross-sectoral Catalysts
6. Translator between Sectors/ Alternative Economic Paradigms
7. User-centric Design/ Approaches
8. Ethical Practices, Critical Thinking, Understanding Biases
9. Learning How to Learn & Unlearn
10. Navigate accelerating Change
11. Eco-fuel Scientists & Researchers
12. LifeCycle Analysis: Cost, Social & Eco
13. Circular Economy Specialist
14. Green Advocate
15. Regenerative & Sustainable Skills
16. Mental Health & Wellbeing Design
17. Learning to Reconnect with Nature
18. Big Data Analytics
19. Cybersecuity
20. IoT Skills + System Operation
21. Licensed Drone Operators & Engineers
22. Training / Programming AI
23. Business Continuity Manager: Restore Operations after Disruption
24. Lean / Agile Processes
25. Meta Programming
26. AR / VR / MR Skills (Use/Design/Engineering)
27. Blockchain Systems Design
28. Robotics Design & Integration
29. Service Roles = Remote Diagnostic, Programming & Maintaining
30. Quantum Computing Roles

Skills/Roles Clusters

- TECHNICAL & DIGITAL
- COGNITIVE FOUNDATIONAL
- SOCIO-ECONOMIC & CULTURAL
- GREEN & UNIVERSAL WELLBEING

3.1 Shifting Paradigms of the Global Economy

This section describes the emergent socio-economic model:
5 key ‘paradigm shifts’ and a nuanced set of trends arising in the 2020s.

From Inert Things to Smart Environments

The Institute for the Future published the 2009 report ‘When everything is programmable’,[80] and it felt like a science-fiction piece: to imagine a world where every device has an intelligent and a programmable component to support our work and our daily needs. In 2020, we are much closer to that vision. Retail and consumer services are using chatbots and automated call centres, fully automated factories and ports operate all over the world, unmanned vehicles drive on highways, and smart houses serve hot coffee in the morning. In the next 10-15 years these technologies will transit from a ‘pioneer’ stage to a ‘new normal’: we should expect the technosphere to be not only ‘smart’, but ‘autonomously smart’ — it will begin to learn and evolve on its own. The technology will be omnipresent: in 2020, almost 3.5 bn people (45% of the world population) have smartphones, and there will be over 8 bn connected smartphones by 2030.[81] By 2030, it is forecasted there will be more robots in cities than humans, with many of these robots replacing humans in their daily jobs.[82]

We are entering the world where the human-made environment will not be inert and unresponsive — every tool or device will have some ‘smart’ element, and ‘everything programmable’ becomes real. What does such a reality mean for all of us?

- **‘Everything is programmable’ does not mean we need more programmers**. In fact, we will most likely need less of them. Programming becomes highly-intuitive, looking more like a comprehensive ‘user setting’ adjustment that occurs by creating simple and easily comprehended algorithms created in user-friendly visual environments. Many of these programming actions will be easily created even by young children.

- **From Smart Things to Smart Environments.** The fact that things become ‘smart’ is only part of the topic — what is more important is that they begin to interact with each other, adjusting themselves to user scenarios.[83] We should start thinking in terms of designing environments and distributed systems of solutions that interact with individual users and human groups. For instance, we should not only design a single ‘smart lamp’, but should also think of a ‘smart lighting’ that responds to human distribution in the building. We should not just use ‘smart washing machines’, but also design solutions that help ‘smart apartment blocks’ to coordinate washing hours to balance out energy and water grid capacity load. We should not just promote autonomous ‘smart cars’, but invest into ‘smart traffic’ systems that minimise travel times for all people on the road, including pedestrians and bicyclists. Integration competencies, such as IoT integration or m2m (machine-to-machine language) communication will be highly demanded.

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80 *IFTF: When Everything is Programmable*, Institute for the Future

81 *Smartphone Users 2020*, Statista and *Mobile Phone Market Forecast | 2019*, ARPPIM

82 *A World Reimagined: 2030 is Full of Robots, Drones and Driverless Cars*, CIO and *How Robots Change the World*, Oxford Economics

83 *Classification of Smart Environment Scenarios in Combination with a Human-wearable Environment-communication*, Friess & Herwig

❖ **Cybersecurity is the number one factor to survive and thrive in complex technological environments.** Security of 'smart' solutions and environments has multiple aspects. First, it is an economic issue: a cyberattack on a 'smart' factory can halt its operation or, what is worse, can irreversibly destroy the technological process and damage the product. Cyber-criminals can steal money from electronic purses, blackmail or abuse individuals. Finally, a 'smart' environment can be used to assault a single person or accomplish a massive terrorist attack. Therefore, in the next decade cybersecurity will become essential [84] – only the appropriate maintenance of personal, organisational and collective security protocols will guarantee the well-being of people in cities and offices.

'Smart' physical environment will create a lot of opportunities and challenges – but most likely we will quickly get used to them, just the same way we are getting used to automatic doors opening in front of us in a supermarket. Perhaps many still romanticise the digital and consider it to be the driver of human development, just as the steam machines were in the early 1800s. As we get used to the fact that everything is digital, smart and programmable, it becomes a 'new norm' — just like electricity. In the early 20th century, engineers wanted to create a cult of electricity, seeing it as a transforming force for humanity (which, in many senses, it is). However, it was very soon apparent that electricity simply becomes a basic infrastructure of modern society, and that every house and every factory should be connected to the energy grid. Similarly, the 'smart' stack of technologies will become our basic infrastructure, the condition for a comfortable living — but not the essence of our future world.

From Global Supply Chains to Relocalised Production Ecologies

Twentieth century economies, largely modelled after Ford conveyor factories (such as River Rouge complex), were leveraging the 'scale economy': in order to fulfil consumer demand in cheap and high quality product (such as cars, smartphones, or soda drinks), it should be produced by millions if not billions of units. 20th century corporations tried to address two main challenges: [85] first, they had to ensure mass scale demand with advertising and marketing (quite often, by creating artificial 'wants', rather than addressing actual 'needs'); second, they had to acquire cheap resources and means of production. The Fourth industrial revolution disrupts these models. In regard to marketing, companies are using Big Data to create consumer digital profiles (or 'digital twins') that help them model consumer needs, describe existing and potential market niches, and forecast future product success with great precision. For instance, for many years Netflix was a content-delivery company that learned to personalise offerings of cinema and series movies — and with this capacity, Netflix was able to start producing its own content that can consistently get the top viewer rankings — not by the gut feeling of Netflix producers (as was normal with Hollywood film industry for almost a century), but by the precise calculation of its digital models. [86] In terms of manufacturing, AI, robotics and 3D printing enable 'mass customisation': manufacturing of unique and personalised products at the price of a mass scale product. [87]

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[84] *2020 And Beyond: What Cybersecurity Challenges Will We Face?*, Yoram Salinger, Forbes

[85] This has been discussed at length in John Galbraith's seminal book *The New Industrial State*

[86] *Has Netflix officially disrupted Hollywood?*, Thea Sokolowski, Outside Insight

[87] *3D Printing and Mass Customisation: Where Are We Today?*, AFMG

The relocalisation process begins, when, instead of expanding their global supply chains to leverage cost advantages, companies relocate their manufacturing towards the end consumers in order to increase speed to market and production flexibility. The process of relocalisation is accelerated by COVID pandemics,[88] when it became apparent that global supply chains are highly vulnerable to lockdowns and production disruptions — however, it is also a long-term change driven by the need to be closer to customers, to secure supply chains, and to make them more environment-friendly. It is highly plausible that future economies will be created around localised consumer communities — and they will appear more as independently resilient production networks and local industrial ecologies serving local consumer needs within local bioregions.[89] We use the word ecologies here as it describes the relationship between organisms and their environment. Economic regenerative ecologies are explored further later in the chapter.

It is very likely that this changing production model will affect human habitats: in the 20th century, urbanisation was on the rise, with 'hive' megacities serving as hubs of mass scale production and consumption, and shopping malls serving as central megacity public spaces that organise urban consumption and leisure. In the 21st century, and especially in the light of pandemics, the shopping mall and the megacity 'centralised' consumption model is changing, while villages, towns, small and medium cities become increasingly attractive again.

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88 *Rising Regionalisation: Will the Post-COVID-19 World see a Retreat from Globalisation?*, Peter Enderwick and Peter Buckley, UNCTAD

89 *The Future of Eco-innovation: The Role of Business Models in Green Transformation*, OECD

From Standardized Produce to Creativity-infused Products

The idea of replacing humans with technologies has been present since before the Industrial Revolution. In response to previous stages of this process, the basic idea of the 1990-2000s was to develop the 'knowledge-based economy' and 'creative economy' — in other words, to stimulate sectors where scientific, technological, and artistic creativity become the main sources of value added. However, as evident from the experience of multiple countries that have ventured on this path for the last few decades, the potential of creative sectors growth is limited.[90] You can stimulate the musical industry to produce dozens of pop stars, but you cannot have the whole national economy to be based on music alone. Many traditional occupations that can now be automated, e.g. bakery, sewing and singing, will remain the playground of artisans and hobbyists pursuing passions and creative expression. Personal relationships will remain in the human domain, e.g. the service mindset of a local baker or a tailor, their knowledge of your preferences, their satisfaction and enjoyment from providing their expertise. Therefore, the idea of humans 'competing' with robots and finding a 'refuge' in the creative economy is probably a false one. Yet creativity is indeed a key driver of value creation. The age of mass uniqueness assumes that each of us is expected to produce and consume things that are unique — and usually do so in localised and intentional communities. Global sales of customised products are currently only at 10%, but are expected to grow nearly to 30% by 2025.[91] Many jobs of the future in the manufacturing and service sectors will have a creative twist — a human-centric approach and a personal touch of creativity. This will be seen as the main value added that people will desire to engage with.

Kyllönen Marjo
Head of Development Services
City of Helsinki

It is important to prepare learners to adapt or to cope with the unexpected, how to be innovative and brave to find new solutions, how to meet and solve the problems of today for the success of our societies. A transformative competence, an ability to create new value, to shape the world and our future, where well-being and sustainability is perceivable for everyone. A competence to be responsible and take responsibility, to be able to reconcile tensions.

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90 *Growing the UK's Creative Industries*, Creative Industries Federation

91 *The Future of Personalisation – and How to Get Ready for it*, Julien Boudet, Brian Gregg et al, McKinsey

From Alienated Consumerism to Participative Experience-based Economy

Consumer economy and continuing division assume a certain type of social contract: to participate in a global economic system, people have to specialise in the skill and occupation that suit them best, obtain income, and pay for other specialists' products with their money earned. In fact, this 'social contract' has led to a separation, or alienation, of people both from the fruits of their labour and from their own consumption. The materialist consumer economy in its current form is not able to fulfil the deepest human need — the need to be present, to participate, to co-create, to engage. In order to respond to this issue, a new idea emerges, that the product consumed is less important than the consumer experience obtained, and the quality of this product is (often) proportionate to the level of human engagement. As a result, it becomes increasingly important to move away from individual consumption to a community-based consumption: for instance, when you buy Nike shoes, you are encouraged to become a Nike Run Club member with your own 'peers' and 'elders' that you can train with. Another important concept is 'prosumption', when consumers acquire 'building kits' instead of ready-made products and participate in final stages of production: for instance, when someone buys Ikea or Home Depot furniture kits, they are able to share the joy of building their own furniture; and when someone buys a 'meal kit' from companies like Mindful Chef or Elementaree, they can become their own 'kitchen chef'. Prioritising experiences over material consumption also leads to 'dematerialisation' of consumption: many people prefer to spend money on travel, education, online video gaming or digital services, while living modest material lives with 'minimalist' consumption.

From Simple & Linear to Complex Systems

At the macroscale, the transition from material consumerism to participative experience economy implies that classical measurements of economic efficiency, such as GDP or shareholder return, are becoming less relevant. What is more important is indication of personal well-being (e.g. Happiness Index), of quality inner-personal relations (e.g. social and human capital measures, such as Human Development Index), as well as of good relationship between humans and nature (e.g. Ecological Footprint). The interdependency of various measures of well-being — local & global, economic & ecological — should also be underpinned, that can be captured with holistic frameworks, such as Doughnut Economics.

Furthermore, to create sustainable and regenerative economies, it is necessary to overcome the linearity, including the linear focus on 'profit maximising.' It is necessary to track and control the outcomes and 'externalities' of the production process, to design and assess the product life cycle, to recycle the waste and reuse the product. In order to create such systems, digital solutions (including RFID and blockchain) are increasingly used, enabling the creation of a regenerative network around the core business. By 2023 more than 50% of large global companies will be using AI, Advanced Analytics & IoT in various supply chain operations [92] — allowing for greater flexibility of the supply chain organisation, which can further benefit from the active use of AI technologies. [93]

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[92] *5 Supply Chain Technology Trends for 2020. Supply Chain Trends*, Lingaro Group

[93] *Artificial Intelligence and the Circular Economy*, Ellen Macarthur Foundation

Accordingly, the new business model is not the linear 'chain' (of supply and distribution) but a complex network, or even an ecosystem that often does not have one central 'orchestrator' and acts as an alliance or a partnership. Such producer/consumer systems are more similar to living ecosystems, such as forests or coral reefs, than machine-like conveyor systems. These distributed multi-stakeholder communities bring together the multitude of interconnected players that work not only to maximise their own well-being, but also the well-being of the whole ecosystem. A good example of this model are open source developer communities, such as GitHub or Linux that bring together hundreds of teams and organisations that create, share and capitalise co-created software and a personal touch of creativity. This will be seen as the main value added that people will desire to engage with.

It is natural that governance systems in such structures should differ from the ones used in 'linear' organisations. For linear organisations, the unity of action was important, and therefore the power was monopolised in the hierarchical structure by leadership teams that included top management and owners — a kind of 'hub and spokes' model where many systems are governed from a single centre. Multi-stakeholder communities assume a multitude of governance centres, with success dependent upon constant evolution, empowered 'grassroot' action, distributed decision-making and constant negotiations between participants about the future of the system. It is the ecosystemic governance model that brings forward a distributed leadership that can in the future become 'omnipresent' or 'liminal' leadership, [94] with everyone and the whole enabling system serving as a leader.

George Pór

Founder, Campus Co-Evolve

The future belongs to societies governed by wisdom, the next stage of human consciousness. Such a society has three key features. First: all social institutions are reimagined and optimised for the benefit of the full development of every citizen. Second: self-organizing collective intelligence is a high priority in all communities and organisations. Third: consequently, this society is also antifragile, which means that in response to disruptions, shocks, failures or crises, it keeps strengthening its capability to thrive and prosper.

94 The concept introduced by Nora Bateson, see *Liminal Leadership – Kosmos Journal*

From Extractive to Regenerative Economy

Since the Industrial Revolution, the main sources of economic 'value creation' has often been based on extracting this value from 'cheap' or 'free' resources, such as oppressed and enslaved workforces, and natural ecosystems. In the 17th and 18th century, American sugarcane and coffee plantations required cheap labour force, so European stock companies created a large-scale slavery system that exploited and murdered millions of people from Africa. In the 19th century, cities of Europe and North America required lighting, so whaling corporations killed hundreds of thousands of whales to harvest whale oil.[95] In the 21st century, the Amazon jungle and Siberian taiga are destroyed to produce furniture and paper, to free production spots for soybeans, or oil drilling and mineral mining. Because colonial/capitalist models often assume that nature, human culture and even well-being of foreign nations are considered to be 'free resources', the capitalist economy continues to exploit and destroy these resources. Surveillance capitalism unilaterally claims human experience as free raw material for translation into proprietary behavioural data and prediction products.[96] Unique indigenous cultures and languages, wild animal populations and natural landscapes are devastated at the rate that is unprecedented in our history. In 1972, the Club of Rome claimed with its Limits to Growth report that the present economic model is unsustainable and can only last for a few decades. In 2010, the Stockholm Resilience Centre pointed out to the 'planetary boundaries' issue: we 'overshoot' the ecological limits for our population, we destroy our natural habitat faster than we can adapt to the change we initiate — meaning our species faces the risk of extinction. In order to overcome these lethal dynamics, we have to consciously transit to a new paradigm — a 'green', sustainable and regenerative economy.

The basic idea behind regenerative economy is that all key resources in the system have to reproduce or regenerate — and therefore, nature-like (biomimetic) & cyclical solutions and regenerative design need to be used to restore nature, as well as health and well-being of human communities.[97] Natural solutions are also optimal to address global issues, such as climate change. For instance, planting grass and trees absorbs greenhouse gasses, and creating a billion hectares of new forests could keep temperature increase by 2050 below 1.5ºC vs pre-industrial levels.[98] Global companies adopt regenerative solutions to take responsibility for their resources and production processes: e.g. Unilever has established a global redesign of its supply chains, so that all of its supplying farmers also restore soil and biodiversity in the areas of their operation.[99]

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95 *They Used to Say Whale Oil Was Indispensable, Too*, The New York Times

96 *'The Goal is to Automate Us': Welcome to the Age of Surveillance Capitalism*, John Naughton, The Guardian

97 *Forum: Shifting from 'Sustainability' to Regeneration*, Bill Reed, ResearchGate

98 *Examining the Viability of Planting Trees to Help Mitigate Climate Change*, Alan Buis, NASA Global Climate Change

99 *Unilever sets out New Actions to Fight Climate Change, and Protect and Regenerate Nature, to Preserve Resources for Future Generations*, Unilever

The regenerative economic growth model assumes that human prosperity is directly connected with the flourishing of territories (e.g. bioregions [100]) and all life, including future generations. If 20th century market economies were capital-centred, and modern economies become human-centred, then, in order to survive and thrive in the 21st century, we should create systems that are life-centred and relational. These systems explore our relationships with self, others, places and other beings. The economy of the future should serve all living beings (and not just human beings) — this is the condition for universal well-being and economic prosperity as a part of the endless 'web of life' that we are all a part of. [101]

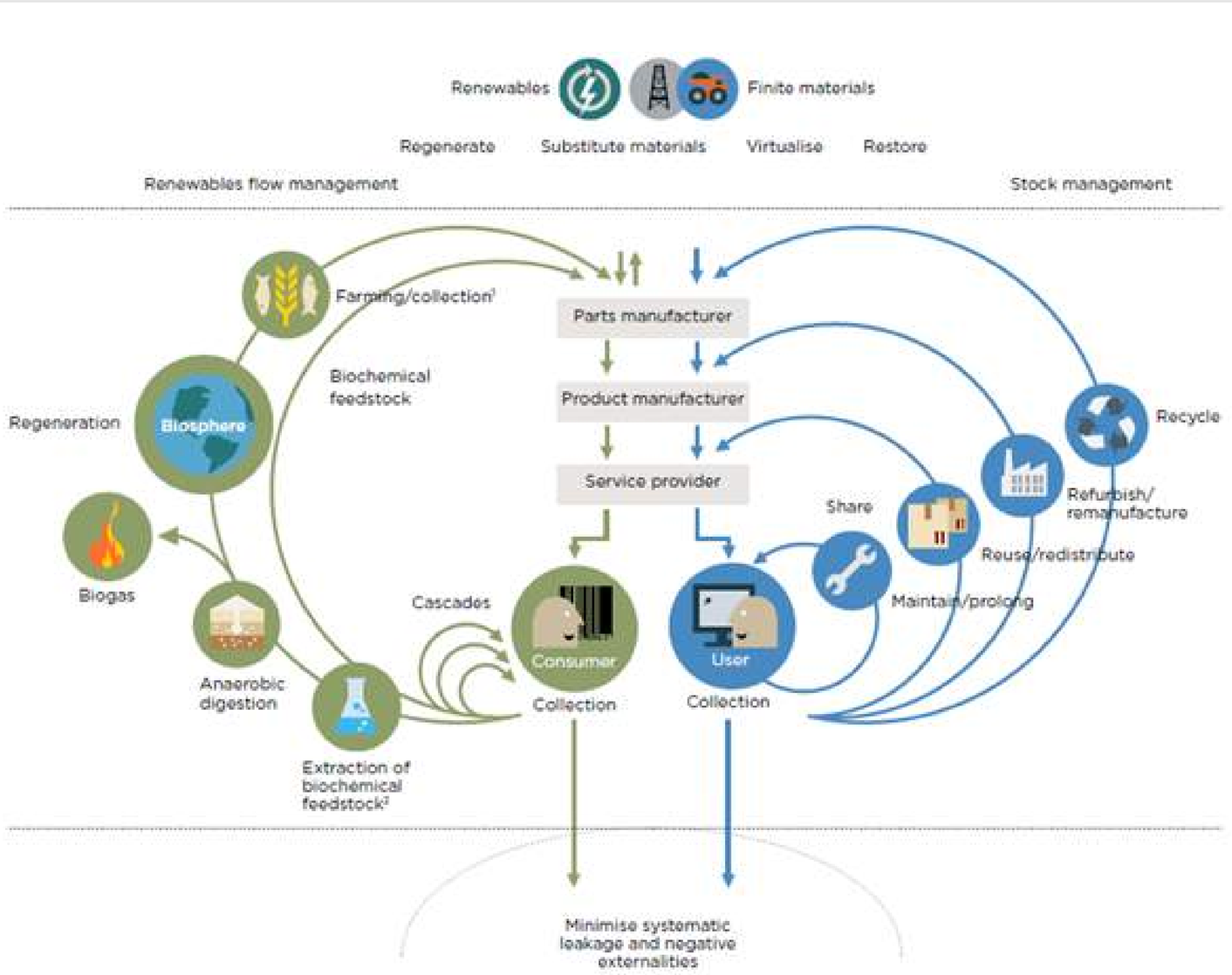

Figure 16: **Key Models of Regenerative Economy**

Source: McKinsey & Ellen MacArthur Foundation

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[100] *A Bioregional Economy: A Green and Post-capitalist Alternative to an Economy of Accumulation*, Rhydian Fôn James, Molly Scott Cato, SAGE Journals

[101] *The Web of Life: A New Scientific Understanding of Living Systems*, Fritjof Capra

New socio-economic model of 2020s

What scenarios emerge for the economy and society in the 2020s? Our foresight sessions revealed a number of paradoxical tensions with participants predicting trends that appeared contradictory. For instance, some participants claimed that urbanisation and megacity growth will continue and maybe even accelerate in the 2020s, while others suggested that we enter a period when people will start to relocate from cities and come back to 'rustic life' — and both sides provided strong arguments to support their position. Whose point is more valid? In order to understand it, we identified key 'scenario forkings' that emerged throughout sessions, and conducted a survey, where respondents had to rank the likelihood of seemingly mutually exclusive scenarios A & B on the scale between 0 (strongly expect A) and 10 (strongly expect B).

The factors we wanted to explore describe various economic aspects that defined the early 21st century economy:

- **Globalisation**: will it continue — or will it stop & even reverse?
- **Urbanisation**: will it continue — or stop / reverse?
- **Mass Scale Standardised Production**: will it continue to dominate?
- **Sustainability / Regenerative Economy**: will it continue to be ignored ('business as usual') or will it come into the spotlight?
- **Digital Divide**: will it reduce further (as in the last decade) or will it grow again?
- **Innovative Growth**: will it be driven by startups & venture business, or will large companies (re)take the lead?

For many of these factors, there was no clear preference of one scenario over the other in the group of experts. Some experts could strongly and confidently support the globalisation scenario, while others were equally strongly supportive of deglobalisation and nation-inward focus — these positions would offset each other, so that a weak preference of 'national self-sufficiency' scenario emerged. We saw the same story with other scenarios: urbanisation (weak preference of 'slowing urbanisation'), digital divide (weak preference of 'divide growth') and 'engines of growth' (weak preference of 'large scale business as a driver'). Our interpretation is that no clear choice of these scenarios have occurred yet. From these factors' standpoint, the world is in the point of transition, in the potential bifurcation point. Clearly, COVID has influence the world's dynamic — but the selection of these scenarios had not occurred yet, and if we consider some of them as 'undesirable' (e.g. digital divide growth or national isolation), we should realise that the new model of the world is being decided right now, and it can depend on our effort.

However, experts predict two scenarios to emerge very clearly: the transition to customisation & personalisation, and the transition to regenerative life-centred economies. For these factors, there is a strong signal in all sectors (even though ICT implies lower engagement in sustainable / regenerative economy, and construction & infrastructure is low on customisation).

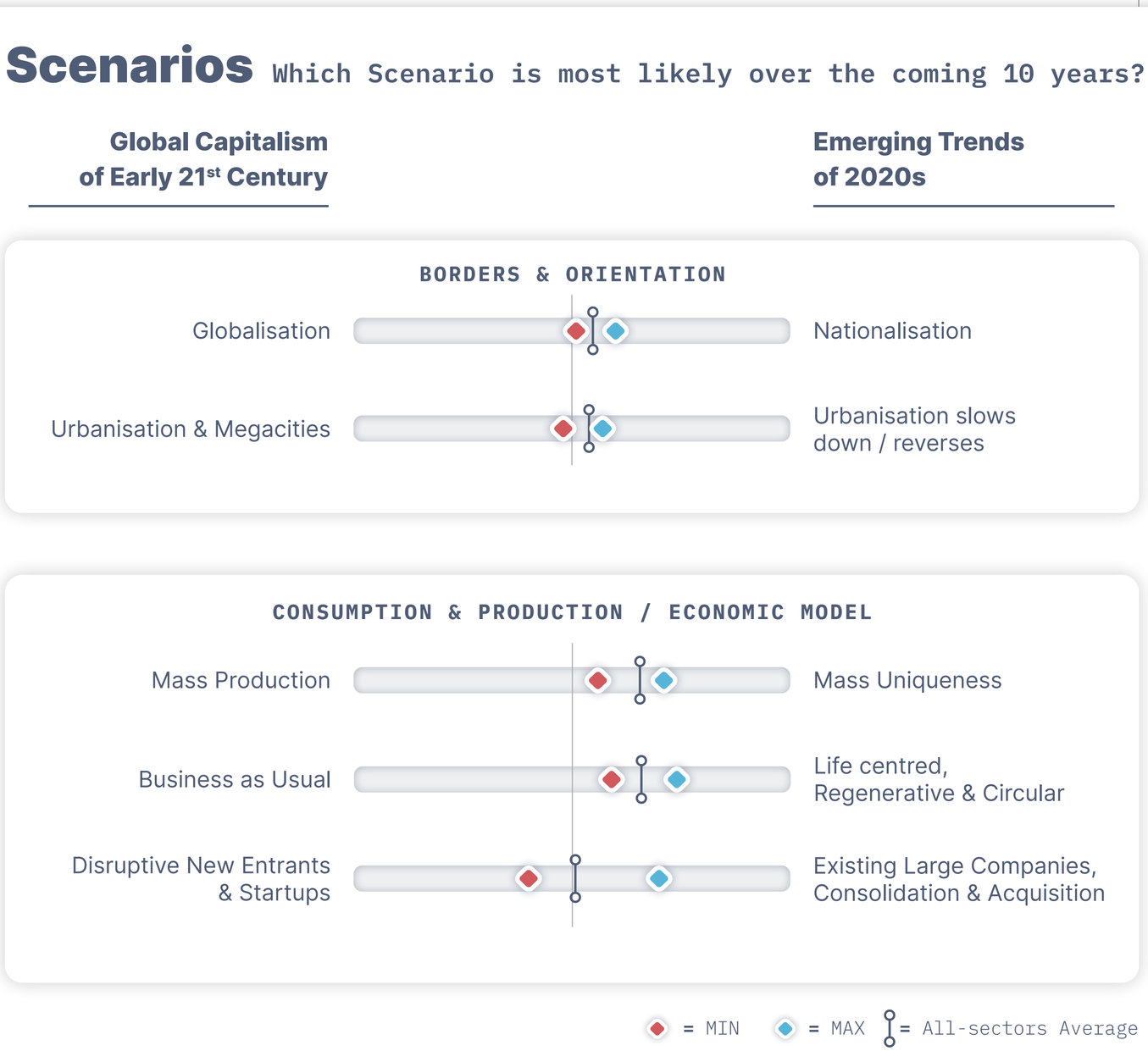

Figure 17: **Emerging Skills Scenarios of 2020s**
Source: GEF Expert Surveys n=302

3.2 A Land of Paradoxes: Transformation of Job/Skill Landscape

The landscape of jobs and skills in the 2020s is shaped by both life-embracing and dehumanising forces — the ones that empower and liberate, and the ones that constrain and exploit — creating a complex mix of practices and solutions. Many of these solutions appear to be strongly incompatible with each other, and yet each of them will very likely become a normal employment practice throughout the next decade. We present this emergent landscape in the form of five 'paradoxes' that, as they become addressed, will produce a new labour market model for the 21st century. Rather than separate and opposite contradictory choices, these paradoxes can be mutually enabling, contextual & iterative, in dynamic interdependent equilibrium.[102] Addressing paradoxes is an emerging skill, involving exploring tensions & holding spaces, in which dualities can co-exist, blending the best of both worlds without being reductionist. It has benefits for leadership, innovation & creativity,[103] collaboration, empathy and system change.

102 *Organisation Studies Special Issue on Paradox, Tensions, and Dualities of Innovation and Change*, Wendy K smith, Miriam Erez et al, SAGE Journals

103 *Why the Paradox Mindset is the Key to Success*, BBC

Gig Economy: Everyone is Commoditised

The idea of 'gig economy' implies that most people will have temporary jobs or will do separate tasks, selling their services through a platform that will allocate tasks and payments based on gig worker performance. While worker commoditisation can be exploitative, the future workforce has been encouraged by the rise of gig employment platforms, ranging from Uber for drivers to Fiverr for freelancers. As more people were moved into remote work and flexible contracts during the COVID pandemic, the possibility of using a gig economy approach was explicated even in more traditional businesses that previously used long-term employment — a recent study by McKinsey has confirmed that 70% of global CEOs want to significantly increase number of temporary / flexible contracts even for on-site jobs. [104] Companies may be forced into the gig economy by competitive pressures — e.g. part of Uber's business model 'success' is that it does not cover drivers' medical insurance and many similar costs that a traditional employer would incur. [105] Potentially, future businesses can organise hordes of highly specialised gig workers into supply chains, using AI and unmanned logistical solutions, replacing factories with distributed production or servicing systems. [106] In the gig economy, there is a risk that people will find themselves in the role of the 21st century precariat: workers seem as interchangeable and potentially replaceable by technologies. Over time.

Purpose-driven Economy: Everyone is Unique

Studies of work motivation show that people perform best in 'purposeful' working environments — where they see themselves as part of the team that does meaningful and impactful work, and where their own self-esteem and personal growth can be enhanced by the work they do. [107] Equally, it has been recognised that workers with high levels of intrinsic motivation do not require to be controlled too much, will act more collaboratively and supportively, and can overcome complex and non-standardised challenges. [108] In purpose-driven economies, every worker has high and unquestionable value — and provides their unique and meaningful contribution. Organisations seek to repurpose their working practices and culture around talent, rather than 'human resource' management — and they even experiment with creating jobs and assignments that focus on employees' unique abilities and praise personal contributions. [109] The purpose-driven economy offers a vision of a human-centric talent ecosystem that is coupled with an ecosystem for life-long holistic learning to support everyone's meaningful life-long journey.

Addressing the Paradox:

What do we put first: economic efficiency or individual and collective well-being? Do we design systems for people — or people for systems? The paradox seems unresolvable until we restructure/abandon 20th century economic priorities. But if we recognise that systems should be built with human- and life-centricity in mind, and especially if we couple working opportunities with learning & growth opportunities, then 'gig economy' platforms can turn from 'ruthless exploitation machines' into 'matchmaking spaces' that enable every purposeful worker find their next challenge for meaningful growth and development. Hell and Heaven on Earth can be built with the same tools.

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104 *The Post-pandemic Workforce: Responses to a McKinsey Global Survey of 800 Executives,* McKinsey

105 *Uber Asks US Government to Give Its Workers Health Insurance*, The Washington Post

106 *Google Cabs And Uber Bots Will Challenge Jobs 'Below The API'*, Anthony Wing Kosner, Forbes

107 *The Benefits of Meaningful Work: A Meta-Analysis | Academy of Management Proceedings*, Jing Hu and Jacob Hirsh, Academy of Management

108 *The Four Intrinsic Rewards that Drive Employee Engagement*, Kenneth Thomas, Ivey Business Journal

109 *Creating the Best Workplace on Earth*, Rob Goffee and Gareth Jones, Harvard Business Review

❖ Paradox 2: Surveillance & Empowerment

Surveillance Economy: Everyone is Controlled

Shoshanna Zuboff's recognition of omnipresent digital platforms as 'surveillance capitalism' alerted us to the risks of being controlled by a handful of global 'data empires'. [110] As we move into increasingly digitised workplaces, every action every second could potentially be recorded, digitalised, analysed and controlled. How do we cope with being under constant surveillance in the workplace, and how do we survive in the invisible 'digital cage' set up by algorithms? How will we perform in environments, where the payment and career advancement are recommended by algorithms based on surveillance results? The constant digital monitoring may not necessarily be evil — for example, real-time tracking of body indicators by fitness bracelets helps turn unhealthy habits into healthy ones. [111] Similarly, evidences suggest that the workplace surveillance may often improve employees' productivity. [112] But the issue holds: will we accept the constant surveillance in the workplace, or will we rebel? Will we consider limited surveillance as a working benefit enjoyed by more loyal employees? We can think of these and many other questions quickly emerging as a new working reality.

Empowered Society: Everyone is Trusted & Empowered

The main value that human beings bring to the workplace is not doing what they are told — but being able to act 'outside the box', create and innovate, and deal with situations of uncertainty. In doing so, people perform best not when they are constantly controlled and monitored — but when they are entrusted to do their best, even at the risk of failing. [113] As our society has to deal with more complex and uncertain situations — it demands more people that are able to think and act independently. The idea of empowerment implies that people become more autonomous and self-determined, and so they gain more control over their lives, their work, and their future. Being empowered is highly beneficial for business, especially the one that depends on the employee responsibility and commitment — whether it is a consultant, a flight dispatcher or a waiter. But it is also highly beneficial for human beings themselves — as it nourishes our dignity and contributes to our happiness and our feeling of self-accomplishment. Empowered organisations create new ways of organising roles and processes that dismantle hierarchies and enhance intra-organisational communications. [114]

Addressing the Paradox:

Surveillance issues arise where there is asymmetry of power when it is exercised by powerful superiors to control and exploit the powerless inferiors. However, if digital monitoring tools are used for self-improvement – in the same manner as people use fitness trackers to monitor their physical activity and encourage exercise – then they are not perceived as 'tools of oppression' but more as 'tools of enhancement'. In empowered organisations and collaborative communities, digital tracking and monitoring can create a form of 'digital mirror' – a human 'digital twin' in the form of a chatbot or an AI assistant that supports personal and collective betterment and enhances conflict resolutions. But to achieve these ends it has to be available for individual and collective design and fine-tuning to serve human well-being above all.

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110 'The Goal is to Automate Us': Welcome to the Age of Surveillance Capitalism, John Naughton, The Guardian

111 How Fitness Trackers can improve your Health, Harvard Health Publishing

112 The Advantages of Surveillance in the Workplace, Lynne Haley Rose, Chron

113 *Trusting Employees Supports Better Performance*, Maria Williams, The SHRM Blog

114 Power in the Empowered Organisation: The Design of Power in Highly Adaptive Organisations, Gervase Bushe, Organisation Development Practitioner

❖ Paradox 3: Individuality & Collectivity

Increased Individuality

The systems of employment and social security, consumer economy and urban culture throughout the 20th century have made enormous effort to 'atomise' human beings [115] or isolate them from each other (as described in Yuval Harari's Homo Deus), promoting patterns, such as individualised consumption, self-employment, independent decision-making, small families or single parenting.
The trend of individualisation will remain strong in the coming decade. The continuing division of labour and rising platformisation of increasingly flexible employment suggest shifting from massive hiring in 'bulks' towards an increasingly personalised talent acquisition. Whether in distributed remote teams or in 'gig' contracts, workers will have to become increasingly self-reliant, self-disciplined, and organised by their own commitment more than by peer pressure. People will take personalised development pathways to cultivate unique 'bundles' of competencies — and they will compete by the ability to make unique value contributions with their talent.

The Age of Team Play

The success of businesses is highly dependent upon the performance of their collectives and teams. Michael Lewis' book Moneyball explains the secret of top sports teams' performance is not to create a group of star personalities, but to find players that perform well with each other. A team or a community is more than 'sum of its parts' or a collection of individuals — it is a living system that acts, learns and evolves as a whole (as suggested by Peter Senge and proponents of organisational learning approach). Teams are also not static, they are flexible and transforming, so learning how to set up and drive high performing teams is considered crucial to organisational success. Hiring practices begin to prioritise teams over individual players, especially in emerging sectors where startups are often acquired in order to obtain their young and ambitious teams. Workers are increasingly anticipated to become great team players, so they need to learn to serve their collectives with team-oriented skills, such as empathy, mutual support and empowerment, and conflict resolution, rather than praise their own talent.

Addressing the Paradox:

The interplay between personal and collective has been at the centre of social evolution and cultural stories for centuries, and gets more complex with time. The age of mass uniqueness will require unique teams — but it will also invite unique individuals that contribute to multiple teams and communities. There is risk in juxtaposing individuation / focus on personal success with collectivity / focus on team or community success — but finding healthy ways to combine these motives appears the right way forward. As work processes become more complex and networked, leaders need to cultivate the capacity of teaming — a practice of organising and evolving dynamic teams of irreplaceable talent.

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115 The Spreading Process of Social Atomisation, Simone Redaelli, Culturico

❖ Paradox 4: Specialising & Generalising

Age of Specialising: Narrow & Technology-focused Skills

The growing complexity and diversification of the global economy is coupled with the increased division of labour. While O*NET Occupational database currently recognises 969 distinct occupations for the US economy, LinkedIn network identifies already over 6,000 distinct occupations and over 36,000 unique skills [116] (this number rose from 30,000 in 2017). Solutions and technical systems become increasingly complex, requiring more narrow specialist skills in highly tech-focused areas. In GEF 2018 Future Skills Study we called them 'context-dependent skills' defined by the specific field of application and the use of specific tools. Our study also argued that the number of diverse skills will continue to increase. Professionals are expected to keep their technical skills constantly updated as tools continue to evolve. For example, in ICT, programmers constantly move from one platform to another, [117] with companies launching new language training only for them to become obsolete within a year. So it can be expected that in the future, as in the past, professional success will be dependent on the personal mastery of narrow and highly sophisticated technical skills.

Age of Generalism: Broad, Multi-disciplinary, Integrated & Human Skills

The greater complexity we encounter, the more we demand ways in which our complex and diversified world can be integrated — we demand connectors, storytellers and weavers that can pull it together. We also recognise that, in the rapidly changing world, a narrow specialisation brings a risk of losing the relevance if a job role becomes disrupted by technological innovation. An antidote against rapid changes is skills transferability based on mastering more foundational skills — for example, a programmer who comprehends foundations of programming and has strong mathematical intelligence can easily move between programming languages and paradigms. Also, both teams and individual talent need to prioritise multi-disciplinarity ('T' and 'M' shaped skill sets) as well as the ability to generalise and comprehend complex systems (enabled by critical and system thinking). Finally, since our survival and well-being is based on our ability to relate with our thoughts, emotions, and sources of energy, as well as with other humans — mastering existential and relational skills becomes crucial for success and flourishing.

Addressing the Paradox:

Not all skills are made equal — we can see that 'narrow' technical skills differ from 'generic' human skills, and that mastering a computer language can go hand in hand with learning to be a good team player. The GEF 2018 Education Ecosystems report tried to address this paradox by recognising that various skills can be distinguished by the breadth of the context and duration of their validity: the skill of Java programming can only be applied in a professional context and be valid when there are devices that use Java — while optimism is a universal 'existential' skill that can be applied throughout lifetime and all contexts. To be more versatile in narrow skills, one needs to master generic and human skills: an ability to learn, to self-discipline, to collaborate, etc. Soft skills can also strengthen each other: as Howard Gardner's theory of multiple intelligences suggests, the more modalities of intelligence one masters, the more adaptive and creative one becomes.

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116 Find New Jobs with the Skills you already have, LinkedIn Economic Graph

117 Predicting the Most Popular Programming Languages, Sieuwert van Otterloo, ICT Institute

❖ Paradox 5: Knowledge Abundance & Co-creation

Knowledge Abundance: Global Knowledge on Fingertips

The design of the Internet comes as a system of organising all human scientific and technological knowledge. Today, Wikipedia can be seen as the most comprehensive collective effort to structure all human knowledge available, while Google offers a fast way of accessing any digital source in the open web. This knowledge is increasingly globalised — we may still have borders, but our Google and Bing searches offer links to resources in dozens of languages, created by people from all over the planet, and automatic translators help us comprehend solutions and ideas from other cultures. Instead of memorising the old ways or trying to invent our own new ways, we just need to know where to look for answers. Knowing how to ask and who to trust now becomes the skill. Evidence shows that most successful Internet searches are performed by people who have their own knowledge 'mind maps' and cultivate system thinking to comprehend the complex world. [118] Knowledge transferability is further enhanced by shared language and skills that serve as a basis for fast and efficient communication. In the future, globalised collections of transferable human knowledge can be increasingly organised and enhanced by AI that will establish networks and ecologies of knowledge, and will also guide or even accomplish further knowledge creation. The knowledge abundance may come at a price however if knowledge absorption is not controlled: much like obesity is a problem with overeating, digital overload/overconsumption can lead to communicative dysfunctions and mental health issues.

Knowledge Co-creation: Community-based & Contextualised

Many forms of knowledge are tacit or personal and community-based, and exist in a form of know-how that can only come through experience. [119] Tacit knowledge is hard to transfer from one person to another, even if a technology is well documented. [120] It becomes even more apparent when knowledge is locally situated: what makes up a success of a local community (including both modern and indigenous groups) is its collective knowledge of social relations, culture, natural processes, etc., and if a community wants to re-learn its way of being it has to go through this process together, by acquiring new rituals, habits and structures. It has to reinvent itself locally, and there are no one-size-fit-all recipes for the process — external materials can only offer guidelines or tips to learning that still has to be local, personal / communal and experiential. Also, any worker or team facing a situation of uncertainty or an unresolved challenge is welcomed with an opportunity to create new knowledge that can become a local wealth or can be globally shared. There is a wealth of hands-on traditional human knowledge still to be unrooted — indigenous communities, for example, often champion low-cost sustainable and regenerative practices, and hold many human practices that help heal our relationship with ourselves and with each other.

Addressing the Paradox:

Albert Einstein famously said: 'The more I learn, the more I realise how much I don't know'. The increased access to the infinite pool of explicit and transferable collective human knowledge opens many new possibilities for learning with each other, recognising what we know and opening up to what we do not know. Mastering and co-creating knowledge is one of the greatest and most exciting human ventures that transforms life from a routine into an inspiring journey.

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118 TED Blog: 10 Research Tips for Finding Answers Online, Danielle Thomson, TED Blog

119 The Tacid Dimension, Michael Polanyi

120 The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, Ikujiro Nonaka and Hirotaka Takeuchi

Our survey has analysed four key factors that describe possible future scenarios:

- Will the skill gap continue to widen or begin to close?
- Will the society need narrow focused specialists — or will it need more generalists?
- Will the greater demand be around individual skills — or collaborative team skills?
- Will we continue to use digital tools and drive their development — or will we see these tools using and organising ourselves?

Clearly, in all four dimensions we can see the future skill paradigm emerging. Two strongest anticipations are to recognise the need for multi-disciplinary-focused and team-oriented professionals. It is also expected that in the future of work people will be increasingly controlled by software, including, but not limited to, 'gig economy' platforms. Flexible learning systems are expected to help close the skill gap — but this scenario is the least certain among the four.

Scenarios

Which Scenario is most likely over the coming 10 years?

3.3 Fundamental Skill Set: What is Critical?

Our earlier work, as well as the WorldSkills Kazan 2019 Skills Declaration, emphasised that every professional should receive a set of skills for employability, or a fundamental skill set that should include certain basic, cognitive, digital, socio-economic, cultural, and green skills. In this section, we explicate the key components of the 'fundamental skill set' model. During our analysis across key sectors of the global economy, we identifed a recurrent set of skills that appear to be universally relevant. Certainly, not everyone can be versatile across this skill set — but, to navigate and succeed in the complex environment of the 2020s, one needs to cultivate at least a basic knowledge of the skills listed below, applying to the world with wisdom.[121]

Resources that help to develop these skills can be explored in subsequent research projects — we welcome collaborations from the professional community.

121 Transforming Knowledge Systems for Life on Earth: Visions of Future Systems and How to get there, IoanFazey, NikoSchäpke et al, Science Direct

Fundamental Skill Set: What is Critical?

COGNITIVE FOUNDATIONAL

Internal skills of self that help us adapt and thrive in an increasingly complex & uncertain world

- **Adaptability**, Future Thinking & Navigating Accelerating Change (e.g. across technologies), Coping with Uncertainty & Crisis
- **Critical & Creative Thinking**, Understanding Biases, Intellectual Humility
- **Multi-disciplinary Versatility & Systems thinking**, Understanding Complexity & Seeing our Role in Systems
- **Learning to Learn**, Unlearning, Intellectual Humility

TECHNICAL & DIGITAL

Skills that connect to the 2020s tech teality and help use the full potential of digitised workplaces

- **Digital Skills**, including **AI Skills** & Big Data, and **Emerging Technologies** (e.g. Blockchain, AR/VR/MR...)
- **Cybersecurity**
- Programming & Controlling **Robotics / IoT**
- **Tech Integration & Bridging**
- **Neo-crafts** & Services (incl. 3D Manufacturing)
- Basic Skills for Digital: **Mathematics & Logic, Reasoning**

SOCIO-ECONOMIC & CULTURAL

Relational skills that support prospering in teams and across communities & networks

- **Collaboration & Teaming** (On & Offline – incl. Trust Building)
- **Facilitation & Co-creation**
- **Entrepreneurship** (incl. Finance & E-Commerce, Customer Focus...)
- UX / UI Design / **User-centric** Approaches*
- **Agile** Project Management*
- **Human, Social & Emotional Skills**: Kindness & Compassion, Empathy, Conflict Mediation
- Paperless / Visual Communication
- Interdisciplinary, Cross-sectoral & Cross-cultural **Communication, Storytelling** & Advocacy
- Language Skills

GREEN & UNIVERSAL WELLBEING

Skills that ensure we are building a thriving future for all life

- **Environmental, Practices**, Sustainable & Regenerative — both Technological (e.g. Carbon Footprint Analysis, Lifecycle Management, etc.) & Human (Reconnecting with Nature)
- Awareness & Well-being (incl. Taking Care of Oneself — Mental Health, Intentional Downtime, Self-protection)
- Diversity, Multi-cultural Awareness, Inclusion*
- **Ethical** Decision-making*

Mutually exclusive categories have limitations, so readers should see these skill clusters as broad families with fuzzy boundaries. For example, 'Diversity, multi-cultural awareness, inclusion' could sit in the Socio-Cultural or well-being cluster. Skills that could fit in multiple clusters are denoted with '*'

Key Skills 2021 2030

Skills/ Roles Clusters

TECHNICAL & DIGITAL · COGNITIVE FOUNDATIONAL · SOCIO-ECONOMIC & CULTURAL · GREEN & UNIVERSAL WELLBEING

ALL SECTORS	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY
Collaboration (On & Offline)	**Collaboration (On & Offline)**	**Recycling, Rebuilding & Retrofit design**	**Collaboration (On & Offline)**	**Big Data Analytics**	**Human / Soft Skills (Social, Emotional, etc.)**	**Activist Art**	**Collaboration (On & Offline)**
Facilitation & Co-creation	Facilitation & Co-creation	Ethical Practices, Critical Thinking, Understanding Biases	Human / Soft Skills (Social, Emotional, etc.)	Infrastructure as a Service (IaaS)	Ethical Practices, Critical Thinking, Understanding Biases	Facilitation & Co-creation of Art / Creativity	Facilitation & Co-creation
Ethical Practices, Critical Thinking, Understanding Biases	Big Data Analytics	Collaboration (On & Offline)	Ethical Practices, Critical Thinking, Understanding Biases	Facilitation & Co-creation	Storytelling, Advocacy & Community Roles	Human / Soft Skills (Social, Emotional, etc.)	Diversity, Equity, Cultural Awareness & Race Relations
Diversity, Cultural Awareness & Race Relations	CNC Operation & Programming (Unified Role)	Environmental Maintenance & Green Skills	Facilitation & Co-creation	Collaboration (On & Offline)	Resilience Roles (eg Counseling)	Diversity, Cultural Awareness & Race Relations	Cybersecurity Skills
Learning How to Learn & Unlearn	Digital Quality Control	Mental Health & Wellbeing Design Roles	Diversity, Equity, Cultural Awareness & Race Relations	Cloud Solutions Architect & Disaster Recovery	Big Data Analytics	Info Stylist - helps customize Presentations / Materials for various Audiences	Habitat Conservation

Source: GEF + sector expert foresight sessions n=281 + surveys n=350

Rising Skills/Roles for the Decade 2021 2030

Skills/ Roles Clusters

TECHNICAL & DIGITAL | COGNITIVE FOUNDATIONAL | SOCIO-ECONOMIC & CULTURAL | GREEN & UNIVERSAL WELLBEING

ALL SECTORS	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY
IoT Skills + System Operation	**Robotics Designer / Integrator**	**IoT Skills + System Operation**	**Drone Service Engineers**	**Meta Programming skills**	**UX & Customer Centric Roles**	**New Communication Skills (Visual / Touch / Gesture / Thought)**	**Big Data Solutions for Agriculture**
AR / VR / MR Design, Engineering, etc.	Small Batch Manufacturer (VR Design + 3D Printing)	Full Lifecycle Approaches: Cost, Social & Eco Outcomes Measurement	IoT Skills + System Operation	Data as a Service (DaaS)	Training / Programming AI	Transdisciplinary Designers, Catalysts & Community Builders	IoT Skills supporting Agriculture & Automated Solutions
Regenerative & Sustainable Skills	Regenerative & Sustainable Skills	3D Printing Designers & Operators	Regenerative & Sustainable Skills	IoT Architecture Design	AR / VR / MR Design, Engineering, etc.	AR / VR / MR Design, Engineering, etc.	Biosystemic Designer of Regenerative Farming Ecosystems
Blockchain Systems Design	Navigate accelerating Change (eg New Tech)	Health & Safety Awareness / Skills (Using AR/VR Remote Tech)	Regenerative & Sustainable Skills	AR / VR / MR Design, Engineering, etc.	Health & Safety Awareness / Skills (Using AR/VR Remote Tech)	Cross-sectoral Bridge Role	Designers, Catalysts & Community Builders for Wellbeing of People & Nature
Multidisciplinary Cross-sectoral Catalysts	Licensed Drone Operators & Engineers	Lean / Agile Implementor	Cybersecurity Specialist	UX UI design / User-centric Approaches	New Communication Skills (Visual/ Touch/Gesture/ Thought)	Storytelling, Advocacy & Community Roles	Blockchain Systems Design

Source: GEF + sector expert foresight sessions n=281 + surveys n=350

4. Sectoral Overviews

This chapter describes key trends shaping the future of specific sectors, and outlines most important job roles and skills that are anticipated to emerge in the 2020s. The findings below are results of sectoral foresight sessions and surveys.

MANUFACTURING & ENGINEERING

4.1

4.1 Manufacturing & Engineering

Definition

Manufacturing is the agglomeration of industries engaged in chemical, mechanical or physical processing of raw materials and components, through the use of tools & labour, into consumer or industrial goods. Examples include Aerospace Manufacturing, Chemical Industry and Machinery Building.

Engineering is the use of scientific principles to design and build machines, structures and related products, including fabricated metal products, industrial equipment, electronic and chemical products and instruments.

The global workforce in manufacturing amounts to 12% of the total working population, and the share of global GDP amounts to 17%. [124]

Skills represented in WorldSkills competitions include Additive Manufacturing, Chemical Laboratory Technology, CNC Milling, CNC Turning, Construction Metal Work, Electronics, Industrial Control, Industrial Design Technology, Industrial Mechanics, Industry 4.0, Manufacturing Team Challenge, Mechanical Engineering CAD, Mechatronics, Mobile Robotics, Optoelectronic Technology, Plastic Die Engineering, Prototype Modelling, Renewable Energy, Robot Systems Integration, Water Technology and Welding.

The top three most likely scenarios for the sector are increasing demand for collaborative skills, customisation & personalisation and transitioning to life-centred, regenerative & circular business models. The sector may lag behind other sectors in the transition away from 'business as usual' (-8% v other sectors). The trend towards demand for generalists over specialists is also likely to be slower than other sectors, reflecting the continued need for more narrow specialists in this sector. Digitisation and automation are both predicted to impact the sector more than any other.

[124] *ILO World Employment and Social Outlook*, *WorldBank Data on Manufacturing Value Added*

Key Aspects

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.1

Key Skills/Roles

	2020	2030
1	Collaboration	Robotics Designer / Integrator
2	Facilitation & Co-creation	Small Batch Manufacturer (VR design + 3D printing)
3	Big Data Analytics	Regenerative & Sustainable Skills
4	CNC Operation & Programming (Unified Role)	Navigate accelerating Change (eg New Tech)
5	Digital Quality Control	Licensed Drone Operators & Engineers
6	Learning How to Learn & Unlearn	Circular Economy Specialist
7	Human / Soft skills (Social & Emotional, etc.)	Business Continuity Manager: Resilient Operations in Critical Situations
8	Agile/Lean Manufacturing to respond to Rapid Cycles	Multidisciplinary Cross-sectoral Catalysts
9	New Communication Skills (Visual/Touch/Gesture/Thought)	AR / VR / MR Design, Engineering, etc.
10	Digital Ergonomic Design	CNC Operation & Programming (Unified Role)

Key Factors

	2020	2030
1	Strict Hygiene & Biosecurity Rules	AI Prediction & Self-learning Machines / Production Lines
2	Cybersecurity & Privacy Threats	Robotics & Cobots
3	Remote Working = New Norm	Autonomous Manufacturing & RFID logistics
4	Unemployment & Reduced Spending	Eco Materials & Production Modes Essential
5	3D Printing	Personalisation of Production
6	Building Information Modeling (BIM)	Permanent Loss of Jobs due to Structural Shifts
7	Growth of Cloud, Network & Computing Capacity	Automated Coding
8	New Designer Materials (Composites, Alloys, Nanotech)	New Human-computer Interfaces (Touch, Brain)
9	Industrial Internet: Big Data Analytics & IoT	Ageing Workforce
10	National Self Reliance & Domestic Supply Chains	Remote Diagnosis & Maintenance – Drones & VR/AR

Megatrends

Impact on Skills in the sector over the next 10 years

		VS AVG. IMPACT:			VS AVG. IMPACT:
HIGH	Automation	+9%	HIGH	Environmentalization & Sustainability	
HIGH	Digitalization	+5%	MED.	Demographic Changes	-8%
HIGH	Globalization		MED.	Accelerating Change	

Scenarios

Which Scenario is most likely over the coming 10 years?

BORDERS & ORIENTATION

Urbanisation & Megacities	Urbanisation slows down / reverses
Globalisation	Nationalisation

CONSUMPTION & PRODUCTION / ECONOMIC MODEL

Disruptive New Entrants & Startups	Existing Large Companies, Consolidation & Acquisition
Mass Production	Mass Uniqueness
Business as Usual	Life centred, Regenerative & Circular

EQUITY

Digital Divide closes	Digital Divide widens
Skills Gap widens	Skills Gap closes

DEMAND FOR

Specialists	Generalists
Individual Skills	Collaborative Skills

PRIVACY & FREEDOM

People control Algorithms	Algorithms control People

◆ = Sector | = All-sectors Average

Source: GEF + Sector Expert Foresight Sessions + Surveys

Map of the Future

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.1

MANUFACTURING & ENGINEERING

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

RELOCALIZED/ COVID

- Strict Hygiene / Biosecurity
- Unemployment & Reduced Spending
- National Self Reliance & Domestic Supply Chains
- Remote Work = New Norm
- Small Batch Manufacturer VR Design + 3D Printing
- Blockchain Systems Design

PARTICIPATORY/ SOCIAL

- MULTIDISCIPLINARY CROSS-SECTORAL CATALYSTS
- UX-UI Design / User-centric Approaches
- FACILITATION & CO-CREATION
- LICENSED DRONE OPERATORS & ENGINEERS
- Tech Bridge: Building Capacity for Emerging Competencies
- COLLABORATION (ON & OFFLINE)
- NAVIGATE ACCELERATING CHANGE (EG NEW TECH)
- Nationalization of Platforms & Data
- Ageing Workforce
- Learning How to Learn & Unlearn
- NEW COMMUNICATION SKILLS (VISUAL / TOUCH / GESTURE / THOUGHT)
- Permanent Job Loss due to Structural Shifts
- Human / Soft Skills (Social, Emotional, etc.)
- Business Continuity Manager: Resilient Operations in Critical Situations

GREEN & UNIVERSAL WELLBEING

- Health & Safety Awareness / Skills (Using AR/VR Remote Tech)
- Circular Economy Specialist
- Sustainable / Eco Materials & Production Modes become Essential
- Regenerative & Sustainable Skills

TECH

- DIGITAL QUALITY CONTROL
- HAND SKILLS MOVES TO PROGRAMMING & REMOTE USE
- Electronics moves to Autoconfiguration Solutions
- NEURO INTERFACE ENGINEERING
- Bioelectronics Design
- BIG DATA ANALYTICS
- AGILE MANUFACTURING IN RAPID CYCLES
- Advanced Materials Engineer (Composite, Alloy, Nano)
- REMOTE DIAGNOSIS & MAINTENANCE (DRONES & VR/AR)
- ROBOTICS DESIGNER / INTEGRATOR
- AR / VR / MR Design, Engineering, etc.
- ROBOTICS & COBOTS
- CNC Operation & Programming (Unified Role)
- NEW DESIGNER MATERIALS
- New Human-computer Interfaces (Touch/Brain)
- Digital Ergonomic Design
- 3D PRINTING
- AUTOMATED CODING
- Total Digital Monitoring
- Unmanned Vehicles
- CYBERSECURITY & PRIVACY THREATS
- INDUSTRIAL INTERNET (BIG DATA ANALYTICS & IOT)
- Personalisation of Production
- Digital Currency replaces Cash
- GROWTH OF CLOUD, NETWORK & COMPUTING CAPACITY
- Building Information Modeling (BIM)
- AI Prediction & Self-learning Machines / Production Lines
- Mixed / Augmented / Virtual Reality
- Autonomous Manufacturing & RFID Logistics
- Blockchain & Supply Chain Transparency

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

Skills/ Roles Clusters: TECHNICAL & DIGITAL; COGNITIVE FOUNDATIONAL; SOCIO-ECONOMIC & CULTURAL; GREEN & UNIVERSAL WELLBEING

Factor Clusters: COVID ACCELERATED; TECHNOLOGY /SMART; GENERAL

ITEMS IN CAPS: 100% of experts surveyed indicate it is significant for the sector: widespread impact, or clearly disrupting sector & transforming roles.

AUTOMATION & DIGITISATION

The sector is significantly more affected by these two interrelated megatrends than most other sectors (see Key Aspects - MegaTrends) and the dominance of Tech factors in Factor Table (Annex). Automated manufacturing of manual & rote tasks is augmented by next generation robotics for increasingly complex tasks, e.g. welding. Collaborative robots have been commercially available for several years from companies, such as KUKA, FANUC & ABB. Blockchain, RFID & GPS and IoT are key drivers of digitising supply chains, increasing control and transparency throughout the ecosystem. Integrating with AI drives self-learning and self-repairing machines & production lines which may become an important driver of change at the end of the decade. Similarly, the use of cloud twins (digital copy of a product in the factory automated system) allows the simulation of all possible situations, or at an aggregated level predicting factory problems / failures. Multiple step increases in cloud networking and computing capacity will occur throughout the decade, with quantum computing expected to be the biggest leap, towards the end of the decade. Building Information Modelling (BIM) is already significantly affecting sector skills. BIM, as a tool incorporating Big Data & AI, and critically as a process, can drive collaboration, customisation, cost estimation and reduction and lifecycle management. Hyperconnectivity and other technological factors are discussed in Section 2.3.

GLOBALISATION VS RE-LOCALISATION

See Section 3.1 for description of the transition from 'Global supply chains to relocalised production ecologies'. In this sector, COVID disrupts global supply chains & collaboration, as political policies push towards national self-reliance and full-production cycles inside every country. This accelerates existing relocalisation manufacturing trends and demand for turnkey installation of industrial facilities. More fragmented, local, niche and small batch manufacturing is driven by both demand (for personalisation of manufacturing and shorter lead times), and by supply on demand (mass use of 3D printing for small scale production, more precise control from digitised supply chains lowers inventories). This relocalisation trend could further exacerbate the digital divide between poorer & richer regions & nations due to lack of connectivity, energy infrastructure & competencies.

WHERE & HOW WE WORK

REMOTE & SAFE?

COVID-related distance working has become the new norm for many, including engineers & in particular programmers. Other sectoral factors driving this trend include automation moving maintenance skills to programming skills, Internet of Things, and later in the decade, the mass use of unmanned vehicles for industrial logistics. Strict hygiene / biosecurity rules for COVID-safe production & delivery environments is top of the list of factors affecting skills in the sector. Second on the list of factors affecting sector skills is Cybersecurity, increasingly critical and described in Section 2.3 Technological drivers. Safety & Security will come under increasing scrutiny.

INTERFACES

Today, on site work is being transformed by use of mobile and tablet devices, augmenting collaboration & management control. Skilled workers using Mixed Reality/AR/VR will become more commonplace through the decade. Intuitive visual UX/UIs aim to aid the adoption of the new methods for workers, although there is often a learning curve which can steepen with age. (By the end of the decade, the workforce will be increasingly senior almost everywhere, due to fewer births, starting work later and retiring later). These examples of Human-Machine Interfaces (HMI) will be followed by Neural (brain) Interface engineering, emerging much later in the decade. Second on the list of factors affecting sector skills is Cybersecurity, increasingly critical and described in Section 2.3 Technological drivers. Safety & Security will come under increasing scrutiny.

ENVIRONMENTAL SUSTAINABILITY

is a key message from our Foresight sessions. According to surveys it becomes a ‘must have’ around the middle of the decade, including the use of eco-friendly materials, energy sources and production modes. 3D Printing is seen as the most significant factor affecting skills in the sector this decade, and is 21% more significant than other sectors. Printing only what is needed reduces waste and transport costs, and increases design flexibility & sustainability. The use of new advanced designer materials, including composites, alloys, nanotech, is predicted to be significant by 2023, although there is a more nuanced picture when looking at each new material innovation separately.

Margin pressure comes from increasing global competition, rising material costs and environmental legislation and COVID induced spending reductions. An emerging option to differentiate is ‘Industry as a service’: a digital transformation to provide services and solutions that supplement traditional product offerings. This requires closer collaboration with customers to understand changing needs. Demographic factors include ‘permanent’ loss of jobs due to structural shifts (+11% more significant than other sectors), and the workforce becoming more senior (+14% more significant than other sectors). These will be significant in the second half of the decade and will require significant reskilling and risk mitigation strategies.

Emerging & Transforming Roles & Skills

The current critical importance of collaboration, facilitation & co-creation (#1 & #2 in Sector Skills 2020) reflects both their importance to organisations internally and the shift towards larger-scale industrial collaborations, such as industry ecosystems and Digital Supply Networks (DSN). Related to this, learning how to learn and unlearn (#6 in sector skills 2020) reflects the accelerating change in the sector, in particular technologically. International collaboration was mentioned as a particular focus in our expert foresight breakout sessions, as were Interdisciplinary skills. Lean and Agile processes — predicted to be significant this decade by all experts surveyed — typically requires improved collaboration & communication skills. This brings cost savings, higher productivity and shorter schedules. Related roles include Small Batch Manufacturer (for example, incorporating VR design, modelling and servicing 3D printing) and UI Experts to help customise production on demand. Communication skills will transform through the decade, from writing & drawing on paper to typing & touch on tablets, voice & gesture-activated automations.

An example of the trend towards interdisciplinary skill sets is the application of computer numerical control (CNC) to machinery (e.g. drills, mills & lathes), where operation, maintenance & programming is predicted to become a unified role early this decade. Other examples come from merging disciplines, such as electronics, electromechanics, bioelectronics and digital (as discussed below).

Hand skills are not going away completely, although they are decreasing and will need to integrate increasingly with new technological advances. They are unsurprisingly more important in this sector than any other sector (+11%). Historically over the past 5 years they match manufacturing automation in terms of search volume. Note the recent rise in interest in Cobots in Comparison Annex. Robot Teaming Coordinator (RTC) is an emerging role training humans and robots to work together collaboratively.

Scott Walker

Director, Matter Innovation,
UK

The current pandemic has made it very obvious that organisations need to prepare better for flux and an ever more unpredictable and complex world. Critical gaps include adaptability, managing uncertainty, processing high volumes of contrasting information (to allow for better decision-making), and evaluating strategic risk very quickly. The demand for real systems thinking (beyond just mapping, but actual implementation and 'doing') will require capacitating critical thinking, resilience and creative leadership competencies. Education must adapt from its Victorian model and start preparing future generations for constant adaptation, ongoing reskilling, stress tolerance and self-management.

AUTOMATION & DIGITISATION

A Digital Manufacturing Engineer has functions of designing and building new systems and processes that use advanced manufacturing technologies, like 3D printing, reducing errors, increasing efficiency and designing/upgrading manufacturing operations and systems. AI Trainers help machines and programs learn to make better decisions. Machine vision systems operators, developers, programmers may focus on a single unit/machine/application. They are supported by AI Integration Developers, Worker Experience Designers and Smart Factory Managers with oversight of larger processes and projects, making information more accessible, streamlining relationships between operator and machine (hardware & software). While training in process-automation tools is relatively easy, training in AI tools (including office functions, such as purchasing strategies or forecasting and pricing decisions) is more complex. Both direct and indirect functions will receive a productivity boost through big data analytics. Data collected by an ecosystem of IoT sensors and AI that analyses and interprets the information in real time will provide actionable insights to Industrial Engineers, increasingly via Virtual/Augmented Reality. Roles in Data Science and Digital Quality Control will be needed to develop and set up the systems while the existing workforce will need to be trained for the new tools. [125] Chief Digital Officers advocate for new technologies and envision how their companies can implement new ideas. Rapidly changing technology requires constant retraining and cultural management in the face of resistance to change. Information overload requires AI assistance and/or screening skills.

Robotics Engineer is #2 on LinkedIn's emerging roles 2019 with 40% annual growth in the USA. Companies focused on information technology and services, industrial automation, computer software, financial services and the automotive industry will be looking for software and hardware engineers to continue the upswing in physical and virtual bots. Key skills: Robotic process automation (RPA) e.g. UiPath and Blue Prism. Other Automation roles include Robotics Designers, Operators and Integrators and Manless Logistics Dispatchers. Predictive maintenance soon becomes part of the work of the technician, not an exclusive task for the engineer. Machines and automated software move to self-repair & auto-maintenance, transforming the servicing workload to oversight. Automations should be considered as 'workers', who need instruction, coordination, performance reviews and maintenance themselves.

Mixed, Augmented and Virtual Reality skills are now used for Design, Engineering, Maintenance, Safety and Remote Management roles, incorporating visualisation, simulation, and virtual prototyping techniques.

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125 *Building the Workforce for the Future in Manufacturing Industries*, Oliver Wyman

Implications for Policy, Education & Training

The skills gap in this sector may leave an estimated 2.4 million positions unfilled (2018 - 2028), with a potential economic impact of $2.5 trillion. [126]

Recommendations: Education & Training, policy

- Upskilling & reskilling for Industry 4.0: Education and Industry work together to ensure skills aligned in the workplace and while learning; retraining strategies for manual & hand skills specialists as they are replaced by automations.
- Virtual Learning Spaces — AR / VR to simulate factories for training, self-education.
- Green skills do not feature in skills rankings as other sectors. This should be addressed through: advocacy to raise awareness of the benefits (e.g. cost savings & staff retention); training focused on solving environmental and health problems; integration of the sector with other sectors (education, consumers, local communities, etc.). [127]
- Mechanisms for Global Technology transfer/open innovation/sharing wise practices. Critical for the sector globally that 'the 4th industrial revolution we're going through now is also co-owned and developed by emerging economies — not only the technology giants/corporates'.

Recommendations: Companies

- Create new roles that embrace & maximise the effectiveness of digital technologies. The existing workforce can be trained for new roles (e.g. Robot Controllers).
- Partner with learning institutes and pooling/collaborating with other companies to nurture digital talent.
- Depending on the scale required, outsourcing may be the best route to fill certain specialized, highly technical roles (e.g. Data Science). [128]

See also Chapter 6 for more stakeholder-specific recommendations.

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[126] 2018 Manufacturing Skills Gap Study, Deloitte

[127] Sustainable Manufacturing Good Practices, OECD and Global South Examples, UNCTAD

[128] Building the Vital Skills for the Future of Work in Operations, Kweilin Ellingrud, Rahul Gupta et al, McKinsey

CONSTRUCTION & INFRASTRUCTURE

4.2

4.2 Construction & Infrastructure

Definition

Construction includes building technology sectors where capacity for civic engineering, construction of residential, commercial, heavy civil, industrial and environmental structures is most essential. Infrastructure includes power, water and waste, transportation, telecommunications and social assets.

7% of the world's working-age population is employed in construction [129] and the sector contributes 13% of global GDP. [130]

Skills represented in WorldSkills competitions include Bricklaying, Building Information Modelling, Cabinetmaking, Carpentry, Concrete Construction Work, Electrical Installations, Joinery, Landscape Gardening, Painting and Decorating, Plastering and Drywall Systems, Plumbing and Heating, Refrigeration and Air Conditioning, Wall and Floor Tiling.

The clearest scenario emerging for the sector is the transition to life-centred, regenerative & circular business models, the strongest scenario in any sector and 15% stronger here than other sectors. Our research predicts predominantly large companies driving change through mergers and consolidation (much more so than other sectors). This is contrary to WEF's 2016 report [131] which indicated the sector had high industry fragmentation at that time. Our findings indicate either a recent shift towards the predicted dominance of large companies driving change, or the paradoxical nuance that both scenarios may co-exist in varying degrees over time and region. Other predicted scenarios include: increasing demand for collaborative skills; and interdisciplinary generalists, in particular in technological integration. COVID restrictions, automation, job losses and structural employment shifts are some of the factors driving the trend towards multifunctional roles. It should be noted that there will still be demand for specialists in construction. While the sector is still predicted to move towards customisation and personalisation, this is 19% less likely than other sectors. Digitisation and Automation are the highest impact megatrends, along with Sustainability (which is predicted to impact the sector more than all other sectors).

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[129] Reinventing Construction: A Route to Higher Productivity, McKinsey Global Institute

[130] The Next Normal in Construction: How Disruption is Reshaping the World's Largest Ecosystem, Maria João Ribeirinho, Jan Mischke et al, McKinsey

[131] Shaping the Future of Construction A Breakthrough in Mindset and Technology, World Economic Forum

Key Aspects

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.2

CONSTRUCTION & INFRASTRUCTURE

Key Skills/Roles

	2020	2030
1	Recycling, Rebuilding & Retrofit design	IoT Skills + System Operation
2	Ethical Practices, Critical Thinking, Understanding Biases	Full Lifecycle Approaches: Cost, Social & Environmental Outcomes Measurement
3	Collaboration (On & Offline)	3D Printing Designers & Operators
4	Environmental Maintenance & Green Skills	Health & Safety Awareness/Skills (Using AR/VR Remote Tech)
5	Mental Health & Wellbeing Design Roles	Lean / Agile Implementor
6	Risk Management & Supply Chain Resiliency	Green Construction Advocate
7	Learning How to Learn & Unlearn	Licensed Drone Operators & Engineers
8	Maths, Computing, Programming	Maintenance Jobs: Software & Mechanical Knowledge
9	Cybersecurity	New Communication Skills (Visual/Touch/Gesture/Thought)
10	Building Information Modeling (BIM)	Cybersecurity

Key Factors

	2020	2030
1	Strict Hygiene & Biosecurity Rules	Smart Infastructure Sensing Environmental & Digital Metrics
2	Unemployment & Reduced Spending	Smart and Life-cycle Optimizing Equipment
3	Customisation & Personalisation	Smart Wearable Tech increases Safety, Collaboration & Efficiency
4	Mobile Devices & Apps for Collaboration & Management	Ecosystemic Supply Chain Approaches
5	Prefabrication & Modular Construction	3D Printing
6	Rising Material Costs & High Financial Investment	Lean and Agile Processes increase Efficiencies
7	Building Information Modeling (BIM)	New Sustainable / Smart Materials
8	Remote Working = New Norm	Prefabrication & Modular Construction
9	National Self Reliance & Domestic Supply Chains	Industrial Internet: Big data analytics & IoT
10	Circular Construction	Digital Supply Network (DSN)

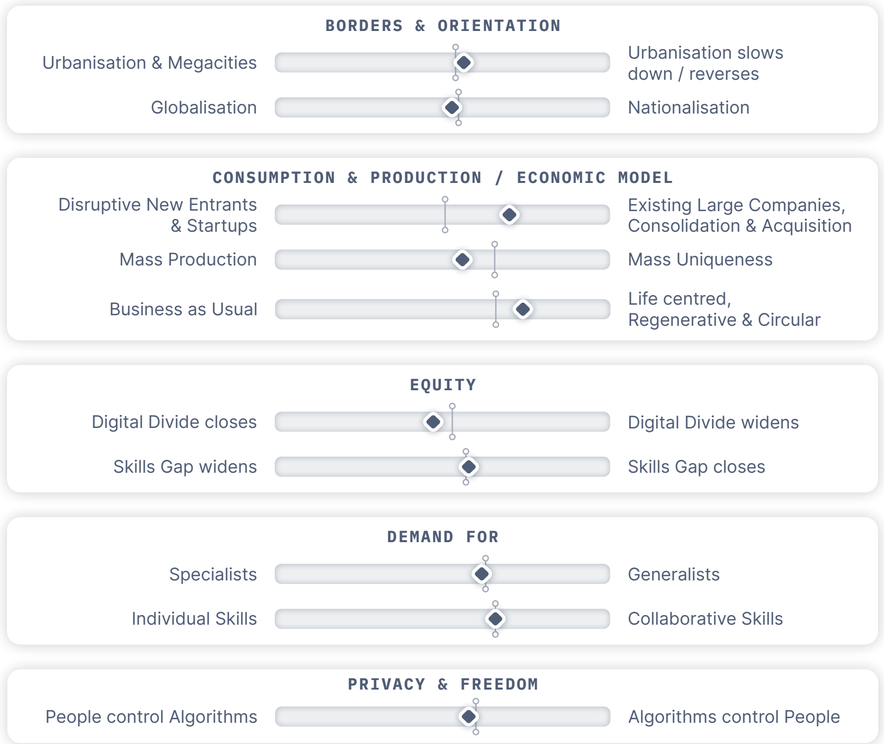
Megatrends

Impact on Skills in the sector over the next 10 years

		VS AVG. IMPACT:			VS AVG. IMPACT:
HIGH	Digitalization		MED.	Globalization	-6%
HIGH	Environmentalization & Sustainability	+7%	MED.	Accelerating Change	-8%
HIGH	Automation		MED.	Demographic Changes	-8%

Scenarios

Which Scenario is most likely over the coming 10 years?



◆ = Sector | = All-sectors Average

Source: GEF + Sector Expert Foresight Sessions + Surveys

Map of the Future

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.2

CONSTRUCTION & INFRASTRUCTURE

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

RELOCALIZED/ COVID

- PREFABRICATION / MODULAR CONSTRUCTION
- 3D PRINTING ADVISORS & ARTISANS
- Unemployment & Reduced Spending
- NATIONAL SELF RELIANCE & DOMESTIC SUPPLY CHAINS
- Strict Hygiene / Biosecurity
- Risk Management Supply Chain Resiliency
- Remote Work = New Norm
- 3D PRINTING
- Blockchain Systems Design
- Nationalization of Platforms & Data

PARTICI-PATORY/ SOCIAL

- NEW COMMUNICATION SKILLS (VISUAL / TOUCH / GESTURE / THOUGHT)
- ETHICAL PRACTICES, CRITICAL THINKING, UNDERSTANDING BIASES
- LEARNING HOW TO LEARN & UNLEARN
- Navigate accelerating Change (eg New Tech)
- Infrastructure Design (Remote Control & User Experience)
- Tech Bridge: Building Capacity for Emerging Competencies
- Collaboration (On & Offline)
- Multidisciplinary Cross-sectoral Catalysts
- Cross-industry Collaboration
- Digital Supply Network (DSN)
- Ageing workforce
- Facilitation & Co-creation
- PERSONALISATION & CONSUMPTION INCREASES
- Ecosystemic Supply Chain Approaches
- Permanent Job Loss due to Structural Shifts
- Human / Soft Skills (Social, Emotional, etc.)
- Active Inclusion of Local Communities
- Personalisation of Production

GREEN & UNIVERSAL WELLBEING

- ENVIRONMENTAL MAINTENANCE & GREEN SKILLS
- FULL LIFECYCLE APPROACHES: COST, SOCIAL & ENVIRONMENTAL OUTCOMES MEASUREMENT
- HEALTH & SAFETY AWARENESS
- GREEN CONSTRUCTION ADVOCATE
- Regenerative & Sustainable Skills
- Connecting with Nature & Biomimicry
- Biotech Regenerative solutions
- RECYCLING, REBUILDING & RETROFIT DESIGN
- Mental Health & Wellbeing Design Roles
- Weather Resistance & Disaster Management
- Electric mobility + Battery Tech
- Smart Roads
- Circular Construction
- NEW SUSTAINABLE/SMART MATERIALS
- SMART AND LIFE-CYCLE OPTIMIZING EQUIPMENT
- Smart Wearable Tech increases Safety, Collaboration & Efficiency
- Eco Materials & Production Modes Essential
- Regenerative & Bio-tech Solutions reduce Cost

TECH

- MAINTENANCE JOBS: SOFTWARE & MECHANICAL KNOWLEDGE
- LOCAL POWER GENERATION: DESIGNING AUTONOMOUS SOLUTIONS
- Robotics Designer/Integrator
- New Human-computer Interfaces (Touch/Brain)
- BIG DATA ANALYTICS
- CYBERSECURITY
- LEAN / AGILE IMPLEMENTOR
- IOT SKILLS + SYSTEM OPERATION
- Mixed / Augmented / Virtual Reality
- Digital Currency replaces Cash
- Reverse Engineering Roles
- Maths, Computing, Programming
- CNC Operation & Programming (Unified Role)
- LICENSED DRONE OPERATORS & ENGINEERS
- Dimensional Design Applications
- Total Digital Monitoring
- RISING MATERIAL COSTS & HIGH INVESTMENT REQUIREMENTS
- Training / Programming AI
- AR / VR / MR Design, Engineering, etc.
- Robotics & Cobots
- AI Prediction & Self-learning Machines / Production Lines
- MOBILE DEVICES & APPS FOR COLLABORATION & MANAGEMENT
- Hand Skills moves to Programming
- Biosecurity
- Supply Chain Transparency
- Ultra High Speed Rail
- Cybersecurity & Privacy Threats
- Building Information Modeling (BIM)
- Industrial Internet: Big Data Analytics & IoT
- Remote Monitoring - Drones & VR/AR

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

Skills/ Roles Clusters

- TECHNICAL & DIGITAL
- COGNITIVE FOUNDATIONAL
- SOCIO-ECONOMIC & CULTURAL
- GREEN & UNIVERSAL WELLBEING

Factor Clusters

- COVID ACCELERATED
- TECHNOLOGY /SMART
- GENERAL

ITEMS IN CAPS: 100% of experts surveyed indicate it is significant for the sector: widespread impact, or clearly disrupting sector & transforming roles.

Sector Trends

WAYS OF WORKING

Obsolete practices, lagging digitisation, industry fragmentation, human and data silos, labour shortages and rising material costs have led to profitability and productivity stagnating in the sector over the past 50 years.[132] Until now the sector had arguably not been significantly disrupted. Change is knocking on the door now, so the sector can look to a brighter, smarter, greener future. Lean and Agile Construction processes are emerging, although slower than in other sectors (only 47% of experts say it is significant now). This will bring reduced inventories/transport/waste/uncertainty, cost savings, higher productivity and shorter schedules.[133] High speed construction becomes the new industry standard,[134] as prefabrication & modular lean construction is predicted to become ubiquitous (where relevant) mid-decade and is the most significant factor for the coming decade (Factors Annex). This enhances efficiency, consistency and flexibility. Parts of the industry move toward a manufacturing-inspired mass-production system, built from prefabricated standardised components off-site. Plug-and-play, rather than build or repair, is an emerging format for building and maintaining infrastructure.COVID now clearly disrupts global supply chains & pushes towards national self-reliance (+9% more than other sectors). Focus on site health and safety is currently the most significant factor for the sector, along with job losses & budget cuts. Interestingly, these COVID-accelerated factors (and remote working) are not predicted to become more significant later in the decade, as other factors come to the fore.

AUTOMATION & DIGITISATION

Advanced automation and (semi-)automated equipment (e.g. bricklaying & cementing, forklifts & diggers) can help address labour shortfall issues experienced in the sector. Building Information Modelling (BIM) will transform into the centrepiece of the industry's digital transformation, combining Big Data and Machine Learning. Use of these insights via Cloud technology and Mobile/tablet apps on Connected job sites can make information about almost every aspect of a project available to all the relevant parties anywhere in the world. Real-time data allows greater collaboration & management control along the value chain, e.g. enabling schedulers & purchasers to make better informed project decisions. Usage of 3, 4, 5, 6, 7 dimensional design applications (assets' scheduling, cost, sustainability, operations & maintenance) can ensure information is shared accurately and consistently throughout total assets' lifecycles. Digital supply networks (DSN) & ecosystemic supply chain approaches incorporate these technologies, e.g. blockchain applications increasing supply chain transparency, reducing the need for intermediaries. The growth of the Industrial Internet of Things (IIoT: AI-enhanced & automated networked web of interconnected devices and sensors) brings many benefits but also an explosion in the number of access points for cyberattacks on urban & industrial infrastructure. In construction, a digital twin is a virtual model of a building that collects real-world information about the structure via sensors, drones and other wireless technology. Digital twins apply machine-learning algorithms to test, simulate or record events and experiences, gaining insight on performance & profitability of a project, whether built or in progress.

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132 Major Events Affecting the Construction Industry, Tyler Riddell, Construction Executive

133 2020 Engineering and Construction Industry Outlook: A midyear update, Deloitte

134 Shaping the Future of Construction A Breakthrough in Mindset and Technology, World Economic Forum

135 Why don't we Start at the Beginning?, Ignasi Pérez Arnal, BIM Community

136 Building a Transparent supply Chain, Harvard Business Review

137 Tech 101: Digital Twins, Jenn Goodman, Construction Dive

GREEN & SMART

The sector is the largest global consumer of raw materials, and constructed objects are responsible for around 40% of global carbon emissions.[138] Therefore, it is unsurprising that environmental sustainability regulations will continue to increase, requiring more sustainable practices, technologies and materials. Smart buildings and life-cycle optimising equipment can reduce carbon footprints like Eco-homes (by utilising passive energy sources, such as sunlight, human- and appliance-generated heat to dramatically decrease the need for additional heating), Zero-carbon homes (produce zero or negative CO2 emissions by maximising the use of energy efficiency and renewable energy), or installing very high performance window with an airtight building fabric to reduce energy cost. New material innovations include sustainable energy efficiency, e.g. organic paints and non-toxic stains
and sealers for paints with low VOCs (Volatile Organic Compounds); transparent aluminium, used to build glassy structures with less support required than with traditional glass structures; self-healing concrete; Nanotech/materials for easier application, greater strength and other benefits.

3D printing of components, walls and full buildings speeds up construction, reduces accidents, cost and waste, increases design flexibility & sustainability.[139] This emerging tech is predicted to be ubiquitous by the end of the decade. This represents the transition from subtractive (discarding waste) to additive construction (printing only what is needed, layer by layer). The potential impact of this technology is potentially larger in this sector than any other due to the scale of printing and environmental impact (e.g. using printed soil, rather than concrete).

The sector can also benefit from cultivating regenerative economy approaches, including Lo-TEK (lesser known technologies, traditional ecological knowledge). A toolkit by Harvard University published in 2020 lists over 100 traditional eco-friendly solutions that are superior to modern technological analogues, in terms of cost and durability, and can help the sector address climate change challenges.[140]

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[138] Embodied Carbon Call to Action Report, World Green Building Council The UK reports a similar figure: Climate Change, UK Green Building Council

[139] Impacts of 3D Printing on the Construction Industry, Whirlwinds Steel

[140] First-ever Compendium of Indigenous Technologies provides a Powerful Toolkit for Climate-resilient Design, Sala Elise Patterson, Harvard University

Emerging & Transforming Roles & Skills

TECHNICAL & DIGITAL

On the connected job site, digital fitness becomes an essential general skill for construction workers, e.g. use of BIM, mobile apps & mixed reality tools. From bricklaying to painting, carpentry and artisanal design, many construction roles transform focus from hand skills to operation of new technologies, e.g. collaborative robotics (cobots) or 3D printing. This also applies to repetitive rule-based administrative and high risk tasks (e.g. demolition), whether they are to be automated by physical robotics or software automations. Important to note that for most of the decade at least, human hand skills will remain better at precise details, managing errors and adapting to unpredictable circumstances. As AI and Big Data enhance automation capabilities, more complex processes will be open for transformation later in the decade, transforming roles such, as planning, design & management to work with automations. Similarly, communication skills transform through the decade from writing & drawing on paper to typing & touch on tablets, voice & gesture-activated automations.

The power of Blockchain and Big Data analytics to drive better data-driven decision-making leads to growth in Data Engineering roles & data presentation skills. This transforms supply chain management roles, giving purchasing and contract management roles greater visibility and control. Prefabrication will require more front-loaded project planning. Being in the position to design and solve construction problems pre-build can save significant time and money on project delivery. Reverse Engineering roles (deconstructing how things are made) will also increase with COVID disruption.

Mixed, Augmented and Virtual Reality skills are now used for Design, Maintenance and Remote construction & infrastructure site management roles, combining with Surveillance Drones operation skills. For example, this technology can give users access to BIM data and provide instant task feedback, e.g. check compliance, pre-fabrication tools, identify clashes or compare construction to design. Visualisation, simulation and virtual prototyping techniques allow BIM architects to preview possible scenarios and risks. Drones can also be used to reduce Health & Safety risk via remote surveillance and inspection that would be dangerous or time-consuming for workers to survey vast areas in just a few minutes. Smart wearable tech increases safety, collaboration & efficiency. Devices, like smart boots, will allow for the tracking of workers and even sense when they are fatigued or get hurt. Smart vests, smart helmets and smart glasses will be the additional wearables, used to increase the safety of workers on job sites. This transforms Health & Safety roles towards more real-time & remote data decision-making. Sanitation and Safety specialists now become mandatory as the sector prepares for a COVID-ready decade. Site Cybersecurity and Biosecurity becomes critical this decade to prevent large scale disruption of smart buildings and intrusions on individuals around infrastructure. IIoT brings an explosion in the number of access points for potential cyberattack.

TECHNICAL & DIGITAL

Technological Integration & social 'bridge' roles are emerging. These roles have both technical and social skills. They foster continual learning & knowledge transfer on new technologies, materials, methods & standards — between people, projects and places. An example of integration of digital platforms into the construction field can be seen with the adoption of digital twins, a complex process requiring extensive training and infrastructure to deliver benefits. AI Integration Developer is one example responsible for part of the wider integration of automated engineering processes.

SOCIO-ECONOMIC & CULTURAL

Collaboration is currently the 3rd most significant skill for the construction sector in 2020. The popularity of collaborative project delivery methods is growing while the days of design-bid-build domination may be waning, as experts expect multi-stakeholder cross-industry collaborative approaches to become more commonly adopted for construction projects. This requires a holistic view of project management and information sharing/translation between businesses, public sectors and local communities. Participatory Design Specialists ensure inclusion and active involvement of these groups throughout new & retrofit design processes. With pressures coming from urbanisation, commercial spaces, farming and climate change, equitable approaches are needed to solve challenges in land management. Innovative contracting models with balanced risk-sharing also emerge.[141] Virtual collaboration is clearly much needed today and will continue to rise in importance to deliver the cost & safety benefits of remote work. Examples: In the German 'National Initiative on Energy Transition', the construction industry coordinated with the German government in developing a strategy on climate change. Kalundborg Symbiosis of Denmark is a public-private alliance for converting waste materials from its member companies into the raw production materials for others. As an example of by-product reuse, the gypsum waste produced during desulfurisation of flue gas at the Asnæs plant — 150,000 tons per year — is used by Gyproc to manufacture gypsum board.[142]

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141 Shaping the Future of Construction, WEF

142 50 Examples of Business Collaboration, Teresa Turiera & Susanna Cros

GREEN & UNIVERSAL WELLBEING

The effects of climate change and natural disasters are felt and seen around the world today. Weather Resistance & Disaster/Crisis Management roles require a highly pragmatic, hands-on architectural and product design approach. Risk Management & Supply Chain Resiliency are key skills throughout the decade. An example role is Local Power Generation Architect: designing autonomous solutions for individual buildings, microgeneration technology (alternative energy sources, trigeneration, i.e. using three energy sources at once: electricity, heat and cold), and utilisation of energy-saving materials and structures.

Environmental roles are emerging — e.g. Impact Analysis, Design and Maintenance — and gradually their tasks and skills will infuse most other roles. Full LifeCycle Analysis (LCA) of projects and objects incorporate cradle-to-cradle philosophy to measure cost, social & environmental outcomes. Several green skills feature at the top of the sector skills list (see Annex for full list) and are typically more significant than other sectors. Smart and life-cycle optimising equipment needs implementation, management, interpretation and maintenance. Calculating embodied carbon (carbon footprint) considers how many greenhouse gases are released throughout the supply chain. Specialists in life-centred design use bio-tech, regenerative and biomimicry solutions to reduce cost of construction and maintenance and enhance environmental impact. Use of biotech / regenerative solutions can significantly reduce cost of construction & maintenance. Designers find ways to move from concrete and steel (emitting 0.5 - 12.2 tonnes CO2/m3) to timber (which can absorb up to 0.6 tonnes CO2/m3).[143] Circular construction focuses on 'Repair, Reuse, Recycle' (Number one on skills list for the decade) instead of building anew: recycling steel, rubber, glass or paper composite slabs for countertop finishing, linoleum & tiles for flooring; usage of salvaged or reclaimed wood, rather than 'new' timber; increasing use of retrofit design in infrastructure & construction. Huge gains can be made here, as the construction sector currently produces about one-third of all global waste, most of which is not recycled or reused, but ends up in landfills.[144] 3D printing expertise can deliver more efficient and unique designs, reducing waste, material and transport — although, as with most projects, full LCA needs to be applied to evaluate social, economic and environmental outcomes.

Mental health & well-being design roles are key throughout the decade, and 15% more significant here than in other sectors. For example, the Accessible Environment Designer is an emerging role in the development of infrastructural solutions for children, senior persons and disabled persons around properties (e.g. playgrounds, elevators for the disabled, signboards for people with impaired eyesight, ramps, recreational space, etc.).

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143 Carbon Counts, Feilden Clegg Bradley Studios

144 Building a circular construction sector, Circle Economy

Implications for Policy, Education & Training

The EU Commission stated that three million construction workers lack the skills they need in energy efficiency and renewable energy. [145] 80% of firms in the construction industry report difficulty finding skilled workers for hourly craft positions, according to the Associated General Contractors of America (AGC) and Autodesk. [146]

Recommendations: Education & Training, policy

- Industry collaboration and policy to increase standardisation of components brings many benefits, including a reduction in construction costs, fewer interface and tolerance problems, greater certainty over outcomes, reduced maintenance costs for end-users, and more scope for recycling. This also applies to design, materials distribution and logistics, general contracting and specialised subcontracting.
- Interdisciplinary approach in education with specific efforts to integrating private and public.
- Promotion & funding & adoption of technical & environmental innovation, e.g. Circular economy policy.
- BIM in Vocational & Higher Education curricula.
- Policies fostering freelancing & entrepreneurship to empower those displaced to create their own jobs.

Recommendations: Companies

- New technologies require a highly skilled workforce, and the construction industry – traditionally perceived as less glamorous than other sectors – needs advocacy and repositioning to recruit the necessary 'digital' talent. Tech-savvy millennials prioritise education and economic accomplishments.
- Finding qualified workers in the industry remains a major problem. Some companies have taken measures to try to fix the problem, such as increasing spending on training and raising workers' pay. Others are advancing their technology usage to offer employees new skills and growth opportunities.
- Continuous training (in particular on-site) and knowledge management — ensure knowledge transfer from project to project.

See also Chapter 6 for more stakeholder-specific recommendations.

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145 European Construction Sector Observatory, Analytical Report: Improving the Human Capital Basis, European Commission

146 Skills Gap stalls Construction Industry Growth, Report says, Riia O'Donnell, HR Dive

TRANSPORTATION & LOGISTICS

4.3

4.3 Transportation and Logistics

Definition

Sectors where the capabilities of moving goods and people are most critical, including:

- Distribution, including Postal & Courier services
- Warehousing & Storage
- Supply Chain & Cold Chain Solutions
- Services related to maintenance of transportation equipment and infrastructure
- Logistics procurement & packaging

Transportation and logistics amount to 6% of the global workforce.[147] Logistics and transportation is crucial for local & global trade and domestic & international connection, and is estimated to account for 13% of global GDP.[148]

Skills represented in WorldSkills competitions include Aircraft Maintenance, Autobody Repair, Automobile Technology, Car Painting, Freight Forwarding, Heavy Vehicle Technology, and Rail Vehicle Technology.

Sector Trends

The evolution of technology is pushing the boundaries and changing how the world does business. E-commerce required the logistics industry to adapt to supply chains with multiple channels, including direct to consumer, responding rapidly to their changing needs. Through organisations, like Amazon, it's possible to receive a package less than an hour after ordering in some areas. Improved technology has also increased productivity in the supply chain, minimising costs and errors. These advances benefit all areas of the logistics industry: trucking transportation, international transportation (ocean and air), supply chain management, and shipment tracking.

This sector faces an era of unprecedented change. The most significant factors affecting skills in the sector today are accelerated by COVID: remote work, relocalisation, strict hygiene in delivery and reduced spending (see Annex for full list). As digitisation takes hold and customer expectations evolve, new technologies are enabling greater efficiency and more collaborative operating models, reshaping the marketplace. New entrants, whether they be start-ups or the industry's own customers and suppliers, are also shaking up the sector. Like individual consumers, industrial customers now expect to get shipments faster, more flexibly, with more transparency, at a lower price.

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147 ILO World Employment and Social Outlook

148 There is no precise calculation for the sector, this estimate is given by the World Bank representative Bert Hofman

In the last few years, the ride-sharing model has transformed the taxi business, and a similar trend is growing in the freight sector as well. To this end, companies are offering Uber-like services through online applications. The objective is to give end-users more control of transport movement and inventory, since they are looking for more visibility. Some of the apps being used currently include LaneHoney Cargomatic and Transfix. These online companies allow shippers to see which trucks are close to their location and then book directly in just one click, without having to use a broker.

Integration of new emerging technologies and techniques into the sectors, such as additive manufacturing / 3D printing, are causing big disruptions to the traditional transportation and logistics model, and can cause enablement of newer and more decentralised business models. For example, raw materials and components can be 3D printed on-site, rather than transported. This is an opportunity for logistics providers to add 3D printing services to their last-mile customisation offering.

AUTOMATION

The sector has seen advancements recently in the collection and analysis of data, e.g. helping optimise network routes, or calculate drivers and trucks needing per day, or track their deliveries on time status. [149] Many companies are already using Robotic Process Automation in Logistics & Transportation Management, [150] including providers, such as Kofax, or retailers, like Walmart.

INTERNET OF THINGS (IoT)

IoT is a game changer for the sector. Combined with next generation connectivity and sensors, it allows traceability and transparency from shipper to delivery. Smart connected trucks will collect data on their movements and idle time for dynamic route planning, and to maximise fleet utilisation, as well as lowering maintenance costs by monitoring vehicle health. While RFID has been used to tag individual items since the '70s, modern warehouses now have greater 'connected efficiency', relaying constant information on their status, operation and position, allowing for greater visibility and efficiency in warehouse processes.

SMART STORAGE

The logistics and warehousing industry has also come a long way since the bar code reader of the '50s. Adoption of Warehouse Management Systems and other IT solutions have increased efficiency and competitiveness in the industry. The future of smart transport is about more efficient and intelligent signs, roads and other modes. We are entering the era where the information superhighway (connectivity, Internet and data grid) meets the transportation highway. Roads are becoming 'empowered' with communications, intelligence and sensing capability. Work, done on Intelligent Transportation System (ITS) by standardisation bodies, includes ISO TC 204, IEEE 802.11WAVE, car-to-car consortium, etc. While most of the early standardisation work was focused on air interfaces, there is an increasing need to look at architectures, systems and applications.

BLOCKCHAIN

This distributed ledger technology is changing the sector outlook with decentralised data, increased transparency and traceability, giving every end-user the access of product movement. Supply chains have become more efficient, as all parties involved are able to track the progress and status of goods. Digitalisation of important documents, like the e-AWB and bill of lading, opens these up to the possibility of blockchain adoption, allowing the original document to be issued, transferred and received on distributed ledgers that are visible to all participants in the process, increasing efficiency and security across the supply chain. Distributed Ledger Technology has use cases in automation of warehousing, payments and document flows, authentication and tracking goods.

AUTONOMOUS TRUCKS AND DRONES

Embark, Tesla and Uber have already made long hauls using autonomous trucks. While it is not yet completely driverless, with a driver in the passenger seat to monitor the computer, it is a huge step in this breakthrough technology and has the potential to increase efficiency and safety in the delivery process. Amazon has announced the future of packages being delivered right to doorstep by drones.

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149 Cloud Logistics, DHL

150 Five Forces Transforming Transport & Logistics, PWC

CLOUD LOGISTICS

Cloud logistics are rapidly being adopted, with 50% of logistics providers already using cloud services.[151] As data shifts to the cloud, logistics IT services are becoming available on a flexible, on-demand, pay-per-use model. This means smaller businesses no longer need to fork out on monolithic IT structures. Services, such as Shipwire and Freightly, provide real-time cloud-based transport management systems that cover all logistics processes from procurement to billing, making the whole process easier and cheaper for enterprises. Cloud technology has made it possible for warehouse and logistics management solutions to transmit their data over the Internet with ease. It is therefore critical for System Administrators to ensure that their systems are robust and able to thwart any cyberattacks.

151 Cloud Logistics, DHL

Forces impacting Transportation & Logistics:

Digital solutions/Digitalization	- Simplified processes and wider consumer network - Enabling new business models to enter marketplaces - Due to increasing transparency, end-users are willing to share data
Application & Software Driven Solutions	- Global Intelligent Transportation System in roadways is has improved quality of services - Predictive Maintenance Stabilizing delivery ensuring that a set of fleets is timely available - Using Big Data to analyze movement & traffic to dynamically react to unexpected situation is improving movement
Shift in Omnichannel sales impacting CEP (Courier, Express & Parcel) Services	- Integrated purchases of products from different sellers/stores - Increase in demand for short-term cargo storage - Need for last mile delivery capacity
Electro Mobility & Machine-Driven Core Processes	- Improved efficiency of warehousing management using new transport technologies - Last mile robotization leading to increased reliability, speed and efficiency of the delivery process - Merging data streams concerning weather, traffic and shipment information is dynamically shifted to optimum route

Key Aspects

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.3

Key Skills/Roles

	2020	2030
1	Collaboration (On & Offline)	Drone Service Engineers
2	Human / Soft Skills (Social & Emotional, etc.)	IoT Skills + System Operation
3	Ethical Practices, Critical Thinking, Understanding Biases	Mobility Advisers
4	Facilitation & Co-creation	Regenerative & Sustainable Skills
5	Diversity, Equity Cultural Awareness & Race Relations	Cybersecurity
6	Navigate accelerating Change (eg New Tech)	Service Roles = Remote Diagnostic, Programming & Maintaining
7	Learning How to Learn & Unlearn	Training / Programming AI
8	Big Data Analytics	Blockchain Systems Design
9	Health & Safety Awareness/Skills (Using AR/VR Remote Tech)	Multidisciplinary Cross-sectoral Catalysts
10	Cybersecurity	Eco-fuel Scientists and Researchers

Key Factors

2020	2030
Strict Hygiene & Biosecurity Rules	Unmanned Vehicles
Remote Working = New Norm	Smart Roads
Unemployment & Reduced Spending	Integration of Digital Transport Network & IT
National Self Reliance & Domestic Supply Chains	Robotics & Cobots
RFID & GPS Smart Logistics	Electric Mobility + Battery Tech
High Financial Investment Costs	Crowd Sharing Transport Solutions
Lean and Agile Processes increase Efficiencies	Eco Materials & Production Modes Essential
Personalisation & Consumption increases	Personalisation of Production
Industrial Internet: Big Data Analytics & IoT	AI Prediction & Self-learning Machines / Production Lines
Cybersecurity & Risks of UAV Hacking	Supply Chain Transparency

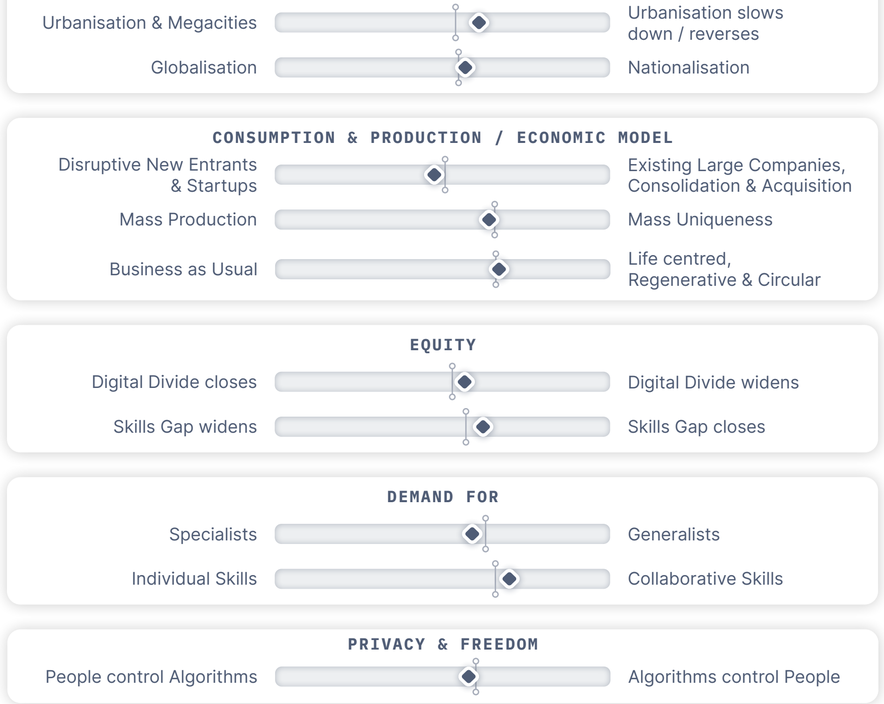
Megatrends

Impact on Skills in the sector over the next 10 years

	VS AVG. IMPACT:		VS AVG. IMPACT:	
HIGH	Digitalization	HIGH	Environmentalization & Sustainability	
HIGH	Globalization	MED.	Accelerating Change	
HIGH	Automation	MED.	Demographic Changes	-8%

Scenarios

Which Scenario is most likely over the coming 10 years?



◆ = Sector | = All-sectors Average

Source: GEF + Sector Expert Foresight Sessions + Surveys

Map of the Future

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.3

TRANSPORTATION & LOGISTICS

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

RELOCALIZED/ COVID

- STRICT HYGIENE / BIOSECURITY
- Unemployment & Reduced Spending
- NATIONAL SELF RELIANCE & DOMESTIC SUPPLY CHAINS
- REMOTE WORK = NEW NORM
- PREFABRICATION / MODULAR CONSTRUCTION: FLEXIBLE ADAPTABLE INFRASTRUCTURE

PARTICI-PATORY/ SOCIAL

- FACILITATION & CO-CREATION
- MULTIDISCIPLINARY CROSS-SECTORAL CATALYSTS
- ETHICAL PRACTICES, CRITICAL THINKING, UNDERSTANDING BIASES
- COLLABORATION (ON & OFFLINE)
- NEW COMMUNICATION SKILLS (VISUAL / TOUCH / GESTURE / THOUGHT)
- TECH BRIDGE: BUILDING CAPACITY FOR EMERGING COMPETENCIES
- HUMAN / SOFT SKILLS (SOCIAL, EMOTIONAL, ETC.)
- NAVIGATE ACCELERATING CHANGE (EG NEW TECH)
- Infrastructure Designer (Remote Control & UX)
- Ageing Workforce
- Learning How to Learn & Unlearn
- Diversity, Cultural Awareness & Race Relations
- PERSONALISATION & CONSUMPTION INCREASES
- Permanent Job Loss due to Structural Shifts
- Universal Translation for Learning & Safety Measures
- Personalisation of Production
- Crowd Sharing Transport Solutions

GREEN & UNIVERSAL WELLBEING

- ENVIRONMENTAL MAINTENANCE & GREEN SKILLS
- REGENERATIVE & SUSTAINABLE SKILLS
- Recuperation System Designer
- SMART ROADS
- HEALTH & SAFETY AWARENESS
- ECO-FUEL SCIENTISTS AND RESEARCHERS
- Eco Materials & Production Modes Essential
- Electric mobility + Battery Tech
- SMART ROAD TECHNOLOGIST

TECH

- SERVICE ROLES = REMOTE DIAGNOSTIC, PROGRAMMING & MAINTAINING
- IOT SKILLS + SYSTEM OPERATION
- REMOTE INTERFACE DESIGN
- BLOCKCHAIN ROLES
- BIG DATA ANALYTICS
- CYBERSECURITY
- DRONE SERVICE ENGINEERS
- ROBOTICS DESIGNER/INTEGRATOR
- Arctic Navigation Specialist
- PROGRAMMING SKILLS (VISUAL, SEMI-AUTOMATIC, VOICE & GESTURE)
- DRIVING MOVES TO REMOTE & TRAFFIC CONTROL ROLES
- High Speed Railway System Engineer
- Biosecurity
- TOTAL DIGITAL MONITORING
- MOBILITY ADVISERS
- Training / Programming AI
- AR / VR / MR Design, Engineering, etc.
- ROBOTICS & COBOTS
- Air Traffic Saturation = New Control Systems
- INDUSTRIAL INTERNET (BIG DATA ANALYTICS & IOT)
- INTEGRATION OF DIGITAL TRANSPORT NETWORK
- High Tech Airships
- REMOTE SURVEILLANCE - DRONES & VR/AR
- New Human-computer Interfaces (Touch/Brain)
- LEAN AND AGILE PROCESSES
- HIGH FINANCIAL INVESTMENT COSTS
- Mixed / Augmented / Virtual Reality
- Ultra High Speed Rail
- New Long Haul Trade Routes
- Digital Currency replaces Cash
- RFID & GPS Logistics
- Cybersecurity & Risks of UAV Hacking
- AI Prediction & Self-learning Machines / Production Lines
- 3D Printing reduces Transportation to Mainly Raw Materials
- Unmanned Vehicles

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

Skills/ Roles Clusters: TECHNICAL & DIGITAL; COGNITIVE FOUNDATIONAL; SOCIO-ECONOMIC & CULTURAL; GREEN & UNIVERSAL WELLBEING

Factor Clusters: COVID ACCELERATED; TECHNOLOGY /SMART; GENERAL

ITEMS IN CAPS: 100% of experts surveyed indicate it is significant for the sector: widespread impact, or clearly disrupting sector & transforming roles.

Emerging & Transforming Roles & Skills

COLLABORATIVE SUPPLY CHAIN ECOSYSTEMS

Collaboration is the most significant skill for the decade, as voted for by sector experts (see Annex for full list). Social 'human' skills and facilitation also feature early and throughout the coming decade. Companies such as FedEx and DHL have been partnering with national postal companies and small local players for many years. But with the advent of new technology, collaboration has become much more dynamic. 'Digital fitness' is becoming a prerequisite for success: the winners will be those who understand how to exploit a whole range of new technologies, from data analytics to automation and platform solutions. 'Sharing' is going to be a big story for logistics & transportation now – from Uber-style approaches to last-mile delivery, to more formal JVs and partnerships at corporate level. A range of new job roles now emerge, including: Intelligent Tracking Developer, Smart Fleet Manager, Intelligent Tracking System Manager, Smart Warehouse Manager, Big Data Analyst, and International Logistics Manager.

NEW ENTRANTS DRIVING INNOVATION & EMERGING JOBS

Platform technology has given rise to new business models in the sector, often around sharing/crowdsourcing (e.g. public transport), or mobility as a service. The sector's current customers and suppliers may end up being the biggest new entrants. New entrants of all sizes are looking to use new technology to find their niche or competitive advantage. To date most of these are in 'asset light' parts of the value chain; for example, virtual freight forwarders. These businesses exploit digital technology to offer interactive benchmarking of freight rates, or match shippers with available capacity. Many of the new entrants in freight forwarding are basing their offering on more agile pricing. Some enable carriers to bid on loads, allowing them to lower their bids in order to fill up capacity. They're also providing quotes more quickly and increasing price transparency – for example, by linking via API directly to a large number of carriers, and providing customers with their negotiated rates for each of the carriers they use, so they can compare directly. These innovative approaches create new job roles, such as:

- IoT & AI Expert: Algorithm skills & machine learning to deal with demand/supply fluctuations.
- Demand Forecasting Manager: using AI-based software solutions for price prediction, demand forecasting and optimisation of flows & processes, catering mainly to the consumer packaged goods (CPG) and retail industries.
- Last Mile Delivery Manager: The last step of the supply chain, from the warehouse or distribution centre to the customer, has been a growing concern and also comprises a major portion of the total cost to move goods. Companies are strengthening last-mile delivery as it is directly related to customer satisfaction, for example, Fedex's Roxo, or food delivery robots. Job role requires tech expertise to develop algorithms on traffic congestion, customer nuances, government regulation and delivery density, etc.

- Warehouse Automation Manager: New logistics & transportation firms are aggressively investing in warehouse automation to increase efficiency, speed and productivity by reducing human interventions. In the current pandemic this process has accelerated. The job role requires advanced skills in technologies, such as automated guided vehicles (AGVs), robotic picking and automated storage and retrieval (ASRS), etc.

TECHNICAL

Robotics in warehousing, autonomous transport, automation technologies for other parts of the supply chain systems, and analytics for new-age transportation drive emerging jobs in the Transportation & Logistics Sector. Warehouse automation technologies can be broadly categorised into devices that assist the *movement* of goods and those that improve their *handling*. Recently the sector integrated automated guided vehicles (AGVs) to move cases and pallets. New twists are the equipment and software needed to retrofit standard forklifts and make them autonomous. Other recent technologies include swarm robots (e.g. Amazon's Kiva robots) that move shelves with goods to picking stations and advanced conveyors that can move goods in any direction. Advanced automated storage/retrieval systems (AS/RSs) store goods in large racks, with robotic shuttles moving in three dimensions on rails attached to the structure .[152]

New handling devices automate the picking, sorting and palletising of goods. Picking systems typically include a robotic arm with sensors that can determine the shape and structure of an object, then grasp it. Some devices remain fixed and have goods brought to them (often by AGVs). Others travel to the goods and retrieve and move them at once. Magazino's new TORU Cube is an example of the latter. It is also important to mention that with the e-commerce boom, efficient sorting has become increasingly important, particularly in parcel operations. Advanced conveyor systems use scanners that can pick up bar codes on any side of a package to determine the appropriate action. These changes create jobs, such as Logistics Engineer, Electric Vehicle Expert and Mobility Surveillance Expert. Skills in Big data analytics, cybersecurity and IoT are increasingly significant though the decade.

[152] Automation in Logistics: Big Opportunity, Bigger Uncertainty, Ashutosh Dekhne, Greg Hastings et al, McKinsey

Case Studies

Singapore recently launched a logistics skills framework. The government worked with companies to showcase the opportunities for professional development offered by the sector, for example, from Operations Executive to General Manager. The German Government created a Freight Transport and Logistics Action Plan. One of the key initiatives is to ensure recruitment and retention of skilled workers by improving the image of the sector, informing potential recruits about the diversity of jobs available, and ensuring good working conditions. The government also awards the Freight Transport and Logistics Higher Education Prize to distinguish outstanding education courses. This underscores the importance of logistics training, for employees to exploit the advantages of job redesign. Employees should be taught technology management to augment their productivity. Their Logistics Professional Conversion Program includes classroom sessions delivered by training institutes, mentorship by seasoned practitioners and structured on-the-job training by employers. Workers are encouraged to embrace life-long learning, and participants train and work concurrently at the companies.
Under its Human Capital Agenda, the Netherlands has developed an inspiring approach for disseminating knowledge about innovation and technology. They established six Knowledge Distribution Centers (KDC) across the country. Those serve as knowledge hubs, allowing universities to work with various parties to advance knowledge about technology, and make it more accessible to students/the local workforce. They also developed an interesting feedback loop/virtuous circle between the industry, knowledge institutes, and the government. First, the government funds logistics institutes, like the Dutch Institute for Advanced Logistics. Those institutes act as focal points for the dissemination of knowledge to the industry, and the industry itself, in turn, helps inform the content of the training.

Implications for Policy, Education & Training

Recommendations: Education & Training, policy

- Adopt multi-disciplinary training for multi-modal transport systems. With burgeoning urban agglomerations and advent of smart cities, urban transport planners need to straddle communications, logistics, energy and the environment to manage advanced transport systems.

- Go beyond engineering and science to cover marketing, business, economics, law and regulations, behavioural sciences and psychology. These capabilities would help to develop cost-effective business models, implement transport as a service, and improve efficiency.

- Support course offerings to increase skill levels of workers, particularly in using high technology. The pervasive use of apps, the rapid growth of high-speed rail networks and the emergence of AI — all require transport professionals to have advanced digital skills.

- Promote research and innovation in emerging areas like new materials and autonomous vehicles.

- Break down silos between academic degrees and technical qualifications, with more emphasis on ‘applied’ degrees. Combined offerings of degree and vocational courses in vertically integrated institutions would enable holistic talent and skills development.

See also Chapter 6 for more stakeholder-specific recommendations.

ICT &DIGITAL

4.4

4.4 Information and Communication Technology (ICT) & Digital

Definition

Sectors where stresses the role of unified communications, telecommunications or digital information is the primary value creator. This report focuses on consumer, commercial and industrial applications. Major industry groups included are:

- IT software and services
- Creation and maintenance of the Internet
- Cloud Computing
- Big Data
- Fintech
- Technology hardware and equipment used to collect, store, analyse and share information digitally and transform social interactions, including semiconductors and semiconductor equipment
- Telecommunications — service & equipment companies that transmit data in words, voice, audio or video
- Digital sector — core activities of digitalisation, ICT goods and services, online platforms and activities

The ICT sector employed 1.7% of the global workforce in 2019. [153] Whilst this is smaller than other sectors considered in this report in terms of employment, it is certainly one of the most impactful for the futureof all sectors of the global economy.

Skills represented in WorldSkills competitions include Cloud Computing, Cybersecurity, Information Network Cabling, IT Network Systems Administration, IT Software Solutions for Business, Mobile Applications Development, Print Media Technology and Web Technologies.

153 Statista Full-time Workers in ICT 2019, ILO World Employment and Social Outlook Trends 2020

Key Aspects

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.4

ICT & DIGITAL

Key Skills/Roles

	2020	2030
1	Big Data Analytics	Meta Programming Skills
2	Infrastructure as a Service (IaaS)	Data as a service (DaaS)
3	Facilitation & Co-creation	IoT Architecture Design
4	Collaboration (On & Offline)	AR / VR / MR Design, Engineering, etc.
5	Cloud Solutions Architect & Disaster Recovery	UX UI design / User-centric Approaches
6	Learning How to Learn & Unlearn	Blockchain Systems Design
7	Diversity, Equity Cultural Awareness & Race Relations	Multidisciplinary Cross-sectoral Catalysts
8	Cybersecurity	Quantum Computing Ops & Dev Roles
9	Platform as a service (PaaS)	Bioelectronics & Biosecurity
10	Training & Programming AI	Human / Soft skills (Social & Emotional, etc.)

Key Factors

	2020	2030
1	Remote Working = New Norm	Automated Coding
2	COVID speeds up digital transformation & demand for ICT	Robotics & Cobots
3	Strict Hygiene & Biosecurity Rules	Total Digital Monitoring
4	Integrated providers of IT service infrastructure	New Human-computer Interfaces (Touch, Brain)
5	Unemployment & Reduced Spending	AI-created Entertainment
6	Industrial Internet: Big Data Analytics & IoT	Robot as a Service (RaaS) & IoT Business Model
7	Cybersecurity & Privacy Threats	Social & Environmental Justice through Tech
8	National Self Reliance & Domestic Supply Chains	Supply Chain Transparency
9	Growth of Cloud / Network & Computing Capacity	User Data Re-appropriated / Re-privatized by Users
10	Personalisation of Production	Mixed / Augmented / Virtual Reality

Megatrends

Impact on Skills in the sector over the next 10 years

		VS AVG. IMPACT:			VS AVG. IMPACT:
HIGH	Digitalization		MED.	Accelerating Change	
HIGH	Automation		MED.	Environmentalization & Sustainability	-9%
HIGH	Globalization	-5%	MED.	Demographic Changes	-5%

Scenarios

Which Scenario is most likely over the coming 10 years?

BORDERS & ORIENTATION

Urbanisation & Megacities	Urbanisation slows down / reverses
Globalisation	Nationalisation

CONSUMPTION & PRODUCTION / ECONOMIC MODEL

Disruptive New Entrants & Startups	Existing Large Companies, Consolidation & Acquisition
Mass Production	Mass Uniqueness
Business as Usual	Life centred, Regenerative & Circular

EQUITY

Digital Divide closes	Digital Divide widens
Skills Gap widens	Skills Gap closes

DEMAND FOR

Specialists	Generalists
Individual Skills	Collaborative Skills

PRIVACY & FREEDOM

People control Algorithms	Algorithms control People

◆ = Sector | = All-sectors Average

Source: GEF + Sector Expert Foresight Sessions + Surveys

Map of the Future

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.4

ICT & DIGITAL

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

RELOCALIZED/ COVID

- COVID speeds up Digital Transformation & increases Demand for ICT
- Unemployment & Reduced Spending
- National Self Reliance & Domestic Supply Chains
- Strict Hygiene / Biosecurity
- Remote Work = New Norm
- Data Sovereignty (Political/National)
- **BLOCKCHAIN SYSTEMS DESIGN**

PARTICI-PATORY/ SOCIAL

- Collaboration (On & Offline)
- **NAVIGATE ACCELERATING CHANGE (EG NEW TECH)**
- **UX-UI DESIGN / USER-CENTRIC APPROACHES**
- Learning How to Learn & Unlearn
- Facilitation & Co-creation
- **NEW COMMUNICATION SKILLS (VISUAL / TOUCH / GESTURE / THOUGHT)**
- Tech Bridge: Building Capacity for Emerging Competencies
- Multidisciplinary Cross-sectoral Catalysts
- Ethical Practices, Critical Thinking, Understanding Biases
- Digital Linguist
- Permanent Job Loss due to Structural Shifts
- Ageing workforce
- Human / Soft Skills (Social, Emotional, etc.)
- Diversity, Cultural Awareness & Race Relations
- Digital Empathy / Emotion roles
- User Data Re-appropriated / Re-privatized by Users
- Digital Finance Literacy (Currency Advisor)
- Personalisation of Production
- Electronic Governments & Digital Legislation

GREEN & UNIVERSAL WELLBEING

- Health & Safety Awareness / Skills (Using AR/VR Remote Tech)
- Social & Environmental Justice through Tech
- Wellbeing Roles at Work & Home
- Mental Health Care (Social Media Anxiety Therapists, VR Detox)
- Regenerative & Sustainable Skills

TECH

- **CLOUD SOLUTIONS ARCHITECT & DISASTER RECOVERY**
- **PROGRAMMING AI**
- **PLATFORM AS A SERVICE (PaaS)**
- **META PROGRAMMING SKILLS**
- Ambient Computing 'that you can't see'
- **BIG DATA ANALYTICS**
- **CYBERSECURITY**
- **IoT ARCHITECTURE DESIGN**
- Quantum Computing Ops & Dev Roles
- Robot as a Service & IoT Business Model
- **INFRASTRUCTURE AS A SERVICE (IaaS)**
- **DATA AS A SERVICE (DaaS)**
- Electronics moves to Autoconfiguration Solutions
- Neuro Interface Communications
- New Human-computer Interfaces (Touch/Brain)
- Integrated Providers of IT Service Infrastructure
- Digital Business Transformation Architect
- AR / VR / MR Design, Engineering, etc.
- Bioelectronics & Biosecurity
- AI Created Entertainment / Movies
- Digital Ergonomic Design
- Digital Regulator & Legislation Coding
- AI Prediction & Self-learning Machines / Production Lines
- Mixed / Augmented / Virtual Reality
- **INDUSTRIAL INTERNET (BIG DATA ANALYTICS & IOT)**
- 3D Printing
- Robotics & Cobots
- Automated Coding
- Digital Currency replaces Cash
- Cybersecurity & Privacy Threats
- Growth of Cloud, Network & Computing Capacity
- Supply Chain Transparency
- New Social Classes of Tech Literacy drives ICT Education
- Total Digital Monitoring

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

Skills/ Roles Clusters

- TECHNICAL & DIGITAL
- COGNITIVE FOUNDATIONAL
- SOCIO-ECONOMIC & CULTURAL
- GREEN & UNIVERSAL WELLBEING

Factor Clusters

- COVID ACCELERATED
- TECHNOLOGY /SMART
- GENERAL

ITEMS IN CAPS: 100% of experts surveyed indicate it is significant for the sector: widespread impact, or clearly disrupting sector & transforming roles.

Sector Trends

The clearest scenario emerging for the sector is the transition to customisation & personalisation (also, 9% stronger here than other sectors), driven by Big Data and AI, and another strong signal from our research in this sector — the dominance of algorithms over people (also, 11% stronger than other sectors). Other notable sectoral scenarios are the need for collaborative skills and interdisciplinary generalists. COVID restrictions, automation, job losses and structural employment shifts are some of the factors driving the trend towards multifunctional roles. Digitisation and Automation are unsurprisingly the highest impact megatrends. Environmental considerations are 9% lower here than other sectors.

Consumers, businesses & e-government — all show increasing Internet consumption to access information and use digital services, e.g. mobile banking, online shopping, e-learning, media & communications. In 2019, Internet usage has grown 12 times since 2010, while penetration is around 62% of global population in 2020, [154] with huge variation across regions. Growth in digital consumption will continue, as it will no longer be limited to a particular demographic, geography or social class. Healthcare and agriculture are expected to drive additional demand. COVID clearly accelerates this further, with increased focus on transformative technologies, such as 5G, AI, AR, VR, location & payment technologies, cloud and entertainment localisation, robotics and many others. Although 5G radio deployments will be delayed further due to geopolitical constraints and COVID-19. [155] Other trends include telecom growth, demand for platform and storage solutions, automation and a blurring of sector boundaries. [156] Through cellular and Wi-Fi technology, any device with a power switch is being enabled for remote control via the Internet. For system integrators, this means new requirements for business customers that are developing and managing IoT systems. Whilst estimates vary, 2020 will see 20-31 billion active IoT devices, reaching 50-75 billion by 2025. [157]

Remote working becoming the new norm[158] is understandably the most significant current factor in the sector, with COVID speeding up Digital Transformation & increasing demand for ICT globally. See Annex for full list of factors. ICT Solutions are needed for home office infrastructure, accelerating the move to cloud platforms. While costs of cloud computing and storage decrease, the growth of network capacity may struggle to keep up with the data overload. Increasing data transmission speeds and new forms of media create new needs for data harvesting. A threshold approaches in the hardware capability for mobile devices, which also move to cloud computing. Only 19% of network strategists believe that their networks are very well aligned to meet the demands of digital business, according to Cisco. [159] Note, communications and computer electronics industries are considered highly exposed to geopolitical and pandemic shocks. [160]

154 Global Trends in Internet traffic, IEA, and Internet Users Distribution in the World, Internet World Stats

155 Future of 5G in COVID-19 Era, Industrial Automation Asia

156 Bridging the Digital Skills Gap, Denise Shortt, Brain Robson et al, Skills Next

157 Internet of Things Statistics, Facts & Predictions [2020's Update], Malvina Vega, Review 42

158 Why Remote Working will be the New Normal, even after COVID-19, EY Belgium

159 2020 Global Networking Trends Report, Cisco

160 Risk, Resilience, and Rebalancing in Global Value Chains, Susan Lund, James Manyika, McKinsey

A number of paradoxical digital scenarios are emerging.

- On the one hand, Digital Democracy is the current process of opening government institutions for online access (e.g. open citizen micro-democracy cloud platforms, e-residency or digital marketplaces for public sector services). Experts predict that digital-related legislation itself becomes code later in the decade. On the other hand, by the end of the decade, 'Total Digital Monitoring' is predicted to be a significant factor on skills in the sector. Network coverage, CCTV & drone proliferation and online tracking gives visibility of our activity in the physical and digital worlds to governments & corporations.

- Another set of tensions arise with the observed trends of Data Sovereignty and Nationalisation of platforms. At the user level, security and privacy issues sees user data reappropriated / reprivatised by users. At the policy level, there is demand for sanctions-free national data centres & cloud platforms. See also section 2.3.

- Whether the 'digital divide' between poorer & richer regions & nations (connectivity, energy infrastructure & competencies) disappears or not is unclear. But there is growing demand for social justice, and equity in access and affordability of tech to improve lives & the social environment.

See Section 2.3 for more descriptions of technology factors: Automation, Automated Programming, Robotics and Cobotics (collaboration of humans with robots), AI, Industrial Internet, Big Data, IIoT, Blockchain, Mixed & Augmented & Virtual Reality, 3D Printing, Human-computer interfaces (HCI) and Cybersecurity & Privacy. The Industrial Internet is a key factor affecting skills, and interestingly, is the only factor to reach 100% consensus from experts to be significant this decade.

Many new business models are emerging around technology pillars, such as consulting and professional services. The Industrial Internet of Things gives rise to Robot as a service business models around delivery, cleaning, warehousing, security and more. These models are predicted to be significant by the end of the decade. Digital currencies — cryptocurrencies, such as Bitcoin and Ethereum, virtual currencies, central bank digital currencies and e-cash — are collectively forecast to be significantly impacting skills in the second half of the decade. Blockchain has huge transformative potential (e.g. Notary) and is offered as a service today by Amazon (AWS), IBM (BlueMix) and more. Integrated providers of IT service infrastructure are #4 on the 2020 sector factor table.

AI has applications across all sectors, e.g. Intent-based networking, Cybersecurity, entertainment & movies. Automated Coding and Quantum computing will bring next level innovations later in the decade.

Emerging & Transforming Roles & Skills

9 of the top 14 emerging roles last year are digital according to LinkedIn (675m users globally): [161]

1. Artificial Intelligence Specialist +74% annual growth 2019 USA. Key skills include machine learning, deep learning, TensorFlow, Python, Natural Language Processing.
3. Data Scientist +37%. Key skills include machine learning, data science, Python, R, Apache Spark.
4. Full Stack Engineer +35%. Key skills include React.js, Node.js, JavaScript, AngularJS, CSS.
5. Site Reliability Engineer +34%. Key skills include AWS, Ansible, Kubernetes, Docker Products, Terraform.
8. Data Engineer +33%.
10. Cybersecurity Specialist +30%.
11. Back-end Developers +30%.
13. Cloud Engineers +27%.
14. JavaScript Developers +25%.

This reflects the critical nature of the sector at this digital inflection point in society, and the permeation of digital roles and skills across all sectors. Digital Transformation Advisors are emerging in all the fields, helping reduce the digital divide. They specialise in communications and promotion of new software and services to technophobic groups.

According to Linkedin, 4 of the 5 most in demand hard skills are digital:

1. Blockchain
2. Cloud Computing
4. AI
5. UX design

SECURITY

Cybersecurity now becomes multi-disciplinary across all media & formats, from listening devices & phones to the more human elements of 'how do I protect myself from cyberattack'? Therefore, it needs holistic & human skills to address the need to feel your data, connections, work and life is safe. So, the importance of understanding human emotions and connections in the cyber and tech space is becoming more critical. As with many digital skills (but perhaps more so than any other this decade), cybersecurity is becoming a new literacy for everyone across all sectors, e.g. integrated security/design mindset.

Cyber Forensics and Network Detective roles are growing today, investigating and preventing cyber crimes. Skills include criminal science, investigation (modern detective), search (including active search through officially sanctioned cyberattacks against suspects) and processing of information (AI design, data analytics & defense programing skills). Privacy Doctors or Personal Profile Security Advisors are also emerging, auditing and editing the currently available Internet information & activities of a client, eliminating weak spots.

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161 15 Skills LinkedIn say will Help you Get Hired in 2020 - and Where to Learn them, Mara Leighton, World Economic Forum

COMPUTE, NETWORK & STORAGE

Key roles/skills identified include Network Integration Architect (Re-engineering and integration of IT & network processes, ITSM, DevOps), Database Management & Edge Computing Development. DevOps / SysOps / NetDevOps combines software development and IT operations — bridging teams to develop collaboratively across platforms. Information Systems Architect is responsible for a range of operations involving data processing systems, designing databases & algorithms, controlling the quality, logic and access of information.

PROGRAMMING & DESIGN

Design of automated programming software for ICT teams includes AutoML & Meta programming skills. AI Engineer, Analytics and Reporting roles are key, along with Blockchain Engineer and Algorithm Engineer. Interface design of visual & intuitive programming interfaces for industrial & commercial applications will increasingly focus on haptic (touch) and computer-brain connections. Robotology, 5G Engineering and Ambient Computing ('that you can't see') are examples of roles integrating hardware and software. In Mixed Reality/AR/VR, current roles include Designer/Developer, Journey Builders, Guides, Sales, and in the coming years, Detective. Quantum computing is here today, with many roles in research. Widespread commercial use, in particular for complex systems analysis and security, is expected later in the decade, opening up the field to implementers/programmers/app developers.

HUMANIZING TECH

With AI & automation increasingly placing control over many in the hands of a few, Digital Regulator is one of the most critical roles of our time. Data ethics and judgement are critical skills. Encouragingly the Australian Computer Society has defined an ICT Profession Core Body of Knowledge, which includes six core areas:

1. Ethics
2. Professional expectations
3. Teamwork concepts and issues
4. Interpersonal communication
5. Societal issues/legal issues/privacy
6. Understanding the ICT profession and general ICT knowledge (hardware and software fundamentals, data and information management, networking and technology-building).

Well-being roles include Digital ergonomic design today, and soon, 'Digital detox clinicians' aiding psychological rehabilitation from online/VR overexposure.

Implications for Policy, Education & Training

Recommendations: Education & Training, policy

- Existentially imperative to create standards to oversee ethical regulation of technology development.

- What policy interventions are needed for cybersecurity, e.g. integrating private and public efforts? CyberSecurity risks are higher with the growth of IoT & home working. COVID also drives contact tracing, which drives security & privacy concerns. The explosion in demand for cybersecurity, driven by the increase in security exposure points, requires new business models. Skills gap of 3-10 million people skilled in cybersecurity on the demand side. [162]

- Better linkages between technology leaders and actors involved in Sustainable Development Goals.

- More liberal arts courses integrated with tech courses. As computers behave more like humans, the social sciences and humanities will become even more important. Languages, art, history, economics, ethics, philosophy, psychology and human development courses can teach critical, philosophical and ethics-based skills. [163]

- ICT skills for teachers via Remote Learning / Online classes

Recommendations: Companies

- Work-integrated learning and Outsourcing to third-party training companies (Brainstation, Udacity, Galvanize) can be used by employers to advance employee IT competencies.

- WorldSkills partners with leading Global Industrial Partners to test drive new ICT technologies for 'skills of the future.' Modelling spaces are needed, along with integration with other sectors.

- Equity-seeking groups — e.g. immigrants and women — are still underrepresented. In many regions they do not hold enough ICT roles or have equal pay. Despite commitments to diversity, decades of initiatives designed to advance women in technology have scarcely had an effect on the proportion & pay of women. Alternative recruitment policies aimed at under-represented minorities include hackathons, remote roles and exploring opportunities to recruit autistic talent (e.g. Microsoft [164]). Cross-company mentorships and peer-support groups can lower exit rates.

See also Chapter 6 for more stakeholder-specific recommendations.

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[162] The Mad Dash to Find a Cybersecurity Force, The New York Times

[163] Microsoft's President says Liberal Arts Majors are Necessary for the Future of Tech, Richard Feloni, Business Insider

[164] Why Employing Autistic People Makes Good Business Sense, The Conversation

Editorials — Voices from Expert Community

Aleksandr Gorbachev

Founder & Consulting Engineer, NSALAB

It’s clear that information technology soon will become an integral part of every industry in every sector. It is important to understand that this symbiosis becomes possible due to the rapid growth of changes in the ICT sector itself. Such technologies like AI, Big Data and IoT already create and increase value for business. However, rapid implementation of such tools no longer possible without transition from classic on-premises infrastructure to cloud computing infrastructure models where any business can get any modern technology as a service.

On the other hand, the more economies rely on internal digital interaction, the more we will observe trends in the nationalization of such digital platforms. In turn, cyber security will increasingly become a part of the digital literacy.

HUMAN & SOCIAL SERVICES

4.5

4.5 Human-centred & Social Services

Definition

Human-centred and social services sector comprises many activities and economic industries where the relationship between humans, and servicing to individuals and groups, is most essential for value creation. Human-centred services are marked by humanistic values and focus on human welfare. This broad sector includes:

- Social Services — welfare service to aid disadvantaged, distressed or vulnerable people.
- Health Services and Psychotherapy — in this research, we are only providing a limited overview of health services, focusing only on those where human relationship is essential, e.g. nurses, remedial care or service.
- Beauty and well-being — beauty services will usually be more cosmetic in nature, whereas wellness services usually have more to do with mental, physical and spiritual health.
- Sports and Fitness.
- Coaching & Advisory Services.
- Education.
- Tourism and hospitality — often cited as one of the largest industries in the world, contributing 10% of the world's GDP. [165]
- Cooking and restaurants.
- Retail — selling goods to the public.
- Banking, Financial and Legal Services.

Human-Centred and Social Services is one of the largest sectors of the global economy, both in terms of employment and the share of GDP, [166] even though there is no exact estimate for the composition of sectors listed above. The 'large' service sector (which also includes ICT, creative sector, public services, finance and healthcare) amounts to 61% of global GDP. The wholesale & retail sector (only one of subsectors) alone accounts for 17% of global employment. [167]

Skills represented in WorldSkills competitions include Bakery, Beauty Therapy, Cooking, Hairdressing, Health and Social Care, Hotel Reception, Pâtisserie and Confectionery, and Restaurant Service.

165 Hospitality and Tourism, Richard Parsons, Stephen Skripak et al, Fundamentals of Business
166 Statista - Share of Economic Sectors in GDP
167 ILO World Employment and Social Outlook

Key Aspects

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.5

Key Skills/Roles

	2020	2030
1	Human / Soft Skills (Social & Emotional, etc.)	UX & Customer Centric Roles
2	Ethical Practices, Critical Thinking, Understanding Biases	Training / Programming AI
3	Storytelling, Advocacy & Community Roles	AR / VR / MR Design, Engineering, etc.
4	Resilience Roles (eg Counselling)	Health & Safety Awareness/Skills (Using AR/VR Remote Tech)
5	Big Data Analytics	New Communication Skills (Visual/Touch/Gesture/Thought)
6	Facilitation & Co-creation	Crowdfunding / Crowdinvesting / Crowdsourcing
7	Mental Health care (Social Media Anxiety Therapists)	Regenerative & Sustainable Skills
8	Learning How to Learn & Unlearn	Translator between Sectors/ Alternative Economic Paradigms
9	Designers, Catalysts & Community Builders for Wellbeing & Kindness	Tech Bridge Role: Building Capacity for Emerging Competencies
10	Diversity, Equity Cultural Awareness & Race Relations	Navigate accelerating Change (eg New Tech)

Key Factors

2020	2030
Remote Working = New Norm	Customised Services
Strict Hygiene & Biosecurity Rules	Robotics & Cobots
Unemployment & Reduced Spending	Ageing Populations: Assistive Technology & Senior Services
Cybersecurity & Privacy Threats	New Human-computer Interfaces (Touch, Brain)
Self Directed & Online & Blended Learning	Total Digital Monitoring
National Self Reliance & Domestic Supply Chains	Digital Badging Profiles & Blockchain; Distributed Assessments
Permanent Loss of Jobs due to Structural Shifts	Supply Chain Transparency
Nationalization of Platforms & Data	AI Prediction & Self-learning Machines / Production Lines
Industrial Internet: Big Data Analytics & IoT	3D Printing
Prioritisation of Wellbeing	Mixed / Augmented / Virtual Reality

Megatrends

Impact on Skills in the sector over the next 10 years

		VS AVG. IMPACT:			VS AVG. IMPACT:
HIGH	Globalization		MED.	Accelerating Change	+15%
HIGH	Environmentalization & Sustainability	+6%	MED.	Demographic Changes	
HIGH	Automation		MED.	Digitalization	-8%

Scenarios

Which Scenario is most likely over the coming 10 years?

BORDERS & ORIENTATION

Urbanisation & Megacities	Urbanisation slows down / reverses
Globalisation	Nationalisation

CONSUMPTION & PRODUCTION / ECONOMIC MODEL

Disruptive New Entrants & Startups	Existing Large Companies, Consolidation & Acquisition
Mass Production	Mass Uniqueness
Business as Usual	Life centred, Regenerative & Circular

EQUITY

Digital Divide closes	Digital Divide widens
Skills Gap widens	Skills Gap closes

DEMAND FOR

Specialists	Generalists
Individual Skills	Collaborative Skills

PRIVACY & FREEDOM

People control Algorithms	Algorithms control People

◆ = Sector | = All-sectors Average

Source: GEF + Sector Expert Foresight Sessions + Surveys

Map of the Future

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.5

HUMAN & SOCIAL SERVICES

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

RELOCALIZED/ COVID

- STRICT HYGIENE / BIOSECURITY
- Unemployment & Reduced Spending
- NATIONAL SELF RELIANCE & DOMESTIC SUPPLY CHAINS
- Remote Work = New Norm
- Blockchain Systems Design

PARTICI-PATORY/ SOCIAL

- FACILITATION & CO-CREATION
- NEW COMMUNICATION SKILLS (VISUAL / TOUCH / GESTURE / THOUGHT)
- NAVIGATE ACCELERATING CHANGE (EG NEW TECH)
- TECH BRIDGE: BUILDING CAPACITY FOR EMERGING COMPETENCIES
- LEARNING HOW TO LEARN & UNLEARN
- CROWDFUNDING / CROWDINVESTING / CROWDSOURCING
- Ethical Practices, Critical Thinking, Understanding Biases
- Ageing Workforce
- HUMAN / SOFT SKILLS (SOCIAL, EMOTIONAL, ETC.)
- Multidisciplinary Cross-sectoral Catalysts
- DIGITAL BADGING PROFILES & BLOCKCHAIN; DISTRIBUTED ASSESSMENTS
- Increasing Leisure Time
- Diversity, Cultural Awareness & Race Relations
- UX & Customer Centric Roles
- Nationalization of Platforms & Data
- Learning Communities & Collective Intelligence
- Storytelling, Advocacy & Community Roles
- AGEING POPULATIONS: ASSISTIVE TECHNOLOGY & SENIOR SERVICES FOR SENIORS
- Permanent Job Loss due to Structural Shifts
- Self Directed & Online & Blended Learning
- Distributed Educational Eco-systems & Lifelong Learning

GREEN & UNIVERSAL WELLBEING

- Health & Safety Awareness / Skills (Using AR/VR Remote Tech)
- MENTAL HEALTH CARE (SOCIAL MEDIA ANXIETY THERAPISTS, VR DETOX)
- REGENERATIVE & SUSTAINABLE SKILLS (LANDSCAPE DESIGN)
- Resilience Roles (eg Counselling)
- Learning to Reconnect with Nature
- Eco Materials & Production Modes Essential
- Prioritisation of Wellbeing (Physical / Mental / Emotional / Spiritual)
- Designers, Catalysts & Community Builders for Wellbeing & Kindness
- Workplace Wellness Therapy & Holistic Family Consultancy

TECH

- BIG DATA ANALYTICS
- TRAINING / PROGRAMMING AI
- AR / VR / MR DESIGN, ENGINEERING, ETC.
- Automation Integrator (eg Massage, Food Prep or Hospitality)
- Translator between Sectors / Alternative Economic Paradigms
- Hand Skills moves to Programming & Remote
- MIXED / AUGMENTED / VIRTUAL REALITY
- New Human-computer Interfaces (Touch/Brain)
- INDUSTRIAL INTERNET (BIG DATA ANALYTICS & IOT)
- 3D Printing
- Loss of Human Connection due to Reliance on Technology
- TOTAL DIGITAL MONITORING
- Cybersecurity & Privacy Threats
- Supply Chain Transparency
- Robotics & Cobots
- Digital Currency replaces Cash
- Customised Services
- AI Prediction & Self-learning Machines / Production Lines

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

Skills/ Roles Clusters: TECHNICAL & DIGITAL; COGNITIVE FOUNDATIONAL; SOCIO-ECONOMIC & CULTURAL; GREEN & UNIVERSAL WELLBEING

Factor Clusters: COVID ACCELERATED; TECHNOLOGY /SMART; GENERAL

ITEMS IN CAPS: 100% of experts surveyed indicate it is significant for the sector: widespread impact, or clearly disrupting sector & transforming roles.

Sector Trends

The most likely scenarios emerging for the sector are: customisation & personalisation (mass uniqueness — see section 3.1 & 3.2), the growing demand for multi-disciplinary generalists; transition to life-centred, regenerative & circular business models. Collaborative skills will be more in demand and algorithms are predicted to have more control over people. Other scenarios do not show clear signals in one direction, suggesting complex tensions that require further investigation.

After Globalisation, Environmetalisation & Sustainability is the #2 megatrend affecting the sector, +6% more than other sectors. This is also the most critical area to prepare the sector for the coming decade (Key Areas Annex). Accelerating change is expected to impact skills in this sector in the next decade more than most other sectors. It has traditionally been quite conservative in adopting new technology and ways of working, but change becomes inevitable this decade, in part driven by 'mass uniqueness'.

COVID REMOTE AUSTERITY

COVID accelerating the underlying trend of remote work is #1 factor in the sector today. Virtual meeting & learning environments become omnipresent but do require service workers to adapt to new ways of conducting work remotely.[168] This sector is perhaps hit hardest by distance working, due to the fundamental need for physical proximity for human interactions to be fully experienced. But, we adapt. Arguably this is our greatest strength as a species. Sport adapts to reduced crowds. We see reduced restaurant capacity, remote learning/shopping/therapy... But for how long? With impeccable timing, telehaptics (Internet-enabled prosthetics) can be used with holograms to simulate human touch today.

New Human-Computer Interfaces include haptic (touch) interfaces and later in the decade, more commercially available Brain-Computer Interfaces. Combining this with Mixed reality/AR/VR allows immersive experience of human connection remotely. The rapid shift online can democratise access to services and reach a wider audience. Interest in open and online platforms for services, learning skills & training simulators has exploded. On the other hand, opportunities can be limited by lack of online access, or COVID pushing national policies towards increased self-reliance & isolation. Inequality of access to both services and technology is a perennial challenge. In this sector, the digital divide is predicted to neither close nor widen, maintaining the disparity of connectivity, energy infrastructure & competencies across classes and countries. Technology can come at a price, with many struggling with human connection due to reliance on digital devices.

COVID has also led to unprecedented unemployment, recessions and reduced spending decreasing social, health and educational budgets. This forces shifts in business models, often polarised towards either mass online or high-end bespoke offerings,[169] leaving little in the middle ground.

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168 Microsoft found that Brainwave Patterns Associated with Stress and Overwork were Much Higher when Collaborating Remotely than in-person

169 1 Million Flies vs 1 Elephant Strategies: 5 Ways to Build a $100 Million Company, Jeff Desjardins, Visual Capitalist

SERVICE COMMUNITIES & ECOSYSTEMS

Traditional educational structures can be augmented by emerging distributed learning ecosystems, where learning takes place outside traditional institutions. Examples include Pittsburgh and 15 other cities in the USA, LenPolitgrafMash in Russia and many more referenced here. In these 'schools without walls', networks of facilitators guide learning pathways and embrace a systems approach to learning. They include self-directed learning, digital badging and widespread community support in development through learning buddies, parents, mentors and more. Educators turn into coaches, co-learners and integral guides, and offline and online teaching blend together. This model will become mainstream in the middle of the decade and can be applied to many other sectors, e.g. healthcare, hospitality, food systems. A small scale example in healthcare is 'connected care,' including multi-disciplinary perspectives — several experts can look at the case simultaneously, and each expert incorporates feedback from others. Combining across sectors can provide elegant solutions, e.g. Elderly social services & Intergenerational learning.[170] Community ownership (e.g. Kenyan Chamas, or collective savings groups) and community learning models (e.g. collective intelligence projects and courses at CRI) are emerging trends. A COVID-heightened sense of community can be seen in the nightly cheering from apartment windows and in organized drives to supply health care workers with personal protective equipment. Finally, most workplaces are placing more attention on inclusion and equity.

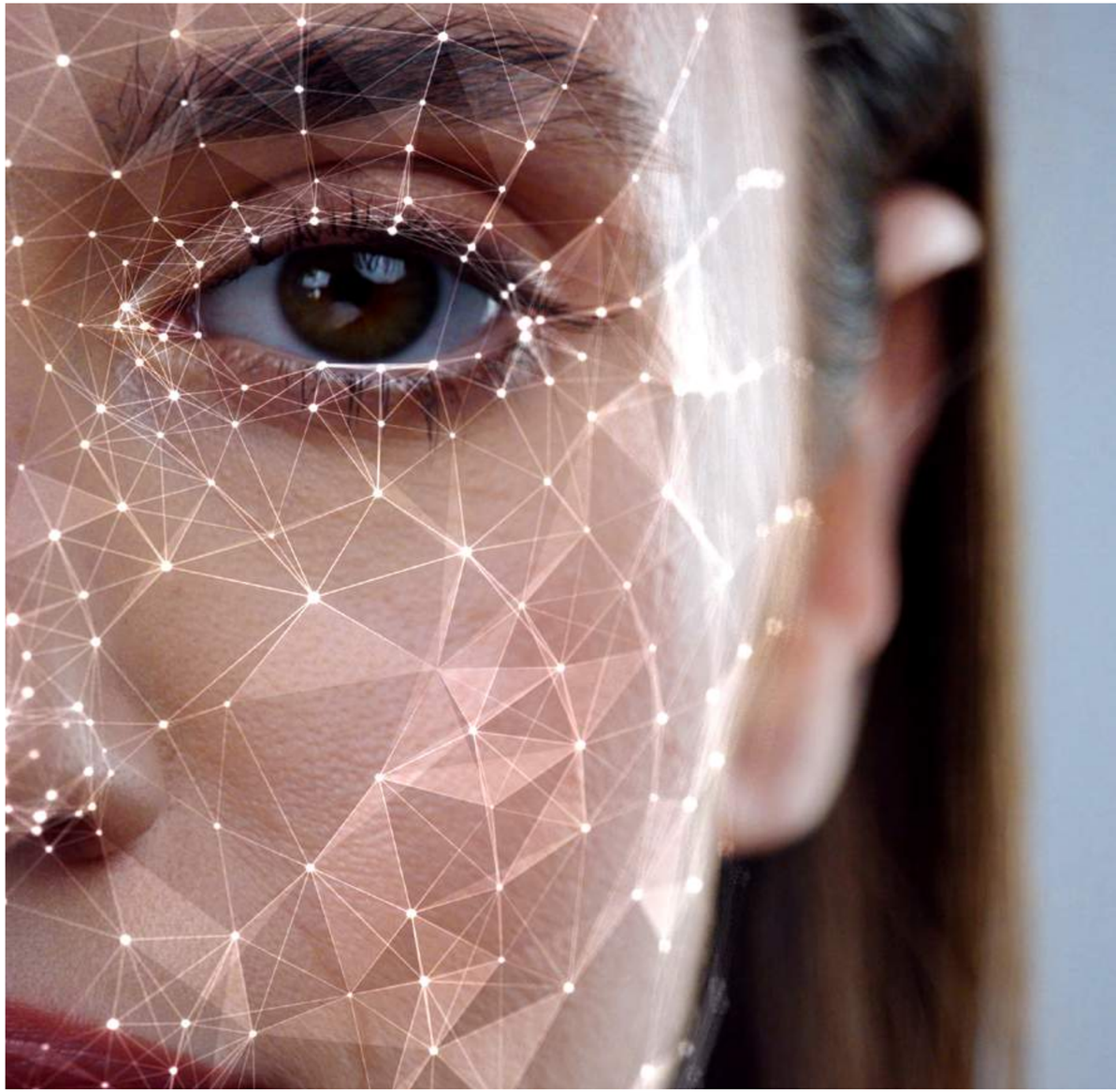
MAINSTREAMING MINDFULNESS & MENTAL HEALTHCARE

There are interesting correlations and increases in web searches for 'mindfulness', 'sustainability' and, noticeably recently, 'well-being' (see Comparison Annex). We leave readers to draw their own conclusions! The effect of 2008 financial crisis can be seen, taking attention away from sustainability, until a resurgence in the past 5 years. Will we learn our lesson this time in COVID-induced recessions?

170 The Benefits of Intergenerational Care, IFStudies.org

DIGITALISATION

In healthcare, digitisation includes enhanced biometrics & digitised diagnostics. Sensing tech, such as depth cameras, enables smart devices to measure facial expressions, heart rate variability, blood pressure, vascular dilation and more. Today this allows apps to detect health conditions, such as malnutrition, or enhance well-being mindset. Telemedicine, remote sensing tools and big data analytics can enable caregivers to see more patients per hour. Big Data & AI drives personalisation in services, consultations and treatment, e.g. as gene analysis becomes more affordable, preventive healthcare and individual therapy at the genome level can take centre stage. With ageing populations increasing pressure on healthcare institutions, assistive technology and specialised services for seniors are more in demand. Society is altering its approach to people with disabilities, with technology enabling more inclusion. Visually impaired people can communicate online in a variety of ways, while people with limited mobility can simulate in VR/AR. AI & empathy: human-friendly interfaces that understand emotion & empathise with people in distress have already shown good results. This will progress into 'Robo-nannies': robots with human features that can take care of people with disabilities or senior people. Collaborative robotics (cobots) can be applied in cooking, healthcare and other service sectors, although this may not be highly significant until the middle of the decade. With all these additional technological access points, comes increased risk of cyberattack and privacy threats, predicted to be significant in the sector early this decade. Paradoxically, services are becoming more transparent and blockchain can show full traceability, e.g. banking, specialist healthcare, or, later in the decade, holistic treatment that weaves together insights from all sectors and aspects of a person's life.



Emerging & Transforming Roles & Skills

HOLISTIC HUMAN-CENTRED ROLES & WEAVING SOCIAL SYSTEMS

This decade, customer-centricity and user experience (UX) — understanding feelings & emotions, needs and motivations — are increasingly central to all lines of work. Our experts called out care and education for particular focus here. Increasingly customers/learners/patients are invited to be co-creators, not just users/consumers. The importance of human connection has been experienced by all during this COVID year. So now, thankfully, we place more value on day-to-day social interactions with teachers, hairdressers, barista, etc.

While specialists are still needed, cross-sectoral generalists come to the fore this decade. Systems Experts across disciplinary fields weave interconnected human and social professions together. Regenerative Community Designer, Resilience Catalyst & Social Weaver roles are integrators and catalysts of transformation across society. They facilitate multi-stakeholder collaboration between actors in their system and build capacity for emerging competencies, e.g. peer-to-peer learning communities, integrated with schools to demonstrate progressive skills. Community Builders can now work with new / social media to build support connections. Integrating more nature-based activities requires new skills (e.g. risk management, outdoor skills for the educator). Social skills of facilitation, collaboration, co-creation and equity are already seen as superpowers to catalyse groups and social cohesion. Roles include: 'Justice, Equity, Diversity & Inclusion facilitator' (BIPOC, 2SLGBTQA+); Disability leader; Moderator (organises group discussions or collective activities — can apply to education or elsewhere); Social Conflict Mediator (assisting in the peaceful resolution of group conflicts caused by social, cultural, national, religious tensions and increased pressure on resources, etc.); Migrant Adaptation Specialist (engages in teaching national language and culture, including via online platforms).

GREEN & WELL-BEING SERVICE ROLES

Many people generally wish to participate in some kind of environmental activity, though they often lack an organiser who would tell them what to do and where. Some environmental activists are already gathering people into volunteer groups, but this area will see more specialists in the future. Related roles include well-being Guide for reconnecting to nature, Permaculture Coach, Regenerative Educator, Social Media Anxiety Therapist and Wellness Conversation Facilitator. Child care services and training will be transformed by teaching children to work with their own well-being and connect to their environment, e.g. growing food around school and home spaces. The Creative State Trainer is an emerging mind fitness role engaged in helping workers enter flow state, as well as other states characterised by increased creativity, often through mindfulness and nature. A Consciousness Training Tools Designer designs programs and equipment (e.g. biofeedback devices) to train users in entering productive states of consciousness (high focus, relaxation, increased creative abilities, lucid dreaming, etc.).

To provide service to others, one must first be mindful of one's own personal well-being.[171] Inner Guides help others navigate inner change & growth. Mental Health & Resilience will be central in education and

[171] Note the top 5 roles in this list are care roles: Which Professionals Are Prone to Burnout?, Mary Gormandy White

care services, utilising meditation, nature and VR / AR mental well-being systems. Example roles: Wellness Music Therapist impacting mood, anxiety and pain; Workplace Wellness Therapists will become a mandatory Human Resource; Sleep Therapists with a new focus on circadian health optimisation; Energy Healing Therapists blending both ancient and modern solutions, e.g. applying cutting edge research bio-field of electromagnetic, light and sound therapies impacting our physical and mental functioning.

NEW LEADERSHIP

As we enter the decade of some of the most profound changes in the history of humanity, new leadership and learning is required to navigate this transformation.[172] Flatter models of organisational leadership, such as teal, holacracy and sociocracy are on the rise *(Section 2.3)*. Transformative economic models, including a greater understanding of sustainability and well-being, have been referenced earlier. Due to accelerating crises (e.g. climate, inequality), accelerating complexity and demand for system change, all levels of leadership now require a greater understanding of systems thinking and inter-relational complexity. Navigating accelerating change across technologies is a key skill early this decade, while future-thinking and adaptability is #3 on critical areas to prepare the sector.

Ross Hall

Learning Societies Co-Lead at Jacobs Foundation
Switzerland

The most important thing from an employment and economic perspective is to empower people to collaborate in service of our collective thriving. As a matter of urgency, we need to forge whole economies and businesses that are fundamentally focused on creating regenerative and sustainable futures. People need to develop a wide range of interrelated skills, attitudes and 'ways of being'. And use them enhance the wellbeing of themselves, our species and the planet together. In other words, we need to nurture rounded human beings who are equipped and inclined to work together and learn together to thrive together.

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172 New Leadership Literacies according to Skip Richard include Backcasting, Voluntary Fear Engagement, Leadership for Shape-shifting Organisations.

DIGITAL SERVICE

Smart automation and AI will continue to reshape the revenue and margins of retailers, as self-checkout machines replace cashiers, robots restock shelves, machine learning improves prediction of customer demand, and sensors help inventory management. It will also change the interaction among patients and healthcare professionals. The demand for care providers, such as nurses, will continue to see growth, while the demand for office-support staff will see decreases because of automation of tasks related to record keeping and administration. These software automations can free up clerical and administrative roles to focus on more strategic, creative and complex tasks. Demand for digital skills, entrepreneurship and adaptability will grow.

HEALTHCARE ROLES

One billion people — 15% of the world's population — experience some form of disability, but have often been more than marginalised by society. With rises in disabilities [173] and other mental issues, the importance of inclusion is clear. A Disability Adaptation Social Worker helps people with disabilities learn skills required for remote employment, job hunting and organising activities by finding relevant communities, platforms, courses, etc. Behavioural Health Technician is #9 on LinkedIn's list of emerging roles, with 32% annual growth 2019 in the USA. As health insurance companies increase their coverage for mental health and substance abuse treatment, new opportunities have also emerged for individuals who specialise in working with patients with autism or behavioural disorders. [174] Global population over 65 is predicted to double to 1.5 billion in 2050, continuing the ageing trend of the past decades. This requires more human / social services catering to senior people, augmented by assistive technology. Health Consultant for Seniors is a sociomedical expert developing balanced solutions for the ageing population, helping adjust lifestyle, diet & exercise.

Genetic analysis and forecasting capabilities will enable the prevention of many diseases before they requir3e treatment. Emerging roles include Personalised Healthcare Expert, Genetic Consultant (studies the genetic record of a patient to develop tailored diagnosis, prevention, treatment plans) and Bioethicist (provides regulatory and ethical framework for medical, diagnostic and bioengineering centres engaged in transplantology and genetic modelling. Bioethics is now offered in many healthcare curricula).

As vegan and health-conscious lifestyles continue to rise (see Comparison Annex), this is coupled with increasing research and production of plant-based substitutes for meat & dairy. Nutritional Advisors & Food Scientists are growth roles, encouraging food curiosity and health literacy.

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173 The World Health Organisation suggests in the 1970s 10% had Disabilities, Rising to 15% today.

174 LinkedIn's Top 15 Fastest Growing, Emerging Job list of 2020 Puts the Focus on the Future, PTP Chicago

In Tourism, VR & AR skills will be key in the second half of the decade. Territory Architects & Augmented Reality Area Designers[175] will create 'information landscapes' for tourists, taking into account the realities of the region, types of consumers and currently popular trends in the travel industry. They design layers of augmented reality around an area, taking into account its landscape, historical and cultural context. Using VR, customers can take a virtual tour of a restaurant, hotel or travel destination, prior to booking.

175 Freelancers in this role can be found on platforms, such as Toptal

Implications for Policy, Education & Training

Recommendations: Education & Training, policy

- Sustainable & Regenerative & well-being practices & Future thinking formally & informally, included in curricula and company learning programs.

- Entrepreneurial agility becomes increasingly essential, pivoting to find new ways to meet new or unmet needs. This is the 2nd most critical area to prepare the sector, +26% more than other sectors.

- Promoting Learning Ecosystems & Community Embodied Learning Models: learning outside schools (e.g. interactions between business and learners) and in learning communities; Experiential education based on real problems; Widespread learning partners (e.g. buddies, parents) & mentors; catalysed by transformative community builders.

- Researching and fostering new ways of conveying human connection, emotion and expression online, e.g. haptic feedback, telepresence & mixed / AR/ VR, non-digital ways.

- Investing in connectivity at the local level, ensuring more people have Internet access for services (e.g. community hubs).

- Adaptable skill standards: Digital badging & blockchain; Distributed assessments & practical certifications.

- The ILO Global Commission on the Future of Work has called on governments to commit to:
  1. A universal entitlement to life-long learning that enables people to skill, reskill and upskill.
  2. Greater investments in the care, green and rural economies.
  3. A transformative and measurable agenda for gender equality.

Recommendations: Companies

- Virtual internships

- Recruitment policies aimed at under-represented minorities include designathons, remote roles and exploring opportunities to recruit autistic talent (e.g. Microsoft). Cross-company mentorships and peer-support groups can lower exit rates.

See also Chapter 6 for more stakeholder-specific recommendations.

176 A Human-centred Agenda Needed for a Decent Future of Work, ILO

CREATIVE INDUSTRIES

4.6

4.6 Creative Industries, Design and Art

Definition

Activities & industries where human creativity and human uniqueness are the main value creators, including:

- Performing arts and crafts
- Cultural & natural heritage (paintings, sculptures, coins, manuscripts, monuments, ruins, traditions, rituals, cultural landscapes, etc.)
- Cinema and Entertainment
- New media
- Video games
- Design of all kinds
- Fashion
- Floristics
- Architecture
- Creative business services, e.g. Advertising

Depending on the region & definition of the creative economy sector, it employs anywhere from 1% to 15% of workforce: for example, in South Africa the sector employed 6.7% of the workforce in 2015. [177] It also typically delivers a large share of GDP: an Oxford Economics study estimated that the sector accounts for over 10% of GDP in Brazil and the United States. [178]

Skills represented in WorldSkills competitions include 3D Digital Game Art, Fashion Technology, Floristry, Graphic Design Technology, Jewellery and Visual Merchandising.

The sector shows strong trends towards environmental advocacy and transformative economies in the coming decade. These are the most likely scenarios (14% more than other sectors), with high impact on skills in the decade ahead, according to our sector experts. The arts sector in particular, has historically been at the forefront of change movements — indeed, change itself could be viewed as natural artistic expression. Increasing personalisation and demand for multi-disciplinary generalists are also highly likely this decade, and more so than most other sectors. Automation may affect the sector 13% less than other sectors, due to the non-repetitive nature of many creative tasks — although expect this to evolve in the future as more complex tasks can be automated.

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177 Employment in Cultural Industries in South Africa, Global Talent Report, Creative Industries Federation

178 How Cultural and Creative Industries can Power Human Development in the 21st Century, Thangavel Palanivel, UNDP; Culture and Urban Regeneration, URBACT Culture. Cultural and Creative Industries: Fulfilling the Potential, OECD.

Key Aspects

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.6

Key Skills/Roles

	2020	2030
1	Activist Art	New Communication Skills (Visual/Touch/Gesture/Thought)
2	Facilitation & Co-creation of Art / Creativity	Transdisciplinary Designers, Catalysts & Community Builders
3	Human / Soft Skills (Social & Emotional, etc.)	AR / VR / MR Design, Engineering, etc.
4	Diversity, Equity Cultural Awareness & Race Relations	Cross-sectoral Bridge Role
5	Info Stylist - helps customize Presentations & Data	Storytelling, Advocacy & Community Roles
6	Ethical Practices, Critical Thinking, Understanding Biases	Blockchain Systems Design
7	Collaboration (On & Offline)	Regenerative & Sustainable Skills
8	Health & Safety Awareness/Skills (Using AR/VR Remote Tech)	Neo-craftsman: VR/AR Supported Design + 3D Printing & Wearables
9	Navigate accelerating Change (eg New Tech)	Wearables Tech Design (eg Personal Power Devices)
10	Training / Programming AI	Mind Fitness Coach focused on Cognitive Skills, Flow & Creativity

Key Factors

2020	2030
Remote Working = New Norm	New Human-computer Interfaces (Touch, Brain)
Social Media Sensationalism over Competence	Digital Currency replaces Cash
Affordable Graphic Technologies	Full Sensory Tech & Wearables in Entertainment Experiences, Clothing & Bodies
Unemployment & Reduced Spending	Decentralisation & Crowdsourcing democratises Creativity
Social Activism - Demand for Socially Engaged Art / Creative Work	AI prediction & Self-learning Machines / Production Lines
Strict Hygiene & Biosecurity Rules	Supply Chain Transparency
Personalisation of Art, Fashion & Entertainment	Total Digital Monitoring
Prioritisation of Wellbeing	3D Printing
Co-creation, Social & Community Creativity (Mobbing)	Participatory Experiences (Theatre)
Fusing Art and Other Fields (Science Art)	Nationalization of Platforms and Data

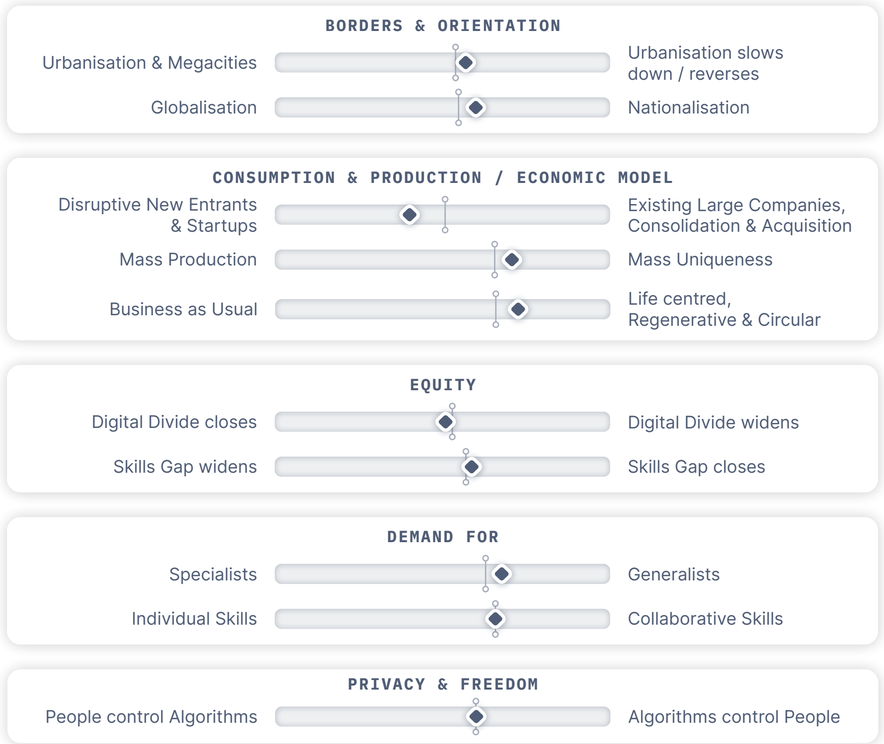
Megatrends

Impact on Skills in the sector over the next 10 years

		VS AVG. IMPACT:			VS AVG. IMPACT:
HIGH	Digitalization		MED.	Globalization	-6%
HIGH	Accelerating Change	+8%	MED.	Automation	-13%
HIGH	Environmentalization & Sustainability		MED.	Demographic Changes	

Scenarios

Which Scenario is most likely over the coming 10 years?

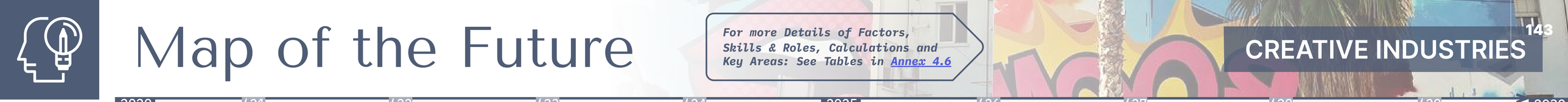


◆ = Sector | = All-sectors Average

Source: GEF + Sector Expert Foresight Sessions + Surveys

Map of the Future

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.6



2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

RELOCALIZED/ COVID

- REMOTE WORK = NEW NORM
- UNEMPLOYMENT & REDUCED SPENDING
- National Self Reliance & Domestic Supply Chains
- Strict Hygiene / Biosecurity
- Blockchain Systems Design

PARTICI-PATORY/ SOCIAL

- COLLABORATION (ON & OFFLINE)
- ETHICAL PRACTICES, CRITICAL THINKING, UNDERSTANDING BIASES
- DECENTRALISATION & CROWDSOURCING DEMOCRATISES CREATIVITY
- FACILITATION & CO-CREATION OF ART / CREATIVITY
- NAVIGATE ACCELERATING CHANGE (EG NEW TECH)
- CROSS-SECTORAL BRIDGE ROLE
- Permanent Job Loss due to Structural Shifts
- NEW COMMUNICATION SKILLS (VISUAL / TOUCH / GESTURE / THOUGHT)
- LEARNING HOW TO LEARN & UNLEARN
- NATIONALIZATION OF PLATFORMS & DATA
- Ageing Workforce
- HUMAN / SOFT SKILLS (SOCIAL, EMOTIONAL, ETC.)
- PARTICIPATORY EXPERIENCES (THEATRE)
- Pop Up Architecture: Unique Temporary Combinations of Objects, Places & People
- Diversity, Cultural Awareness & Race Relations
- TRANSDISCIPLINARY DESIGNERS, CATALYSTS & COMMUNITY BUILDERS
- Increasing Leisure Time
- Personalisation of Art & Fashion, & Entertainment
- Storytelling, Advocacy & Community Roles
- Social Media Sensationalism over Competence
- FUSING ART AND OTHER FIELDS (SCIENCE ART)

GREEN & UNIVERSAL WELLBEING

- ACTIVIST ART
- Learning to Reconnect with Nature
- Regenerative & Sustainable Skills
- Clothes Recycling Specialist
- Health & Safety Awareness / Skills (Using AR/VR Remote Tech)
- PRIORITISATION OF WELLBEING
- Mind Fitness Coach focused on Cognitive Skills, Flow & Creativity
- SOCIAL ACTIVISM - DEMAND FOR SOCIALLY ENGAGED ART / CREATIVE WORK
- ECO MATERIALS & PRODUCTION MODES ESSENTIAL

TECH

- AFFORDABLE GRAPHIC TECHNOLOGIES
- Wearables Tech Design (eg Personal Power Devices)
- Neo-craftsman (eg VR/AR Supported Design + 3D Printing & Wearables)
- Info Stylist - helps customize Presentations & Data
- AR / VR / MR Design, Engineering, etc.
- NEW HUMAN-COMPUTER INTERFACES (TOUCH/BRAIN)
- Training / Programming AI
- FULL SENSORY TECH & WEARABLES IN ENTERTAINMENT EXPERIENCES, CLOTHING & BODIES
- TOTAL DIGITAL MONITORING
- INDUSTRIAL INTERNET (BIG DATA ANALYTICS & IOT)
- 3D PRINTING
- AI PREDICTION & SELF-LEARNING MACHINES / PRODUCTION LINES
- SUPPLY CHAIN TRANSPARENCY
- Robotics & Cobots
- DIGITAL CURRENCY REPLACES CASH
- Personalisation of Production
- Mixed / Augmented / Virtual Reality

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

Skills/ Roles Clusters: TECHNICAL & DIGITAL; COGNITIVE FOUNDATIONAL; SOCIO-ECONOMIC & CULTURAL; GREEN & UNIVERSAL WELLBEING

Factor Clusters: COVID ACCELERATED; TECHNOLOGY /SMART; GENERAL; SECTOR SPECIFIC

ITEMS IN CAPS: 100% of experts surveyed indicate it is significant for the sector: widespread impact, or clearly disrupting sector & transforming roles.

CREATIVITY AS MAIN VALUE DRIVER OF THE DECADE

Automation in other sectors creates more time for entertainment and creativity. Average hours worked have reduced by 20-30 hours per week globally since the 19th Century, but have stabilised in the past 5 years according to OECD.[179] Hours worked are expected to reduce again this decade. As automation continues to increase, creativity and uniqueness become value drivers for employees and companies alike. The existing trend from standardised produce to creativity-infused continues this decade, where products without a 'creative' component will have lower perceived value. Education systems are slowly starting to focus more on creativity, helping creativity spread to many more sectors, from the aerospace industry to financial services. Common manufacturing & service jobs will increasingly have creative elements, e.g. cooks, builders.

TECH EMPOWERS THE RISE OF 'CREATIVE CLASS'

As AI & Big Data helps model more complex creative activities, this can be a productivity boost to creatives who embrace these tools. AI & Automation are also key drivers towards the personalisation & democratisation of artistic creation. Affordable graphic technologies is high on the sector factors list (see Annex for full list). With creative tech tools, such as ubiquitous mobile phones and AI apps, a novice can make instant works of art (e.g. Prisma), or shorten a learning curve in music. Movies have used Computer Generated Imagery (CGI) to create environments and effects for decades, and now AI can be used for deep fakes, facial response monitoring, behavioural analysis and forecasting. This Personalisationof art, fashion, & entertainment experiences is accompanied by decentralised media/creative content production & consumption models, allowing everyone to become a creator. There is risk of this emerging large 'creative class' devaluing creative professions, so creatives must continually stay ahead of trends and evolve with technology.

Creatives now have an increasingly multi-dimensional and multi-sensory pallet of tools to explore new ways of measuring and perceiving our environment. New touch and brain interfaces emerge this decade. VR, AR & Mixed reality allows cocreation of simulated worlds. Full sensory tech will continue to innovate in entertainment experiences, from movies and dance, to connecting with nature. Gaming, triple in size, to global movie revenues,[180] before COVID cemented us to our sofas, will continue to grow in popularity this decade as it becomes more immersive.

COVID REMOTE GLOBAL GIG WORK

COVID accelerating the underlying trend of remote work is #1 factor in the sector today. Virtual meeting & learning environments become omnipresent, but do require creatives to adapt to new ways of conducting / facilitating work remotely. With many embracing a more global mindset (e.g. adopting transnational digital currencies), the lack of geographical restrictions empowers a more democratic wave of globalisation. On the other hand, opportunities can be limited by lack of online access, or COVID pushing national policies towards increased self-reliance & isolation. Inequality of access to both creative inspiration and technology is a perennial (class) challenge. Technology can come at a price, with many struggling with human connection due to reliance on technology.

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179 Average working hours (Statistical data 2020), Clockify

180 Digital Games Earn 120 Billion Globally 2019, SYFY Wire

COVID has also led to unprecedented unemployment, recessions and reduced spending. With creative sector funding scarce, there is a need to diversify income streams away from public sector funds towards innovative and financially sustainable models. Our experts also observe the beginnings of a shift away from consumerist civilisation, a greater understanding of personal well-being and transition to 'new' economies of joy, play, creativity and care. Whether this happens before, during or after further degrees of environmental breakdown this decade, creative energy will be essential to help us adapt.

RETURN OF PARTICIPATORY & PERFORMANCE ART

Performance events, music, movies, dance shows, theatre, festivals, contests are slowly emerging as we prepare for a COVID-ready world. The return of 'traditional' live art has to evolve with reduced capacity, scale and budget. More intimate micro gigs & micro venues are popping up. Outdoor events, utilising open spaces and street entertainment present opportunities, not only for emerging artists. Live artists now have to curate remote performances to give a feel of a live set, and/or explore opportunities for new forms of digital audience interaction. Immersive participatory experiences allow us to act in movie scenes (e.g. Escape rooms, Secret Cinema), co-create art at festivals (e.g. Burning Man) or experience a day in the life of a refugee.

Emerging & Transforming Roles & Skills

Art and creativity are intrinsically expression and communication, as reflected by the dominance of inter-relational social skills — 9 of the 13 skills reaching 100% consensus from our sector experts that they will be significant this decade. The Partnership for 21st Century Skills posits that the 4Cs (Communication, Collaboration, Critical Thinking, and Creativity) are the central skills and dispositions that all students must master to be successful in our increasingly complex world.

ACTIVISM, DIVERSITY & ETHICAL CONSUMPTION

Activist Art is seen as significant today by the highest % of experts, with ethical practices and cultural awareness increasing in importance through the decade. Advertising models start to reflect the shift away from consumerist civilisation towards more purpose-driven ethical branding. This, together with increasingly personalised economic models, leads fast fashion to transform to ethically produced, slow fashion, upcycling, smaller batches & personalised make to order 'fashion on demand.' Creative roles focus on use of sustainable fabrics or recycling in fashion, reimagining business models to be circular. Creative placemaking roles, such Urban Designer, Architect and Natural Landscape Designer are examples in the regenerative economy. User experience, human- and life-centred design principles are key. Design Thinking is both a practical and creative approach to problem-solving and product development. These trends and skills also translate to digital community and place making.

Emerging at the core of this movement are designers, catalysts & community builders for happiness, well-being, compassion & kindness. They are cross-sectoral connectors, weaving conversations and groups together. Storytelling and advocacy is significantly more important in the creative sector compared to other sectors. Persuasive presentation and influencing skills are required to motivate an audience to action. Community social art and working together with teams of individuals with diverse perspectives are examples. Facilitators of co-created art is #2 on the sector skills list (see Annex for full list), with examples in music, art and many more. The proliferation of open online media making & collaborative tools, social media/online communities and co-curated niche entertainment platforms supports this trend. Social engagement through creative arts can help co-create just futures (e.g. TAAP and Mi Sangre in LatAm) and bring new ways to drive messages like social justice and sustainability. Google search data (see Comparison Annex) shows a slow but steady increase in interest in sustainability, and the recent increase in social justice this year with Black Lives Matter.

TECH-ENHANCED CREATIVE ROLES

Digital fitness is increasingly essential to access new audience platforms, and use tools to interpret and communicate with the modern world. Creatives are required to navigate accelerating change across technologies, with anticipation / future thinking becoming essential (see Key Areas Annex). Creative AI-driven 'generative design' systems can support design / architectural / artistic work. Experts reported a decline in the numbers of boundary-pushing artists recently, so these new tech mediums can be seen as a welcome source of creative inspiration.

Neo-crafts: as hand skills for repetitive rule-based tasks are replaced by automation, creative roles transition to skilled use of tools to control robotics (e.g. fabric pattern cutting and pottery), software (e.g. audiovisual) or 3D printing craftwork. New materials are used by architects, furniture and fashion designers. Video Game Developers use increasingly sophisticated AI. Game Practitioners, Mixed Reality Guides & Experience Designers can now use AI-enhanced VR/AR/MR tools for personalised entertainment, leading the evolution of participatory experiences into the virtual and augmented worlds, where boundaries blur between game and reality. Knowledge of wearables and advanced fabrics are already becoming key differentiators in clothing. The most difficult fashion jobs to fill are in design and product followed closely by technology and digital. Pattern makers and accessory designers are in short supply. It is also becoming difficult across the sector to find employees who combine analytical and creative skills at and above managerial levels.[181] Increasingly there is a demand for multi-disciplinary creatives with versatility across mediums.

Around the middle of the decade the role of Info Stylist will emerge, helping customise presentations / materials for various audiences, e.g. streaming recommended product content based on geotargeting, interests, search history. Key skills are visual synthesis and working with AI / Big Data algorithms. The more traditional role of Personal Stylist can now be enhanced by virtual clothing testing and AI trend analysis. Trend prediction algorithms are already shaping our music and media consumption at industrial scale (e.g. Spotify, Netflix), and these tools will become more accessible to individual creators through the decade. The need for tech skills can again be seen with Open Sourced Librarians.[182] The Personal Aesthetic Development Tutor will build individual trajectories of interaction with works of art for the user. They will possess an excellent knowledge of the cultural environment and draw up aesthetic development programmes, in accordance with the tastes, needs and opportunities of the client, e.g. to track the development of various aspects of Gothic art from the Middle Ages to the present time, in the fields of architecture, design, literature, music, and cinema.

RECONNECTION & WELL-BEING

Emerging roles include Wellness Conversation Facilitator, Social Media Anxiety Therapist and Creative State Trainer — an emerging mind fitness role engaged in helping workers enter flow state, as well as other states characterised by increased creativity, often through mindfulness and nature. The trainer is also engaged in developing awareness, because one of the most important challenges for an artist is the continuous reflection on reality. Note there is a paradoxical counterculture, with anti-AI art & design expressions and reconnection to analogue processes. Creativity and hand skills are not disappearing! Human motor skills are more precise, adaptable and creative than our automated friends, at least for the next decade. Creativity is inherently human, embedded in ever-changing social structures and paradigm shifts.

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181 Creativity, the Arts and the Future of Work, Linda F Nathan, Sustainability, Human Well-Being, and the Future of Education.

182 Open Library Foundation

Implications for Policy, Education & Training

Recommendations: Education & Training, policy

- Entrepreneurial skills are most critical as up to a half of those working in the sector are self-employed freelancers — for instance, in the UK the share of freelance employees is 47%, compared to 15% average in other sectors. [183] Policies, platforms and pathways needed for learners to develop skills for self-promotion, business, self management, etc.

- New metrics of 'creative capacity' to measure 'intrinsic' value of creative culture: entertainment, advocacy, sensemaking, inspiration. Measuring how the creative sector (and other sectors) contribute to social cohesion, city and nation-building through the promotion of intercultural dialogue, understanding and collaboration. Rather than measure and manage economic, social and physical dimensions independently, an integrated systems approach is needed.

- To keep up with the increasing rate of change, continually monitor the skills gap, e.g. quarterly 'pulse check' with a pool of businesses, educators, learners and workers. Government should also commission regular reviews of the Shortage Occupation List, which can go many years without update. For example, in the gaming sector alone, game analyst, senior game artist, senior game designer, senior producer, engine programmer and machine vision and software tools engineers are missing (UK). These lists need a regular rethink, e.g. to ensure interdisciplinary generalists are considered correctly.[184]

- Expert quote: 'Creative sector leads integration of ecosocial values. The creative sector could have a critical leadership role to invite inclusive reflection on new integrated ecosocial values needed for a sustainable, just and beautiful ecological era.' E.g. Earth Charter for education.

- Companies could get closer to fresh talent on both business and creative sides, by forging closer relationships with educational institutions.

See also Chapter 6 for more stakeholder-specific recommendations.

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[183] Creative Freelancers Report

[184] Global Talent Report, Creative Industries Federation

Julene Siddique

Co-Chair for Arts, Humanities and Culture - Global Leadership 21
WAAS & UN Office Geneva

The arts play a critical role in the development of the brain, social and emotional skills and empathetic capacities, and hold critical keys for human development, social progress and the qualitative skills we need to ensure a better future… Rapid technological advances devoid of the knowledge of Humanities could become a detrimental force for accelerating world issues such as ecological decline and socioeconomic inequality. The critical skills we need will come from the Arts and Humanities. 'The future will come from the quality of our being and the quality of human decision.' [185] The Arts can infuse technological advances and educational initiatives with capacities for compassion, empathy, understanding and vital insights on the nature of our humanity. The Arts, Humanities and Culture play a critical role in enabling us to understand how to carve an ethical path towards shared prosperity, through a deeper understanding and value for our common humanity.

[185] Popovich, M. and Siddique, J., 2020 Report to Global Leadership for the 21st Century, World Academy of Art & Science and United Nations Geneva Office.

AGRICULTURE & ECOLOGY

4.7

4.7 Agriculture & Ecology

Definition

Agriculture is the art and science of cultivating the soil, growing crops and raising livestock. It includes the preparation of plant and animal products for people to use and their distribution to markets. It includes cultivation, domestication, horticulture, arboriculture, fish farming and vegeculture, and forms of livestock management, such as mixed crop-livestock farming, pastoralism, and transhumance. [186] Agricultural methods vary widely around the world, depending on climate, terrain, traditions and available technology. Associated categories of agriculture include smart farming (embracing technology), industrial or big agriculture (embracing scale) and organic farming (embracing nature). We include food services in this research.

Ecology is the study of the relationships between organisms and their environment. We include Nature protection and Restoration, Regenerative, Sustainable & Circular economy.

For the purposes of this report we include both of the above fields as discrete areas of activity. We also include a subset or merging of these two fields: AgroEcology, which refers to the integrated use of natural resources and mechanisms for the purpose of ecologically sustainable agricultural production. It combines ecological, economic and social dimensions and aims to make better use of interactions between humans and the natural environment. We also include Land, Water and Energy management in this sector.

4% of global GDP is attributed to agriculture, [187] yet it employs 26% of the global workforce, [188] more than any other sector. Also, concerns for food security, climate change and soil depletion (rapidly making many regions of the world unsuitable for food production) may again raise the importance of this sector in the world.

Ecological services do not have established accounting of their own yet — largely because they are developing as a new paradigm of design and production within many economic sectors, rather than a sector of their own. However, a shift towards ‘green’ jobs — with employment focused on Nature-Based Solutions — may become a significant driver in job creation and transformation during the upcoming decades, and even a vehicle for global economic recovery after COVID. [189]

Agriculture and Ecology skills are currently not a part of WorldSkills global competition.

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186 Agriculture: Definition and Overview, David R. Harris and Dorian Q Fuller, ResearchGate

187 Statista - Share of Economic Sectors in the Global GDP

188 World Bank Data - Employment in Agriculture

189 NATURE HIRES: How Nature-based Solutions can Power a Green Jobs Recovery – joint publication by ILO and WWF, October 2020

Key Aspects

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.7

Key Skills/Roles

	2020	2030
1	Collaboration (On & Offline)	Designing / Using Big Data Solutions for Agriculture
2	Facilitation & Co-creation	Big Data Solutions for Agriculture
3	Diversity, Equity Cultural Awareness & Race Relations	Biosystemic Designer of Regenerative Farming Ecosystems
4	Cybersecurity	Designers, Catalysts & Community Builders for Wellbeing & Kindness
5	Habitat Conservation	Blockchain Systems Design
6	Farm / Food Partnership Specialists	Seed Breeding
7	Climate Crisis Mitigation Expert	Reconnecting with Nature
8	Fertiliser & Soil Health Specialists	Navigate accelerating Change (eg New Tech)
9	Ethics & Practices, Critical Thinking, Understanding Biases	Carbon sequestration
10	Regenerative & Sustainable Skills	Training / Programming AI

Key Factors

2020	2030
Resource shortages: Soil Degradation, Biodiversity Loss & Malnutritious Food	AI prediction & Self-learning Machines / Production Lines
Hydroponics	3D Printing
Demand for Organic / Sustainable / Fair Trade + Certified	Full Year Use of Land (Cover Crops, Multi Season Harvest)
Strict Hygiene & Biosecurity Rules	Gene Editing & Epigenetics
Farm Management Software	Robotics & Cobots
Unemployment & Reduced Spending	Supply Chain Transparency
Remote Working = New Norm	Precision Agriculture: Big Data Analytics & IoT
Soil Nutrient Testing & Aerobic Restoration	Ageing Workforce
Indoor, Urban & Vertical Farming	Farming Tech moves to Renewable Energy
Permanent Loss of Jobs due to Structural Shifts	Mixed / Augmented / Virtual Reality

Megatrends

Impact on Skills in the sector over the next 10 years

		VS AVG. IMPACT:			VS AVG. IMPACT:
HIGH	Environmentalization & Sustainability	+7%	HIGH	Digitalization	-9%
HIGH	Globalization		MED.	Demographic Changes	+11%
MED.	Automation		MED.	Accelerating Change	-6%

Scenarios

Which Scenario is most likely over the coming 10 years?

BORDERS & ORIENTATION

Urbanisation & Megacities	Urbanisation slows down / reverses
Globalisation	Nationalisation

CONSUMPTION & PRODUCTION / ECONOMIC MODEL

Disruptive New Entrants & Startups	Existing Large Companies, Consolidation & Acquisition
Mass Production	Mass Uniqueness
Business as Usual	Life centred, Regenerative & Circular

EQUITY

Digital Divide closes	Digital Divide widens
Skills Gap widens	Skills Gap closes

DEMAND FOR

Specialists	Generalists
Individual Skills	Collaborative Skills

PRIVACY & FREEDOM

People control Algorithms	Algorithms control People

◆ = Sector | = All-sectors Average

Source: GEF + Sector Expert Foresight Sessions + Surveys

Map of the Future

For more Details of Factors, Skills & Roles, Calculations and Key Areas: See Tables in Annex 4.7

AGRICULTURE & ECOLOGY

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

RELOCALIZED/ COVID

- STRICT HYGIENE / BIOSECURITY
- UNEMPLOYMENT & REDUCED SPENDING
- National Self Reliance & Domestic Supply Chains
- REMOTE WORK = NEW NORM
- Indoor, Urban & Vertical Farming
- BLOCKCHAIN SYSTEMS DESIGN

PARTICI-PATORY/ SOCIAL

- FACILITATION & CO-CREATION
- COLLABORATION (ON & OFFLINE)
- ETHICAL PRACTICES, CRITICAL THINKING, UNDERSTANDING BIASES
- PERMANENT JOB LOSS DUE TO STRUCTURAL SHIFTS
- AGEING WORKFORCE
- LEARNING HOW TO LEARN & UNLEARN
- NAVIGATE ACCELERATING CHANGE (EG NEW TECH)
- CULTIVATORS AND WEAVERS OF LEARNING COMMUNITIES OF AGROECOLOGICAL PRACTICE / RESILIENCE CATALYST
- DIVERSITY, CULTURAL AWARENESS & RACE RELATIONS
- FARM/FOOD PARTNERSHIP SPECIALISTS
- NEW COMMUNICATION SKILLS (VISUAL / TOUCH / GESTURE / THOUGHT)
- Human / Soft Skills (Social, Emotional, etc.)
- Nationalization of Platforms & Data
- Storytelling, Advocacy & Community Roles

GREEN & UNIVERSAL WELLBEING

- CLIMATE CRISIS MITIGATION EXPERT
- REGENERATIVE & SUSTAINABLE SKILLS
- OUTCOMES FARMING: HUMAN & ECOLOGICAL IMPACT
- Insect Farming
- FERTILISER & SOIL HEALTH SPECIALISTS
- RECONNECTING WITH NATURE
- CARBON SEQUESTRATION
- FULL YEAR USE OF LAND (COVER CROPS, MULTI SEASON HARVEST)
- HABITAT CONSERVATION
- BIOSYSTEMIC DESIGNER OF REGENERATIVE FARMING ECOSYSTEMS
- Living System Intelligence into AI (Internet of Living Organisms)
- REGENERATIVE FARMING: ECOLOGICAL & SOCIAL
- HEALTH & SAFETY AWARENESS
- AFORESTATION EXPERT
- Crop Swap Impact Analysis
- Decentralised Agriculture: Indigenous & Local Knowledge
- RESOURCE SHORTAGES: SOIL DEGRADATION, BIODIVERSITY LOSS & MALNUTRITIOUS FOOD
- FARMING TECH MOVES TO RENEWABLE ENERGY
- DEMAND FOR ORGANIC / SUSTAINABLE / FAIR TRADE + CERTIFIED
- Soil Nutrient Testing & Aerobic Restoration
- Eco Materials & Production Modes Essential

TECH

- SEED BREEDING
- CYBERSECURITY
- AR / VR / MR SKILLS
- BIG DATA SOLUTIONS FOR AGRICULTURE
- TRAINING / PROGRAMMING AI
- AGRI GENE SCIENTIST & EPIGENETICS
- TECH INTEGRATORS: CAPACITY BUILDER FOR NEW SECTORAL COMPETENCIES
- PRECISION AGRICULTURE: BIG DATA ANALYTICS & IOT
- 3D PRINTING
- Agrodrones & Agrobots
- Cloned Crops & Meat
- New Human-computer Interfaces (Touch/Brain)
- HYDROPONICS
- FARM MANAGEMENT SOFTWARE
- SUPPLY CHAIN TRANSPARENCY
- AI PREDICTION & SELF-LEARNING MACHINES / PRODUCTION LINES
- Mixed / Augmented / Virtual Reality
- Robotics & Cobots
- Total Digital Monitoring
- Personalisation of Production
- Digital Currency replaces Cash

2020 '21 '22 '23 '24 2025 '26 '27 '28 '29 2030

Skills/ Roles Clusters: TECHNICAL & DIGITAL; COGNITIVE FOUNDATIONAL; SOCIO-ECONOMIC & CULTURAL; GREEN & UNIVERSAL WELLBEING

Factor Clusters: COVID ACCELERATED; TECHNOLOGY /SMART; GENERAL; SECTOR SPECIFIC

ITEMS IN CAPS: 100% of experts surveyed indicate it is significant for the sector: widespread impact, or clearly disrupting sector & transforming roles.

Sector Trends

The most likely scenarios emerging for the sector are: the growing demand for multi-disciplinary generalists; coupled with transition to life-centred, regenerative & circular business models. As smart farming increasingly requires digital fitness, collaboration across communities and silos drives demand for the new breed of 'whole farmers'. Our research suggests change will be led by both large companies and disruptive startups equally. Environmetalisation & Sustainability is the #1 megatrend affecting the sector, +7% more than other sectors. This is reflected in the predominance of green roles and skills (see Key Aspects, or Annex for full list of sector skills). Demographic changes are also notably more impactful here than other sectors.

CAPITAL PROFIT PRESSURING PEOPLE & PLANET

Prioritising profit & shareholder value for agricultural businesses has exposed us to high risk in our 'planetary boundaries' of biodiversity, phosphorus and nitrogen, as shown by Stockholm Resilience Centre's research. Breaching any one of these boundaries threatens humanity's ability to thrive today & for generations to come. Increasing demands on natural resources results in ecosystem damage and biodiversity loss, while fertiliser production and application is the main concern with biogeochemical flows, e.g. decline in the shrimp catch in the Gulf of Mexico's 'dead zone', caused by fertiliser transported in rivers from the US Midwest. Big agriculture monocultures dictate that 75% of global food comes from just 12 plant and 5 animal species. 75% of the genetic plant diversity in agriculture has been lost since 1900. [190]

Soil quality has degraded to the extent that many staple foods now deliver a small fraction of the nutritional value they did a hundred years ago, leading to poor nutrition at societal scale. Modern intensive agricultural methods have stripped increasing amounts of nutrients from the soil e.g. up to 75% decrease in USA iron levels since 1930. This loss of land fertility is irreversible in many cases. The availability of fertile farming land is further squeezed by erosion, climate change and urbanisation. Increasing levels of atmospheric CO2 has been shown to significantly reduce nutritional values of rice and other staples, potentially leading to millions of health deficiencies. [191]

Unsustainable meat & dairy farming:

- Global demand for meat and dairy products is expected to continue to increase (in particular in the Global South), [192] driven by rising incomes, lowering prices, unsustainable eating habits, and rapid urbanisation.

- Meat contributes 18% of global greenhouse gases (animal digestion methane, deforestation and artificial fertilisers). While meat and dairy provide just 18% of calories, they use 83% of farmland and produce 60% of agriculture's greenhouse gas emissions. [193]

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190 What is Agrobiodiversity? Food and Agriculture Organisation of the United Nations

191 Global Health Implications of Nutrient Changes in Rice Under High Atmospheric Carbon Dioxide, Smith & Myers, Harvard

192 Food Consumption, World Health Organisation

193 Avoiding Meat and Dairy is 'Single Biggest Way' to Reduce your Impact on Earth, The Guardian

- Serious deterioration of water quality is linked to ammonia and nitrous oxides from cattle feeding, animal wastes, antibiotics and hormones, chemicals from tanneries, fertilisers and pesticides, used for feed crops, and sediments from eroded pastures. [194]

- Transitioning to primarily plant-based diets would reduce global farmland use by 75% and still feed the world. Note that regenerative grasing practices (e.g. using livestock feed crops that are carbon negative) does mean meat can still be on the table sustainably.

Pressures on margins from shareholders and on pricing from consumers creates financially unsustainable farming models, with disturbing increases in farming bankruptcies and suicide rates. In addition to an uneven distribution of natural resources, there are also significant economic and technical inequalities geographically at micro and macro levels. Yield gaps in developing countries and family owned farms / smallholdings are exacerbated by knowledge gaps and access to new technologies.

Growing awareness of these issues, and our role on the planet as a 'key species', drives consumer demand for organic, sustainable, & fairtrade certified goods. In the near future, there will be greater end-consumer involvement in agriculture, wanting traceability of where and how their food is produced. Many are now replacing meat with plant-based diets, +30-40% of consumers in many large European countries. [195]

SMART FARMING 4.0

Farming is transforming further through a multitude of interconnected technical innovations, aimed at delivering environmental, financial and safety benefits. Examples include:

- Autonomous tractors, Agrobots & drones, e.g. planting/harvesting machinery. A strawberry harvester, costing $25k, can free up 8 workers for other tasks and pay for itself in 18 months.
- Precision agriculture utilise big data analytics to provide insights from aerial images, sensors and drones to monitor crop & environmental conditions at micro levels
- Connected Internet of Things & GPS gives precise spatial awareness to farming machinery, e.g. tailoring watering & nutrients to each plant. GPS is worth up to $1.5bn a day in the USA during planting season (April and May). [196]
- AI predicting the optimal crops and yield on land, or consumption & pricing patterns. Climate smart approaches pave opportunities for farmers, e.g. against extreme weather.

Automation could reach 52% of jobs in the sector in the USA by 2030. Farm manual labour and pesticide applicators are projected to be most highly automated (97%). Farmers, ranchers and agricultural managers are least likely to be automated (5%). [197]

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[194] The Sustainability Challenges of our Meat and Dairy Diets, Susanne Stoll-Kleemann and Tim O'Riordan

[195] Plant-based Push: UK Sales of meat-free Foods Shoot up 40% between 2014-19, Mintel

[196] Economic benefits of Global Positioning System (GPS), RTI International

[197] Automated Pastures and Digital Divide: How Agricultural Technologies are Shaping Labour and Rural Communities, Sarah Rotz, Evan Gravely et al, Science Direct

TRANSITIONING FROM CAPITAL-CENTRED TO SUSTAINABLE TO REGENERATIVE LIFE-CENTRED PRACTICES

Regenerative is evolutionary or developmental, it's never a destination — the notion of being regenerative is developing the capacity of people in 'place' to keep evolving. 'Regenerative Agriculture' describes farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity – resulting in both carbon drawdown and improving the water cycle. [198] It is an ideology and farming practice, based on decades of scientific research and agroecological farming practices, such as organic, biodynamic and permaculture. Good practice creates competitive yields, provides jobs – safer working environments for farming communities and healthier, better tasting food.' [199]

Shifting to outcomes-based farming means designing systems that quantitatively measure and show improvements in soil health, biodiversity, carbon, water use, human and animal welfare, as well as traditional yield & economic measures. Agricultural machinery will be designed with user experience, regeneration and biomimicry in mind. There is a seemingly paradoxical growth in Mega farms + Consolidation of small farms into bigger farms AND decentralisation of agriculture: small local farms growing 'regionally relevant' produce closer to consumers. Combined with a growing movement/culture of city dwellers migrating to rural areas with the dream of becoming agroecological farmers. The rise of regenerative agriculture in the past year, and the continued importance of smart agriculture (in particular in Africa & SE Asia) is indicated by Google search volumes (Comparison Annex).

198 Why Regenerative Agriculture?, Regeneration International
199 Sustainability Glossary, Tom Hunt

Emerging & Transforming Roles & Skills

Green and COVID factors unsurprisingly feature heavily at the top of the list of significant factors affecting sector skills.

FROM CAPITAL-CENTRED TO SUSTAINABLE TO REGENERATIVE PRACTICES

These factors make bleak reading, but there is hope. The sector is uniquely positioned to address global challenges, with emerging practices and skills central. The transition from extractive monocultures, meat and monopolies towards sustainable and regenerative, plant-based, life-centred agroecology systems is underway. 4 of the top 10 sector skills are green regenerative skills. Encouragingly, outcomes-based farming now shifts the currency of farming from yield to 'quality,' by tracking human & ecological footprints of food, including soil regeneration, carbon sequestration, farmer income and welfare/equality. For example, Ecological Outcome Verification is a certification that measures Ecological Uplift. A raft of emerging regenerative roles include biosystemic, permaculture & natural landscape ecosystem design of integrated farming, in some cases shifting scope to self-sustaining bioregional food production and distribution structures, or regenerative multi-season harvesting. Similarly, urban, indoor & vertical farming incorporate regenerative and circular design principles into walls & roofs, buildings & city infrastructure, such as the 'plantscraper'. These roles require holistic skill sets, such as long term thinking, resiliency scenario planning and emergence mindset (dancing with complex living systems we cannot hope to fully 'command & control'). Sector experts predict multi-sector generalists, or 'whole farmers,' to be significantly more in demand than specialists, 14% more than other sectors. As farming becomes increasingly complex it requires multi-disciplinary blends of scientific, technical and nature-based skills.

SOCIAL / LIVING SYSTEMS WEAVING, ANALYTICS & SCENARIO BUILDING

Inter-relational skills of collaboration, co-creation, equity and partnering are among the highest on the sector skills list (see Key Aspects, or Sector Skills Annex). Regenerative Community Designer / Resilience Catalyst / Social Weaver are integrators of food systems transformation across society. They facilitate collaboration between actors in the supply chain food system and build capacity for emerging competencies, e.g. peer-to-peer learning communities of agroecological practice, integrated with school farming to demonstrate progressive regenerative & urban ecology skills. More nature-based education requires new skills for the educator (e.g. risk management, outdoor skills). Related roles include:

- Land Guardian weaving indigenous knowledge about food production & ecology and heritage together with advanced agricultural production models.
- Mediation / Negotiation roles to navigate tensions, e.g. between urban & rural areas in a bioregion, or integrating sectors, such as agri-tourism (with COVID disrupting international tourism, domestic eco/agri-tourism becomes more prominent).
- Farm/Food Partnership Specialist. When consumer preferences change, farmers get insight into the feedback, and food companies better understand the capabilities of their own supply chains. This collaborative practise creates more transparency between the consumers and the food companies, thus providing them with healthier and less processed options.
- Co-designer of projects with emphasis on inclusive equitable approaches, e.g. highlighting women in agriculture, e.g. giving power back to consumers & farmers to decide what are the right regenerative products.

NUTRITION & QUALITY

Food Analyst roles help us better understand what is regionally relevant and when, while finding ways to deliver health benefits, focusing on quality and traceability. The demand for precise information around the nutritional value and quality will drive the need for food analysts to be proficient in evaluating soil, crops and the impact of processing. Food preservation techniques are the methods of preventing food from spoilage or slaughter. Among the oldest methods of preservation are drying, refrigeration and fermentation. Modern methods include canning, pasteurisation, freesing, irradiation and the addition of chemicals. Consumer Relationship Specialists help customers choose the relevant eco-products and read the advertisement and packaging labels.

INTEGRATING TECHNOLOGY ACROSS SUPPLY CHAIN

Fertiliser and Soil Health Specialists collect data on soil to recommend what plant is suitable and when, and shift from chemical to local organic fertilisers, e.g. chicken feathers. Micronutrient fertilisers can address micronutrient deficiencies not just in soils, but also in humans and animals. Analysis of plant health data triggers actions on each crop individually, in real time. Nutrient recycling (phosphorus, potassium and nitrogen) is another growth area. Automation Specialists/Smart Farming roles integrate technological factors mentioned above.

Combining Living Systems Intelligence with AI, e.g. to model the impacts of permaculture, or crop swaps, such as rice to quinoa. While initiatives such as indoor temperature-controlled urban farms, cloned factory meat, hydroponics or irrigation with desalinated seawater may reduce food miles & open up access to food in areas of scarcity, there is a need for holistic suitability analysis & thermodynamic evaluation.
Blockchain solution designers for agriculture are a key part in new Information management systems, delivering more transparency and responsiveness across supply chains.

- Crop Gene Scientists: precisely edit gene DNA with the goal of creating a better crop variety, disease resistance, drought tolerance or more nutritious yields.
- Plant-based solutions and biomimicry improves crop health, resilience and production.
- Climate-smart approaches drive increasing demand for roles, such as Water Resource Scientist.
- Agri-Predictive Tech Experts raise awareness of emerging technologies and their impact for farming systems.

EDUCATION & MINDSET SHIFT

Agriculture and rural areas often suffer from 'brain drain,' and/or ageing workforce. [200] Advocacy roles & Agricultural recruiters increase the status of this field, by highlighting the aspirational and entrepreneurial emerging blend of earth science, tech and systems thinking**.** Many sustainable technologies are already developed — spreading knowledge requires translation and adaptation. These roles also raise awareness of sustainable practices and Life Cycle Assessment (LCA) of food's cradle-to-cradle impact on carbon footprint & human systems (e.g. inequality). A key objective is to empower young local farmers with more control, especially in rural countries & global south. Here simple interventions, such as 6-8 appropriate fruit trees around houses, can deliver nutrition, resilience, biodiversity and climate benefits.

NEW GENERATION FARMERS

Seaweed, algae and insect farming can deliver protein efficiently, but needs risk management evaluation to ensure ecosystem balance is not disturbed. Seed breeders/savers & seed banks (germplasm preservation) can increase genetic diversity, or introduce crops in areas of water shortage. Afforestation specialists, Habitat conservation and Restoration experts focus on biodiversity. Natural beekeepers emerge, along with new policies & models of cultivating pollinators, such as bees. Integrated Pest Management (IPM) emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

Lee Anderson Mottern

Emergency Management & Humanitarian Relief Expert at BCFS

USA

Indoor, vertical and soilless farming can repurpose urban real estate, eliminate pesticides and fertiliser runoff, since both water and growth solutions are recycled. CO2 injection into the enclosed growing spaces will increase plant growth and health, while sequestering any captured CO2.

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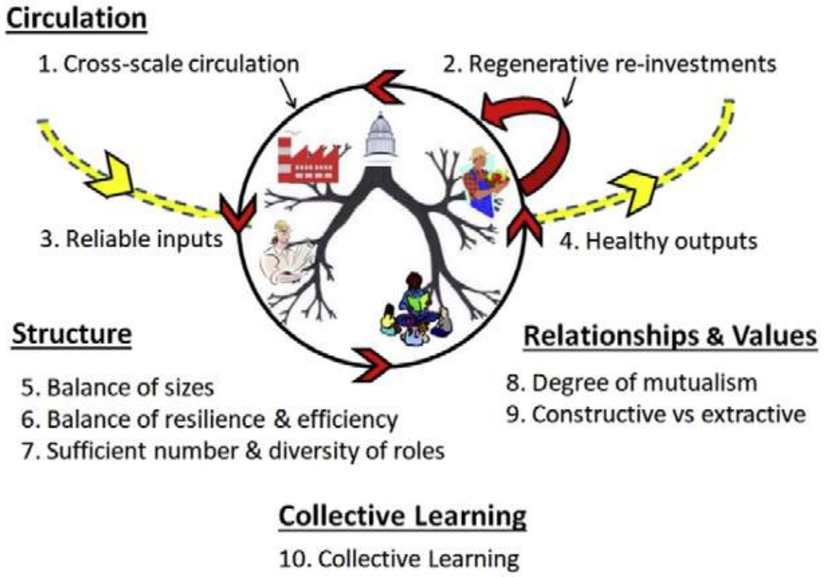
[200] The Ageing Crisis Threatening Farming, BBC

Implications for Policy, Education & Training

Tables show clear direction from our experts that sustainable and regenerative practices are top priority, as a standout result from the survey (the highest priority above, 58% higher than other sectors). Other notable areas are smart farming (AI, Big Data, Robotics & IoT), adaptability and Social Emotional Learning. Interesting to note some extreme variances to other sectors, which reflects the unique position of the sector in terms of skills. Therefore, careful analysis and adaptation is required when innovating or importing ideas from other sectors, rather than a 'copy and paste' or one-size-fits-all approach.

Recommendations: Education & Training, Policy

- Regenerative Learning Sites — global network of practical learning centres. Resilience planning & education at interconnected local, national & bioregional levels (interrelated fractals)
- Hybrid multi-location learning environments that combine classroom — nature — farm — virtual learning experiences
- Initiatives by institutions to convert spaces to organic production & experimentation, e.g. Dartington
- Subsidies for future food
- Funding for advocacy to reposition Farming roles as aspirational & empowering, entrepreneurial & scientific.
- Growth, in new blended agri-finance models for small & medium businesses, includes micro-credits and micro-insurance, or local consumer cooperatives for collective investment
- Measuring regenerative economics has 10 principles according to Fath, Fiscus et al:



Focus content: sustainability & regeneration, integrated well-being of people & planet, localised knowledge of self-sustenance & regionally relevant practices, carbon sequestration, water management, food technology, food transportation & logistics, soil studies and health studies, outcomes evaluation, lifecycle assessment, financially sustainable farming. **Focus capabilities:** entrepreneurship, client orientation, innovation.

See also Chapter 6 for more stakeholder-specific recommendations.

5. Evolution of Education & Training

5. Evolution of Education & Training

5.1 General Implications for Education & Training

Earlier reports by Global Education Futures, including Educational Ecosystems for Societal Transformation and Learning Ecosystems: An Emerging Praxis, considered the systemic transformation of education. This transformation is paramount, in order to deal with shifting socio-economic demands and the challenges of the 21st century. This present report primarily considers implications for vocational education & training (VET) — with focus on elements, such as college education, apprenticeship system, and life-long professional learning.

Vocational education & training is 'designed for learners to acquire the knowledge, skills and competencies, specific to a particular occupation or trade. Vocational education may have work-based components (e.g. apprenticeships). Successful completion of such programmes leads to market-relevant vocational qualifications acknowledged as occupationally-oriented by the relevant national authorities and/or the labour market.' [201]

However, many conclusions of this Chapter are also applicable to a broader context of tertiary education, and can be used by representatives of higher education, [202] such as universities. And, as the world is increasingly moving towards a continuous life-long learning, the ideas on new models of teaching and assessment, organising frameworks and forms of collaboration can be employed across the whole spectrum of learning institutions.

The results of our foresight sessions and surveys highlighted four groups of skills that will be increasingly demanded in the 2020s:

- New technical skills to prepare for new wave of the Fourth Industrial Revolution in the '20s
- Basic skills that increase human adaptability, future-readiness, and proactive behaviour
- Human skills that increase personal and collective resilience and productivity
- Green and universal well-being skills that can serve the thriving future of our communities and our civilisation

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[201] As defined in 2015 by UNESCO. Source: TVETipedia

[202] Tertiary education is defined as "formal education following the completion of secondary education, including higher education, vocational education and training, or other specialist post-secondary education or training.". Source: TVETipedia

Most Critical Training Areas to Prepare for the Next 10 Years

	ALL SECTORS	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY	EDUCATION & TRAINING SECTOR
1	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	Environmentally Sustainable & Regenerative Practices	Cybersecurity	Environmentally Sustainable & Regenerative Practices	Entrepreneurial Skills, Customer Focus & UX	Environmentally Sustainable & Regenerative Practices	Adaptability, Future Thinking & Navigating Change
2	Environmentally Sustainable & Regenerative Practices	Robotics & Internet of Things	Environmentally Sustainable & Regenerative Practices	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	Adaptability, Future Thinking & Navigating Change	AI & Big Data Analytics	Critical & Creative Thinking, Understanding Biases
3	AI & Big Data Analytics	Collaboration & Co-Creation (On & Offline)	3D Manufacturing	Cybersecurity	Critical & Creative Thinking, Understanding Biases	Entrepreneurial Skills, Customer Focus & UX	Systems Thinking & Understanding Complexity	Robotics & Internet of Things	Collaboration & Co-Creation (On & Offline)

Source: GEF Expert Surveys, n=502

***Table 4:* VET Focus Areas to Prepare for the 2020s.**

For full list of 16 areas, please see Annex Table 5.1

Training Areas Clusters: TECHNICAL & DIGITAL; COGNITIVE FOUNDATIONAL; SOCIO-ECONOMIC & CULTURAL; GREEN & UNIVERSAL WELLBEING

The majority of these skills have little, if any, representation in mainstream professional education, although some cutting edge VET and HE institutions adopted them years ago. We suggest that these skills need to move from elite / top tier education into mass-scale education, and become part of the fundamental skill set that makes professionals employable and successful in the 2020s.

The task of introducing new skills — especially the ones that deal with character and mindset — is not an easy one. As an example, if we want people to be kind, we cannot simply introduce a 'Kindness 101' course and teach them about 'kindness theories.' We need to create learning environments where they can practice kindness with each other on a daily basis, so that kindness should become an element of the school culture. This applies to creativity, teamwork, inclusivity, and adaptability — they should be experienced, integrated into culture, supported by learning frameworks and assessments.

Alan Boldon
MD, Dartington Hall Trust & Weave Global
UK

The potential of a network that sets out to learn from and with each other is that the approaches can be tested across the various settings. This brings back the question of uniqueness. The myriad of qualities and properties that make up the wondrous complexities of any place mean that one could talk of uniqueness, the fascinating challenge that is then presented is how to play with models and approaches that had value in one setting and see how they might be adapted to reveal something of other places, and our relationships to them. There may be soil remediation techniques that work in one place that can be more or less transferred to other bioregions, but even here, they will need to be contextual adaptations, even more so when we come to pedagogies.

In order to adapt vocational education & training to the needs of the coming decade, holistic change is required in these areas:

- Curriculum
- Teaching methods & approaches
- Frameworks
- Assessment methodologies
- Capabilities of teachers and teacher training programs

This requires more than an educational reform — it requires a different theory of change. The complexity of emerging learning requirements demands coordinated effort from teachers, administrators, policymakers, business partners, learners and more. A range of new sectoral partnerships are needed, as well as cross-sectoral development programs and global collaborations, including the ones that are future skills focused.

In our foresight sessions, we encountered recurrent ideas for necessary changes in education & training, many of which applied to the whole educational system. We explored these ideas in a separate survey with VET system professionals. Our research revealed many important changes that the global educator community desires. Please note that all content for questions below came from sectoral foresight sessions (included if an item was recurrent in 3 or more sectors).

Changes in Curriculum

Adaptation to the changing economic reality begins with changes in educational content. New programs should be able to support the formation of a 'fundamental skill set' considered in Section 3.3. Here we consider some of the key adjustments that are needed across various sectors.

Technical Skills

Vocational education prioritises technical skills. Our previous Chapter covers sector-specific skills and knowledge that learners should develop. In addition, programs should develop an ongoing general knowledge of technologies. Foundational knowledge of mathematics and logic is a priority before teaching specific skills, such as programming AI / neural networks. Other top technical skills include programming robotics, designing user interfaces and user experiences, and cybersecurity. The cross-sectoral comparisons (see Table 4 for top 3 and Annex for top 16) highlights a significant difference in the importance of technologies across sectors: e.g. cybersecurity is extremely important in ICT and transport, but has a much lower priority in agriculture & ecology (due to a notably lower level of automation) and creative industries (since the risk of hacking only influences limited number of operation areas). It is important to note that each sector's perspective can be significantly different, and so priorities should be established in dialogue with sector industrial partners.

Which technical training areas are MOST CRITICAL to prepare for the next 10 years?	% of responses
Robotics & Internet of Things	59%
3D manufacturing	47%
AI & Big Data analytics	44%
Cybersecurity	41%
Mixed/Augmented/Virtual Reality	34%
Entrepreneurial skills, Customer focus & UX	22%
Agile / lean project management	19%
New human-computer interfaces (touch, brain)	19%

Table 5. Source: GEF E&T Expert Surveys n=120

Socio-economic Skills

Throughout this report, we emphasized that human skills — that help maintain strong teams and understand professional partners — become crucial for all sectors, and that collaboration stands out as the top skill from the beginning of 2020s. It is no surprise that the top socio-economic skill to be developed is collaboration / team building. As explored in Section 3.2, the emergence of team-focused economy and employment is a very strong trend that shapes the skills & jobs landscape. This is supported by three specific skills that further enhance collaboration and feature in the top five: multicultural communication that supports global collaboration, new ways of enhancing team performance with collective intelligence and AI, and conflict mediation. Entrepreneurship & finance is the only non-team related top-5 skill.

Which SOCIO-ECONOMIC / MANAGERIAL SKILLS should become the priority in VET CURRICULUM?	% of responses
Collaboration, trust building, team building (in person & remote)	74%
Global collaboration skills including multicultural communication & languages	57%
Entrepreneurship & finance for business	48%
New models of enhancing team performance including collective intelligence & AI enhanced teams	44%
Conflict resolution / mediation	43%
Diversity, equity & inclusion	40%
Lean & agile methods	26%
Crisis management	25%
Using e-commerce	13%

Table 6. Source: GEF E&T Expert Surveys n=120

Socio-emotional and Foundational Skills

A great team is created not only by the communication or organisational skills of its members — but equally so, by their ability to relate with each other as humans. Socio-emotional and life skills consistently were named among the top learning needs across all sectors. The highest priority skill named by our expert participants is empathy, an ability to understand and share feelings of another. Empathy requires perspective-taking, recreating the other person's viewpoint, connecting with an emotional experience of the other. Another priority skill of comparable importance is the ability to learn and unlearn, a skill that is crucial in a rapidly changing world. The foundation of 'learning to learn', sometimes dubbed as 'metacognition', is in designing, applying, evaluating and reflecting, upon various learning strategies and styles, and also creating personal reward systems.[203] Another equally important skill is mind & body well-being. As indicated in Section 3.1, the transition to a well-being focused economy is under way, and it begins with mastering personal well-being. The skill of self-awareness is foundational to personal well-being, and a number of studies emphasise the importance of the mindfulness practices and intentional downtime to cultivate this skill.[204] Practices, such as (secular) meditation, increasingly find their way into education, and also support learners and professionals, by instilling greater focus, attention, creativity, connections, health benefits & much more.

Which SOCIO-EMOTIONAL & LIFE SKILLS should become the priority in VET CURRICULUM?	% of responses
Empathy, including empathic active listening	70%
Learning to learn & unlearn	67%
Mind & body well-being skills including awareness, health & digital well-being	65%
Storytelling & motivational communication	42%
Self-protection skills	22%
Kindness & compassion	21%

Table 7. Source: GEF E&T Expert Surveys n=120

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203 How to Stay Motivated by Creating a Reward System, Grace

204 e.g. What Self Awareness Really is and How to Cultivate it, Tasha Eurich, Harvard Business Review

Victoria Haro

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A crucial skill for our future is critical thinking, to be able to discern the 'external' world from the world that appears to be real in our search engines and social media. Not only because of rampant fake-news, but also because the related algorithms are designed to reflect our own interests —or whatever it takes to keep us more time on screen.

Therefore, the world we see is unconsciously self-edited. A free society will depend greatly on our ability to question, research and compare information beyond the artificial bubble of our digital world. This interest will also raise the value of professional critical researchers.

Three types of learning seem essential for forward-looking education systems: self-directed learning, action learning and collective learning. Learning how to learn in an independent way is not about becoming good at studying: it is about being able to design a learning process for yourself, identifying what you want to learn and figuring out how best you can learn it. Action learning is about learning by doing: learning by designing and implementing projects, so that students may go beyond theoretical knowledge. Collective learning requires developing the skill of learning from and with your peers: incorporating the experience of others in your practice and building learnings with others. These three types of learning are fundamental to foster the creative, horizontal and cooperative culture that our best future calls for. What if universities focused on developing communities of practice instead of developing individual professionals? Higher education would be based on implementing what we are learning and improving our practice, by regularly sharing our experience within a reflection group of peers. Reflection groups would also interact with each other, forming a community of reflective practitioners. We would graduate well-prepared to create and sustain collaborative learning processes throughout our professional life, enhancing our possibility of adaptation, diversification and cooperation. And what if the goal of communities of practice were to figure out how a profession may serve personal, social and environmental well-being simultaneously? A world full of interconnected communities learning for well-being would harness the human potential for regeneration —this seems an evolutionary path to aim for.

Green / Regenerative Skills

Green & regenerative skills are necessary for the well-being of our society and future generations, and they are becoming part of a 'foundational skill set' that should be acquired for professional success in the coming decade. They are reported among the top three skills demanded by the sectors explored in our study. Given the importance of the climate change issue, it is no surprise that understanding climate change and ways to cope with it comes as a top priority. Professionals should acquire the foundational ecological knowledge, in order to understand how humans create negative impact on planetary systems, and what can be done to change the ways of our civilisation, starting with ourselves individually. Finally, practical knowledge of green and regenerative technologies is required, and it can be partially supported by localised sustainability knowledge (e.g. coming from rural practices and indigenous knowledge). Daniel Christian Wahl's article contains a treasure trove of regenerative education resources.

Which ENVIRONMENTAL SKILLS should become the priority in VET CURRICULUA?	% of responses
Understanding climate change and its effects - and how to adapt	64%
Environmental management theory (incl. regional planning, water management, food technology and health studies)	61%
Greenification technologies: alternative energy engines, nature friendly materials, green building tech etc.	56%
Localised knowledge of self sustenance & sustainability	52%
Regenerative practices: nature based solutions & biomimicry approaches	43%
Life cycle assessment & management	42%
Land and soil restoration, landscape conservation (incl. soil studies as a special area)	34%

Table 8. Source: GEF E&T Expert Surveys n=120

Mindset

The introduction of a proper mindset — a set of attitudes, worldviews, and thinking habits — for both students and teachers is crucial, in order to establish the desired professional behaviour. Our expert audience view flexibility and openness to change as the key mindset — evidently coupled with the skill of learning to learn. Critical & creative thinking is required to address new information and deal with arising challenges, while systems / complexity thinking helps to deal with the growing complexity and uncertainty of the human world. Entrepreneurial mindset, as another strategy of coping with uncertainty, is an ability to focus on arising opportunities instead of threats. Finally, collaboration, a top socio-economic skill, is further enhanced by a collaborative mindset that prioritises human solidarity over competition, and seeks opportunities for non-competitive behaviour.

Abhik Gupta

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The most important role of the education system would be to bring about a change in the mindset of people, so that they will increasingly volunteer for a more sustainable lifestyle and consumption pattern. At the same time, industry and commerce would have to ensure greener production and minimal release of toxic contaminants.

Which MINDSET types should become the priority in VET CURRICULUM?	% of responses
Flexibility & openness to change, exploring new methods and ways of doing things	81%
Critical & Creative thinking	75%
Systems thinking & understanding complexity	57%
Entrepreneurial (opportunity-seeking) mindset	51%
Collaborative (non-competitive) mindset	43%
Intellectual humility, importance of losing, ok to make mistakes	40%
Service ethics - value of 'being in service' to/with others	33%
Focus on equality and equity	33%
Generalist mindset: awareness of other roles rather than mastery	24%
Focus on well-being of people & planet	24%

Table 9. Source: GEF E&T Expert Surveys n=120

System Changes aligned with Curriculum Changes

Changes in Teaching Approaches & Methods

It is evident that our changing reality requires new teaching & training methods and approaches. COVID has triggered a shift towards online learning, so our respondents have highlighted the introduction of remote and virtual training as the top priorities. Virtual environments can simulate various situations to train a wide range of soft skills: for example, a skill of navigating a difficult conversation with customers or colleagues, or a skill of empathy that is necessary in certain human-centred occupations, such as doctors.[205] Augmented and virtual reality is also helpful and even indispensable in training technical skills: for instance, mining companies widely use immersive virtual reality for professional and safety training enormously reducing the number of life-threatening situations or damages to rare and expensive equipment.[206] Simulations, alongside role-playing and gamification, are also among the most demanded experience-based methods of teaching. Team-based learning is another important methodology that helps training collaboration and team building skills (that consistently ranked among the most important fundamental skills in our study), as well as enhancing learning processes in team-supported environments. Holistic learning is crucial for acquiring life and well-being focused skills, as well as adaptability, while multi-disciplinary learning is important for cultivating flexibility and 'generalist' skill set.

Which APPROACHES / METHODS are most important for VET development?	% of responses
Virtual / remote training of practical skills & soft skills (incl. AR / VR)	70%
Team based learning (incl. platforms for team interaction)	64%
Simulation, role play, gamification	54%
Holistic learning, including life skills / well-being focused learning	47%
Multidisciplinary learning	46%
Peer to peer learning	40%
Research / inquiry based learning	29%
Nature based learning (learning in & from nature)	14%

Table 10. Source: GEF E&T Expert Surveys n=120

205 4 Ways Companies are Teaching Soft Skills in Workplace with VR, STRIVR

206 Virtual Reality in Mine Training, L Mallett, R Unger, Centres for Disease Control and Prevention

Teacher Development Areas

Changes in curriculum or teaching practices will typically require teacher retraining. As remote and virtual learning becomes one of the sectoral priorities, teachers need to be trained for remote teaching skills that help them design and deliver high quality online courses in online and blended learning environments, as well as source and integrate the digital material (including virtual experiences) into the learning process. Teachers should also increasingly become future-oriented overall, and strive to understand future technological trends and master promising and advanced technologies whenever possible, so that they instruct students accordingly — in other words, they need to become a model for life-long learner professionals. As learner-centred education becomes increasingly prevalent, teachers need to master skills that help them empower students and cultivate their curiosity and dignity as life-long learners. Collaboration with students (when the teacher is seen as 'the first among equals') is both the method of empowerment and a powerful way of teaching, which shifts education from 'frontal' teaching (lecture-style or teacher-centred instruction where the teaching activities take place from the front of the classroom) towards a collective exploration. This approach can be used in all educational areas, with teachers focusing on collaborative / co-creative projects endorsing creativity and problem-solving.

Valeria Hannon

GELP / Innovation Unit

Teachers as learning facilitators (as opposed to those who just impart knowledge) is quite a big shift. It entails getting to grips with the new science of learning, understanding how humans learn and what conditions they need to make learning as effective as possible. Teachers need to be choreographers, designers of learning experiences. The optimal learning environments in the future will be ecosystems — not classrooms, not schools, not single institutions, but environments that are massively connected to the assets of their community. Teaching will be around enabling agency, that will make a learner a learner for life. The relational dimension — being the caring human — is going to be even more important in the future.

Which TEACHER training areas in VET are needed?	% of responses
Digital / blended education skills (design & deliver courses)	63%
Motivation & empowerment skills (incl. developing student curiosity), respecting student dignity & choice	52%
Teacher as future technology expert / contributor / anticipator (understanding advanced technologies & 'future skills')	43%
Collaboration with students, facilitation & coaching	41%
Learning to learn & life-long learning	36%
International collaboration & world languages	29%
Teaching / developing life skills (e.g. mindfulness & inner peace), cultivating / supporting mental health	27%

Table 11. Source: GEF E&T Expert Surveys n=120

Assessment Methods

New curriculum and teaching methods should be coupled with new ways of assessing — it will be hard to systematically train new types of skills, unless they are properly measured. It is no surprise that the design and implementation of new assessment approaches has been highlighted as a top priority, focused on soft and existential skills, such as open-mindedness and creativity. Digital certification and badging, as well as digital portfolios, are among the crucial changes that can increase flexibility and transparency of the system, as well as transferability of training approaches. Transnational standardisation and assessment of skills are also key changes that should be brought into the system to strengthen quality and training practices. This has been one of the important roles of WorldSkills for a number of years, and so-called 'demonstration exam' approach (when WorldSkills occupational standards are used as the basis of the final exams in VET institutions) is one of the up-and-coming approaches in creating transnational standards.

Which changes in VET models of ASSESSMENT are needed?	% of responses
Assessment of soft skills, creative capacity, life / existential skills (e.g. mindfulness, open-mindedness etc.)	68%
Transnational assessment of skills (including 'demonstrative Exams' according to WorldSkills standards)	51%
Digital certification / badging, digital skills passport / learning passport to replace diploma	49%
Digital portfolio, assessment connected to personal 'digital footprint'	46%
From hierarchical ranking assessment models (grades) to non-ranking, linking models, peer to peer and self assessments	38%
Digitally supervised assessment	28%

Table 12. Source: GEF E&T Expert Surveys n=120

Changes in Frameworks

To introduce a set of complex changes into a professional education system in coordinated fashion, it is helpful for educators, administrators, and policymakers to attach their action to an emerging framework(s) of change. For many years, the framework of personalisation has been seen as fundamental to bringing new pedagogies, tools, and ways of assessment into the system. However, as our survey revealed, this framework has given way to the idea of creating flexible and evolving systems that integrate diverse learning environments and learning models — or, the learning ecosystem. As GEF research reveals, learning ecosystems also embrace the idea of personalisation, 'blurring' of institutional boundaries (in particular between vocational and higher education), and increasing diversity and inclusion. Respondents highlighted was that educational institutions should increasingly see themselves as 'organisations that learn', applying 'learning organisation' methods to build up their own organisational practices. Educational systems should be designed to encompass and transfer the dynamic and evolving nature of our increasingly complex world. This means helping learners to see the interconnected and interdependent nature of things, and the role each and all of us play in these processes. It is why evolutionary frameworks become increasingly important in organising education of the next decade.

Which FRAMEWORKS are most important for VET development?	% of responses
Learning ecosystems, including multilocation learning environments, community embodied learning models, etc.	58%
VET centers / colleges as 'organizations that learn' (updating their curriculum & approaches constantly)	52%
Personalization of learning journeys	42%
Convergence of higher & vocational education	42%
Institutional freedom & curriculum independence (VET centers / colleges freedom to develop their own educational programs)	35%
Diversity, equity & inclusion	32%
Unbundling education: education microservice / short-term (industry-based) programs	28%

Table 13. Source: GEF E&T Expert Surveys n=120

5.2 Bringing Change to Education & Training

Bringing change into education is no easy feat. In a complex society like ours, it cannot be accomplished by any single party: for instance, the government that may be best positioned to mobilise resources and scale up reforms, may lack technological competences of the business and research institutions, and the enthusiasm of educational innovators and NGOs. To ensure the success of instigated sectoral change, a multi-stakeholder collaboration is necessary. In the first section, we want to consider different types of collaborations that can occur on multiple levels — local sector specific, intersectoral and global (including those future skills focused). We then want to explore which drivers of change can be leveraged that need to seek partnerships with each other. Finally, we consider (examples of) strategies that can be accomplished by specific stakeholders in the multi-stakeholder 'team play'. Similarly to the previous section, all results below have been generalised from foresight sessions and online surveys.

Priority Collaborative Initiatives

Local Sector-specific Collaborative Projects

As the framework of the learning ecosystem emerges as an all-encompassing educational transformation paradigm, collaborations should help establish this framework in practice. For learners and teachers alike, ecosystems should enable 'seamless' transitions between learning environments and experience; therefore, it is crucial to create partnerships that will enable 'hybrid' learning environments: online & offline, indoor & outdoor, classroom & actual business. Such partnerships may be created at the local level by colleges that collaborate with businesses, online platforms and public spaces — or, they can be intentionally created by cities & regions that establish platforms for blended life-long learning, as in the case of RSA Cities of Learning, Lyon Metropole Territory of Learning and LRNG. Another important type of collaboration is to create the pool of learning resources between multiple learning institutions and local businesses — including training facilities, internship opportunities, expert databases and online courseware. Apprenticeships and dual education programs is another proven model of connecting professional education and businesses.

Which LOCAL forms of collaboration in VET will be most critical?	% of responses
Creating partnerships for hybrid learning environments (combining classroom-company-outdoors- virtual space)	74%
Pooling of resources with educational institutions & local businesses (e.g. courseware & training facilities)	68%
Apprenticeship education programs / dual education programs	64%
Collaborating for enhanced marketing and promotion of skills education	33%
Collaboration / projects with end users or consumers (of the sector)	28%
Virtual internships	13%

Table 14. Source: GEF E&T Expert Surveys n=120

Partnerships

As education evolves towards life-long, holistic, and multi-disciplinary models, professional education institutions should look beyond the VET sector to engage cross-sectoral partnerships — in particular, with projects that focus on different stages of learning (including schools and life-long learning), or those that support learning of educators themselves. As an example, the idea that was most strongly endorsed by survey participants is to create programs for VET institution teams — helping them to improve curriculums and learning methods by undergoing processes similar to startup acceleration. An example of this type of program is Mifras, an Israel-based foundation that helped over 150 school teams 'accelerate' their pedagogies. Future Generations Park in Yakutia has conducted a series of 'accelerators' for its VET institutions to boost professional training programs for the emerging creative economy of the region.

Another important option is to conduct industry led problem-solving challenges — e.g. hackathons. One of the best examples of this approach is X-Prize, a global system of challenges that encourages technology expert teams to solve 'unsolvable' problems of the technological frontier. The National Technological Initiative's Olympiad brings together teams of young people and professional engineers to address questions, posed by leading technological companies of Russia.

Which formats need to be developed outside of traditional VET, to support VET readiness for the future?	% of responses
Acceleration programs for VET institution teams to improve curriculum & learning methods	72%
Industry led challenges to solve industry problems	63%
Laboratories / clubs & industry internships for talented children & youth	52%
Support to parenting & early childhood development	45%
Corporate universities (as partners of VET)	43%

Table 15. Source: GEF E&T Expert Surveys n=120

In terms of collaborations across stages of learning, laboratories and clubs for talented children and youth are an example of projects that enable professional learning and career advancement at a much earlier age. Another important type of collaboration considered by the study participants was to encourage early childhood learning and to provide support to parents — as many of the 'foundational' skills, such as proactive behaviour and adaptability, are best formed in the first years of human life.

Global Collaborative Projects

While local collaborations are always at the heart of educational transformation, global collaborations can provide conceptual frameworks, best practices, benchmarks, and resources that can facilitate the process of change. One of the important roles of WorldSkills and other international NGOs (such as ILO and UNESCO) can be in establishing the platform for global skills standardisation in areas identified as critical. The benefits of such standardisations are obvious, including enhanced exchange of knowledge on education and training, strengthening of international labour markets and opportunities for global economic cooperation. In addition to standardisation, infrastructural solutions need to be established, including a global digital 'skills passport', a global network of internationally-accredited testing centres, and a global network of practical training centres with advanced equipment that will help benchmarking and transferring of best practices. Knowledge exchange between teachers is necessary, but it should be demand-driven and needs to be established in areas where teachers & VET institutions themselves can create inquiry networks and opportunities for cross-country internships. Also, development of open educational resources should continue (including practical MOOCs, freeware AR/VR applications, and digital objects, such as models for 3D printing) — potentially to be coupled with the use of open source technologies in ICT and other sectors.

Which GLOBAL forms of collaboration in VET will be most critical?	% of responses
Development of international skills standards & infrastructure e.g. WorldSkills Occupational Standards	65%
Global knowledge sharing between teachers (e.g. through inquiry networks, international Internships etc.)	57%
Development of open educational resources (courses, objects etc. e.g. MOOCs)	53%
Global network of practical training centres (in various sectors)	45%
National and international agreements between VET and Global Corporations	42%
Use of open (source) technologies e.g. Linux, Wikimedia	22%

Table 16. Source: GEF E&T Expert Surveys n=120

Future Skills Global Collaborative Projects

To foster the development of future-oriented curriculum and skill standards, a number of global and local initiatives need to encourage collaborations on future skills. Given the importance of green / sustainable / regenerative economy skills in the fundamental skill set, the study participants have agreed that establishing a global collaboration that promotes standardisation and training methodologies in this area may be a top priority. Another widely supported idea is to establish a network of spaces (e.g. in universities, research institutions or corporate research centres), where various skills of the future can be prototyped (including ways of evaluating and training these skills) — and the role of the network would be to spread knowledge and methods of prototyping. WorldSkills movement can play important role in promoting future skills: for instance, Future Skills zone in WorldSkills competitions can serve as an exhibition and promotion for various sectoral 'skills of the future' and a 'living lab' for companies interested in promoting these new skills, while WorldSkills 'demonstration exams' can become a rapid way of standardising the assessment for emerging and transforming skills.

Which GLOBAL collaborations on FUTURE SKILLS will create most significant impact?	% of responses
Global collaboration for sustainable / regenerative economy skills training	73%
Global network of prototype spaces to test skills of the future e.g. with Global Industrial Partners, research centers etc.	68%
'Future Skills' competition zone in WorldSkills national & global events	65%
'Demonstrative exams' on 'future skills' according to WorldSkills standards	45%
Global championship event on collaboration skills	20%

Table 17. Source: GEF E&T Expert Surveys n=120

Leveraging Drivers of Change

VET institutions and policymakers can create various constellations that help transform the education & training sector — but some of these constellations will be more powerful than others. Leveraging the right type of partnerships with key stakeholders, including local and global business partners, is essential for that. Our survey participants tried to appraise which partnership strategies have stronger potential to make the impact.

Key Stakeholders

As learning ecosystems comprise many impactful stakeholders, it is important for VET institutions to prioritise the ones that may yield more productive outcomes. When it comes to evolving the content, methods and tools of the VET system, the 'collective wisdom' of survey participants has given a strong priority to partnerships with universities and research centres. Educational innovators (including specialised consultancies) that can provide top sectoral knowledge and benchmarks are also important. Governments and policymakers, as well as local, national and global industrial partners also feature high on the list of essential partners. What came as a bit of surprise is that parents, local communities and municipalities, and consumers all ranked notably lower. Spiritual & well-being teachers were ranked lowest — however, as mental well-being issues consistently came among the top challenges for the future of work overall and in specific sectors (esp. ICT), this group of stakeholders can provide important practices for adaptability, openness and mental self-regulation.

Which STAKEHOLDERS will be most essential to PARTNER with for VET?	% of responses
Universities, research centres & technical institutions	73%
Educational leaders & educational consulting companies	62%
State & national governments & policymakers	50%
Local & national industrial partners	48%
Global industrial partners	45%
Parents	27%
Local communities, activists & authorities (e.g. municipalities)	26%
Consumers / customers	19%
Spiritual & well-being teachers, psychologists	14%

Table 18. Source: GEF E&T Expert Surveys n=120

Industrial Partners that can demand and drive Changes

Which sectors are perceived as 'most catalytic' in demanding and driving the change in vocational education & training — e.g. asking for new skills & courses, new methods of training, etc.? This ranking illustrates the perception of different sectors within the educator community. While manufacturing & engineering is seen as the sector demanding the most change for VET, we were surprised by the low ranking of logistics and transportation (given the massive change that this sector is anticipated to undergo in the coming decade, as described in Section 4.3). However, this ranking may come of help to policymakers and national / regional authorities that can prioritise collaborations between education and certain business sectors.

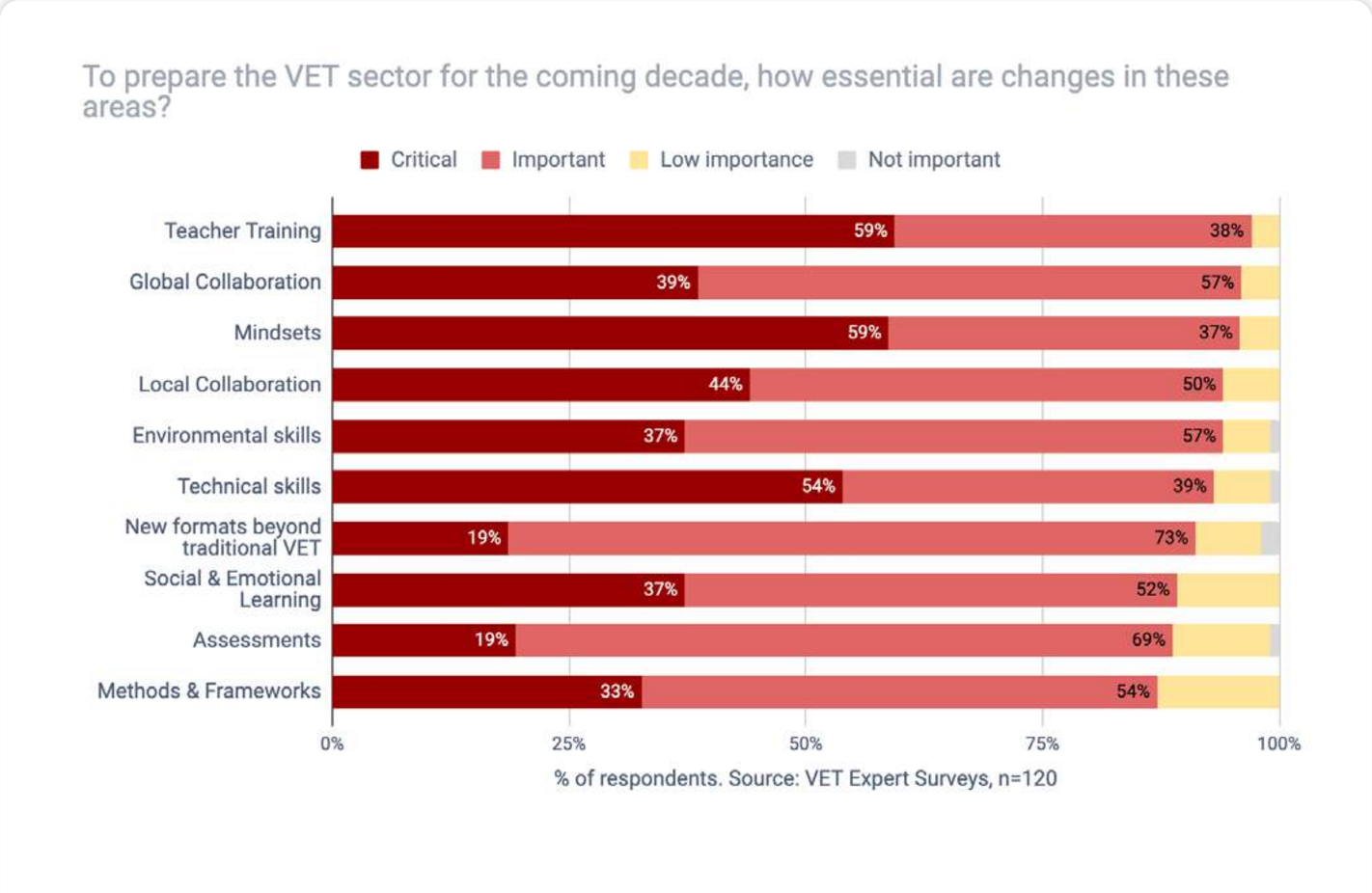
Which SECTORS will demand most changes in VET content, pedagogy, and assessment?	% of responses
Manufacturing & Engineering	59%
ICT & Digital	50%
Human-Centred & Social Services	45%
Agriculture & Ecology	36%
Creative Industries & Design	29%
Construction & Infrastructure	26%
Logistics & Transportation	12%

Table 19. Source: GEF E&T Expert Surveys n=120

Working with Change

Transformation of education is a complex multi-stakeholder game of many interlinked avenues. However, setting up priorities in this game is still very important — it is why our study explored which areas of change in education & training are seen as most impactful. Not surprisingly, teacher training was ranked as a top critical priority by the majority of respondents.

Second is the task of cultivating new mindsets (such as flexibility, critical & creative thinking, and system thinking) in VET programs. Quite unexpectedly, it ranked even higher than the task of introducing new technical skills (such as AI, robotics and blockchain) into curriculum. Local and global collaborations are also ranked among the top change strategies, with local (ecosystem-focused) collaborations ranking slightly higher.



Garry Jacobs

CEO World Academy of Art & Science.

We need fundamental changes in both the pedagogy of education and the content of what we teach. We need a shift in pedagogy from focus on the subject to the student, from disseminating information to teaching students to think for themselves and learn how to learn, and learn throughout their lives. From the passive transmission of information from teachers to the active peer-to-peer project-based contextual learning by the student himself to all the sources of information that are available today. From the communication of ideas to imparting values and developing the personality of a student. We also need a shift in content: from narrow specialisation to multi-disciplinary and transdisciplinary perspectives. No longer can we justify dividing reality in 1000 disciplines and subdisciplines with narrow boundaries, dividing reality into airtight compartments. The age of a specialised expert is drawing to a close. Business and economy are social sciences, inclusive social sciences, we need business and economy to understand the role of changing social needs and values, the critical importance of environmental factors, impact of rising unemployment and inequality on democracy and social stability. We need engineers who understand the impact of technology on unemployment, on society, on people's lives, on the stability of society, on international affairs. We need citizens who understand the process of social change and the central role of value steering social organisations in that change, in that process. We need youth who have learned how to lead themselves, other people, organisations and society at large to a better future.

6.
What can you do? Stakeholder-specific Strategies

6. What can you do? Stakeholder-specific Strategies

The 2020s are bringing massive transformation across all economic sectors. Ensuring that the system of education, training and certification is going to evolve to match the upcoming challenges is not easy. This transition cannot be left in the hands of a single stakeholder — instead, a multi-stakeholder coordinated effort is required. The future of skills is established by many independent, yet intertwined actions, creating a symphony of change. This process begins with sense-making conversations that join into a call for action — and then lead to prototypes, networks and policies. The strategies outlined here are example recommendations from our participant audience. Please get in touch if you have questions or suggestions.

Develop Capacity:
What can you do for yourself?

Catalyse / Lead Change:
What can you do together?

Learners of All Ages = You!

- Master/foster curiosity for life skills and mindsets that are essential for the 21st century, including learning how to learn, empathy, openness and future mindset
- Learn about and experiment with new technologies and practices that become mainstream
- Take responsibility for professional development & career path, rather than expect an employer or government to unlock your full potential, passions and purpose. How clear is your personal purpose in life? How are your daily activities connected to your purpose?

- Organise learning circles that help learn skills not trained locally — engaging in online courses & communities and practising on your own
- Create student and parent committees that demand changes in education, and lead dialogues on necessary changes. What is the skills gap your group needs to address and why? Who can you engage with to close the gap?

VET Teachers

Develop Capacity: What can you do for yourself?

- Learn to become ‘future skill/technology practitioners’
- Master digital training tools and blended learning methodologies
- Experiment with new pedagogies that empower students and encourage collaboration
- Engage in professional retraining programs, including MOOCs

Catalyse / Lead Change: What can you do together?

- Create local, national & international ‘inquiry networks’ that can experiment with new methods & curriculum in VET education (e.g. Chile’s CIN or Canada’s NOIIE)
- Create experimental formats within your own institution, e.g. establish a fablab
- Develop open digital resources, such as courseware and shared ‘digital objects’ (software, 3D models, etc.), and promote open source technologies

VET Administrators

Develop Capacity: What can you do for yourself?

- Model and nurture the ‘culture of learning’ within the institution, exercise trust and support to innovative teachers and proactive students
- Encourage teachers to engage in professional training and existential skills (including socio-emotional skills)
- Create / encourage learning circles for teachers who want to learn new methods, practices and subjects; cultivate more experienced teachers as internal mentors for continuous professional development
- Develop and promote apprenticeship learning models with local business partners
- Create experimental facilities on future technologies and future technological skills, e.g. fablabs
- Cultivate skills of facilitation and multi-stakeholder dialogue (within and outside VET institution) with communities, such as Art of Hosting or Liberating Structures
- Develop the practice of ‘ecosystemic leadership’ with groups, such as The Weaving Lab

Catalyse / Lead Change: What can you do together?

- Learn ‘ecosystemic leadership’ as a new praxis for education
- Cultivate hybrid learning environments — online & offline, indoor & outdoor spaces to create seamless ‘ecosystemic’ learning experiences for practice-oriented education: e.g. integrate instructions with courses from online learning providers, connect with businesses, outdoor spaces / public spaces, etc. — all built into a ‘flow’ of experiences, integrated in the curriculum on daily / weekly basis
- Connect with local & global businesses and communities to obtain real problems for case studies; host hackathons and problem-solving challenges; collect insights on changing landscape of skills to continually update curricula
- Pool learning resources and facilities with other colleges and local / national businesses — in particular, to access advanced / cutting edge technologies and methods
- Engage in, or launch, networks & projects that focus on adaptable skill standards, and use of digital credits / badging / certification
- Integrated interdisciplinary curricula: maximise opportunities to weave siloed skills into learning experiences — e.g. where AI + well-being + entrepreneurial skills might intersect?

Develop Capacity:
What can you do for yourself?

Catalyse / Lead Change:
What can you do together?

Local / National Business Partners

- Identify business problems that can become professional education case studies & opportunities for student problem-solving challenges
- Foster culture of learning: encourage mentorship and apprenticeship models within organisation; cultivate teaching capacity of employees
- Promote adoption of advanced technology and future skills by offering employees new skills and growth opportunities
- Typically, cheaper to reskill, rather than hire or outsource (also brings added loyalty)
- Incentivise base salary payments plans based on skills learned
- Redefine what productivity means for remote workers, including a holistic set of deliverables.
- Remote working tools and social technologies requires practice in a safe space so allow for people to adjust to the new tools
- For greater growth, communicate how your company's purpose and culture contributes to thriving people and planet, e.g. which UN Sustainable Development Goals align to your mission?

- Engage in partnerships with local & national educational institutions, in order to nurture learning ecosystems:
  - identify and mentor top talent within student cohorts
  - provide facilities & help create 'hybrid learning environments' jointly with VET institutions
  - provide training capacities including courseware, facilities, trainers, etc. focused on 'future skills'
- Continually monitor the skills gap, e.g. quarterly 'pulse check' (or better, digital platform for 'real time check') with a pool of partners, educators, learners and workers
- Launch / lead / participate in local & national level dialogues on skill standards and training methodologies in your sector
- Launch or support local & national 'accelerator' programs for VET institutions that create new training programs for future skills
- Engage in (or initiate) projects on adaptable skills standards and digital credits / badging / certification (such as LRNG or RSA Cities of Learning)

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205 Purpose is Everything, Diana O'Brian, Andy Main et al, Deloitte Insights

5/8

Global Business Partners

Develop Capacity: What can you do for yourself?

- Same as above, plus
- Develop / share open courseware that can be used to train specialists both internally and externally
- Design & provide digitally simulated tools & equipment (as well as training scenarios) for learning in AR / VR environments

Catalyse / Lead Change: What can you do together?

- Same as above, plus
- Develop forward-looking standards for future skills, based on your own business practices
- Encourage / create global alliances in particularly sensitive areas, e.g. diversity & inclusion related skills, sustainability / regenerative economy skills, etc.

Local / Regional / National Governance Bodies

Develop Capacity: What can you do for yourself?

- Same as above, plus
- Design and promote an integrated approach to measure and manage economic, social and environmental dimensions, e.g. Doughnut Economics or principles of regenerative economics proposed by Fath et al. Rather than view economic, social and environmental dimensions independently, an integrated systems approach is needed. A new holistic development paradigm should include inner, collective and planetary well-being. [208]
- Introduce metrics / KPIs that hold professional education accountable for the success of the local / national economy & society, e.g. those that connect the changes in education practices with impact indicators
- Introduce or promote metrics / KPIs that help understand the level of equal, open, and personalised access to development and employment opportunities.

Catalyse / Lead Change: What can you do together?

- Same as above, plus
- Whenever possible, deregulate VET institutions to encourage experimenting
- Continually monitor the skills gap, e.g. quarterly ‘pulse check’ (or better, digital platform for ‘real time check’) with a pool of partners, educators, learners and workers.
- Regularly update curricula and assessment frameworks for local / national institutions to reflect changing skills & jobs landscape (e.g. every 2 years)
- Develop policies fostering freelancing & entrepreneurship to empower those displaced to create their own jobs

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[208] We Become What We Think: The Key Roles of Mindsets in Human Development, Jurgen Nagler

7/8

Develop Capacity:
What can you do for yourself?

Catalyse / Lead Change:
What can you do together?

Local / National NGOs in Professional Education & Labour Market Policies

- Create monitoring systems for skills gap (e.g. quarterly ‘pulse check’ with a pool of businesses, educators, learners and workers)
- Cultivate skills of facilitation and multi-stakeholder dialogue, and master the practice of ‘ecosystemic leadership’
- Develop internal expertise on ‘skills of the future’ and future technologies, and cultivate external expert network on this subject to enhance decision-making
- Develop lists of open source materials and shareable education resources (including facilities) for ‘future skills’ training

- Orchestrate multi-stakeholder dialogues on the future of skills & education
- Prioritise collaborations between businesses and training institutions in critical areas, e.g. collaborations in Manufacturing & Engineering and ICT (where many of the ‘future skills’ are needed), or in Agriculture (since it has one of the most significant impacts on the well-being of populations and planetary systems).
- Catalyse & weave local & national learning ecosystems by facilitating multi-stakeholder alliances & collaborations
- Launch or support local & national ‘accelerator’ programs for VET institutions that create new training programs for future skills
- Support the design of specific skills standards and training methodologies for sectors that are crucial for the local economy (e.g. hospitality services)
- Create or support projects on adaptable skills standards and digital credits / badging / certification

Develop Capacity:
What can you do for yourself?

Catalyse / Lead Change:
What can you do together?

Global NGOs & International Governance Bodies

- Same as with local / national NGOs, plus
- Develop knowledge sharing platforms that support exchange of knowledge between teachers / innovators
- Develop ‘integrator’ capacity to bridge the knowledge gap between technology developers and users in critical areas, such as sustainable / regenerative practices. Many sustainable technologies are already developed — spreading knowledge requires translation and adaptation. Policies & practices are needed to support advocacy & awareness & adoption of existing technologies. Integrators are key roles to bridge gaps

- Same as with local / national NGOs, plus
- Create / promote global skills standardisation systems (similar to WS Skills Passport), as well as networks of testing facilities
- Create / promote networks of ‘future skills’ prototype spaces in partnership with global business partners, and also launch future skill alliances in critical areas, such as sustainability, diversity and collaboration
- Create standards to oversee ethical regulation of technology development (such as AI) and educational applications and track accompanying risks

7.
Conclusion: Choosing our Collective Futures

7. Conclusion: Choosing our Collective Futures

Our report explores the world of jobs and skills in the midst of a major shift. COVID accelerates remote work, transitions to data-intense design & management, and intensified automation. It also alerts humans about future global crises — the most critical being the climate emergency and the threat of biosphere collapse, the human-induced Sixth Mass Extinction.[209] The workforce has to adapt to changes — but, as we argue in this report, a much better strategy would be to pre-adapt, to create future-fit abilities[210] by anticipating the change. In particular, we — learners of all ages, teachers, practitioners, leaders and policy-makers — have to proactively establish new skills and habits that prioritise universal well-being (of people and planet) on par with economic effectiveness.

Digital work becomes the new norm. So working habits should accommodate for more discipline, self-reliance and taking care of our own well-being. It is evident that even in a technology-rich world we need much more than just technological capabilities. Earlier work on Future Skills (e.g. Kazan Declaration) considered the idea of a fundamental skill set that included foundational & cognitive skills, digital & tech, relational & cultural, and green & well-being. The present report comprehensively explores this skill set, revealing it as a 'common denominator' of skills demanded across sectors of the economy, skills that are needed to attain personal success alongside collective and planetary well-being.

As the world becomes increasingly digitised, **digital skills** become commonplace — and it is evident that some specialist skills in this sphere become a new global literacy. Perhaps the most clear example is cybersecurity as a key skill for everyone this decade.

Another skill that becomes a universal component of nearly every professional role is **creativity**. The idea that economies of the future are 'creative' may be true, but it does not mean we should abandon manual or intellectual labour for artistic endeavours.[211] Quite the contrary, as we are moving into the age of 'mass uniqueness', all types of labour are increasingly 'infused' with a creative component.

As businesses, innovators and policymakers around the globe come to recognise our shared responsibility for the future of our civilisation and the planet we inhabit, future skills and mindsets need to become 'green': sustainability- and regeneration-focused. Sustainability as an outcome can only be obtained with regenerative approaches as a collective operating system of the economy and society.[212] The emerging economic paradigm needs to include dimensions beyond 'economic efficiency,' becoming not only human-centric, but also life-centric.

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209 The Anthropocene Biosphere Paper, Mark Williams, SAGE Journals and Will Humans Survive the Sixth Great Extinction?, Nadia Drake, National Geographic

210 As discussed in Evolutionary Learning Ecosystems for Thrivable Futures: Crafting and Curating the Conditions for Future-Fit Education by Anneloes Smitsman, Alexander Laszlo, and Pavel Luksha

211 Economists often see creative economies only from a sectoral perspective, as yet another sector generating value added and employment opportunities, describing a transition towards a creative economy in terms of structural change - a process that would be similar to the transition from agricultural to industrial society during the Industrial Revolution. See discussion and critique in Four Models of the Creative Industries, Jason Potts & Stuart Cunningham

212 Thank you to Marc Barasch for this statement

Our experts indicated the top skills of 2020 are collaboration, social & emotional skills, big data and AI skills. By 2030, they indicated key skills / roles will additionally be: regenerative & sustainable practices; Internet of Things and self-learning machines / software; multi-disciplinary communication & catalyst.

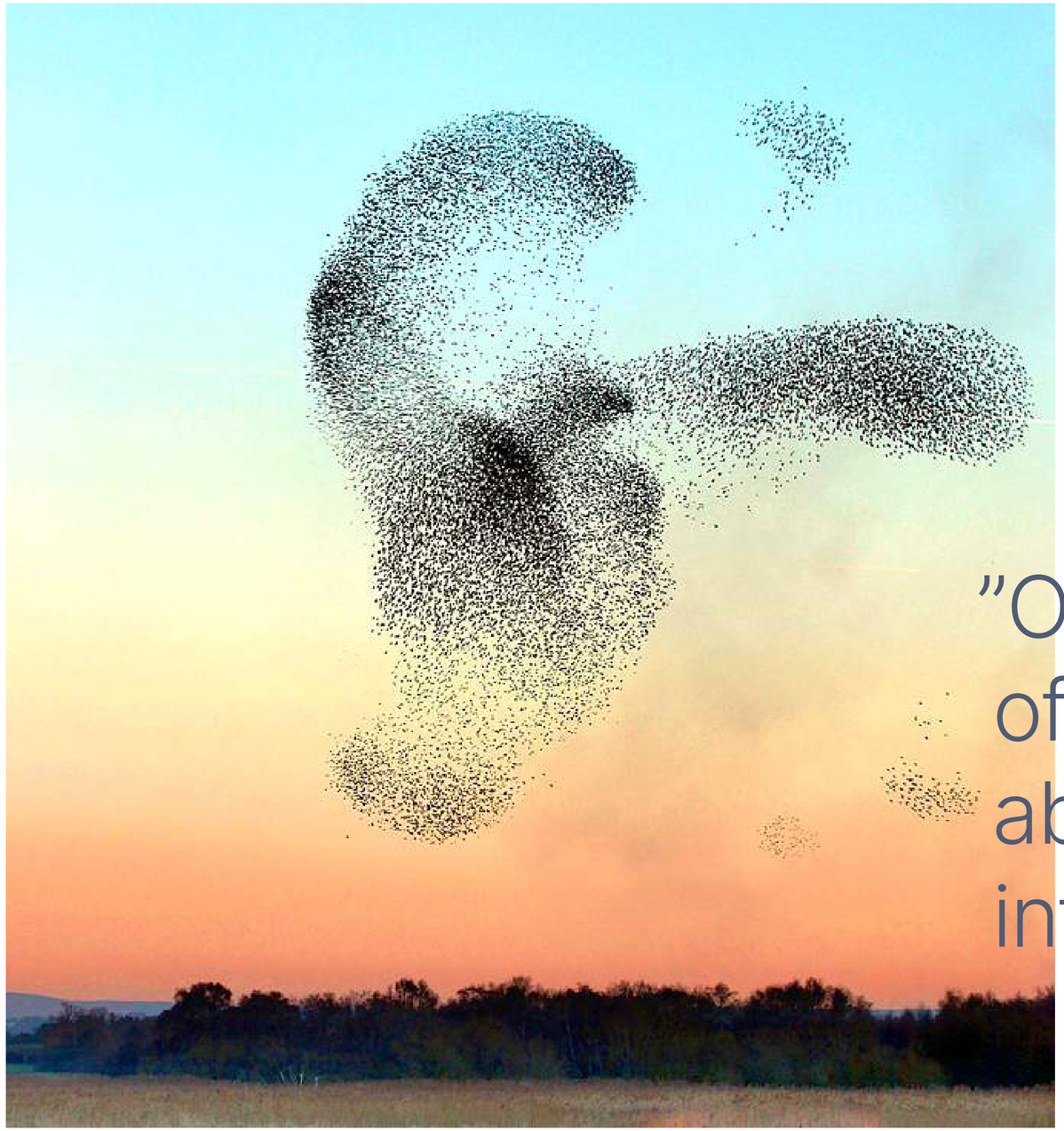
A mass transition towards this emerging fundamental skill set requires more than a change of curriculum. Changes in pedagogical approaches, learning frameworks, and methods of evaluation are also needed — a transition to remote instruction and peer-based learning, the rise of hybrid learning environments and learning ecosystems, digital 'profiling' and soft-skills assessment, and more. But it is even more important to recognise that this comprehensive metamorphosis is a paradigm shift. And so it requires a whole range of stakeholders — businesses, trade unions, colleges, policymakers, NGOs — to act in alignment, supporting each other's transformation. Only through a multitude of formats of local, national and global multi-stakeholder collaboration, can a new 'ecosystemic' paradigm of vocational education be established that serves the needs of evolving economy and society.

Ahead of us lie uncharted waters. This report maps out some of the opportunities and threats that await on our collective journey into the emerging world. It is intended as a provocation and a guide on this journey. It may have some answers, yet it is intended to prompt more questions and further collaborative research and action. What does the future of skills look like in more detail, at country level, or specialised industry sub-sector? How can we anticipate, develop and assess these skills better? How can we make our education & training systems more focused on pre-adaptation and longer-term challenges? This report identifies skill sets that support better futures for all - what are the risks if we do not put sufficient resources towards developing these skills? What are the 'unknowns' we need to explore to move into a more hopeful future?

Solidarity is our bridgeway into the future. 2020 presented itself as the year of turbulence. COVID has pressured the world to change in fast and lean ways. The collective 'future sensing' presented in this report highlights that we are at the threshold of massive changes. Visions of turbulence triggering transformation are mirrored by both futurists and sectoral experts. These changes are long-awaited — from digital transformation to purpose-driven and regenerative economy, they show glimpses of the new global economic model that will establish itself in the 21st century. Will the 2020s be defined by crises or metamorphosis - or both? How might we use this moment of 2020 clarity to reassess, reboot and rise? If we can see this moment as truly transformational, the 21st century begins only now, in the year 2020.

Please do continue the co-creation of our shared future! Please contact partners@globaledufutures.org *or* rda@worldskills.ru *to explore collaboration ideas.*

Global Education Futures & WorldSkills Russia Team
June-December 2020

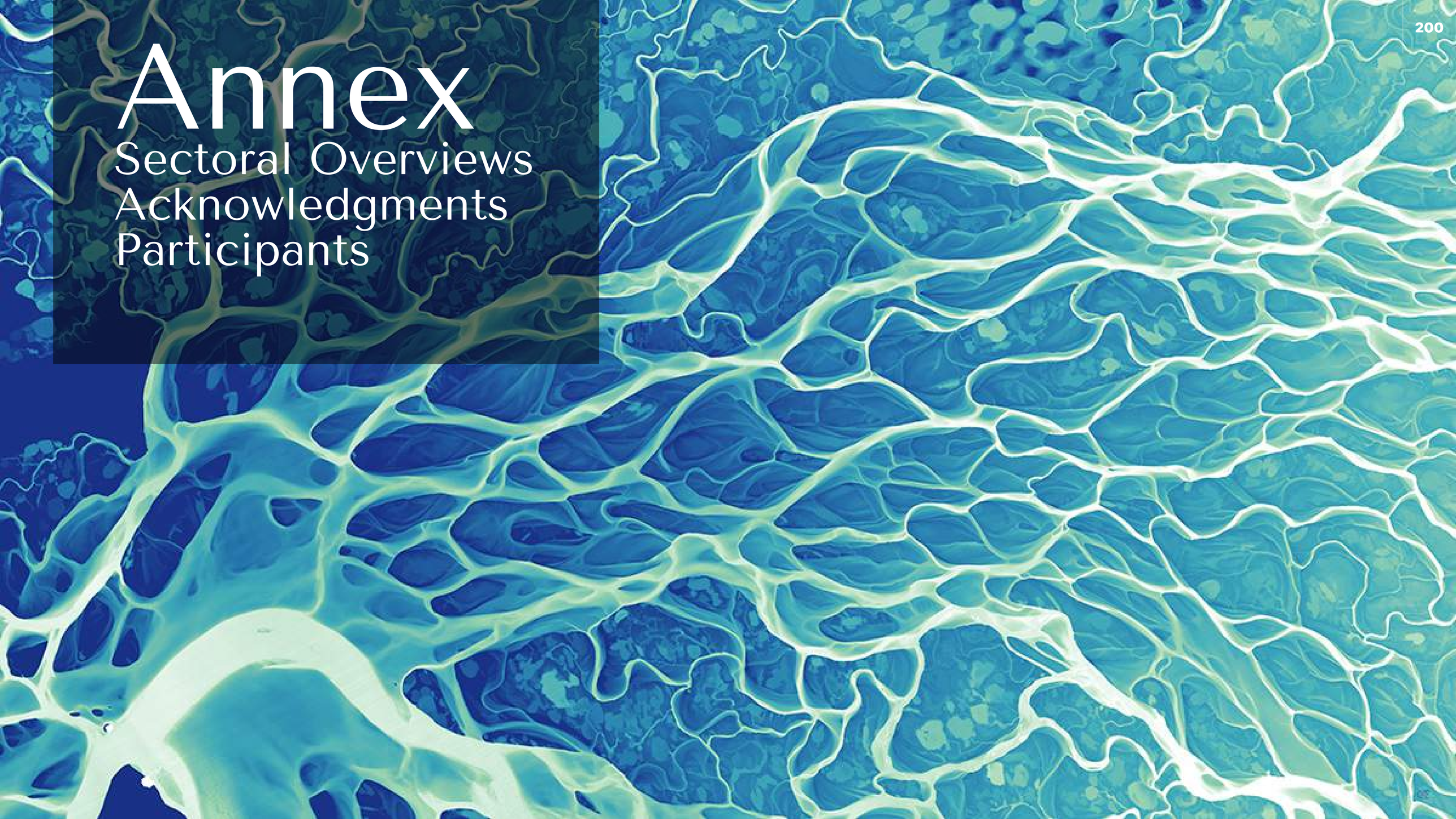


”Our tomorrow is the child of our today... Best to think about it. Best to shape it into something good.”

Octavia E. Butler

Annex

Sectoral Overviews
Acknowledgments
Participants



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When will these Factors significantly impact Skills?

Factor	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY	ALL SECTORS AVERAGE
COVID ACCELERATED								
Strict Hygiene / Biosecurity Rules in Production & Delivery	2021	2022	2020	2023	2022	2023	2022	**2022**
Remote Working becoming New Norm	2023	2024	2021	2022	2022	2021	2023	**2022**
Unemployment, Jobs Disappearing & Reduced Spending	2023	2023	2022	2024	2023	2022	2023	**2023**
Push to more National Self-reliance & Domestic Supply Chains	2024	2022	2022	2025	2023	2024	2024	**2023**
GENERAL								
Eco-materials & Production Modes Essential	2024	2024	2024	2026	2025	2024	2025	**2025**
Nationalisation of Platforms and Data	2025	2025	2026	2025	2024	2024	2024	**2025**
Personalisation of Production: E-commerce + On-demand Small Batches	2025	2026	2024	2025	2025	2025	2026	**2025**
Total Digital Surveillance	2026	2026	2025	2026	2025	2025	2027	**2026**
Permanent Loss of Jobs due to Structural Shifts	2025	2026	2029	2027	2024	2025	2024	**2026**
Digital Currency replaces Cash	2026	2027	2026	2027	2025	2026	2027	**2026**
Demographic Changes: Workforce = increasingly Senior	2025	2026	2028	2027	2026	2027	2025	**2026**
TECHNOLOGY / SMART								
Industrial Internet: Big data analytics & IoT	2023	2024	2023	2023	2023	2024	2024	**2023**
Cybersecurity & Privacy Threats	2022	2023	2023	2024	2023	NA	2022	**2023**
3D Printing	2022	2024	2027	2024	2024	2024	2025	**2024**
Blockchain & Supply Chain Transparency	2026	2025	2026	2025	2025	2024	2025	**2025**
Mixed / Augmented / Virtual Reality	2025	2026	2026	2025	2024	2026	2025	**2025**
Robotics & Cobotics (collaboration of humans with robots)	2025	2026	2026	2026	2026	2027	2026	**2026**
AI prediction & Self-learning machines / production lines	2025	2026	2025	2026	2026	2025	2027	**2026**
New Human-computer Interfaces (e.g. Brain, Touch)	2026	2027	2027	2027	2026	2026	2028	**2027**

Table 3: **Survey Results: COVID Factors affecting Skills.**

Source: GEF Expert Surveys

When will these skills/job roles be significant in the sector?

Skill/role	MANUFACTURING & ENGINEERING	CONSTRUCTION & INFRASTRUCTURE	TRANSPORTATION & LOGISTICS	ICT & DIGITAL	HUMAN & SOCIAL SERVICES	CREATIVE INDUSTRIES	AGRICULTURE & ECOLOGY	ALL SECTORS AVERAGE
SOCIO-ECONOMIC								
Collaboration (on & offline)	2021	2022	2021	2022	2023	2023	2021	**2022**
Facilitation & Co-creation	2022	2023	2022	2022	2022	2022	2021	**2022**
Human/Soft skills: creativity, compassion, social & emotional skills	2022	2023	2021	2023	2022	2022	2023	**2022**
Multidisciplinary cross-sectoral catalysts	2022	2024	2023	2023	2023	2025	2022	**2023**
New communication skills e.g. visual/touch/gesture/thought	2022	2023	2023	2024	2024	2024	2025	**2024**
UX UI design / user-centric approaches	2025	2024	NA	2022	2024	NA	NA	**2024**
COGNITIVE/FOUNDATIONAL								
Ethical practices, critical thinking, understanding biases	2022	2021	2022	2024	2022	2022	2022	**2022**
Learning how to learn & unlearn (intellectual humility)	2022	2022	2022	2023	2023	2024	2022	**2023**
GREEN & WELL-BEING								
Health & Safety awareness/skills e.g. using AR/VR remote tech	2023	2023	2022	2024	2023	2023	2024	**2023**
Regenerative & sustainable skills e.g. lifecycle/carbon analysis	2024	2023	2023	2025	2024	2024	2022	**2024**
Learning to reconnect with nature	NA	2024	NA	NA	2024	2023	2023	**2024**
Well-being roles at work & home	NA	2022	NA	2025	2024	2024	NA	**2024**
TECHNICAL & DIGITAL								
Cybersecurity	NA	2022	2023	2022	NA	NA	2021	**2022**
Big Data analytics	2022	2023	2022	2022	2022	2025	2023	**2022**
IoT architecture design	NA	2023	2022	2023	NA	NA	NA	**2023**
Agile/lean processes	2022	2023	NA	NA	NA	NA	NA	**2023**
CNC operation, maintenance & programming (unified role)	2022	2023	NA	NA	NA	NA	NA	**2023**
Meta Programming skills (semi-automatic solutions)	NA	2022	2023	2024	NA	NA	NA	**2023**
Training & Programming AI e.g. advanced algorithms	2023	2024	2024	2023	2024	2023	2023	**2023**
Licensed drone operators & engineers	2023	2023	2023	NA	NA	NA	NA	**2023**
Navigate accelerating change across technologies	2023	2025	2022	2024	2023	2023	2024	**2023**
Tool operation & servicing moves to programming & remote use	2022	2024	2024	NA	2025	NA	NA	**2024**
Automation Robotics designer/integrator	2022	2024	2025	NA	2026	NA	NA	**2024**
AR/VR/MR experience designers & guides	2023	2024	2025	2025	2023	2025	2025	**2024**
Bioelectronics & Biosecurity	2026	2024	2025	2024	NA	NA	NA	**2025**
Blockchain systems design	2025	2025	2025	2024	2024	2025	2024	**2024**
Tech bridge role: building capacity for emerging competencies	2024	2025	2025	2024	2024	NA	2025	**2025**

Source: GEF Expert Surveys

FACTORS

When will these factors have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Factor	% of Respondents saying when it will be Significant: Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
TECHNICAL & DIGITAL	Cybersecurity & privacy threats	79%	95%	100%	2022	9%
TECHNICAL & DIGITAL	3D Printing	67%	100%	100%	2022	21%
TECHNICAL & DIGITAL	Growth of Cloud, Network & Computing capacity (e.g. Quantum)	59%	95%	100%	2023	
TECHNICAL & DIGITAL	Industrial Internet: Big data analytics & IoT	58%	95%	100%	2023	
TECHNICAL & DIGITAL	New designer materials e.g. composites, alloys, nanotech	59%	87%	100%	2023	
TECHNICAL & DIGITAL	Remote diagnosis & maintenance - drones & VR/AR	33%	100%	100%	2024	
TECHNICAL & DIGITAL	Automated coding	39%	83%	100%	2024	9%
TECHNICAL & DIGITAL	Robots & Cobots (collaboration of humans with robots)	28%	85%	100%	2025	13%
COVID	Strict hygiene/biosecurity rules in production & delivery	85%	98%	98%	2021	
GENERAL	Eco materials & production modes essential	40%	88%	98%	2024	5%
GENERAL	Personalisation of production e.g. e-commerce, on-demand	40%	80%	98%	2025	
GENERAL	Demographic changes e.g. ageing workforce	35%	83%	98%	2025	17%
GENERAL	Permanent loss of jobs due to structural shifts	35%	83%	98%	2025	7%
TECHNICAL & DIGITAL	Building information modeling (BIM)	63%	95%	97%	2023	
COVID	Unemployment, jobs disappearing & reduced spending	73%	90%	95%	2023	
COVID	National self-reliance & domestic supply chains	50%	93%	95%	2024	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	39%	84%	95%	2025	7%
TECHNICAL & DIGITAL	Autonomous manufacturing & RFID logistics	38%	82%	95%	2025	
TECHNICAL & DIGITAL	AI prediction & Self-learning machines / production lines	29%	82%	95%	2025	
TECHNICAL & DIGITAL	New human-computer interfaces (touch, brain)	21%	67%	95%	2026	5%
GENERAL	Total digital monitoring	18%	73%	93%	2026	
TECHNICAL & DIGITAL	Unmanned vehicles	15%	59%	92%	2027	
GENERAL	Nationalisation of platforms and data	44%	80%	90%	2025	
TECHNICAL & DIGITAL	Blockchain & Supply chain transparency	33%	74%	90%	2026	-6%
GENERAL	Digital Currency replaces Cash	28%	63%	90%	2026	
COVID	Remote Working = New Norm	78%	85%	88%	2023	-6%

Source: GEF Expert Surveys

SKILLS

MANUFACTURING & ENGINEERING

When will these SKILLS/ROLES have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Skill / Role	% of Respondents saying when it will be Significant			= average year	vs all-sector average year (above +/-5%)
		Now	2025+	2030+		
SOCIO-ECONOMIC	Collaboration (on & offline)	97%	100%	100%	2021	7%
SOCIO-ECONOMIC	Facilitation & Co-creation	83%	97%	100%	2022	
TECHNICAL & DIGITAL	Big Data analytics	79%	100%	100%	2022	5%
TECHNICAL & DIGITAL	Digital quality control	76%	97%	100%	2022	
TECHNICAL & DIGITAL	Agile/lean manufacturing to respond to rapid cycles	70%	97%	100%	2022	
SOCIO-ECONOMIC	New communication skills e.g. visual/touch/gesture/thought	70%	93%	100%	2022	4%
TECHNICAL & DIGITAL	Robotics designer/integrator e.g. for Welding	67%	97%	100%	2022	15%
TECHNICAL & DIGITAL	Multidisciplinary cross-sectoral catalysts	67%	93%	100%	2022	6%
TECHNICAL & DIGITAL	Tool operation & servicing moves to programming & remote use	60%	100%	100%	2022	11%
COGNITIVE FOUNDATIONAL	Navigate accelerating change across technologies	57%	90%	100%	2023	
TECHNICAL & DIGITAL	Licensed drone operators & engineers	47%	93%	100%	2023	
TECHNICAL & DIGITAL	Neuro Interface engineering	24%	83%	100%	2025	
COGNITIVE FOUNDATIONAL	Learning how to learn & unlearn (intellectual humility)	76%	93%	97%	2022	
SOCIO-ECONOMIC	Human/Soft skills: judgment, creativity, compassion, social & emotional skills	73%	93%	97%	2022	
TECHNICAL & DIGITAL	Digital Ergonomic Design	70%	93%	97%	2022	
TECHNICAL & DIGITAL	AR / VR / MR designer & engineering & maintenance & manufacture	67%	90%	97%	2023	
GREEN & WELL-BEING	Health & Safety awareness/skills e.g. using AR/VR remote tech	67%	90%	97%	2023	
TECHNICAL & DIGITAL	Business continuity manager: restore operations in disruption	57%	97%	97%	2023	3%
GREEN & WELL-BEING	Circular economy specialist	55%	93%	97%	2023	
TECHNICAL & DIGITAL	Advanced materials engineer metal / glass / composite / nanomaterial	53%	87%	97%	2024	
GREEN & WELL-BEING	Regenerative & sustainable skills e.g. carbon footprint & lifecycle design	50%	87%	97%	2024	
TECHNICAL & DIGITAL	Small batch manufacturer (VR design + 3D printing)	47%	93%	97%	2024	
TECHNICAL & DIGITAL	Electronics moves to autoconfiguration solutions	43%	90%	97%	2024	13%
TECHNICAL & DIGITAL	Tech bridge role: building capacity for emerging competencies	41%	86%	97%	2024	
TECHNICAL & DIGITAL	Bioelectronics design	27%	73%	97%	2026	-7%
TECHNICAL & DIGITAL	CNC operation, maintenance & programming (unified role)	77%	93%	93%	2022	
TECHNICAL & DIGITAL	Blockchain systems design	38%	86%	93%	2025	
TECHNICAL & DIGITAL	UX UI design / user-centric approaches	27%	83%	93%	2025	-13%

Source: GEF Expert Surveys

KEY AREAS

MANUFACTURING & ENGINEERING

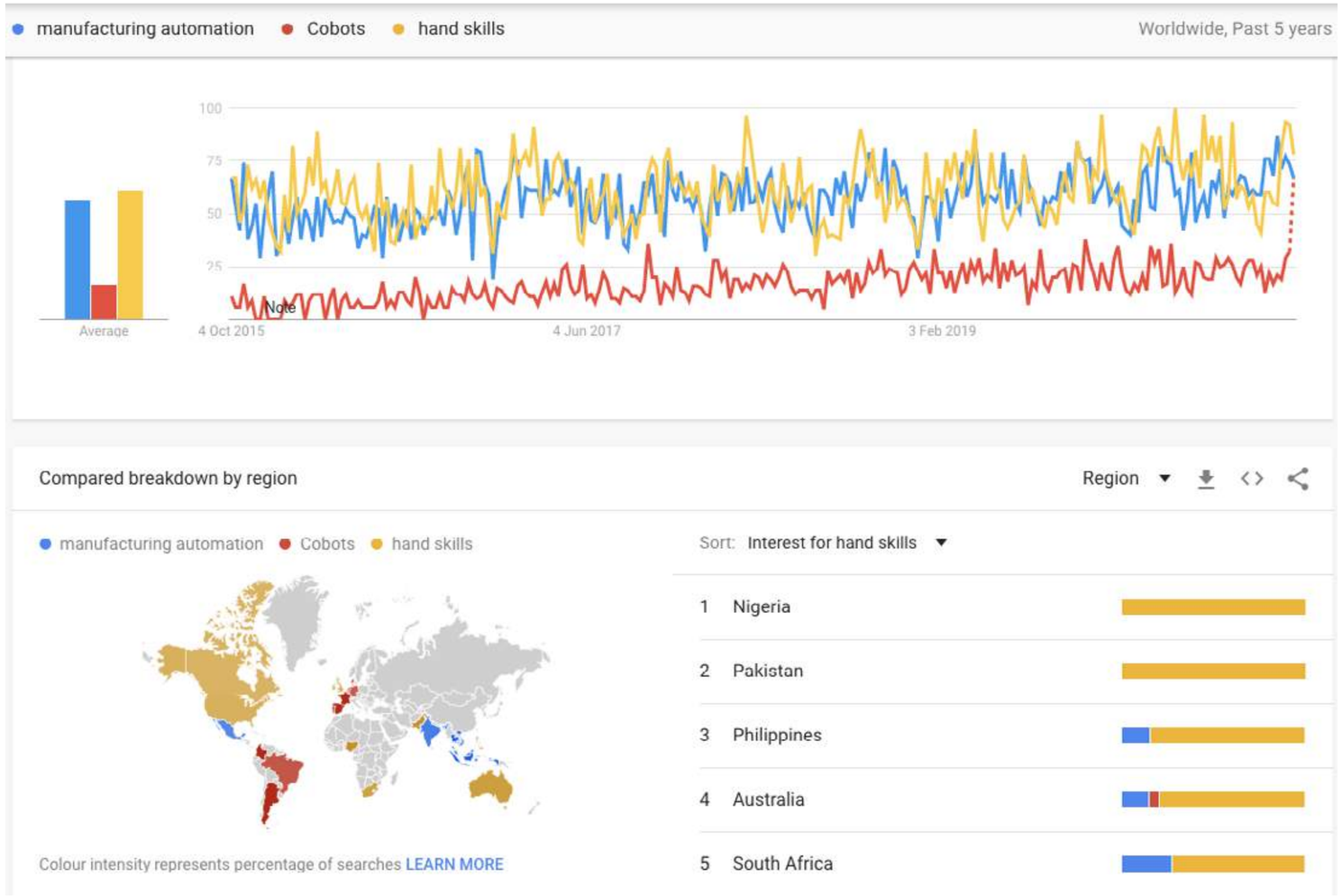
Which areas are most critical to prepare the sector for the next 10 years?

Cluster	Area	% of responses	Rank	vs all-sector average year (above +/-5%)
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	66%	Highest	16%
TECHNICAL & DIGITAL	Robotics & Internet of Things	59%	Highest	-42%
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	53%	Highest	18%
TECHNICAL & DIGITAL	3D manufacturing	47%	Highest	70%
GREEN & WELL-BEING	Environmentally sustainable & regenerative practices	44%	High	
TECHNICAL & DIGITAL	AI & Big Data analytics	41%	High	-9%
TECHNICAL & DIGITAL	Cybersecurity	41%	High	
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	38%	High	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	34%	Medium	30%
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	31%	Medium	-23%
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	25%	Medium	-31%
SOCIO-ECONOMIC	General Social & Emotional skills	25%	Medium	-6%
GREEN & WELL-BEING	Diversity & multicultural awareness	22%	Low	16%
TECHNICAL & DIGITAL	Agile / lean project management	19%	Low	8%
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	19%	Low	8%
SOCIO-ECONOMIC	Inter-sector communication, Storytelling & Advocacy	16%	Low	-58%

Source: GEF Expert Surveys

COMPARISON

MANUFACTURING & ENGINEERING



Source: *Google Trends*

FACTORS

CONSTRUCTION & INFRASTRUCTURE

When will these factors have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Factor	% of Respondents saying when it will be Significant: Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
GENERAL	Customer expectations: personalisation (e.g. homes), on-demand	73%	97%	100%	2022	
TECHNICAL & DIGITAL	Mobile devices & apps for collaboration & management	73%	97%	100%	2022	
TECHNICAL & DIGITAL	Prefabrication & modular construction: flexible infrastructure elements	70%	100%	100%	2022	10%
TECHNICAL & DIGITAL	Rising material costs & high financial investment requirements	70%	97%	100%	2022	
COVID	Push to more national self-reliance & domestic supply chains	67%	100%	100%	2022	9%
TECHNICAL & DIGITAL	New materials are lighter / stronger / safer / sustainable / smart	53%	87%	100%	2023	
TECHNICAL & DIGITAL	3D Printing	50%	87%	100%	2024	8%
TECHNICAL & DIGITAL	Smart and life-cycle optimizing equipment	33%	83%	100%	2025	
GENERAL	Cross-industry collaboration	57%	93%	97%	2023	
TECHNICAL & DIGITAL	Industrial Internet: Big data analytics & IoT	53%	83%	97%	2024	
TECHNICAL & DIGITAL	Electric mobility + Battery tech	50%	77%	97%	2024	
TECHNICAL & DIGITAL	Lean and agile processes increase efficiencies	47%	93%	97%	2024	-5%
GENERAL	Ecosystemic supply chain approaches	37%	90%	97%	2024	
TECHNICAL & DIGITAL	Smart roads sensing speeds, environmental metrics, fuel etc	23%	60%	97%	2026	
GENERAL	Circular construction: Repair, Reuse, Recycle & waste reduction	62%	93%	97%	2023	
TECHNICAL & DIGITAL	Cybersecurity & Privacy threats, for individuals to large scale projects	62%	90%	97%	2023	
TECHNICAL & DIGITAL	Digital supply network (DSN)	55%	86%	97%	2024	
TECHNICAL & DIGITAL	Smart wearable tech increases safety, collaboration & efficiency	31%	76%	97%	2025	
COVID	Strict hygiene/biosecurity rules in production & delivery	80%	93%	93%	2022	
COVID	Unemployment, jobs disappearing & reduced spending	77%	83%	93%	2023	
TECHNICAL & DIGITAL	Building information modeling (BIM)	70%	87%	93%	2023	
GENERAL	Active inclusion of local communities e.g. in retrofit design	53%	87%	93%	2024	
TECHNICAL & DIGITAL	Remote surveillance & maintenance - Drones & VR/AR	50%	77%	93%	2024	
GENERAL	Eco materials & production modes essential	47%	80%	93%	2024	
TECHNICAL & DIGITAL	Blockchain & Supply chain transparency	43%	80%	93%	2025	
GENERAL	Regenerative solutions reduce cost of construction/maintenance e.g. green retrofit	43%	77%	93%	2025	
GENERAL	Permanent loss of jobs due to structural shifts	27%	77%	93%	2026	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	33%	70%	90%	2026	-5%
TECHNICAL & DIGITAL	AI prediction & Self-learning machines / assembly lines	33%	67%	90%	2026	
TECHNICAL & DIGITAL	Robots & Cobots (collaboration of humans with robots)	30%	60%	90%	2026	
GENERAL	Personalisation of production: e-commerce + on-demand small batches	27%	73%	90%	2026	-9%
GENERAL	Total digital monitoring	27%	67%	90%	2026	-6%
TECHNICAL & DIGITAL	3, 4, 5, 6, 7 -Dimensional design applications	23%	73%	90%	2026	
GENERAL	Nationalisation of platforms and data	43%	77%	87%	2025	
GENERAL	Demographic changes: workforce becomes increasingly senior	33%	73%	87%	2026	
TECHNICAL & DIGITAL	Ultra high speed rail e.g. Hyperloop, Maglev	20%	67%	87%	2027	
TECHNICAL & DIGITAL	New human-computer interfaces e.g. neural & 3D touch	20%	57%	87%	2027	-6%
GENERAL	Digital Currency replaces Cash	31%	62%	86%	2027	
TECHNICAL & DIGITAL	Unmanned vehicles	11%	54%	82%	2028	-9%
COVID	Remote Working = New Norm	70%	73%	80%	2024	-16%

Source: GEF Expert Surveys

When will these SKILLS/ROLES have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Skill / Role	% of Respondents saying when it will be Significant			= average year	vs all-sector average year (above +/-5%)
		Now	2025+	2030+		
GREEN & WELL-BEING	Recycling, Rebuilding & Retrofit design	82%	100%	100%	2021	
COGNITIVE FOUNDATIONAL	Ethical decisions & practices, Critical thinking, understanding biases	81%	100%	100%	2021	6%
GREEN & WELL-BEING	Environmental maintenance & green skills e.g. Solar	79%	100%	100%	2022	
COGNITIVE FOUNDATIONAL	Learning how to learn & unlearn (intellectual humility)	77%	100%	100%	2022	7%
TECHNICAL & DIGITAL	Cybersecurity	71%	93%	100%	2022	
GREEN & WELL-BEING	Full lifecycle approaches: cost, social & environmental outcomes measurement	68%	96%	100%	2022	9%
TECHNICAL & DIGITAL	Big Data analytics	68%	89%	100%	2023	
TECHNICAL & DIGITAL	Local power generation: designing autonomous solutions for individual buildings	68%	89%	100%	2023	
TECHNICAL & DIGITAL	IoT (Electronics and programming) skills interfacing with system operation	64%	93%	100%	2023	
TECHNICAL & DIGITAL	Maintenance jobs include software knowledge & mechanical elements	61%	96%	100%	2023	
TECHNICAL & DIGITAL	Lean / Agile implementor	57%	93%	100%	2023	
GREEN & WELL-BEING	Green construction advocate	57%	93%	100%	2023	
GREEN & WELL-BEING	Health & Safety awareness/skills e.g. using AR/VR remote tech	48%	100%	100%	2023	
TECHNICAL & DIGITAL	Licensed drone operators & engineers	46%	96%	100%	2023	
TECHNICAL & DIGITAL	3D Printing Advisors & Artisans	46%	96%	100%	2023	
SOCIO-ECONOMIC	New communication skills e.g. visual/touch/gesture/thought	44%	96%	100%	2023	
GREEN & WELL-BEING	Mental health & well-being design roles	79%	96%	96%	2022	15%
TECHNICAL & DIGITAL	Risk management & supply chain resiliency	79%	96%	96%	2022	
TECHNICAL & DIGITAL	Maths, computing, programming	75%	96%	96%	2022	9%
TECHNICAL & DIGITAL	Building Information Modeling (BIM)	71%	96%	96%	2022	
GREEN & WELL-BEING	Weather resistance & disaster management	57%	93%	96%	2023	
TECHNICAL & DIGITAL	Training / Programming AI e.g. for diagnosis	57%	86%	96%	2024	
TECHNICAL & DIGITAL	Tool operation & servicing moves to programming & remote use	54%	86%	96%	2024	
SOCIO-ECONOMIC	Infrastructure design focusing on remote control & user experience	46%	86%	96%	2024	
TECHNICAL & DIGITAL	Biosecurity	43%	86%	96%	2024	
TECHNICAL & DIGITAL	AR / VR / MR used in design, implementation & maintenance	39%	89%	96%	2024	
SOCIO-ECONOMIC	Collaboration (on & offline)	81%	96%	96%	2022	
SOCIO-ECONOMIC	Facilitation & Co-creation	70%	93%	93%	2023	-5%
SOCIO-ECONOMIC	Human/Soft skills: judgment, creativity, compassion, social & emotional skills	67%	93%	93%	2023	
GREEN & WELL-BEING	Connecting with nature & Biomimicry	44%	89%	93%	2024	-5%
COGNITIVE FOUNDATIONAL	Navigate accelerating change across technologies	41%	85%	93%	2025	-9%
TECHNICAL & DIGITAL	Tech bridge role: building capacity for emerging competencies	37%	81%	93%	2025	

Source: GEF Expert Surveys

KEY AREAS

CONSTRUCTION & INFRASTRUCTURE

Which areas are most critical to prepare the sector for the next 10 years?

Cluster	Area	% of responses	Rank	vs all-sector average (above +/-5%)
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	62%	Highest	9%
GREEN & WELL-BEING	Environmentally sustainable & regenerative practices	55%	Highest	
TECHNICAL & DIGITAL	3D manufacturing	52%	Highest	70%
TECHNICAL & DIGITAL	AI & Big Data analytics	41%	Highest	-9%
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	41%	High	18%
TECHNICAL & DIGITAL	Cybersecurity	41%	High	
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	38%	High	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	38%	High	30%
TECHNICAL & DIGITAL	Agile / lean project management	31%	Medium	8%
GREEN & WELL-BEING	Diversity & multicultural awareness	31%	Medium	16%
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	31%	Medium	-23%
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	28%	Medium	-31%
SOCIO-ECONOMIC	General Social & Emotional skills	28%	Low	-6%
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	28%	Low	8%
TECHNICAL & DIGITAL	Robotics & Internet of Things	24%	Low	-42%
SOCIO-ECONOMIC	Inter-sector communication, Storytelling & Advocacy	7%	Low	-58%

Source: GEF Expert Surveys

FACTORS

TRANSPORTATION & LOGISTICS

When will these factors have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Factor	% of Respondents saying when it will be Significant Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
COVID	Strict hygiene/biosecurity rules in production & delivery	100%	100%	100%	2020	12%
COVID	Remote Working = New Norm	89%	100%	100%	2021	9%
COVID	Push to more national self-reliance & domestic supply chains	79%	100%	100%	2022	14%
TECHNICAL & DIGITAL	RFID & GPS logistics - Smart Storage adjusting capacity, movement, packaging	68%	95%	100%	2022	10%
TECHNICAL & DIGITAL	Lean and agile processes increase efficiencies	63%	100%	100%	2022	5%
GENERAL	Customer expectations: personalisation, e-commerce, on-demand & consumptic	63%	100%	100%	2022	
TECHNICAL & DIGITAL	Industrial Internet: Big data analytics & IoT	58%	89%	100%	2023	
TECHNICAL & DIGITAL	Cybersecurity & Risks of UAV hacking	53%	89%	100%	2023	
GENERAL	Eco materials & production modes essential	42%	89%	100%	2024	8%
GENERAL	Personalisation of production: e-commerce + on-demand small batches	42%	89%	100%	2024	12%
TECHNICAL & DIGITAL	AI prediction & Self-learning/driving machines	42%	68%	100%	2025	7%
TECHNICAL & DIGITAL	Integration of Transport Network & IT: digital transportation networks to replace	37%	84%	100%	2024	
TECHNICAL & DIGITAL	Robots & Cobots (collaboration of humans with robots)	32%	63%	100%	2026	
GENERAL	Total digital monitoring	22%	78%	100%	2025	
TECHNICAL & DIGITAL	Remote diagnosis & maintenance - Drones & VR/AR	21%	95%	100%	2025	
TECHNICAL & DIGITAL	Smart roads sensing speeds, environmental metrics, fuel, traffic etc	21%	68%	100%	2026	
COVID	Unemployment, jobs disappearing & reduced spending	84%	95%	95%	2022	7%
TECHNICAL & DIGITAL	High financial investment costs	68%	89%	95%	2023	
TECHNICAL & DIGITAL	Prefabrication & modular construction: flexible adaptable infrastructure	47%	79%	95%	2024	-10%
GENERAL	Crowd sharing transport solutions	37%	84%	95%	2025	
TECHNICAL & DIGITAL	Universal translation for learning & safety measures	26%	79%	95%	2025	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	21%	68%	95%	2026	-10%
TECHNICAL & DIGITAL	Ultra-high speed rail e.g. Hyperloop, Maglev	21%	63%	95%	2027	
TECHNICAL & DIGITAL	High tech Airships for delivery or hard-to-reach areas e.g. to extinguish forest fi	16%	74%	95%	2026	
TECHNICAL & DIGITAL	3D printing reduces transportation to mainly raw materials	5%	63%	95%	2027	-26%
TECHNICAL & DIGITAL	Electric mobility + Battery recharging & replacement tech extends range	39%	78%	94%	2025	
GENERAL	New long haul trade routes - Belt & Road (Chinese export/import routes), Northe	33%	67%	94%	2026	
TECHNICAL & DIGITAL	Unmanned vehicles	6%	67%	94%	2027	
TECHNICAL & DIGITAL	Blockchain: Supply chain transparency, reduces intermediary roles	26%	79%	89%	2026	-7%
TECHNICAL & DIGITAL	New human-computer interfaces (touch, brain)	16%	58%	89%	2027	-6%
TECHNICAL & DIGITAL	Air traffic saturation requires new control systems & infrastructure	11%	58%	89%	2028	
GENERAL	Digital Currency replaces Cash	42%	63%	84%	2026	
GENERAL	Nationalisation of platforms and data	37%	63%	84%	2026	-14%
GENERAL	Permanent loss of jobs due to structural shifts	5%	47%	84%	2029	-32%
GENERAL	Demographic changes: workforce becomes increasingly senior	5%	58%	79%	2028	-23%

Source: GEF Expert Surveys

SKILLS

TRANSPORTATION & LOGISTICS

When will these SKILLS/ROLES have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Skill / Role	% of Respondents saying when it will be Significant			= average year	vs all-sector average year (above +/-5%)
		Now	2025+	2030+		
SOCIO-ECONOMIC	Collaboration (on & offline)	88%	100%	100%	2021	
SOCIO-ECONOMIC	Human/Soft skills: judgment, creativity, compassion, social & emotional skills	82%	100%	100%	2021	8%
COGNITIVE FOUNDATIONAL	Ethical decisions & practices, Critical thinking, understanding biases	82%	94%	100%	2022	
SOCIO-ECONOMIC	Facilitation & Co-creation	82%	94%	100%	2022	
SOCIO-ECONOMIC	Diversity, equity, cultural awareness & race relations	76%	100%	100%	2022	
COGNITIVE FOUNDATIONAL	Navigate accelerating change across technologies	76%	94%	100%	2022	13%
TECHNICAL & DIGITAL	Big Data analytics	71%	94%	100%	2022	
GREEN & WELL-BEING	Health & Safety awareness/skills e.g. using AR/VR remote tech	71%	94%	100%	2022	8%
TECHNICAL & DIGITAL	Cybersecurity e.g. Customs digital security designer	71%	88%	100%	2023	
TECHNICAL & DIGITAL	IoT (Electronics and programming) skills interfacing with system operation	65%	100%	100%	2022	
GREEN & WELL-BEING	Eco-fuel scientists and researchers	65%	100%	100%	2022	
SOCIO-ECONOMIC	New communication skills e.g. visual/touch/gesture/thought	65%	94%	100%	2023	8%
TECHNICAL & DIGITAL	Mobility advisers: big data analytics & intermodal relationship management	59%	94%	100%	2023	
GREEN & WELL-BEING	Regenerative & sustainable skills e.g. lifecycle / carbon analysis of tech	53%	100%	100%	2023	5%
GREEN & WELL-BEING	Environmental maintenance & green skills e.g. Solar	53%	100%	100%	2023	
TECHNICAL & DIGITAL	Programming skills (+moves to visual, semi-automatic, voice & gesture)	53%	94%	100%	2023	
TECHNICAL & DIGITAL	Training / Programming AI e.g. for traffic control	53%	76%	100%	2024	-5%
SOCIO-ECONOMIC	Multidisciplinary cross-sectoral catalysts	47%	100%	100%	2023	
TECHNICAL & DIGITAL	Drone service engineers	47%	94%	100%	2023	
TECHNICAL & DIGITAL	Tech bridge role: building capacity for emerging competencies	47%	71%	100%	2025	
TECHNICAL & DIGITAL	Robotics designer / integrator	41%	76%	100%	2025	
TECHNICAL & DIGITAL	Remote Interface Design - software design, traffic management systems	35%	76%	100%	2025	
TECHNICAL & DIGITAL	Service roles transform to remote diagnostic, programming & maintaining	29%	100%	100%	2024	
TECHNICAL & DIGITAL	AR / VR / MR designer & engineering & maintenance & manufacture	29%	88%	100%	2025	
TECHNICAL & DIGITAL	Driving moves to remote & traffic control roles	24%	88%	100%	2025	
TECHNICAL & DIGITAL	Blockchain roles e.g. system design, digitised trade documents, customs	24%	82%	100%	2025	-7%
TECHNICAL & DIGITAL	Smart Road technologist	18%	71%	100%	2026	
COGNITIVE FOUNDATIONAL	Learning how to learn & unlearn (intellectual humility)	76%	94%	94%	2022	
TECHNICAL & DIGITAL	Biosecurity	31%	81%	94%	2025	
TECHNICAL & DIGITAL	Infrastructure designer focusing on remote control & user experience	29%	71%	94%	2026	
TECHNICAL & DIGITAL	Recuperation System Designer: capturing vehicle excess energy e.g. braking	24%	88%	94%	2025	
TECHNICAL & DIGITAL	Hyperloop & Maglev roles e.g. High speed railway system engineer	19%	69%	88%	2027	
TECHNICAL & DIGITAL	Arctic navigation specialist	13%	50%	88%	2028	

Source: GEF Expert Surveys

KEY AREAS

TRANSPORTATION & LOGISTICS

Which areas are most critical to prepare the sector for the next 10 years?

Cluster	Area	% of responses	Rank	vs all-sector average (above +/-5%)
GREEN & WELL-BEING	Environmentally sustainable & regenerative practices	67%	Highest	26%
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	61%	Highest	8%
TECHNICAL & DIGITAL	Cybersecurity	61%	Highest	48%
TECHNICAL & DIGITAL	AI & Big Data analytics	50%	Highest	10%
TECHNICAL & DIGITAL	Robotics & Internet of Things	50%	High	20%
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	50%	High	24%
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	39%	High	
TECHNICAL & DIGITAL	Agile / lean project management	28%	Medium	
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	28%	Medium	-21%
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	28%	Medium	-30%
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	28%	Medium	
TECHNICAL & DIGITAL	3D manufacturing	22%	Low	-27%
GREEN & WELL-BEING	Diversity & multicultural awareness	22%	Low	-17%
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	22%	Low	-13%
SOCIO-ECONOMIC	General Social & Emotional skills	17%	Low	-43%
SOCIO-ECONOMIC	Inter-sector communication, Storytelling & Advocacy	17%	Low	

Source: GEF Expert Surveys

FACTORS

ICT & DIGITAL

When will these factors have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Factor	% of Respondents saying when it will be Significant			= average year	vs all-sector average year (above +/-5%)
		Now	2025+	2030+		
TECHNICAL & DIGITAL	Industrial Internet: Big data analytics & IoT	59%	95%	100%	2023	
COVID	Remote Working = New Norm	83%	88%	98%	2022	
TECHNICAL & DIGITAL	Integrated providers of IT service infrastructure	62%	90%	97%	2023	
TECHNICAL & DIGITAL	Growth of Cloud/Network & Computing Capacity & accessibility (e.g. Quantum)	44%	69%	97%	2025	
TECHNICAL & DIGITAL	Robots & Cobots (collaboration of humans with robots)	23%	62%	97%	2026	
TECHNICAL & DIGITAL	Blockchain & Supply chain transparency	32%	84%	97%	2025	
TECHNICAL & DIGITAL	Cybersecurity & privacy threats	56%	85%	95%	2024	-6%
TECHNICAL & DIGITAL	3D Printing	41%	87%	95%	2024	
GENERAL	New social classes in tech literacy drives mass education programmes in ICT	38%	74%	95%	2025	
TECHNICAL & DIGITAL	New human-computer interfaces (touch, brain)	23%	62%	95%	2027	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	33%	75%	93%	2025	
COVID	COVID speeds up digital transformation & demand for ICT	79%	90%	92%	2022	
TECHNICAL & DIGITAL	AI prediction & Self-learning machines / production lines	33%	72%	92%	2026	
TECHNICAL & DIGITAL	User data re-appropriated/re-privatized by users	31%	72%	92%	2026	
TECHNICAL & DIGITAL	Automated Coding	26%	69%	92%	2026	-9%
GENERAL	Demand for social & environmental justice through tech, including equal access	26%	64%	92%	2026	
TECHNICAL & DIGITAL	Robot as a service & IoT business model	5%	56%	92%	2028	
TECHNICAL & DIGITAL	AI-created entertainment	24%	66%	92%	2026	
GENERAL	Total digital monitoring	17%	73%	90%	2026	-7%
COVID	Strict hygiene/biosecurity rules in production & delivery	70%	85%	90%	2023	-8%
GENERAL	Personalisation of production: e-commerce + on-demand small batches	43%	75%	90%	2025	
GENERAL	Nationalisation of platforms and data	40%	75%	90%	2025	
GENERAL	Eco materials & production modes essential	35%	55%	90%	2026	-16%
GENERAL	Digital Currency replaces Cash	20%	68%	90%	2027	
TECHNICAL & DIGITAL	Data Sovereignty (political/national)	41%	77%	90%	2025	
TECHNICAL & DIGITAL	Electronic Governments & Digital legislation	26%	64%	90%	2027	
COVID	Unemployment, jobs disappearing & reduced spending	60%	83%	88%	2024	-10%
COVID	Push to more national self-reliance & domestic supply chains	46%	85%	87%	2025	-11%
GENERAL	Permanent loss of jobs due to structural shifts	33%	60%	85%	2027	-8%
GENERAL	Demographic changes: workforce becomes increasingly senior	28%	55%	85%	2027	-11%
GENERAL	Counselling/rehab for online/VR trauma	15%	51%	79%	2028	

Source: GEF Expert Surveys

SKILLS

ICT & DIGITAL

When will these SKILLS/ROLES have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Skill / Role	% of Respondents saying when it will be Significant			= average year	vs all-sector average year (above +/-5%)
		Now	2025+	2030+		
TECHNICAL & DIGITAL	Big Data analytics	81%	97%	100%	2022	
TECHNICAL & DIGITAL	Infrastructure as a Service (IaaS) ops & dev roles	78%	94%	100%	2022	
TECHNICAL & DIGITAL	Cloud Solutions Architect & Disaster Recovery	72%	94%	100%	2022	
TECHNICAL & DIGITAL	Cybersecurity, Forensic Network Detective, Privacy Doctor	66%	97%	100%	2022	
TECHNICAL & DIGITAL	Platform as a service (PaaS) ops & dev roles	66%	94%	100%	2023	
TECHNICAL & DIGITAL	Training & Programming AI e.g. advanced algorithms, Machine vision dev	66%	84%	100%	2023	
TECHNICAL & DIGITAL	IoT architecture design	63%	94%	100%	2023	
SOCIO-ECONOMIC	UX UI design / user-centric approaches	61%	100%	100%	2022	12%
TECHNICAL & DIGITAL	Blockchain systems design	50%	84%	100%	2024	6%
TECHNICAL & DIGITAL	Data as a service (DaaS) ops & dev roles	47%	94%	100%	2023	
TECHNICAL & DIGITAL	Meta Programming skills (+moves to visual, voice & gesture, semi-automatic)	35%	87%	100%	2024	-9%
COGNITIVE FOUNDATIONAL	Learning how to learn & unlearn (intellectual humility)	69%	91%	97%	2023	
TECHNICAL & DIGITAL	Bioelectronics & Biosecurity	53%	72%	97%	2024	
TECHNICAL & DIGITAL	Quantum computing ops & dev roles	34%	66%	97%	2026	
TECHNICAL & DIGITAL	Digital Business Transformation Architect	65%	94%	97%	2023	
SOCIO-ECONOMIC	Human/Soft skills: judgment, creativity, compassion, social & emotional skills	61%	90%	97%	2023	-5%
TECHNICAL & DIGITAL	AR/VR/MR experience designers & guides	38%	78%	94%	2025	-7%
SOCIO-ECONOMIC	Facilitation & Co-creation	77%	90%	94%	2022	
SOCIO-ECONOMIC	Collaboration (on & offline)	74%	94%	94%	2022	-6%
SOCIO-ECONOMIC	Multidisciplinary cross-sectoral catalysts	58%	90%	94%	2023	
GREEN	Health & Safety awareness/skills e.g. using AR/VR remote tech	52%	90%	94%	2024	
TECHNICAL & DIGITAL	Digital Regulator & Legislation Coding	52%	81%	94%	2024	
COGNITIVE FOUNDATIONAL	Navigate accelerating change across technologies	48%	87%	94%	2024	
TECHNICAL & DIGITAL	Tech bridge role: building capacity for emerging competencies	48%	81%	94%	2024	
SOCIO-ECONOMIC	New communication skills e.g. visual/touch/gesture/thought	45%	84%	94%	2024	-7%
TECHNICAL & DIGITAL	Electronics moves to autoconfiguration solutions	42%	71%	94%	2025	-6%
SOCIO-ECONOMIC	Diversity, cultural awareness & race relations	68%	84%	90%	2023	-9%
COGNITIVE FOUNDATIONAL	Ethical (data) decisions & practices, critical thinking, understanding biases	61%	84%	90%	2024	-11%
TECHNICAL & DIGITAL	Digital finance literacy e.g. currency advisor	48%	71%	90%	2025	
GREEN & WELL-BEING	Regenerative & sustainable skills e.g. lifecycle / carbon analysis of tech	39%	84%	90%	2025	-11%
GREEN & WELL-BEING	Well-being roles at work & home	39%	77%	90%	2025	-13%
TECHNICAL & DIGITAL	Neuro Interface communications	38%	66%	88%	2026	
TECHNICAL & DIGITAL	Ambient Computing 'that you can't see'	30%	70%	87%	2026	
TECHNICAL & DIGITAL	Digital Ergonomic Design	58%	84%	84%	2024	-7%
GREEN & WELL-BEING	Mental Health care e.g. Social Media Anxiety Therapists, VR detox & rehab	32%	65%	84%	2026	-16%
GREEN & WELL-BEING	Psychological Rehabilitation - 'detox clinics" from online/ VR	32%	65%	84%	2026	
TECHNICAL & DIGITAL	Digital Linguist	39%	68%	81%	2026	
SOCIO-ECONOMIC	Digital Empathy / Emotion roles	29%	68%	81%	2027	

Source: GEF Expert Surveys

KEY AREAS

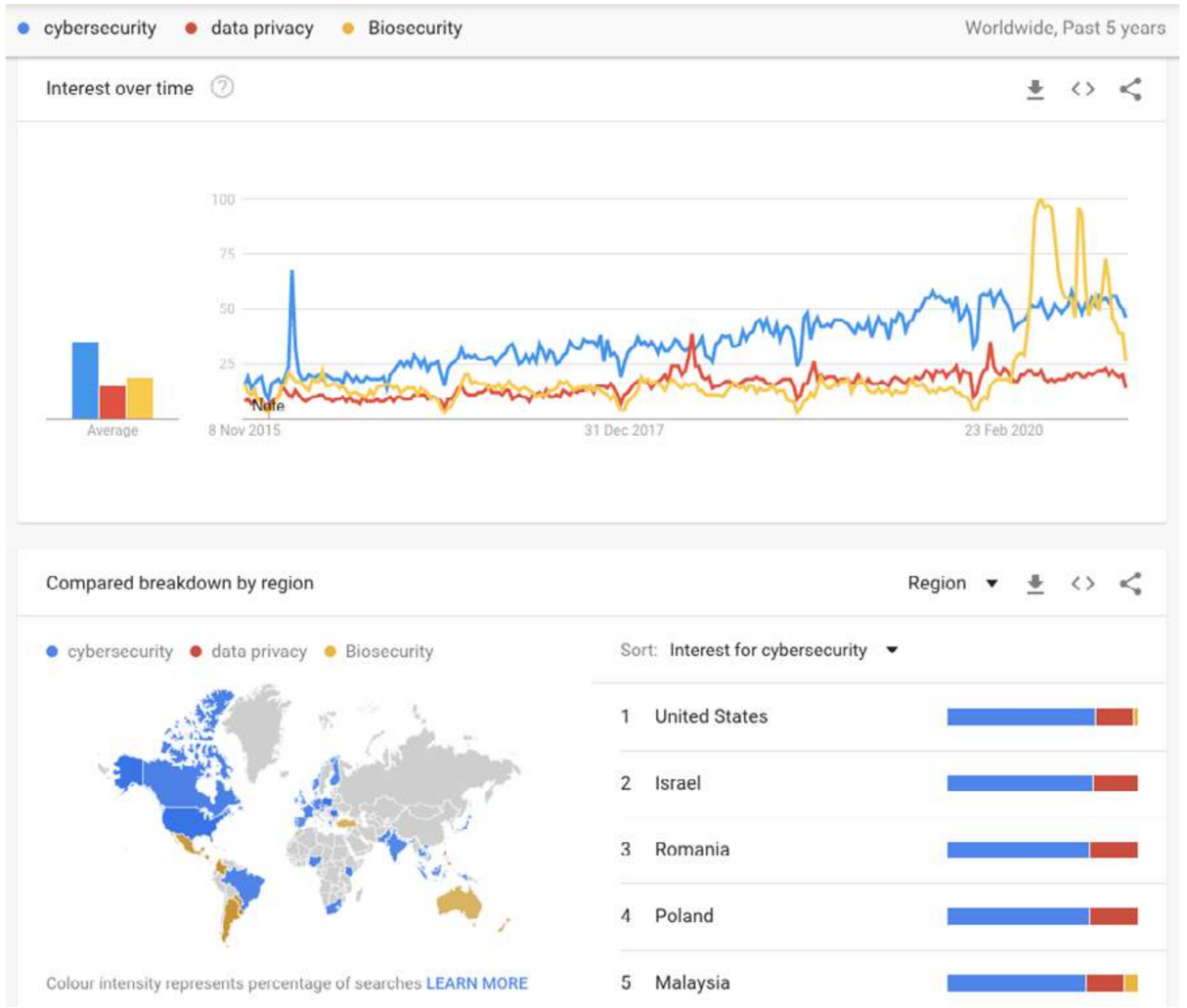
Which areas are most critical to prepare the sector for the next 10 years?

Cluster	Area	% of responses	Rank	vs all-sector average (above +/-5%)
TECHNICAL & DIGITAL	Cybersecurity	62%	Highest	50%
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	59%	Highest	
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	56%	Highest	43%
TECHNICAL & DIGITAL	AI & Big Data analytics	47%	Highest	
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	44%	High	11%
TECHNICAL & DIGITAL	Robotics & Internet of Things	44%	High	5%
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	44%	High	9%
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	38%	High	9%
TECHNICAL & DIGITAL	Agile / lean project management	32%	Medium	13%
GREEN & WELL-BEING	Environmentally sustainable & regenerative practices	32%	Medium	-39%
SOCIO-ECONOMIC	Inter-sector communication, Storytelling & Advocacy	32%	Medium	96%
TECHNICAL & DIGITAL	3D manufacturing	24%	Medium	-23%
SOCIO-ECONOMIC	General Social & Emotional skills	18%	Low	-40%
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	18%	Low	-31%
GREEN & WELL-BEING	Diversity & multicultural awareness	15%	Low	-45%
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	15%	Low	-50%

Source: GEF Expert Surveys

COMPARISON

ICT & DIGITAL



Source: *Google Trends*

FACTORS

HUMAN & SOCIAL SERVICES

When will these factors have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Factor	% of Respondents saying when it will be Significant: Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
COVID	Strict hygiene/biosecurity rules in production & delivery	79%	93%	100%	2022	
COVID	Push to more national self-reliance & domestic supply chains	60%	95%	100%	2023	
TECHNICAL & DIGITAL	Industrial Internet: Big data analytics & IoT	56%	95%	100%	2023	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	44%	84%	100%	2024	12%
GENERAL	Ageing populations: assistive technology & senior services	40%	86%	100%	2024	
TECHNICAL & DIGITAL	Digital badging profiles & blockchain; Distributed assessments & certification	37%	81%	100%	2025	
GENERAL	Total digital monitoring	36%	76%	100%	2025	11%
TECHNICAL & DIGITAL	New human-computer interfaces (touch, brain)	29%	62%	100%	2026	10%
COVID	Remote Working = New Norm	86%	95%	98%	2022	5%
TECHNICAL & DIGITAL	Cybersecurity & Privacy threats	67%	88%	98%	2023	
GENERAL	Distributed educational eco-systems: learning beyond traditional institutions	53%	86%	98%	2024	
GENERAL	Learning communities & Collective intelligence	49%	79%	98%	2024	
TECHNICAL & DIGITAL	3D Printing	40%	84%	98%	2024	
TECHNICAL & DIGITAL	Robots & Cobots (collaboration of humans with robots)	23%	70%	98%	2026	
TECHNICAL & DIGITAL	AI prediction & Self-learning machines / production lines	19%	79%	98%	2026	
GENERAL	Digital Currency replaces Cash	43%	76%	98%	2025	17%
GENERAL	Personalisation of production: e-commerce + on-demand small batches	31%	83%	98%	2025	
COVID	Unemployment, jobs disappearing & reduced spending	77%	86%	95%	2023	
GENERAL	Self-directed & online & blended learning - greater access to learners	63%	86%	95%	2023	
TECHNICAL & DIGITAL	Blockchain & Supply chain transparency	33%	84%	95%	2025	
GENERAL	Permanent loss of jobs due to structural shifts	57%	83%	95%	2024	18%
GENERAL	Eco materials & production modes essential	43%	83%	95%	2024	
GENERAL	Prioritisation of well-being (physical mental emotional spiritual)	56%	84%	93%	2024	
GENERAL	Nationalisation of platforms and data	57%	83%	93%	2024	8%
TECHNICAL & DIGITAL	Loss of human connection due to reliance on technology	53%	84%	91%	2024	
GENERAL	Demographic changes: workforce becomes increasingly senior	31%	64%	90%	2026	
GENERAL	Increasing leisure time	44%	72%	84%	2025	

Source: GEF Expert Surveys

SKILLS

HUMAN & SOCIAL SERVICES

When will these SKILLS/ROLES have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Skill / Role	% of Respondents saying when it will be Significant: Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
SOCIO-ECONOMIC	Human/Soft skills: judgment, creativity, compassion, social & emotional skills	79%	97%	100%	2022	6%
SOCIO-ECONOMIC	Storytelling, Advocacy & Community roles	76%	97%	100%	2022	
TECHNICAL & DIGITAL	Big Data analytics	73%	94%	100%	2022	
SOCIO-ECONOMIC	Facilitation & Co-creation	70%	94%	100%	2022	
SOCIO-ECONOMIC	Mental Health care e.g. Social Media Anxiety Therapists	70%	82%	100%	2023	16%
COGNITIVE FOUNDATIONAL	Learning how to learn & unlearn (intellectual humility)	67%	91%	100%	2023	
SOCIO-ECONOMIC	Crowdfunding / crowdinvesting / crowdsourcing	61%	97%	100%	2023	
GREEN & WELL-BEING	Health & Safety awareness/skills e.g. using AR/VR remote tech	61%	91%	100%	2023	
COGNITIVE FOUNDATIONAL	Navigate accelerating change across technologies	61%	88%	100%	2023	
SOCIO-ECONOMIC	UX & customer-centric roles	55%	85%	100%	2024	
TECHNICAL & DIGITAL	New communication skills e.g. visual/touch/gesture/thought	52%	88%	100%	2024	
GREEN & WELL-BEING	Regenerative & sustainable skills e.g. landscape design	48%	85%	100%	2024	
TECHNICAL & DIGITAL	AR / VR / MR experience designer	47%	94%	100%	2023	8%
TECHNICAL & DIGITAL	Training / Programming AI e.g. for personalised experiences	44%	91%	100%	2024	
TECHNICAL & DIGITAL	Tech bridge role: building capacity for emerging competencies	42%	94%	100%	2024	8%
COGNITIVE FOUNDATIONAL	Ethical decisions & practices, Critical thinking, understanding biases	79%	94%	97%	2022	
GREEN & WELL-BEING	Designers, catalysts & community builders for well-being & kindness	67%	88%	97%	2023	
SOCIO-ECONOMIC	Diversity, cultural awareness & race relations roles e.g. Migration adaptation	67%	85%	97%	2023	
SOCIO-ECONOMIC	Multidisciplinary cross-sectoral catalysts	58%	88%	97%	2023	
SOCIO-ECONOMIC	Translator between sectors/alternative economic paradigms	36%	88%	97%	2024	
GREEN & WELL-BEING	Resilience roles e.g. counselling	75%	91%	97%	2022	
GREEN & WELL-BEING	Workplace wellness therapy & holistic family consultancy	50%	88%	97%	2024	
TECHNICAL & DIGITAL	Blockchain systems design	50%	88%	94%	2024	
GREEN & WELL-BEING	Learning to reconnect with nature	55%	82%	91%	2024	
TECHNICAL & DIGITAL	Hand Skills (e.g. serving, cutting) moves to programming & remote use	42%	79%	91%	2025	-9%
TECHNICAL & DIGITAL	Automation integrator e.g. for massage, food preparation or hospitality	30%	76%	91%	2026	-14%

Source: GEF Expert Surveys

KEY AREAS

HUMAN & SOCIAL SERVICES

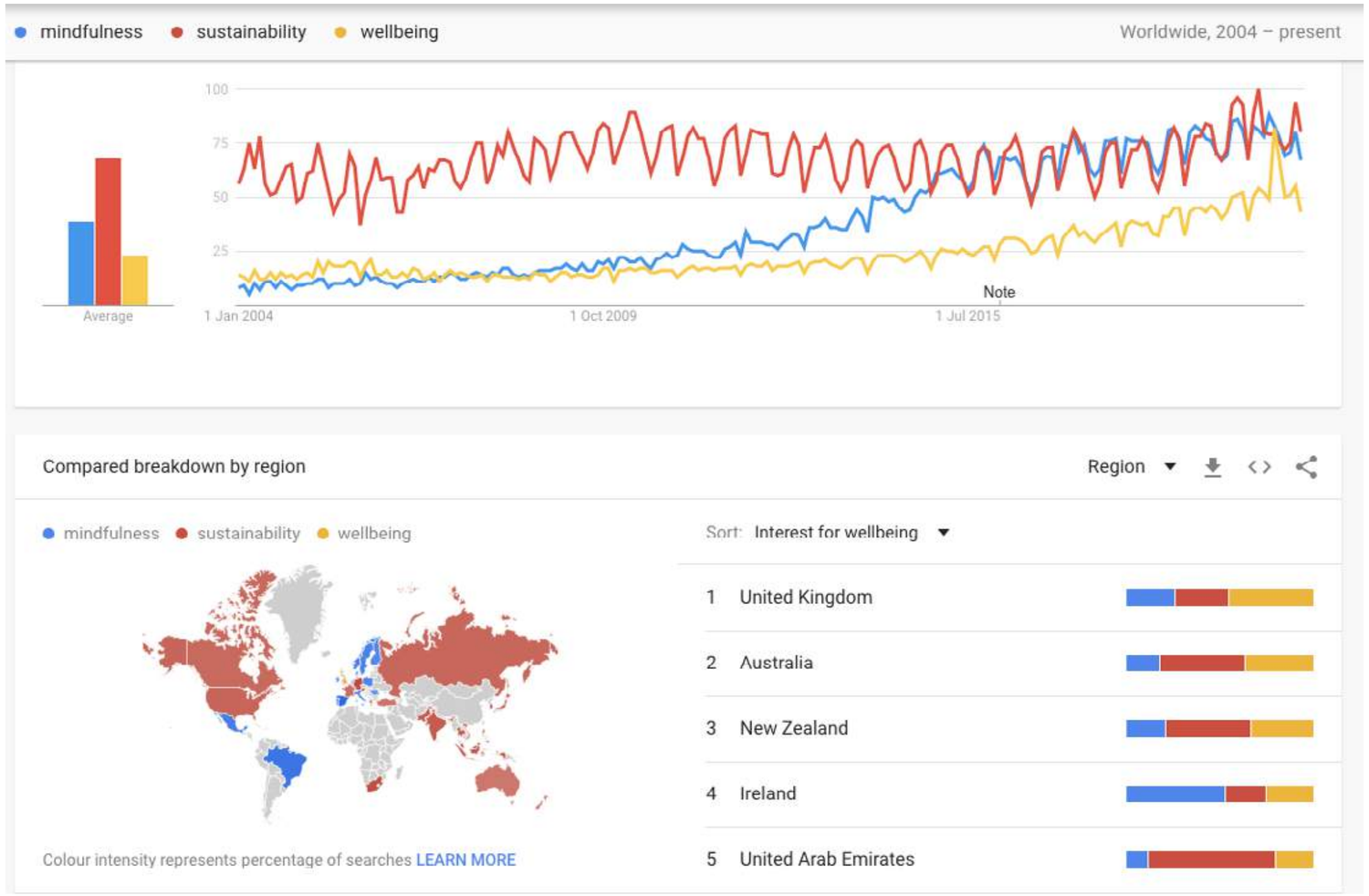
Which areas are most critical to prepare the sector for the next 10 years?

Cluster	Area	% of responses	Rank	vs all-sector average (above +/- 5%)
GREEN & WELL-BEING	Environmentally sustainable & regenerative practices	53%	Highest	
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	50%	Highest	-12%
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	50%	Highest	26%
TECHNICAL & DIGITAL	Cybersecurity	47%	Highest	14%
TECHNICAL & DIGITAL	AI & Big Data analytics	38%	High	-16%
SOCIO-ECONOMIC	General Social & Emotional skills	38%	High	31%
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	38%	High	31%
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	38%	High	-5%
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	35%	Medium	-10%
TECHNICAL & DIGITAL	Agile / lean project management	32%	Medium	13%
GREEN & WELL-BEING	Diversity & multicultural awareness	32%	Medium	21%
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	29%	Medium	15%
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	26%	Low	-24%
TECHNICAL & DIGITAL	Robotics & Internet of Things	24%	Low	-44%
TECHNICAL & DIGITAL	3D manufacturing	18%	Low	-42%

Source: GEF Expert Surveys

COMPARISON

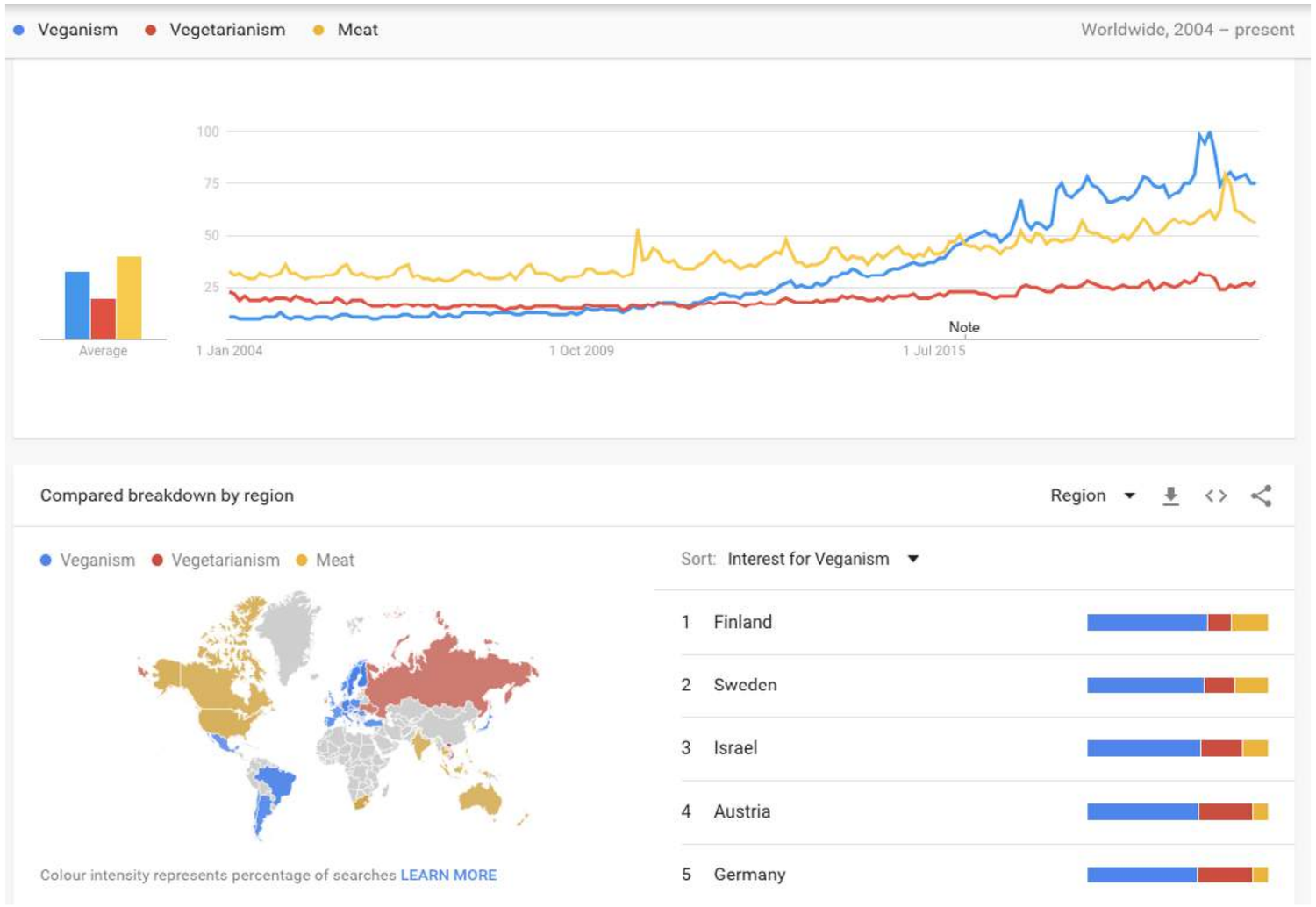
HUMAN & SOCIAL SERVICES



Source: *Google Trends*

COMPARISON

HUMAN & SOCIAL SERVICES



Source: *Google Trends*

FACTORS

CREATIVE INDUSTRIES

When will these factors have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Factor	% of Respondents saying when it will be Significant: Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
COVID	Remote Working = New Norm	92%	96%	100%	2021	9%
TECHNICAL & DIGITAL	Affordable graphic technologies	74%	96%	100%	2022	
COVID	Unemployment, jobs disappearing & reduced spending	73%	95%	100%	2022	
TECHNICAL & DIGITAL	3D Printing	38%	92%	100%	2024	
GENERAL	Nationalisation of platforms and data	46%	92%	100%	2024	11%
CREATIVE	Social Activism - demand for socially engaged art / creative work	70%	91%	100%	2022	
GENERAL	Prioritisation of well-being (physical mental emotional spiritual)	61%	91%	100%	2023	
GENERAL	Co-creation, social & community creativity e.g. mobbing	57%	91%	100%	2023	
TECHNICAL & DIGITAL	Blockchain & Supply chain transparency	33%	88%	100%	2024	5%
CREATIVE	Participatory experiences e.g. Immersive theatre	42%	83%	100%	2024	
CREATIVE	Fusing art and other fields e.g. Science Art	57%	83%	100%	2024	
CREATIVE	Decentralisation & crowdsourcing spreads creativity to new sectors & roles	29%	79%	100%	2025	
TECHNICAL & DIGITAL	New human-computer interfaces (touch, brain)	9%	78%	100%	2026	8%
GENERAL	Eco materials & production modes essential	48%	78%	100%	2024	6%
GENERAL	Total digital monitoring	33%	75%	100%	2025	9%
TECHNICAL & DIGITAL	Sensory tech & wearables in entertainment experiences, clothing & bodies	26%	74%	100%	2025	
TECHNICAL & DIGITAL	AI prediction & Self-learning machines / production lines	29%	71%	100%	2025	
GENERAL	Digital Currency replaces Cash	25%	63%	100%	2026	
CREATIVE	Social media sensationalism over competence	83%	91%	96%	2022	
GENERAL	Personalisation of art & fashion, & entertainment.	63%	88%	96%	2023	
COVID	Push to more national self-reliance & domestic supply chains	42%	88%	96%	2024	-8%
GENERAL	Permanent loss of jobs due to structural shifts	39%	74%	96%	2025	
TECHNICAL & DIGITAL	Robots & Cobots (collaboration of humans with robots)	13%	63%	96%	2027	-9%
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	25%	71%	92%	2026	-8%
COVID	Strict hygiene/biosecurity rules in production & delivery	70%	83%	91%	2023	-9%
GENERAL	Personalisation of production: e-commerce + on-demand small batches	43%	78%	91%	2025	
CREATIVE	Increasing leisure time	30%	74%	91%	2026	
CREATIVE	Pop up architecture: unique/temporary blends of objects, places & people	35%	74%	91%	2025	
GENERAL	Demographic changes: workforce becomes increasingly senior	22%	70%	87%	2027	-6%

Source: GEF Expert Surveys

When will these SKILLS/ROLES have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Skill / Role	% of Respondents saying when it will be Significant			= average year	vs all-sector average year (above +/-5%)
		Now	2025+	2030+		
SOCIO-ECONOMIC	Activist art	78%	94%	100%	2022	
SOCIO-ECONOMIC	Facilitation & Co-creation of art/creativity	75%	95%	100%	2022	
SOCIO-ECONOMIC	Human/Soft skills: judgment, creativity, compassion, social & emotional skills	70%	90%	100%	2022	
SOCIO-ECONOMIC	Diversity, cultural awareness & race relations	70%	90%	100%	2022	
SOCIO-ECONOMIC	Collaboration (on & offline)	65%	90%	100%	2023	-8%
COGNITIVE FOUNDATIONAL	Ethical decisions & practices, Critical Thinking, understanding biases	65%	95%	100%	2022	
COGNITIVE FOUNDATIONAL	Navigate accelerating change across technologies	63%	84%	100%	2023	
SOCIO-ECONOMIC	Storytelling, Advocacy	50%	95%	100%	2023	7%
SOCIO-ECONOMIC	New communication skills e.g. visual/touch/gesture/thought	47%	89%	100%	2024	
SOCIO-ECONOMIC	Transdisciplinary designers, catalysts & community builders	45%	95%	100%	2023	
COGNITIVE FOUNDATIONAL	Learning how to learn & unlearn (intellectual humility)	40%	85%	100%	2024	-13%
TECHNICAL & DIGITAL	Blockchain systems design	37%	79%	100%	2025	
TECHNICAL & DIGITAL	Info stylist - helps customize presentations / materials for various audiences	68%	84%	95%	2023	
GREEN & WELL-BEING	Health & Safety awareness/skills e.g. using AR/VR remote tech	65%	80%	95%	2023	
TECHNICAL & DIGITAL	Training / Programming AI e.g. trend prediction or experience personalisation	63%	84%	95%	2023	
GREEN & WELL-BEING	Learning to reconnect with nature	60%	90%	95%	2023	
GREEN & WELL-BEING	Regenerative & sustainable skills e.g. landscape design	55%	80%	95%	2024	
TECHNICAL & DIGITAL	Wearables tech design e.g. Personal power devices	53%	79%	95%	2024	
TECHNICAL & DIGITAL	Neo-crafts e.g. VR/AR Supported Design + 3D Printing & wearables	47%	68%	95%	2025	
GREEN & WELL-BEING	Mind fitness coach focused on cognitive skills, flow & creativity	47%	89%	95%	2024	
GREEN & WELL-BEING	Clothes recycling specialist	53%	84%	89%	2024	
TECHNICAL & DIGITAL	AR / VR / MR experience designer e.g. creates local information landscapes	42%	79%	89%	2025	-6%

Source: GEF Expert Surveys

KEY AREAS

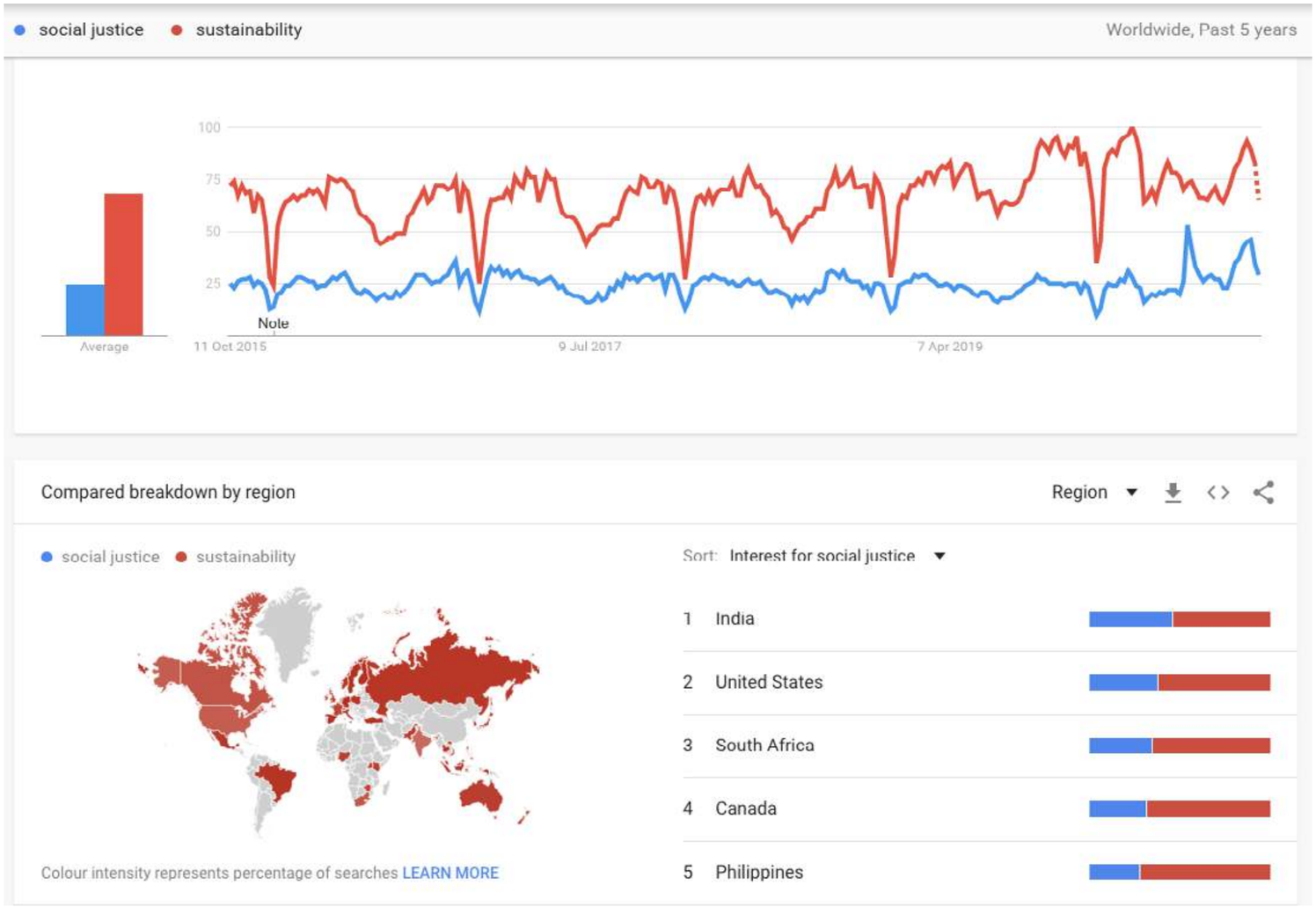
Which areas are most critical to prepare the sector for the next 10 years?

Cluster	Area	% of responses	Rank	vs all-sector average (above +/-5%)
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	65%	Highest	63%
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	55%	Highest	
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	55%	Highest	36%
TECHNICAL & DIGITAL	3D manufacturing	45%	Highest	48%
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	40%	High	
GREEN & WELL-BEING	Diversity & multicultural awareness	40%	High	49%
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	40%	High	37%
GREEN & WELL-BEING	Environmentally sustainable & regenerative practices	35%	High	-34%
SOCIO-ECONOMIC	General Social & Emotional skills	35%	High	20%
TECHNICAL & DIGITAL	Agile / lean project management	25%	Medium	-13%
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	25%	Medium	-29%
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	25%	Medium	
TECHNICAL & DIGITAL	Robotics & Internet of Things	25%	Medium	-40%
TECHNICAL & DIGITAL	AI & Big Data analytics	20%	Low	-56%
TECHNICAL & DIGITAL	Cybersecurity	20%	Low	-51%
SOCIO-ECONOMIC	Inter-sector communication, Storytelling & Advocacy	15%	Low	-9%

Source: GEF Expert Surveys

COMPARISON

CREATIVE INDUSTRIES



Source: *Google Trends*

FACTORS

AGRICULTURE & ECOLOGY

When will these factors have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Factor	% of Respondents saying when it will be Significant: Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
GREEN	Resource shortages: Soil Degradation, Biodiversity loss & Malnutritious Food	72%	94%	100%	2022	
TECHNICAL & DIGITAL	Hydroponics	68%	100%	100%	2022	
GREEN	Demand for Organic / Sustainable / Fair Trade + certified	68%	89%	100%	2023	
COVID	Strict hygiene/biosecurity rules in production & delivery	67%	100%	100%	2022	
TECHNICAL & DIGITAL	Farm Management Software	67%	89%	100%	2023	
COVID	Unemployment, jobs disappearing & reduced spending	67%	83%	100%	2023	
COVID	Remote Working = New Norm	61%	94%	100%	2023	
GREEN	Soil nutrient testing & Aerobic restoration	61%	94%	100%	2023	
GENERAL	Permanent loss of jobs due to structural shifts	56%	78%	100%	2024	16%
GREEN	Regenerative Farming: Ecological & Social Outcomes	50%	83%	100%	2024	
GREEN	Farming tech moves to renewable energy	44%	89%	100%	2024	
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	44%	72%	100%	2025	6%
TECHNICAL & DIGITAL	Precision agriculture: Big data analytics & IoT	42%	84%	100%	2024	-7%
GENERAL	Demographic changes: workforce becomes increasingly senior	42%	63%	100%	2025	11%
TECHNICAL & DIGITAL	Blockchain & Supply chain transparency	41%	71%	100%	2025	
TECHNICAL & DIGITAL	Gene Editing & Epigenetics	35%	65%	100%	2025	
GREEN	Full year use of land (cover crops, multi season harvest)	33%	72%	100%	2025	
TECHNICAL & DIGITAL	3D Printing	28%	72%	100%	2025	-9%
TECHNICAL & DIGITAL	AI prediction & Self-learning machines / production lines	11%	67%	100%	2027	-9%
TECHNICAL & DIGITAL	AgRobots & Cobots (collaboration of humans with robots)	32%	58%	95%	2026	
TECHNICAL & DIGITAL	Indoor, urban & vertical farming	61%	89%	94%	2023	
COVID	Push to more national self-reliance & domestic supply chains	50%	83%	94%	2024	-7%
GENERAL	Nationalisation of platforms and data	50%	78%	94%	2024	
GREEN	Crop swap impact analysis	44%	78%	94%	2025	
TECHNICAL & DIGITAL	Agrodrones & Agrobots	28%	72%	94%	2026	
TECHNICAL & DIGITAL	Cloned Crops & Meat	28%	50%	94%	2027	
GENERAL	Personalisation of production: e-commerce + on-demand small batches	22%	67%	94%	2026	-12%
GREEN	Living System Intelligence into AI - internet of living organisms	22%	61%	94%	2027	
GENERAL	Total digital monitoring	6%	67%	94%	2027	-12%
GENERAL	Digital Currency replaces Cash	12%	59%	94%	2027	-11%
GREEN	Eco materials & production modes essential	44%	67%	89%	2025	-6%
GREEN	Decentralised Agriculture: Indigenous & local knowledge	39%	72%	89%	2025	
SECTOR	Insect Farming	33%	56%	89%	2027	
TECHNICAL & DIGITAL	New human-computer interfaces (touch, brain)	6%	50%	89%	2028	-17%

Source: GEF Expert Surveys

SKILLS

AGRICULTURE & ECOLOGY

When will these SKILLS/ROLES have significant impact on sector skills?

Significant = widespread impact, or clearly disrupting sector & transforming roles

Cluster	Skill / Role	% of Respondents saying when it will be Significant: Now	2025+	2030+	= average year	vs all-sector average year (above +/-5%)
SOCIO-ECONOMIC & CULTURAL	Collaboration (on & offline)	88%	100%	100%	2021	
TECHNICAL & DIGITAL	Cybersecurity	81%	100%	100%	2021	5%
SOCIO-ECONOMIC & CULTURAL	Farm/food partnership specialists	75%	100%	100%	2022	12%
GREEN & WELL-BEING	Regenerative & sustainable skills e.g. landscape design	69%	100%	100%	2022	12%
COGNITIVE FOUNDATIONAL	Learning how to learn & unlearn (intellectual humility)	63%	100%	100%	2022	
COGNITIVE FOUNDATIONAL	Ethical decisions & practices, Critical Thinking, understanding biases	71%	94%	100%	2022	
SOCIO-ECONOMIC & CULTURAL	Facilitation & Co-creation	88%	94%	100%	2021	
SOCIO-ECONOMIC & CULTURAL	Diversity, equity, cultural awareness & race relations	88%	94%	100%	2021	6%
GREEN & WELL-BEING	Climate crisis mitigation expert	75%	94%	100%	2022	
TECHNICAL & DIGITAL	Training / Programming AI e.g. weather prediction, systems outcomes	63%	94%	100%	2023	6%
GREEN & WELL-BEING	Learning to reconnect with nature	63%	94%	100%	2023	7%
GREEN & WELL-BEING	Carbon sequestration	56%	94%	100%	2023	
TECHNICAL & DIGITAL	Blockchain systems design	44%	94%	100%	2024	8%
GREEN & WELL-BEING	Habitat conservation e.g. Land guardian, biodiversity preservation expert	80%	93%	100%	2022	
GREEN & WELL-BEING	Life-Centered Biosystemic Designer of regenerative farming ecosystems	53%	93%	100%	2023	9%
GREEN & WELL-BEING	Fertiliser and Soil health specialists - circular waste ecology	75%	88%	100%	2022	
GREEN & WELL-BEING	Designers, Catalysts & Community Builders for well-being & compassion	50%	88%	100%	2024	
SOCIO-ECONOMIC & CULTURAL	Human/Soft skills: judgment, creativity, compassion, social & emotional skills	69%	88%	94%	2023	
GREEN & WELL-BEING	Afforestation expert	67%	87%	93%	2023	
TECHNICAL & DIGITAL	Designing / using big data solutions for agriculture	65%	82%	100%	2023	-7%
SECTOR	Seed breeding	59%	82%	100%	2023	
TECHNICAL & DIGITAL	AR / VR / MR experience designer	29%	82%	100%	2025	-5%
COGNITIVE FOUNDATIONAL	Navigate accelerating change across technologies	44%	81%	100%	2024	-7%
GREEN & WELL-BEING	Health & Safety awareness/skills e.g. using AR/VR remote tech	44%	81%	100%	2024	-8%
SOCIO-ECONOMIC & CULTURAL	Cultivators and weavers of learning communities of agroecological practice	31%	81%	100%	2025	
GREEN & WELL-BEING	Tracking & forecasting human & ecological outcomes & Lifecycle assessment	44%	75%	100%	2025	-9%
TECHNICAL & DIGITAL	Agri-Gene scientist	44%	75%	100%	2025	
SOCIO-ECONOMIC & CULTURAL	New communication skills e.g. visual/touch/gesture/thought	38%	75%	100%	2025	-11%
TECHNICAL & DIGITAL	Tech bridge role: building capacity for emerging competencies	31%	75%	94%	2025	-9%
SECTOR	Insect farming	38%	69%	94%	2025	
SOCIO-ECONOMIC & CULTURAL	Advocacy & Community roles to change mindset/habits to sustainable/regen	57%	64%	93%	2025	-7%

Source: GEF Expert Surveys

KEY AREAS

AGRICULTURE & ECOLOGY

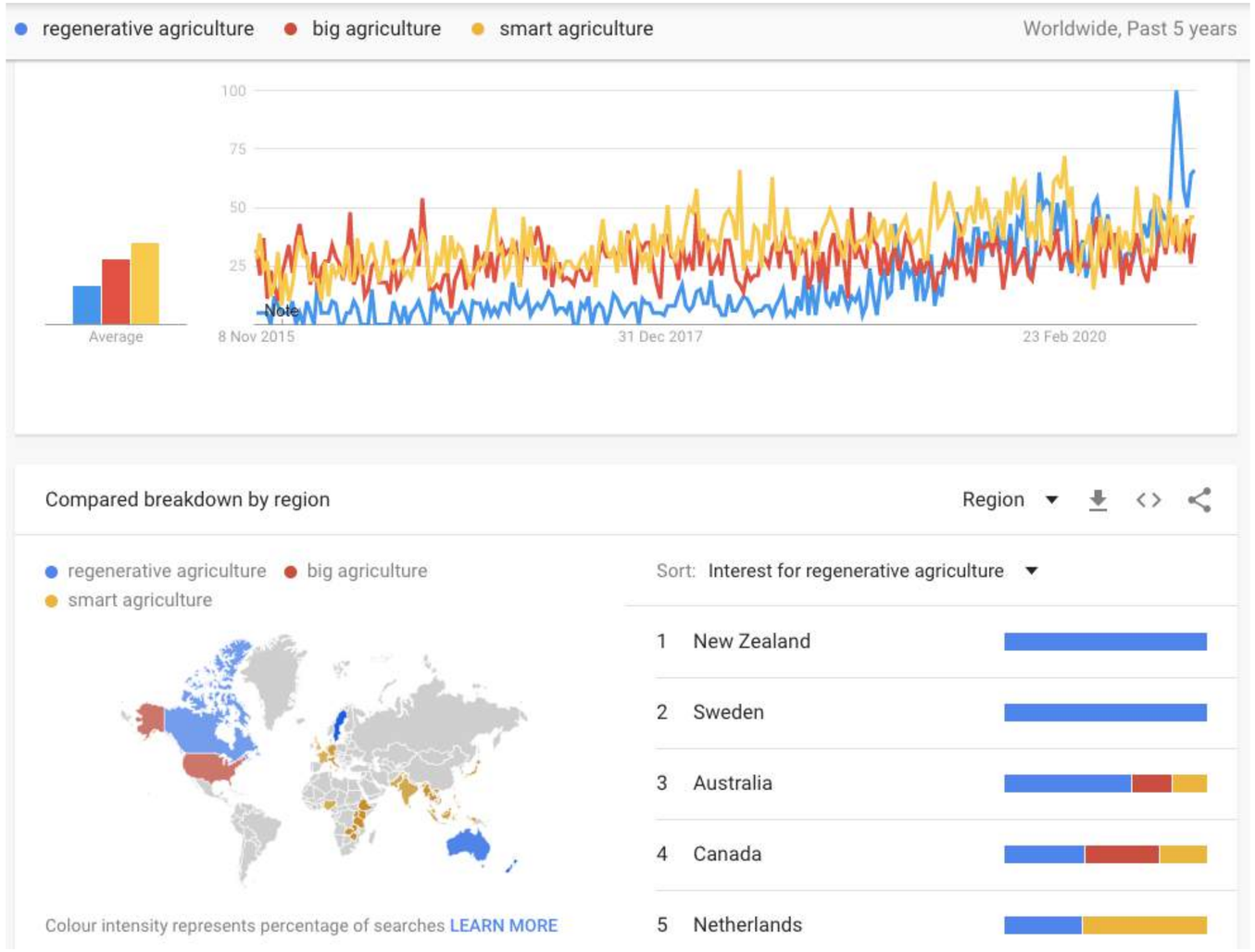
Which areas are most critical to prepare the sector for the next 10 years?

Cluster	Area	% of responses	Rank	vs all-sector average (above +/-5%)
GREEN & WELL-BEING	Environmentally sustainable & regenerative practices	83%	Highest	58%
TECHNICAL & DIGITAL	AI & Big Data analytics	78%	Highest	71%
TECHNICAL & DIGITAL	Robotics & Internet of Things	67%	Highest	59%
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	44%	Highest	-22%
SOCIO-ECONOMIC	General Social & Emotional skills	44%	High	52%
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	39%	High	
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	39%	High	52%
TECHNICAL & DIGITAL	Agile / lean project management	33%	High	16%
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	33%	Medium	
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	33%	Medium	-18%
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	28%	Medium	-29%
GREEN & WELL-BEING	Diversity & multicultural awareness	22%	Medium	-17%
TECHNICAL & DIGITAL	Cybersecurity	17%	Low	-60%
SOCIO-ECONOMIC	Inter-sector communication, Storytelling & Advocacy	11%	Low	-33%
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	11%	Low	-62%
TECHNICAL & DIGITAL	3D manufacturing	6%	Low	-82%

Source: GEF Expert Surveys

COMPARISON

AGRICULTURE & ECOLOGY



Source: *Google Trends*

Which training areas are MOST CRITICAL to prepare the sector for the next 10 years?

Cluster	Skill	Manufacturing & Engineering	Construction & Infrastructure	Transport & Logistics	ICT & Digital	Human & Social Services	Creative Industries	Agri & Ecology	← Cross-sector average	Education & Training
COGNITIVE FOUNDATIONAL	Adaptability, future thinking & navigating change	66%	62%	61%	59%	50%	55%	44%	**57%**	**81%**
GREEN & WELLBEING	Environmentally sustainable & regenerative practices	44%	55%	67%	32%	53%	35%	83%	**53%**	**53%**
TECHNICAL & DIGITAL	AI & Big Data analytics	44%	41%	50%	47%	38%	20%	78%	**45%**	**53%**
TECHNICAL & DIGITAL	Robotics & Internet of Things	59%	24%	50%	44%	24%	25%	67%	**42%**	**48%**
TECHNICAL & DIGITAL	Cybersecurity	41%	41%	61%	62%	47%	20%	17%	**41%**	**43%**
COGNITIVE FOUNDATIONAL	Systems thinking & understanding complexity	31%	31%	50%	44%	38%	55%	33%	**40%**	**57%**
SOCIO-ECONOMIC	Entrepreneurial skills, Customer focus & UX	25%	28%	28%	44%	50%	65%	39%	**40%**	**48%**
COGNITIVE FOUNDATIONAL	Critical & creative thinking, understanding biases	38%	38%	39%	56%	35%	40%	28%	**39%**	**75%**
SOCIO-ECONOMIC	Collaboration & co-creation (on & offline)	53%	41%	28%	38%	26%	25%	33%	**35%**	**74%**
TECHNICAL & DIGITAL	3D manufacturing	47%	52%	22%	24%	18%	45%	6%	**30%**	**35%**
SOCIO-ECONOMIC	General Social & Emotional skills	25%	28%	17%	18%	38%	35%	44%	**29%**	**70%**
TECHNICAL & DIGITAL	Mixed/Augmented/Virtual Reality	34%	38%	28%	15%	38%	40%	11%	**29%**	**39%**
TECHNICAL & DIGITAL	Agile / lean project management	19%	31%	28%	32%	32%	25%	33%	**29%**	**26%**
GREEN & WELLBEING	Diversity & multicultural awareness	25%	31%	22%	15%	32%	40%	22%	**27%**	**32%**
TECHNICAL & DIGITAL	New human-computer interfaces e.g. brain, touch	19%	28%	22%	18%	29%	25%	39%	**26%**	**NA**
SOCIO-ECONOMIC	Inter-sector communication, Storytelling & Advocacy	16%	7%	17%	32%	18%	15%	11%	**16%**	**42%**

Source: GEF Expert Surveys, n=502

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Participant Involvement

Participants	Manufacturing & Engineering	Construction & Infrastructure	Transport & Logistics	ICT & Digital	Human & Social Services	Creative Industries	Agri & Ecology	**7 sectors**	**Education & Training**	**All sectors inc E&T**
Foresight sessions attendees	49	42	35	51	46	40	39	**302**	142 (included in sectors)	**302**
Survey responders	72	55	32	67	70	47	38	**381**	121 (additional to sectors)	**502**
Total years experience in sector	857	753	329	735	837	610	260	**4379**	1641	**6260**

Years experience in sector	% of respondants
0, little knowledge of sector	3%
0, good knowledge of sector	4%
1 - 5	17%
6 - 15	24%
15+	52%

Collective visioning sessions	Dates Sector Expert Sessions	# Sector Expert Sessions	Dates Educational Expert Sessions
Manufacturing and Engineering Technology	Thu, 25 June 2020	2	Mon, 6 July 2020
Information and Communication Technology, Digital	Wed, 1 July 2020	1	Wed, 8 July 2020
Creative Arts, Design and Fashion	Thu, 9 July 2020	1	Wed. 15 July 2020
Social and Personal Services	Thu, 16 July 2020	2	Wed, 22 July 2020
Agriculture and Ecology	Thu, 23 July 2020	2	Wed, 29 July 2020
Transportation and Logistics	Thu, 30 July 2020	1	Wed, 5 August 2020
Construction and Building Technology, Infrastructure	Thu, 6 August 2020	1	Wed, 12 August 2020
Total		10	7

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