Digital Futures

FINAL REPORT

A JOURNEY INTO 2050 VISIONS

AND POLICY CHALLENGES

Foreword

We live in an age characterised by disruptive technological change. I have found it both challenging and engaging over the past few years to help shape the European Commission's response to the changes brought by digital technologies. We see the benefits every day of our lives through digital innovations such as app stores, 3D printing and new forms of social media.

Our enthusiastic adoption of ICT translates into economic growth. According to the World Economic Forum, digitization has boosted global economic output by €142 billion and created 6 million jobs over the past two years. Changes and challenges brought by digital technologies will not stop, but continue. Digital technologies will continue to affect every aspect of our lives as citizens and consumers.

ICT is not the only change agent at work in the world. There are other powerful forces in play that will trigger both massive innovation and pose immense challenges to current social structures and systems. We can shape some of these changes, like developments in life sciences that will extend the span of human life, making centenarians common place. Others such as climate change are harder for us to manage and have potentially much wider repercussions. It is extremely difficult for us to imagine how different changes could interact with each other and what role digital technologies might play in this much wider context in the time period 2030-2050.

The Futurium foresight exercise was launched in autumn 2012 with the twin intentions of priming policy makers' imaginations and prompting wider debate. The aim was precisely to explore potential interactions between different areas of technology, human life and global resources. Foresight has no ambition to predict the future as it will happen, but to explore different futures that might happen. Foresight is excellent therapy for busy policy-makers whose expectations of the future are short term and linear, based on just extending what is happening today.

Foresight techniques have been refined over many years and ensure that the results of any foresight exercise are not mere guess work, but scientifically grounded. This report has scientific rigour; but I also insisted that the Futurium initiative should not be "*just another report by experts from Brussels*". It has two distinguishing features. First most of the underlying visions are crowd-sourced from a much wider range of constituencies than the usual experts. We harvested inputs from a wider range of constituencies beyond the Brussels bubble, for instance students from the Erasmus network. They will after all be building the actual future in the 2030-2050 time horizons. Second, the Futurium exercise contains a philosophical reflection on how our values could be affected by some of these changes and on the choices that will confront us.

Those who read this report will find their minds opening wider to the range of potential outcomes. This is one prediction I am confident will come true.

Neelie Kroes
Vice President of the European Commission

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1 Executive Summary

The world is evolving rapidly and it will change even faster in the future, driven by long-term advances in digital technologies and other key enabling technologies and sciences. Futurologist Ray Kurzweil predicts that by the end of the 21st century we will have experiences the equivalent of 20,000 years of progress at today's rate of change[1].

Indeed, we live in times of "accelerated returns", where the exponential rate of technological progress impacts our societies at a pace that has no precedent in history of mankind. The future may not be a linear extension of what we are doing already. The future may generate many new connections between events and trends that are invisible on our policy radar screens.

European governments need to embrace the opportunities of the digital transformation to provide credible and sustainable responses to systemic issues, such as unemployment or financial stability, and pave the way to a new era of peace and prosperity. They need to re-focus their strategies towards more courageous and future-proof policies, drawing inspiration from long-term visions rather than from the projections of current trends, tapping into Europe's creativity and innovation potential.

Furthermore, the rise of euro-scepticism and the decline of confidence in politics makes it clear that a fundamental shift is required in the way policies are developed: from a centralised approach based on rigid procedures and roles to an open and participatory process harnessing the potential of digital technologies to engage Europeans in the co-creation of policies that matter to them. This would provide more robust ground and legitimacy to public decisions and help improving people's confidence in EU institutions.

To address the above needs and to experiment with forward-looking, participatory and evidence-based policy making practices, the Directorate General for Communications Networks, Content and Technology (DG CONNECT) launched the foresight project **Digital Futures**.

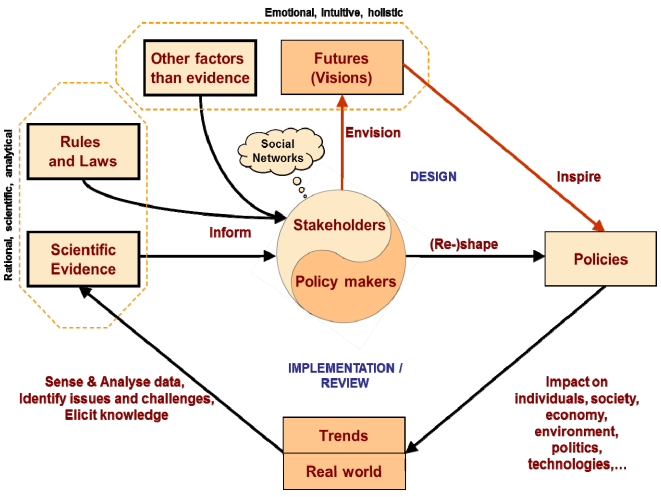
The project's sponsor was Robert Madelin, Director General of DG CONNECT, who had the initial idea to exploit advanced technologies and experiment with future-proof policy making practices.

The project was launched in autumn 2011 and was successfully completed in December 2013. It involved thousands of stakeholders in the co-creation of long term visions to inspire future EU strategic choices, particularly in the context of the renewal of the EU policy framework in 2014.

Exploring future policy making models

The project defined a new policy-making model, **Policy Making 3.0**[2], which allows policies to be co-created by combining altogether the desirable visions of stakeholders with evidence from big data.

The model has been prototyped through the **Futurium** online platform, which combines the informal character of social networks the simplicity of wikis and the methodological approach of foresights.



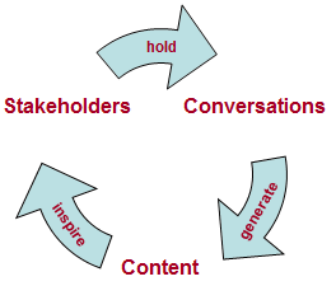
[1] The Law of Accelerating Returns, Ray Kurzweil, March 2001.
[2] The Futurium—a Foresight Platform for Evidence-Based and Participatory Policymaking, Sept. 2013

Futurium is a small concrete attempt to respond to the growing demand for citizen participation in policy making. Its structured approach to content co-creation and synthesis allows streamlining otherwise expensive traditional foresight processes.

The Futurium is an open source project, free for download by any public administration or private organisation. It is work in progress. Everyone can contribute to its further improvement and development or use it to support specific foresight and policy making needs.

Engaging with Futurizens

In order to fuel participation and co-creation, Digital Futures engaged more than 3500 participants in more than 100 participatory brainstorming events. These included more than 30 webinars delivered by prominent keynote speakers and contributed by hundreds of stakeholders from all around the world.



The Futurium community (*futurizens*) consists of more than 1800 members, a good base that could be leveraged by the next European Commission for possible foresight and research programming needs.

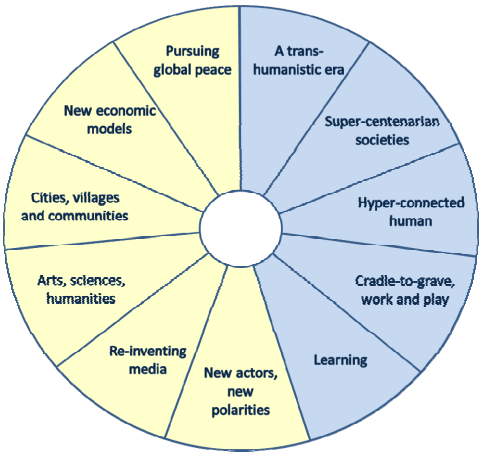
To bootstrap a viral engagement process, the project put in place a strategy where stakeholders hold conversations to generate content that matters to them; in turn, the content inspires the stakeholders to engage continuously with Digital Futures. This aids capture of the emergent collective intelligence.

At any time, both stakeholders and policy makers can symmetrically access data generated through Futurium and draw a snapshot of what the futurizens desire or believe will happen in the future. They can use Futurium to organise conversations and associate content with those conversations. They can relate content and extract all knowledge relevant to a particular topic or stakeholder. This 'viral' process is regularly monitored and actions are implemented to improve hosting and facilitation and support to the futurizen community.

The engagement campaign, "A journey into the 2050's visions and policy challenges", lasted about one year, and produced within the Futurium more than 200 "futures", 35 Interviews with high-standing experts and futurologists, and more than 1800 evidence library entries. The stakeholder engagement strategy included also social media presence on the major networks (Facebook, Twitter and LinkedIn).

Envisaging a better world

The Futurium content was summarised through an expert-driven, "sense-making" process, which consolidated the emergent crowd-sourced content, resulting into **eleven themes**. These themes were grouped into two dimensions:



- *People* (“The singularity is approaching!”)
- *Systems* (“The matrix is no longer fiction!”).

People: **The singularity is approaching!** In 2050, our cognitive and physical capabilities will be enhanced with bio-technological add-ons. Cyborgs will perform complex tasks like humans – they take over routine jobs, from agriculture to construction, from office to industrial automation. We will live longer and healthier because we apply pre-birth prevention, regenerate and repair organs as needed. We will be able to learn, work and play all life-long.

The "People" dimension included five themes:

1. *A Trans-humanistic Era:* By 2050, a new form of human - a trans-human - will emerge, where ICTs and bio-medicine will fundamentally improve the human condition and greatly enhance human intellectual, physical, and psychological capacities. Human beings' cognitive and intellectual abilities will be augmented through technological implants, such as memory and energy storage.
2. *Super-centenarian Societies:* In 2050, people will live longer and healthier lives. Organs will be regenerated in-vitro and implanted with 100% success rate, or grown in-situ using unlimited stem cells. Nano-robots and bio-computers will be commonly used for diagnosis and treatment, extending both lifespan and years of vitality.
3. *Hyper-connected Human:* The Internet will continue its expansion as global connector, pushed by advances in the underlying technologies - photonic networks, quantum, organic computing - and by the need to support ever more sophisticated application scenarios bridging the physical and virtual worlds instantaneously and exchanging zillions of bytes of data every month.
4. *Cradle-to-grave, Work and Play:* Technology will continue to transform the nature of work and the dynamics of organisations and labour markets. People will be able to change jobs according to personal needs and aspirations throughout their life. The steady, permanent job will become a relic of the 20th century. Citizens instead will do what they like, irrespective of their age.
5. *Learning:* Boundaries will increasingly blur across different levels and directions of education, with greater flexibility in designing individualised lifelong educational pathways. Technology will support new forms of learning, e.g. digitally enhanced classrooms, virtual educational spaces, and personalised, interactive, intelligent, wearable teaching systems.

Systems: **The matrix is no longer fiction!** In 2050 the internet will connect bits and atoms at the speed of light. Its algorithms will orchestrate zillions of smart objects, which will share zettabytes of data every day, thus bridging the physical and virtual worlds instantaneously. In such a scenario, prediction and decision will be easier and faster than ever, based on scientific evidence and people aspirations. For instance we will be able to agree where to build a school or to place a stoplight (if such objects still exist in 2050), based on the outcomes of virtual experiments and simulations.

The "Systems" dimension included six themes:

6. *New Actors, New Polarities:* In the coming 20-30 years, people will be more empowered than ever to share knowledge, take informed and responsible decisions and become active players in the global scene. Communities of empowered individuals will likely challenge the roles of the representative decision makers.
7. *Reinventing Media:* Social media will replace traditional editorial media as the dominant media arena. Editorial media will continue to exist, but only as part of the social media conversation. Increasing defiance of copyright, driven by the sharing culture, cannot be overlooked by 2020. Should policy makers sustain traditional culture policies or reboot them from new requirements?
8. *Arts, Sciences, Humanities:* The challenges facing humanity are increasingly global and highly interconnected. Creativity will be the key to harnessing the new possibilities offered by science and technology, and the hyper-connected environments that will surround us. Art, science and humanities will connect to boost this wave of change and creativity in Europe.
9. *Cities, Villages, Communities:* Cities will grow into megacities, with sustainable transport, new buildings made from innovative materials and connectivity to a higher supra-network, the future Internet, on which a new service economy will thrive. Villages will link into the same web of connectivity and develop specific offerings for work, living, socialising or leisure.
10. *New Economic Models:* Technological and societal innovations may change the world's economy significantly. Advanced manufacturing will bring most production back to a local sustainable dimension. 3D printers will make possible the self-production of many consumer items, with only large items produced in a few centralised plants, blurring the roles of consumers and producers.

11. *Pursuing Global Peace:* In the coming 30-40 years, societies will be characterised by tension between individual and collective interests, and two opposing models: 1) a society where only a few decide for all; and 2) a society with neither classes nor hierarchies, characterised by participatory leadership and new forms of 'chaordic' organisation.

The eleven themes have been produced through a normative foresight process: first, futurizens envisaged desirable and likely futures, then the futures were summarised and "back-casted" to show how they could materialise by unfolding and intertwining multiple trends observable today.

The OnLife initiative

Digital Futures supported also the **OnLife Initiative** to better understand how the increasing pervasiveness of digital technologies transforms people's established reference frameworks and societal concepts, our relationships with ourselves, with others and with the world.

Four transformative drivers were considered as a starting point:

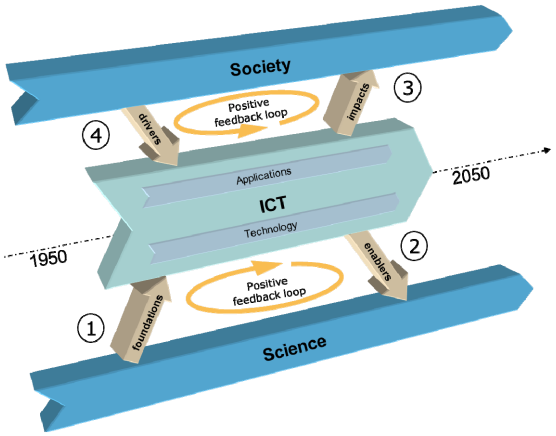
1. the blurring of the distinction between reality and virtuality;
2. the blurring of the distinctions between human, machine and nature;
3. the reversal from information scarcity to information abundance; and
4. the shift from the primacy of entities to the primacy of interactions.

The Onlife Initiative then explored the policy-relevant consequences of the above changes. It inspired a deeper reflection on what happens to us today and on how we could re-envisage the future with greater confidence.

The main output of the OnLife initiative was the **OnLife Manifesto**[3].

Unfolding the digital revolution

Digital Futures devoted particular attention to the future of Information and Communication Technologies (ICT).



From the beginning of the digital age fifty years ago, ICT has been instrumental in radically transforming ourselves and the planet with unprecedented rapidity, scope and levels of disruption. This transformation will continue in the next few decades, fuelled by four influential factors inter-relating technology with scientific and societal progress, as showed in the picture.

(1) We can expect that scientific progress will broaden and advance the scientific foundations of the technology; (2) conversely, increasingly powerful technology will fuel scientific discovery.

(3) Societal challenges such as employment, climate or health will demand new and more powerful technologies and innovations; (4) once adopted, new generation of technology generates impact on the society, thus creating a feedback loop.

1. Scientific foundations

In the coming few decades, long-term technological advances in ICT will be made possible by radically new concepts and scientific foundations:

[3] https://ec.europa.eu/digital-agenda/en/onlife-manifesto

1. **New materials** (e.g. graphene) will unleash new possibilities for the development of new semi-conductors, nano-devices or display technologies. We will be able to exploit the inner properties of matter, at the molecular or atomic level (e.g. spintronics), to build new forms of computing,
2. Progress in **bio-engineering and synthetic biology** will enable to build new forms of biologically-inspired hardware and a 'programmable' bio-chemistry. These in turn may be implanted and used to understand complex biological structures at a molecular scale and also to realise new forms of prevention, diagnosis and medical treatment, but also to perform specific tasks in cleaning the environment or repairing a tissue.
3. The capability to build **quantum processors** and communication devices will allow replacing the current internet backbone with a "quantum internet" capable of transmitting data streams orders of magnitude larger than today's technology. Quantum communication will open new doors for a variety of applications, including 100% secure distributed processing.
4. A better understanding of the **cognitive processes** of the human brain will also trigger significant technological advancements in ICT. For instance, by mimicking the functional sophistication of the brain, future ICTs may advance in terms of energy-efficiency, resilience and robustness, memory and storage, transmission and visualization.
5. New advances in **photonics** will move communications into the terabit era. Photonics will help overcome the limitations of electronics in computers through all-optical computing. Bio-photonics will push advances even further by enabling new and more disruptive applications.
6. New generations of **components and devices** will be integrated into complex cyber-physical systems, making our homes, cars, and our environment smarter. People will be able to programme or customise systems through new interfaces. **Software** will be able to evolve by learning from humans or other software. It will be more trustworthy, resilient and adaptable.
7. Industrial **robots** will continue to revolutionise manufacturing, agriculture, safety or surveillance. Service robots and companions will exhibit sophisticated behaviours to assist humans, particularly elderly people. **Nano-robots** will be able to work together with other nano-robots to deliver new forms of swarm intelligence. Systems as cars or home appliances will be able to interact autonomously and perform tasks they were not designed for.
8. The **Internet** will continue to grow and connect everything, thus blurring the border between the physical and virtual spaces further. New protocols and algorithm will ensure more efficient resource allocation, from spectrum to computing capacity. New forms of distributed computing combining client-server with peer-to-peer approaches will emerge.
9. Our increased capability to sense the real world will produce zettabytes of data per month. This will allow extracting information and knowledge from **big data** and inform decisions at all levels (individuals, communities, states, companies, etc.).
10. New visual interfaces, including 3D virtual models and simulations will allow understand and visualise data more easily than ever. **Multi-sensorial interfaces**, mixed-reality environments, natural language technologies will improve user experiences and interaction considerably.

These developments will pave the way to a post-silicon era characterised by computation and data everywhere and at every scale. They will lead to ICT systems with unprecedented processing and communication power, which in turn will enable new applications in all domains.

We cannot at this stage predict how these technological foundations will evolve and which ones will be more promising– but we can anticipate the range of possibilities to enable more sophisticated application contexts and user experiences, and prepare to take advantage of them.

2. Science enablers

As new generations of ICT become available they will improve the methods of science itself, and scientists will be the first to benefit. Researchers will be able to build more accurate digital ("in silico") models of the world and to perform detailed virtual experiments and simulations of natural phenomena.

They will be able to collaborate from their desks using high-bandwidth-enabled participative processes. Indeed, all citizens will potentially be "scientists" using innovative tools for crowd-sourced research.

Open and participative research practices will bring more and more people into the emerging global knowledge community.

3. Societal impacts

Progress in ICT will continue to drive major social transformations. The complexity of society makes those changes the most difficult to anticipate.

However, it is expected that, beyond the digital society, a new form of humanism (trans-humanism) may emerge, where ICTs and other technologies fundamentally improve the human condition, eliminate aging and enhance human intellectual, physical, and cognitive capacities.

This will open up unprecedented ethical issues, and will require a review of our fundamental values and principles.

4. Societal drivers

Finally, ICT developments will continue to be driven and inspired by social challenges. As new and more ambitious policy targets are set, for instance to further improve quality of life or to face new sustainability challenges, new ICT capabilities are needed to provide more effective responses to the new requirements upstream in the technology supply chain. This will generate new waves of technological and societal innovation.

In summary, ICT can be seen as the technological gateway where advances across science will converge with the requirements posed by an increasingly demanding society. The ICT revolution that has lasted about 70 years will continue for another 20-30 years, pushed by accelerated technological and scientific advances until 2040-50. Then, it will likely become mainstream, as utilities are today for most of us.

How Digital Futures findings have been used

Digital Futures was a unique project with "licence to explore" new foresight approaches, new stakeholder engagement paradigms and new policy making possibilities. As an experiment it was successful as it unveiled new knowledge, methods and lessons learnt. Main impacts:

- The eleven Themes and the OnLife Manifesto provided varied landscapes of futures and potential change impacts to aid issues exploration and policy design. DG CONNECT services used this knowledge as one of the inputs to prepare briefs for the 2015-19's EC College.
- Digital Futures contributed to major foresight exercises carried out at EU level, such as the inter-institutional project ESPAS and the Horizon 2020's strategic programming exercise 2016-18.
- The project successfully integrated participatory brainstorming techniques (e.g. The Art of Participatory Leadership) into a normative foresight process with both virtual and in-person meetings. This approach helped building skills and capacities which has been re-used to support other initiatives within DG CONNECT and the Commission.
- The Futurium platform has been adopted as a corporate platform as part of the EC-wide offering as well as by other institutions such as the Economic and Social Committee. Furthermore, the platform has generated the interest of several academic and industrial actors working on foresight and stakeholder engagement methodologies.

2 Introduction

This section is an introduction to Digital Futures to help reading the rest of this report and its annexes. It includes the foresight methodology, the stakeholder engagement strategy, the project management approach, and a glossary to provide a shared understanding of concepts. Besides explaining the architectural choices underlying the foresight process, it also shows how the content was co-created and how it could be used to inform future policy choices.

Scoping a unique foresight process

Since its inception in spring 2011, Digital Futures is defined as "a participative foresight project aiming to devise 2050's visions and policy options underpinned by the long term advances of Information and Communication Technology (ICT) and other enabling technologies and sciences".

As per any foresight project, the purpose is neither about predicting the future nor about pre-empting future decisions. It is rather on reflecting about possible futures and generating ideas that could inspire future strategic choices related to ICT, at European, national and regional levels.

Cross-disciplinary scope

Digital Futures' centre of gravity is on Information and Communication Technologies (ICT). However, the scope includes also long term developments at the intersection between ICT and society, economy, environment, politics and other key enabling technologies and sciences.

The project does not address too narrow aspects that, although important, are disconnected from or marginally related to ICT.

In the context of the foresight exercise, non-technological issues are therefore equally important as technological ones. This requirement was set to re-balance the technology-driven focus of DG CONNECT and facilitate synergy with other policies.

Time horizon

The selection of the time horizon is an essential step in any foresight exercise. Initially, a lively debate took place as to whether to consider 2030 or 2050. The was a shared view, however, that the interest of policy makers does not necessarily depend on the time horizon set but rather on the impacts the ideas generated by a foresight project would have on policies.

Thinking too long-term may generate doubts especially in a period where policy makers are mostly concerned to address critical short-term issues. However, long term approaches stimulate creativity and new ideas, especially in times when new and courageous policies are sought to find sustainable solutions to long-lasting socio-economic issues.

Ultimately, a time horizon 2050 was chosen because:

1) A long-term approach would help disconnect participants' mind-set from the biases of today's trends and stimulate novel ideas;
2) DG CONNECT has a tradition in supporting visionary ICT research with expected impacts beyond 2030, for instance under Future and Emerging Technology. A longer time horizon was therefore not un-realistic and would complement the path-finding role of FET.
3) A long-term horizon would complement also other foresight exercises being supported within other European Commission departments and at an inter-institutional level, which target usually time horizons 10-20 years ahead.
4) A long term approach would facilitate crowd-sourcing of visions and policy ideas that are easy to understand compared to too technical trend analyses.

Crowd-sourcing and citizen engagement

A key distinctive feature of Digital Futures is also the massive and viral involvement of stakeholders throughout the project. Participatory techniques and tools are used to establish a continuous bridge within and between Commission's internal staff and external stakeholders with a view to gather informed opinions, improve and validate knowledge generated by the project, and ultimately build openness, transparency and legitimacy of the foresight processes.

Foresight projects within the European Commission (and in most governmental bodies) seldom involve citizens from the beginning. Normally, they rely on inputs by experts and policy makers. In some cases, surveys are used to get people's feedback on expert reports, green papers, etc., but only a posteriori.

Digital Futures was one of the first experiments adopting a massive bottom-up, participatory process. The outcome was encouraging and provided useful hints on how to open-up foresights to everyone. Indeed, crowdsourcing the co-creation of ideas requires a tailored methodological approach in the way knowledge is structured, developed and used.

Agile management approach with experimentation at the core

All foresight projects are unique because their objectives and work plans are designed to respond to specific requirements, generally fixed by the project's sponsors from the outset.

Usually, well defined and stable requirements provide a solid ground which enables foresight designers to choose the most appropriate approach from a set of methodologies and techniques[4].

Within Digital Futures, many aspects were unknown from the outset or were deliberately left open throughout the project lifetime because of a number of uncertainties, for instance:

- The uncertainty of political context which characterises the renewal of the European Parliament and the Commission
- The degree of detail expected from the foresight process (e.g. focus on visions and/or policy ideas), depending on the evolution of the policy context
- The uncertainty of the crowd sourcing process due to the complexity of social network dynamics
- The availability of IT infrastructure and tools to enable the engagement and co-creation process
- The availability of resources and the staff turnover throughout the project duration
- The balance between scientific evidence driven by expert inputs and desk research vs. participation fuelled through brainstorming events and social network campaigns

The above uncertainties make Digital Futures somehow a "sui-generis" foresight project. Rather than fixing processes from the outsets we decided to go for an agile method to be able to adapt to new requirements as they emerge.

The project was launched with an exploratory mind-set at the core, i.e. the project sponsor gave a group of officers with complementary backgrounds the licence to experiment. A "no regret" philosophy ensured that we would gain tangible benefits even in the event of failure, as we were trying something new and we had to learn lessons to be shared broadly anyhow.

This said, the simple structure given to the project and the agile project management approach ensured a good level of resilience and risk-tolerance, and allowed to deliver high quality inputs to the preparation of future policies in the context of the renewal of the EU policy framework in spring 2014.

Stakeholder engagement

Digital Futures' strategy to engage stakeholders aimed at fuelling a viral process to enable grassroots generation of content. The idea was to pursue a balanced approach combining the simplicity of

[4] United Nations Industrial Development Organization (UNIDO), Technology Foresight Manual, Vol. 1.

popular social networks (which usually do not impose structure onto the content) and lengthy surveys typically used by policy makers to get stakeholder's feedback (which usually discourage broad participation). The approach can be articulated along two iterative steps:

1. **Host and facilitate a continuous dialogue between stakeholders and policy makers**

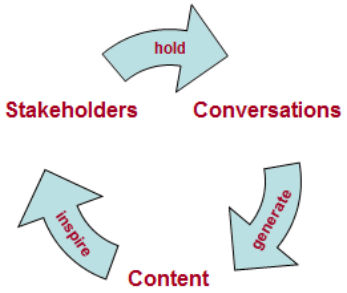
   - Stakeholders and policy makers host conversations using brainstorming techniques such as the "Art of Participatory Leadership" (AoPL).
   - Conversations bring together anyone who is interested in contributing: scientists, citizens, and policy makers.
   - Conversation can take place online, e.g. through webinars, forums, and chats, or in-person.
   - Anyone can host a Digital Futures conversation, for instance in the context of conferences, in local and national events, in schools or at the European Commission premises.
   - A viral process is put in place whereby everyone can invite friends and colleagues to be engaged in Digital Futures.

2. **Use an open platform (Futurium) to capture the content generated during the conversations in a structured, yet understandable way**

   - Based on a foresight model (futures and policies) and simple rules of contribution and participation.
   - Enables co-creation (similar to a wiki) of visions and policy ideas, their voting, and commentary and discussion.
   - Offers access to anonymous data mining and fact-finding tools to all participants.

To maximise openness and engagement, both stakeholders and policy makers can symmetrically access data generated through Futurium and draw a snapshot of what participants' desire or believe will happen in the future. They can use Futurium to organise conversations and associate content with those conversations. They can also link content and extract all knowledge relevant to a particular topic or stakeholder.

In short: stakeholders hold conversations to generate content that matters to them; the content will in turn inspire the stakeholders to engage continuously with Digital Futures. This aids capturing the emergent collective intelligence needed to inform policy decisions. This 'viral' process is regularly monitored and actions are taken to improve community management and facilitation.



Policy Making 3.0

Digital Futures prototyped a new policy making model, Policy Making 3.0, based on the metaphor of a 'collective brain,' or emerging collective intelligence. Stakeholders and policymakers form a social network to co-design policies on the basis of two distinct factors:

- *The scientific evidence stemming from the collective wisdom of stakeholders and policymakers.* This is the collective and rational contribution of the participants to the policy or the 'left hemisphere' of the social network's brain. Evidence is often elicited from data from and numerical models of the real world, e.g., statistics, data mining etc.
- *The visions resulting from the collective aspirations of stakeholders and policy makers, which are measurable through the social network.* This can be considered as the 'emotional and imaginative' contribution of the participants to the policy, or the 'right hemisphere' of the social network's brain.

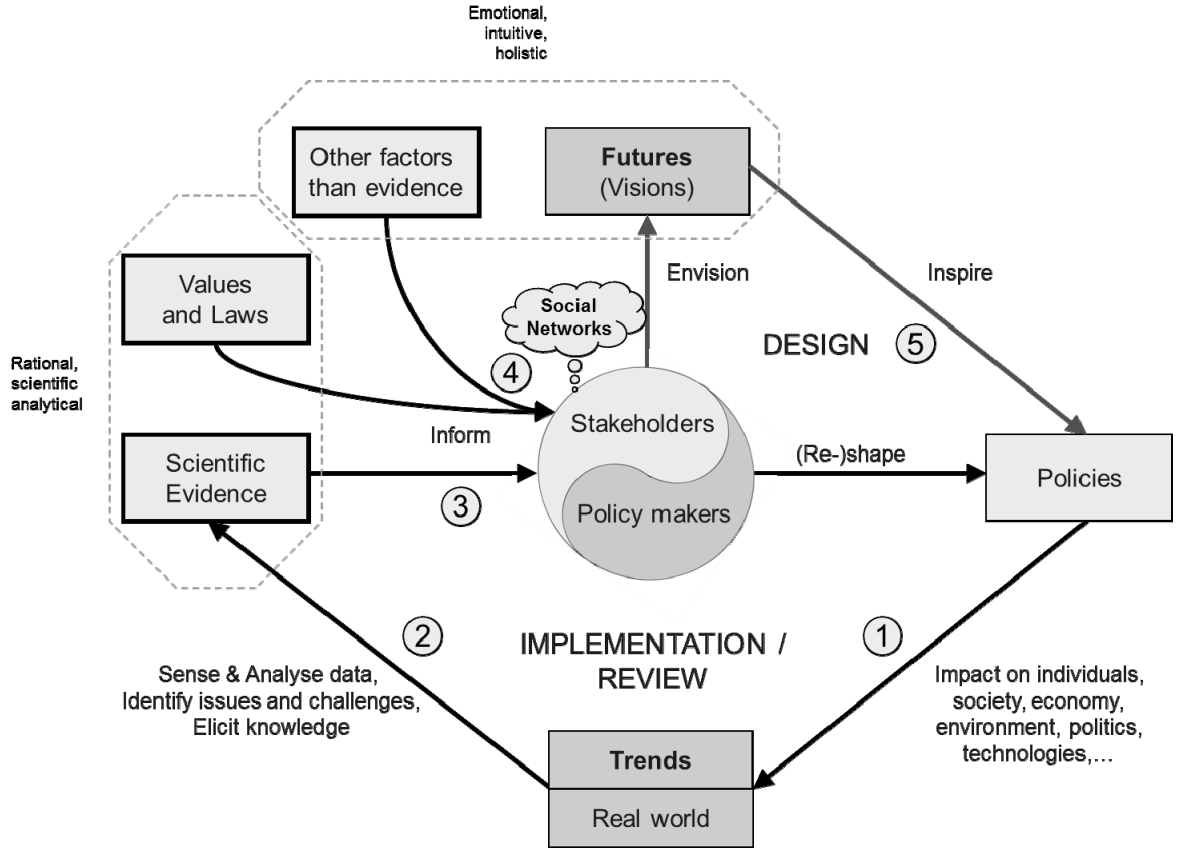


Figure 1. A visual representation of the Policy Making 3.0 model, highlighting the rational and emotional components as well as the evidence stemming from the observation of the real world

Figure 1, above, captures the essential elements of the Policy Making 3.0 model:

1. The implementation of policies co-developed by policymakers and stakeholders has an impact on the real world (individuals, society, economy, environment etc.).
2. The real world is monitored and data are gathered, measured and analysed through knowledge mining and statistical tools, which makes it possible to identify trends, issues and challenges and to elicit scientific evidence.
3. The scientific evidence provides information that stakeholders and policymakers can use to reshape policies.
4. Stakeholders and policymakers interact in social networks where factors other than evidence emerge, such as personal opinions, corporate interests, lobbying, ideological values and other 'non- measurable' factors (i.e. that cannot be easily sensed and automatically captured). Such factors often prevail over the scientific evidence. There are also boundary constraints that come in the form of values and laws (e.g. constitutional rules).
5. Policies may also be inspired by desirable visions and aspirations that are not necessarily in line with current, short-term trends. These can be considered part of the 'emotional' and intuitive factors that influence decisions.

A simple data model to enable co-creation

In order to allow policymakers and stakeholders to work together and co-create in social networks, a common vocabulary of shared concepts was created:

- **Vision**[5]: A vision is a snapshot of the future – what the world might look like at any given point in the future. It can provoke emotions and be a source of inspiration.
- **Trend**: A trend is a complex change phenomenon (or set of phenomena) observable today that is continuing to unfold into the future, and either directly or indirectly generating other trends affecting the future.
- **Future**: Within Digital Futures, a future may be either a vision or a long-lasting trend, i.e. a trend that will still be active in the future. A future, be it a trend or a vision, may have **challenges** and **opportunities** associated with it. It has also a concept of **desirability** (how much an individual *wants* a future to become reality: it reflects a person's emotional response or gut reaction) and **likelihood** (how *probable* an individual *estimates* a future to be, i.e. the extent to which it will materialise (or continue if it is already an established trend) irrespective of the timeframe: it reflects the person's rational view).
- **Library entries**: A bibliographic reference to a source used to provide evidence for futures.
- **Events**: Workshops bringing together stakeholders to discuss futures and their challenges and opportunities and policy implications. They are run with participatory brainstorming techniques such as those drawn from the Art of Participatory Leadership (AOPL)[6] and may be face-to-face or online.

The original model to engage stakeholders consists of three layers (see Figure 2, next page):

1. Stakeholders co-create futures (visions or long lasting trends). They can vote on them according to their desirability (emotional reaction) and likelihood (rational reaction). Stakeholders can also relate futures to each other. In particular, they can analyse the causality links between them (for instance, how to get to a future 'a world without unemployment'), or see a future as the extrapolation (unfolding) of current trends.
2. Stakeholders co-create policy ideas to underpin the futures. They can vote policy ideas according to the perceived impact and the actual support. Policies are expressed as Specific, Measurable, Actionable, Relevant and Timely actions. Policies can be packaged into groups or pillars. Policies are analysed with techniques such as What-If analysis or SWOT analysis to better inform their assessment and actual voting.
3. Stakeholders engage in large-scale online role-playing games to simulate the possible behavioural responses of key actors (or agents) affected by the policies (for instance the commission, member states, or particular stakeholders). This simulation would assist in anticipating the complex flows of actions and reactions that would occur should the policies be implemented. This form of 'reality check' will in turn inform possible refinements and improvements of the vision and the policy ideas.

Please note that the projects and activities addressed only layer 1, the co-creation of futures by stakeholders and futurizens. The policy layer was only partly addressed: everyone was able to post a policy idea; however, we did not take this input into account in order not to interfere with ongoing policies. The third layer (agency) is part of the theoretical model but was not addressed to keep the engagement model simple. Bit all layers are expected to be used synergistically in possible future developments and usages of the Futurium. Finally, evidence was dealt with in a simple way by putting all information on the Futurium Library. This is a simplification as compared to the above Futurium

[5] Please note that the futures research literature usually defines 'vision' as a preferred image of the future, i.e., normative and aspirational, as differentiated from a scenario, or exploratory image of the future created as a thought experiment. This loose definition falls between those more technical usages.

[6] Art of Hosting: Art of Participatory Leadership – EU Institutions at http://artofhosting.ning.com/group/art-of-participatory-leadership-eur-commission.

model where it is assumed that evidence comes from a direct and continuous observation of the real world. This is of course part of future extensions of the platform.

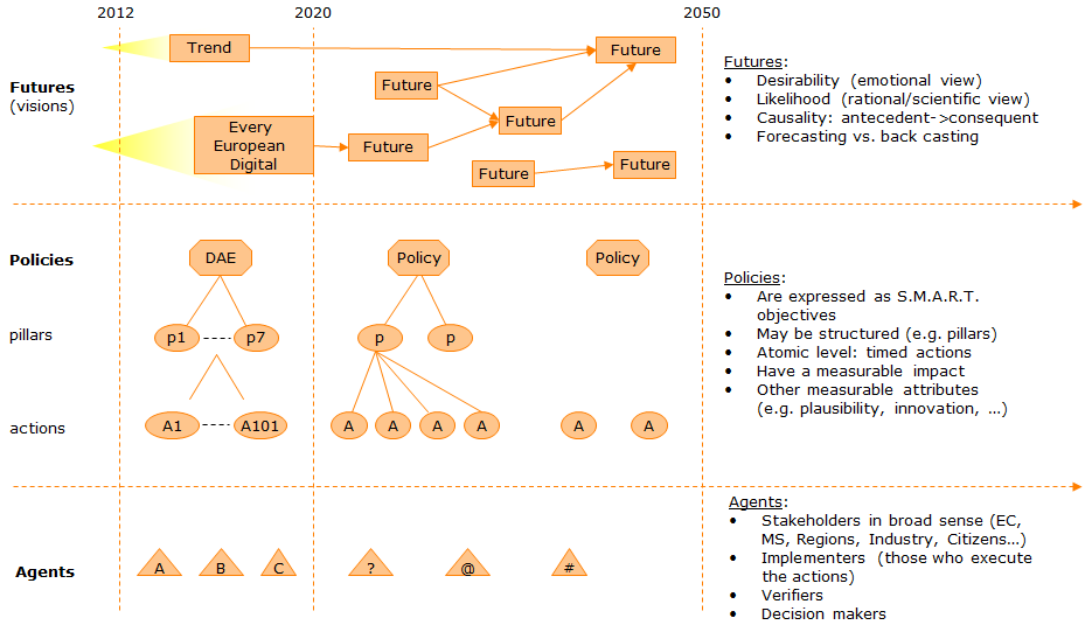


Figure 2. Futurium Data Model

The Futurium ecosystem

Futurium is the online platform implementing the co-creation model described above. It combines the informal character of social networks with the methodological approach of foresight to engage stakeholders in co-creating futures and policy ideas that matter to them.
As a social network, its use is regulated in a way that only pertinent and inoffensive information is published. People, however, have ample freedom to post any content by choosing a suitable content type as described above (visions, policy ideas, etc.).
Similarly to other social networks, the members of the Futurium - futurizens - may take specific roles in the management of the co-creation process.

1. As creative and visionary thinkers

The users who want to write a piece of narrative or essay on Futurium. They may also want to contribute to existing futures just like in a wiki. Contributions will be immediately recognised by Futurium. A versioning system will ensure traceability of contributions with possibility to revert old contributions into new ones.

Users may also want to write an idea for future policies. The policy idea can then be referenced from within one or more futures.

2. As content curators

Each future, be it a vision or a long-lasting trend, has to fulfil minimum quality standards in terms of messages and linguistic style.

Futurium is meant to host intriguing and visionary content that can help inform policy reflections. It does not matter how far forward in time the future is, it has to be inspirational.

Users who want to be a curator for one of the futures have just to make a request. The Futurium will then try to accommodate their request.

Being a curator on the Futurium implies a number of tasks:

- Ensure that content is in the right form and language, simple, concise, clear, understandable by all.
- Raise the right questions and teasers to provoke constructive reaction.
- Value contributions by reinforcing their messages, linking their messages with others, sharing updates, etc.
- Enrich content with evidence, (references to scientific articles, other foresight reports, possibly links EC funded projects and activities).
- Periodically review the keywords to ensure completeness and consistency
- Connecting futures with other relevant futures
- Subscribe to be notified of changes to the future you are curating

3. As online message multipliers:

Futurizens can also decide to be movers to help Futurium becoming known.

- Act as Futurium evangelists and facilitate the contribution of visionary thinkers.
- Engage stakeholders and invite them to become curators and multipliers.
- Value contributions by reinforcing their messages, linking their messages with others, sharing updates, etc.

4. As hosts of Futurium conversations

An online engagement process can be dramatically accelerated by in-person conversations.

Users can hold a brainstorming meeting and invite whomever they want to debate about futures. They need to be open, participatory, and reflexive. The Futurium will try to help in:

- Shaping the participatory brainstorming process
- Harvesting knowledge
- Hosting the synthesis on Futurium for further co-creation

Everyone can post a conversation or event provided that the event produces new futures or policy ideas

5. As testers to help us further improve Futurium:

Futurium is only in its infancy. Implementing the Policy Making 3.0 model may take years or decades. Futurium is just a prototype and requires continuous feedback and hints to better fit its purpose. Feedback may be in term of functionality enhancement, bug reporting, or user experience.

Foresight approach

The choice of the time horizon had an impact on the outputs, which are mostly desirable futures based on people's aspirations rather than on scientific evidence about their likelihood to happen or their plausibility. Some of them are utopian other more dystopian. However, they are all taken as inputs reflecting a shared aspiration.

The foresight approach was determined mostly by:

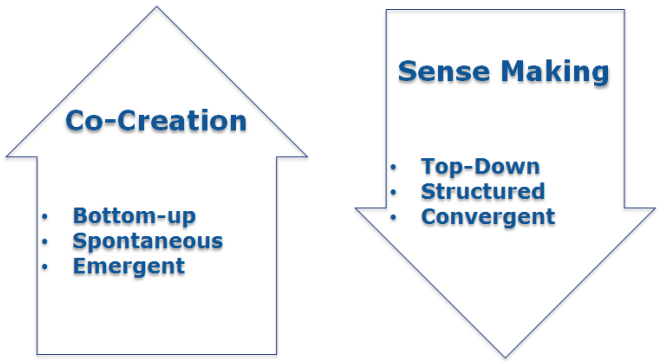
i) The time horizon. A long term future is envisaged and "back casted" into today's trends rather than forecasted from today's trends. On the other hand, because of the long term scope of ICT research, it was also useful to combine the normative approach with an incremental one (unfolding today's trends into futures). This process was supported by evidence

ii) The need to engage any potential contributor. This requirement can be met more easily if the participants are inquired about how they envisage the future (ideally) and then asking to co-create a narrative, rather than asking to perform complex studies on trend analysis based on analytical/numerical models.

Therefore, the Futurium foresight process was conceptually divided into two main steps:

1. ***Co-creation***: bottom-up and participatory generation of futures and hosting them on the futurium platform.

2. ***Sense Making***: top-down consolidation and synthesis of the futurium content and elicitation of policy options.



However, like most social networks, the Futurium co-creation is intended to be an open-ended process fuelled by the spontaneous interest of participants. The Futurium content can be analysed for foresight or policy making purposes at any time and by anyone.

The sense-making process started in April 2013 and ended in Spring 2014. The sense making was conducted mostly internally as part of the policy reflections to prepare for the next EC College.

The Futurium co-creation (engagement) process has been described above.

The focus of this section is on "sense making", which consists of four steps: 1) gap analysis and consolidation; 2) synthesis of futures into Themes; 3) Themes prioritisation survey; 4) back-casting; and 5) scenario planning.

1. Gap analysis and consolidation

Goal: ensuring overall coverage of topics (e.g. w.r.t. H2020) and robustness of individual futures (in terms of depth of narrative, challenges and opportunities, evidence).

Process: The entire Futurium content was reviewed and existing entries have been mapped onto radar diagrams. The radar diagrams provide a visual check of how comprehensive topic coverage is by analysing the spread of content across both the 6 hexagon headings and the available time horizons to 2050. Related topic entries were clustered, and missing topics, based on Horizon 2020 priority topics, were added. All entries were then augmented with extended descriptions, additional bibliographic references, links to Library entries, events, and related futures, and a list of challenges and opportunities and questions for thought.

Output: 87 consolidated futures, clustered in 6 headings of the "Futurium hexagon" (see below) and sub headings covering most of the topics in H2020 and Europe 2020 (6 radar diagrams).

2. Synthesis of futures into Themes

Goal: Cluster and merge the aspirational futures (visions) together into Themes to achieve meaningful integration of narratives.

Process: All futures were reviewer, consolidated and enriched with missing information (for instance not all the futures had challenges and/or opportunities duly compiled). This ensured appropriate quality and harmonisation of the futures. Furthermore, a brief Verge analysis suggesting transformation points that might arise in each theme was performed.

Output: 11 Themes, each associated with a number of Key Issues. Themes are grouped into two perspectives: 1) The perspective of the individual as a human, long-life worker and learner, in an increasingly hyper-connected society. 2) The system perspective, embracing the complexity of the future multi-polar world with increasingly shared rules, values, knowledge, cultures and goods.

3. Themes prioritisation survey

Goal: consolidate and prioritise themes based on relevance (impact), probability and timing.

Process: Run a survey to assess the impact (relevance), probability and timing of the themes against 2-3 selected scenario forecasts extracted from 3rd party reports.

Theme	**Impact (0-100)**	**Probability (0-100)**	**Timing** (2015/2020/2050)
People			
1. A trans-humanistic era			
2. Super-centenarian societies			
3. Hyper-connected human			
4. Cradle-to-grave, work and play			
5. Learning			
Systems			
6. New actors and poles			
7. Re-inventing Media			
8. Art, sciences, humanities			
9. Cities, villages, communities			
10. New Economic Models			
11. Pursuing Global Peace			

Input: 11 Themes

Output: prioritised list of the 11 Themes.

4. Backcasting

Goal: starting from the outcomes described by the 11 Themes, work backwards to see how those future environments might evolve from the 87 consolidated futures.

Process: The 11 Themes were 'backcasted' by compiling each theme's contributing futures, and arranging them in a logical progression that negotiated their evaluated time horizon (when they would mature as a widespread condition) and their interconnections with other futures as stepping stones to the outcomes depicted in the Theme.

Output: back casting diagrams showing how the outcomes described in the Themes evolve out of the interaction between the various changes described in the 87 consolidated futures.

5. Scenario planning

This set of foresight activities started from the critical issues raised within the Themes and identified influencing factors and critical uncertainties. The influencing factors and uncertainties were explored by creating scenarios that illustrated how the uncertainties might play out for each issue. The scenarios helped suggesting policy options for the key issues or ideas for future research and innovation actions under Horizon 2020.

A. Draft scenarios for selected key issues

Goal: identify influencing factors (or drivers) for each Key Issue identified from the Themes.

Example:

- Key Issue = "How can the EU ensure that future hyper-connectivity is available to every EU citizen?"
- Influencing factors = "network connectivity," "skills"

Process: Run workshops to:

- Assess level of uncertainty of the influencing factors, eventually looking at the contingencies and assumptions based on trends and projections (e.g. through a Delphi survey)
- Assess relevance and plausibility (barriers, enablers, costs…)
- Prioritise influencing factors (e.g. most relevant and plausible)
- Build 2-3 alternative scenarios per Key Issue by making assumptions on influencing factors (i.e. instantiating uncertainty variables)

B. Generate policy options

Goal: Generate policy options for each of the scenarios associated to the Key Issues.

Process: Run workshops to:

- Use a participatory technique ("pop-corn") to generate policy options by foresight experts;
- Assess impact and plausibility of these options (engage remixed pools of experts);
- Prioritise policy options

The scenario building was done through the support of external service providers in the context of the preparatory process for Horizon 2020 research themes.

Content quality and curation

Extending and consolidating crowd-sourced futurium entries

In opening Futurium to broad public participation, Digital Futures created an experiment in crowdsourcing policy foresight. People throughout Europe (and, indeed, the world) were invited and encouraged to contribute their ideas and concerns regarding emerging change and evolving futures that the European Union might face. Results range widely across both topics and possible time horizons: everything from the future of villages to trans-humanism to ethics and philosophy, affecting society by anytime between 2015 and 2050, and beyond. In some cases, working groups had compiled extensive and well-documented statements. More often participants entered their ideas and concerns in brief paragraphs. In order to create a robust substantive foundation for sense-making and eventual policy explorations, 87 entries were chosen for consolidation based on their relevance to Horizon 2020.

Each entry of the 87 was edited and augmented with the goal of producing comparable levels of documentation, citation, and annotation across all 87. For the majority this meant:

- expanding the description from one paragraph to 2-5 pages;

- creating a keywords list;
- specifying a time horizon / timeframe;
- crafting a series of thought questions to encourage continued discussion on Futurium;
- presenting a range of challenges and opportunities potential in that future;
- linking to Library Evidence;
- adding additional bibliographic citations and references; and
- linking the specific future to other related futures on Futurium.

The following improvements have also been made in several iterations:

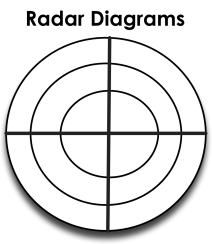
- Harmonisation of description. Check completeness of all fields foreseen in the content types.
- Analysis of the futures and merging/splitting to minimize redundancies, completeness and consistency.
- Removal of 'command and control' and technocratic jargon usually understood only by technocrats.
- Synthesis of futures into themes
- Merging of 'Challenges' and 'Opportunities' (C&O) into one single heading (Key Issues), re-phrased as questions, and sorted into Futurium categories, for the following reasons:
    - C&O are often blurred. A challenge can also be an opportunity and vice-versa.
    - C&O often use Command and Control jargon: "facing," "mastering," etc.
    - Questions can assist in identifying critical uncertainties or assumptions.

This essentially expanded the content, from approximately 100 pages of material to over 500 pages. Bibliographic citations were improved from one or two per future to 7-15 citations per future, in addition to the links to the annotated Futurium Library entries. Mapping interconnections among futures was considerably extended, from 1-2 links to 4-6 in most cases. The complete version of the 87 entries is available as the Annex to this report.

Sense-making: radar diagrams, backcasts, verge, three horizons

The crowd-sourcing of ideas is a process of divergence: generating many disparate ideas scattered across topics of interest. In order to be useful for policy generation, those ideas must converge into organised patterns. Digital Futures applied four futures approaches to organise, deepen, and summarise the possibilities for transformative change emerging from Futurium entries.

Radar diagrams: The research team began by reviewing the existing futures entries on the Futurium platform. Radar diagrams were created for each heading in the Futurium hexagon, with subheadings to enable a more detailed sort of the futures:



- *Science and Technology:*
    - Biotech & Medicine
    - Nanotech
    - Space
    - Manufacturing
    - Materials
    - ICT
- *Economy*:
    - Taxation, Funding & Finance
    - Jobs & Skills
    - New Economic Models

    - New Business Models & Approaches
- *Society*:
    - Culture
    - Values
    - Lifestyles
    - Health & Well-being
- *Personal Life:*
    - Work
    - Leisure
    - Being
    - Relationships
- *Governance:*
    - International Relations
    - Laws & Regulations
    - Civil Engagement
    - Policies
- *Environment and Sustainability:*
    - Transport & Mobility
    - Resources
    - Climate
    - Energy

In order to identify content gaps, the team then mapped Futurium content coverage against these topic themes and time horizons. With the topics as wedges of the circular 'radar,' time horizons were portrayed as concentric circles. The centre represents the present, and successive outward rings indicate each fifteen years from now to 2050. The target thus sorts the futures entries by the near future, the mid future, and the far future. This created a visible check whether Futurium crowdsourcing had produced a comprehensive exploration of evolving trends and futures across a wide time horizon.

Generally when people new to futures work start identifying what is changing around them and what it implies, they think in the near term, and so the researchers expected the Futurium futures to load primarily into the nearer time horizons. The participants surprisingly had explored very far afield and into the distant future, with a balanced spread of futures across all time horizons. Unsurprisingly, the coverage across topics was much less even.

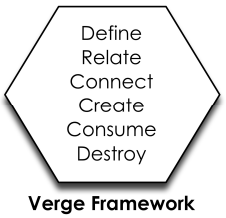
- *Science & Technology:*
    - Very few trends or futures focused on new materials research (especially re bio-mimicry)
    - Very few trends listed regarding the emerging biological age and biosciences breakthroughs
    - Very few trends or futures regarding social and commercial research and applications, e.g. nothing on crowd-sourced or crowd-funded science
    - Very few trends or futures regarding the future of research and innovation itself
- *Economy:*
    - No review of the evolving shadow economy
    - Few trends or futures about taxation, funding, and finance, e.g. nothing on crowd-financing or distributing financing, Islamic economics, micro-financing
- *Society:*
    - Strong focus on ageing; few trends or futures on other demographic shifts in mobility, culture, intergenerational analysis, etc.
    - Few trends or futures on shifts in lifestyle patterns in relation to mature digital age or increased urbanization

- *Personal Life:*
    - Good coverage in long-term futures for the subtopics of *Work*, *Relationships*, and *Being*, but little transitional coverage of more immediate trends and futures
    - Very few trends or futures focussing on *Leisure*

- *Governance:*
  - Little coverage in International Relations and government-to-government trends or futures, especially their evolution in the digital age
  - Few trends in policy-making or futures for policy-making (as opposed to suggested policies)
- *Environment & Sustainability:*
  - The category of environmental / sustainability changes should explore changes originating in the environment: water availability, air quality, soil quality, biodiversity. This entire theme is undersupplied in both trends and futures focused specifically on the environment, rather than on economic, value, or lifestyle trends related to it.

This analysis helped choosing which futures should be consolidated and extended, forming the core of 87 futures entries for subsequent activities.

Verge (The Verge General Practice Framework) offers a layered, robust structure to generate, analyse, and compare alternative future outcomes with impacts on people, society, and culture as a focus. The six Verge domains encompass human experience and focus discussions of change on how people interact with impacts:



Verge Framework

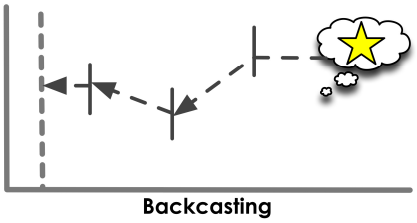
- how we *define* ourselves and the world around us;
- how people, organizations, states, cultures, and nature *relate* to each other;
- what technologies (including ephemera like language and art) *connect* people, places, and things;
- what processes and technology we use to *create* goods and services;
- how we acquire and *consume* the goods and services that we create; and
- how we *destroy* or transform value, and our reasons for doing so.

As an example, considering how the first Theme, "A Trans-humanistic era" may transform our conceptual definitions and what people take for granted raises significant issues:

> *Define:* The basic notions about how society defines and resolves issues of equality and civil rights will need to be re-examined. All across society institutions will wrestle with the question of "what defines fairness" and with a seemingly unbounded notion of "progress."

A brief Verge analysis was prepared for each of the eleven Themes, and they are provided in section 3. These are offered to assist the exploration and identification of key issues in later phases of research, and to add details to any subsequent scenario work as well.

Backcasts start with one or more images of the future as a goal outcome. The process then asks what logically had to occur to create that outcome. This includes discussing and exploring the necessary infrastructure (technological, economic, regulatory) and identifying milestones passed, opportunities taken, and obstacles overcome. In narrative terms, it is 'telling the story of how we got here', creating the vision's history.

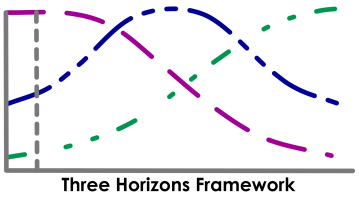

Backcasting

Backcasts are often created as part of a visioning (preferred future articulation) and planning process. They provide a useful ladder of potential events and milestones against which to construct measurable goals and strategies for action. But they also serve to explore how trends and emerging issues might interconnect to and build upon each other to create a future outcome. This was the approach used for the Futurium Themes backcasts. As each Theme was synthesised from a cluster of consolidated futures, the backcasts were drawn from the evolution of those futures and their interconnections with each other. These were mapped out as simple timeline diagrams (with live links to the specific

Futurium entries) with an accompanying bullet-point narrative that starts at the 'end-state', the outcome depicted by the Theme, and works backward to present-day conditions.

As Digital Futures progressed with scenario and policy activities, the backcasts provided useful feedstock for mapping the emergence of different scenarios for the Themes, as scenarios may be depicted as branching from one or another 'stepping stone' event in the backcast.

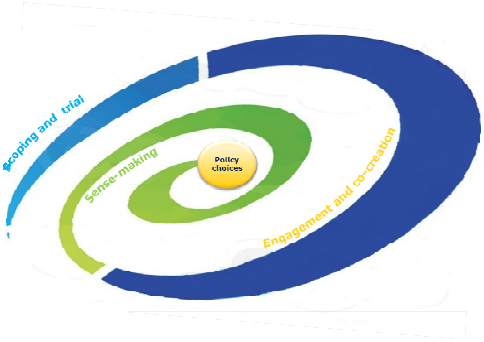
Three Horizons starts with an inventory of the current 'state of play': current mental models, paradigms, operating assumptions, stakeholders, infrastructure, supply lines, policies and regulations, etc., as the 'first horizon'. Emerging weak signals of change and potential long-term transformations and paradigm shifts are mapped onto the rising long-term 'third horizon'. Transition strategies and novel implementation pathways are brainstormed to populate the bridging 'second horizon' – as are conflicts and constraints that might hamper policy implementation.



If the backcasts provide a detailed look of how the Themes may evolve and emerge, the Three Horizons analysis offers instead a very high-level summary of the transformations required for present conditions to morph into those depicted in the Themes. Creating the Three Horizons summary table, available in the Futures Folio, involved combining the insights from all the preceding sense-making activities to identify the critical watershed that would take society from the business-as-usual present to the transformative future of each Theme. These may be used to prompt discussions of what key issues the EU might face in evolving beyond the Digital Society.

Agile Foresight Plan

Because of the experimental nature and complexity of this foresight exercise, an agile project management process was chosen from the outset. It consisted of an initial trial phase followed by converging knowledge co-creation, synthesis and reality-check iterations.



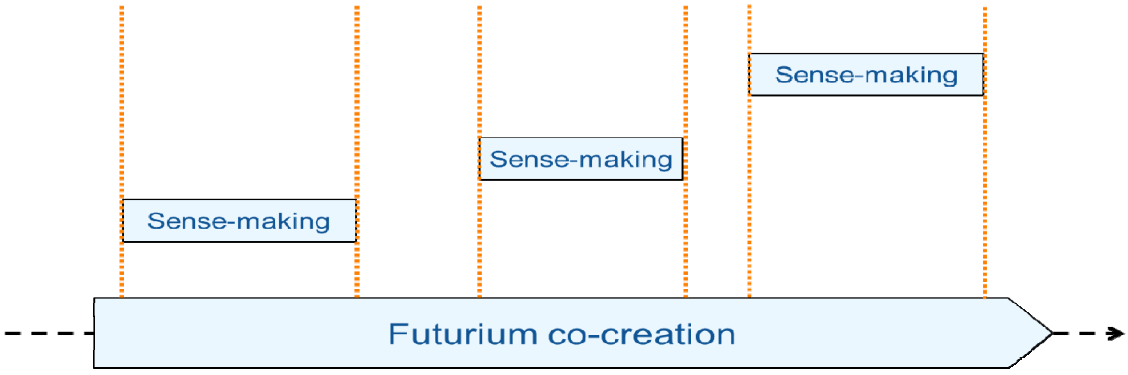
Over time this approach was adapted according to the evolution of the engagement process, the emergence of new needs and the availability of resources. Most of the adaptations were due to the unpredictability and a-synchronicity of the online engagement process.

Furthermore, it was challenging to reconcile the characteristics of a linear foresight process (e.g. an online vote is possible only after locking the co-creation process) with the unpredictability of the co-creation process in a social network.

This suggested de-coupling the two steps:

1. the Futurium becomes an informal open-ended process fuelled by the spontaneous interest of participants;
2. Futurium content can then be analysed at any time by anyone through structured foresight methods, for instance to support future DG CONNECT foresight/long term policy making needs.

The Digital Futures' learn-by-doing approach made it possible to practise and learn new concepts and techniques, which became part of the DG CONNECT's consolidated portfolio of skills to improve its policy making and engagement practices.



Futurium activities and outcomes

Events: building a policy-making lab together

Digital Futures began with a kick-off meeting in Brussels in September 2011. The first full Digital Futures workshop featured 60 participants identifying trends and visions for 2050 over two days from March 29-30, 2012, in Brussels.

On June 28, 2013, the ESPAS workshop in Brussels explored a range of scientific and technological futures and policy challenges. Each of these, and subsequent live and online events, produced significant content made publicly available on Futurium, and also helped to generate momentum in growing participation on the Futurium platform and social media sites.

Face-to-face onsite events: The table below provides examples of face-to-face events that have taken place since the beginning of the project.

Title of the event	Site
The OnLife Manifesto	Brussels
Your Europe, Your Say! (with the EESC)	Brussels
Future of eHealth	Dublin
DAE High Level Group	Dublin
Erasmus Students (with ESN)	Reykjavik
European School	Brussels

The engagement campaign culminated with the large event in Vilnius on 6 November 2013 where Digital Futures outcomes were presented.

These onsite events featured an element of brainstorming on futures and policy ideas (hosted by the Task Force and based on the Art of Participatory Leadership techniques). Although generally by invitation only, the online engagement activities during onsite events created several opportunities for people to engage in and contribute to the discussion of these events without necessarily attending.





On-line engagement events - #futurefridays webinars: The goals of these webinars were to:

1. Stimulate conversation on a particular future or topic featured on Futurium;
2. Enhance the vision and underpin it with possible policy ideas;
3. Attract new users to the Futurium website to contribute to and co-create its content.

Futurium was used as the main source for information regarding the event and the dissemination on social media always linked back to Futurium.

Some online events were related to onsite events and organised shortly after those, in order to build momentum around the topic.

The following table provides examples of webinars.

Title of the event	Timing (D/M/Y)	Main speaker(s)
Future parenting	15/03/13	Andy Miah (Director of Creative Futures Institute)
Designing collective intelligence: The future of civic collaboration	12/04/13	Alberto Cottica (Head of science, OpenPompei project at Studiare Sviluppo)
Women in the Digital Future	16/04/13	Cheryl Miller (Founder and Executive Director of Zen Digital Europe)
The Future of Democracy	19/04/13	Richard Wilson (adviser to the UNDP and founder of The Involve Foundation)
Future of Energy Policy	26/04/13	Andrea Bassi (Founder and CEO of KnowlEdge Srl and Extraordinary Associate Professor of System Dynamics Modelling at Stellenbosch University)
OnLife Manifesto	3/05/23	Luciano Floridi (Chair of the OnLife initiative and Professor of Philosophy at the University of Hertfordshire)
Future of Big Data	10/05/13	Dino Pedreschi (Professor of Computer Science at the University of Pisa)
Future Networked Workspaces	17/05/13	Simon Ulvund (global managing director of the HUB global management team)
Future of Education and Learning (1)	24/05/13	Peter Scott (Director of the Knowledge Media Institute of the UK's Open University)
Future of (Open) Science	31/05/13	Cameron Neylon (Advocacy Director for PLOS)
Future of Education (2)	10/06/13	Stephanie Fahey (Oceania Lead Partner for Education at Ernst & Young) and Xavier Prats Monné (Deputy Director General, DG EAC)
Future of Personal Data	10/07/13	Carolyn Nguyen (Microsoft, US) and Harald Zwingelberg (Independent Center for Privacy Protection, DE)

Interviews: tapping expert perspectives

The interviews were primarily focussed on reinforcing existing visions, trends and policy ideas and – to a limited extent –to generating new ones. The basic design goals for choosing interview content and therefore interviewees were:

- The interviews should attract more contributions due to the profile and knowledge/expertise of the interviewees (who would act as multipliers also within their own networks);
- The quality of the input and the idea of "leading by example," whereby other users would be stimulated to post their contributions in similar formats.

In concrete terms, the outcome that the team worked towards was to complete and publish a total of 60 interviews (20 videos, either in person or as Skype video calls; 30 audio podcasts; 10 texts).

All 60 interviews have been completed and are in line with the split between video, audio and text formats. In the final set of interviews, there has been ample coverage of and complementarity with the content of the platform below, which maps the interviews against the four key "lenses" used to visualise and classify what is on Futurium:

- The 6 hexagon topics used by DG CONNECT's foresight process (Economy, Society, Personal Life, Governance, Environment, Science & Technology);
- The 10 golden hints developed in the lead up to the Digital Agenda Assembly in Dublin (June 2013);
- The topics and gaps identified during their content consolidation phase;
- The 11 thematic futures developed in the lead up to the ICT2013 conference in Vilnius (November 2013).

A mix of policy-makers, scientists, researchers and entrepreneurs was consulted, including Sir Tim Berners-Lee, Dr Hamadoun Touré, Prof. Beth Coleman and Dr. David Brin.

Evidence: annotating the futurium library

The project undertook to build and annotate the Futurium Library, containing bibliographic references for topics relevant to trends, emerging change, and evolving futures. The task was composed of two subtasks:

1. analysis of the available futures and, based on that, extraction of keywords and definition of search strategy for each of the individual futures; and
2. the actual search itself.

Both tasks were however closely interlinked and reiterative.

The search focused on three different types of sources: foresight articles, scientific articles (meaning articles published in academic journals) and other future-related documents from (online) magazines, journals and other specialised web sites. Every uploaded library entry is accompanied by a short abstract.

The final focus of this task was to link the evidence that had been uploaded to the relevant futures on the Futurium. By linking the evidence to relevant futures we successfully highlight the relevance of this evidence and effectively enriched the credibility of the futures. The project uploaded, annotated, and linked 986 evidentiary articles to Futurium entries, greatly enhancing the robustness of the futures discussion and analysis.

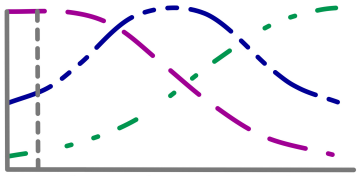
3 Themes

The eleven themes are a synthesis of more than 200 Futures co-created by hundreds of "futurizens" within the Futurium and in brainstorming sessions, both online and in actual events all around Europe.

A Theme may be considered a set of **Key Issues** stemming from the futures co-created on Futurium. Themes do not necessarily entail policy actions, which remain the prerogative of policy makers.

Themes Synthesis and Overview

The Themes and their necessary over-arching paradigm shifts can be summarised via a Three Horizons timeline. The evolution of paradigms, values, infrastructure, and behaviours from the current state of play to any of the Themes will require transformations that a Three Horizons framework neatly summarises as mid-future watersheds on the way to a longer-term future. In using a Three Horizons Framework researchers or participants begin first by mapping the current 'state of play': current mental models, paradigms, operating assumptions, stakeholders, infrastructure, supply lines, policies and regulations, etc., as the 'first horizon'. Emerging weak signals of change and potential long-term transformations and paradigm shifts are mapped onto the rising long-term 'third horizon'. Transition strategies and novel implementation pathways are brainstormed to populate the bridging 'second horizon' – as are conflicts and constraints that might hamper policy implementation.


Three Horizons Framework

In the case of the eleven Themes, the First Horizon consists of 'business as usual' thinking, or lingering 20th century assumptions about the way the world works. These assumptions represent both the stability (a positive characteristic) and the inertia (a potentially inflexible and therefore negative characteristic) inherent in the current state of play. The Third Horizon is populated by the eleven Themes themselves, as positive possible futures. The Second Horizon thus represents key watersheds or transformations necessary to bridge the divide between today's potentially outmoded, no-longer-fit-for-purpose operating assumptions, and the opportunities of the emerging future.

THREE HORIZONS SUMMARY OF THE THEMES		
Horizon One [outmoded assumptions]	**Horizon Two [transformation required]**	**Horizon Three [Theme]**
Clear boundaries separate humans, machines, and nature	Embedded ICTs + bio-nano-tech enhancements redefine human capacity and blur boundaries	**A Trans-Humanistic Era (People)**
Age erodes physical and mental capacity	Genetics + biosciences enable agelessness	**Super-Centenarian Societies (People)**
Limited proprietary technology silos	Hyper-distributed ICT architectures in the fog	**Hyper-Connected Human (People)**
Life Stages: learn content + skills, work at one job, retire from the office	Job fluidity, anywhere workspaces, robotics everywhere, flexible welfare	**Cradle-to-Grave, Work and Play (People)**
Schools teach	Ubiquitous, immersive, interactive digital environment teaches	**Learning (People)**
Hierarchies of power elites rule	Self-organised actors leverage	**New Actors, New**

	disseminated influence	**Polarities (System)**
Consumption-driven broadcasts	Curation-inspired social media exchanges	**Re-Inventing Media (System)**
Linear: creator to creation to audience, applause!	Circular: creators, creations, consumers co-create	**Art, Sciences, Humanities (System)**
Slow accretion of dumb architecture controlled by bureaucracy	Smart, interactive, mutable built environment responds to residents	**Cities, Villages, Communities (System)**
Centralised, hierarchical, economies of scale, consumerist	Localised, self-organising, economies of grid, renewable	**New Economic Models (System)**
A few decide for all – power elite leadership	Participatory leadership in chaordic organisations	**Pursuing Global Peace (System)**

This table provides a quick summary of the opportunities expressed in the Futurium's Themes as well as the significant restructuring of current mental models, not to mention current infrastructure, that would be required to grasp those opportunities. The remainder of this section provide the details of the eleven Themes, the issues they raise, and the collections of trends and futures creating possible paths to realise the opportunities each Theme presents.

Perspectives

The Themes have been clustered into two major perspectives, one that looks at change from a personal perspective, *People*, and another that looks at change from a systemic and society-wide point-of-view, *Systems*:

- *People*: The perspective of the individual as a human, a long-life worker and a learner, in an increasingly hyper-connected society.

This perspective includes the following Themes: "A Trans-humanistic Era," "Super-centenarian Societies," "Hyper-connected Human," "Cradle-to-Grave, Work and Play," and "Learning."

- *Systems*: The holistic perspective, embracing the complexity of the future multi-polar world with increasingly shared rules, values, knowledge, cultures and goods.

This perspective includes the following Themes: "New Actors, New Polarities," "Re-inventing Media," "Art, Sciences, Humanities," "Cities, Villages and Communities," "New Economic Models," and "Pursuing Global Peace."

European Commission

Shape the Future

A trans-humanistic era

By 2050, a new form of human (a trans-human) will emerge, where ICTs and bio-medicine will fundamentally improve the human condition and greatly enhance human intellectual, physical, and psychological capacities.

The augmentation of human beings' cognitive and intellectual abilities through technological implants, such as memory and energy storage, will be possible.

Digital Agenda for Europe

By 2050, a new form of human (a *trans*-human) will emerge, where ICTs and bio-medicine will fundamentally improve the human condition and greatly enhance human intellectual, physical, and psychological capacities. The augmentation of human beings' cognitive and intellectual abilities through technological implants, such as memory and energy storage, will be possible.

Humans will benefit from better senses and biological capabilities that are so far the prerogative of other species (e.g. speed, resistance, adaptation to extreme conditions, etc.). Conversely, future cyborgs and soft robots could be built out of biological components.

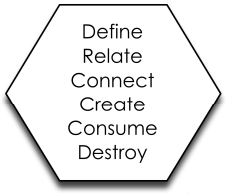
Understanding the ethical and regulatory implications of the "enhanced human", managing change and impacts on individuals (body-mind adaptation), preventing new divides, regulating use of 'add-ons' (e.g. for military use), are the key issues with which future policy makers will have to cope.

Key issues

- Safety: the impacts generated by the contamination of biology with technology are unpredictable, particularly, the side-effects on biological functions and psychology. These remain largely to be studied even today (e.g. drugs for cognitive enhancement).
- Social issues: whereas individual enhancement might be considered an individual's right, the social implications raise issues such as: dealing with the dichotomy of haves and have-nots, avoiding disparities, for instance from the economically disadvantaged not being able to access certain enhancements, societal acceptance, etc.
- Human identity and values: human enhancement blurs the notion of identity and of what it means to be human. It may also lead to a new normative view of the human, thus stigmatising what does not attain this norm, by choice or otherwise. These issues exist already at the heart of debates around trans-humanism.
- Regulation and law enforcement: can we ensure that the rights of all beings (and machines) are accurately defined, reflected in law and respected, as our shared values evolve?
- Legal issues: e.g. how might society view the transfer of augmentation features to offspring, or the right of parents to choose certain augmentations for their children before or after birth?
- Trade-offs: what challenges might arise in building human enhancement technologies to reflect trade-offs between control and freedom, and between risks and needs to advance research?
- Bioethics and the need for new concepts and regulations: what are the moral implications of using human-enhancement technologies for offensive or competition purposes, like combat, intelligence, or sports? Will humanity be able to agree on strong regulations and enforcement worldwide?
- Clash between regulatory frameworks and demand for human enhancement; too restrictive regulatory policies could lead to a potentially huge shadow economy in the related sectors.
- Divides: emergence of an inequality gap between enhanced and non-enhanced humans.
- Acceptance: what might be the primary ethical debates regarding big data storage about human anatomy, diseases, lifestyles; religious acceptance against human extension?
- Will a shared framework of ethical governance emerge that will help to ensure the integrity of all beings, from human to machine - as interconnectedness between humans, machines, and other life forms accelerates, together with our shared cognition, and perception of cognition?
- How will new technologies and applications in bio-medicine, ICT and material sciences; and new market sectors leveraging new technologies and responsible innovation, evolve?

- Will we be able to resolve equality and inclusion issues, particularly recovery and enhancement of lost or damaged physiological functions, making the body more resilient and resistant for all?
- In the light of potential, emerging trans-humanity, will we see enhancement of safety and healing, and improving living conditions for all?
- How, and to what extent, will enhanced capabilities increase of people's productivity?
- Will trans-humanism open up significant opportunities to reduce dependency on unsustainable technologies (e.g. running instead of driving)?

Verge Analysis

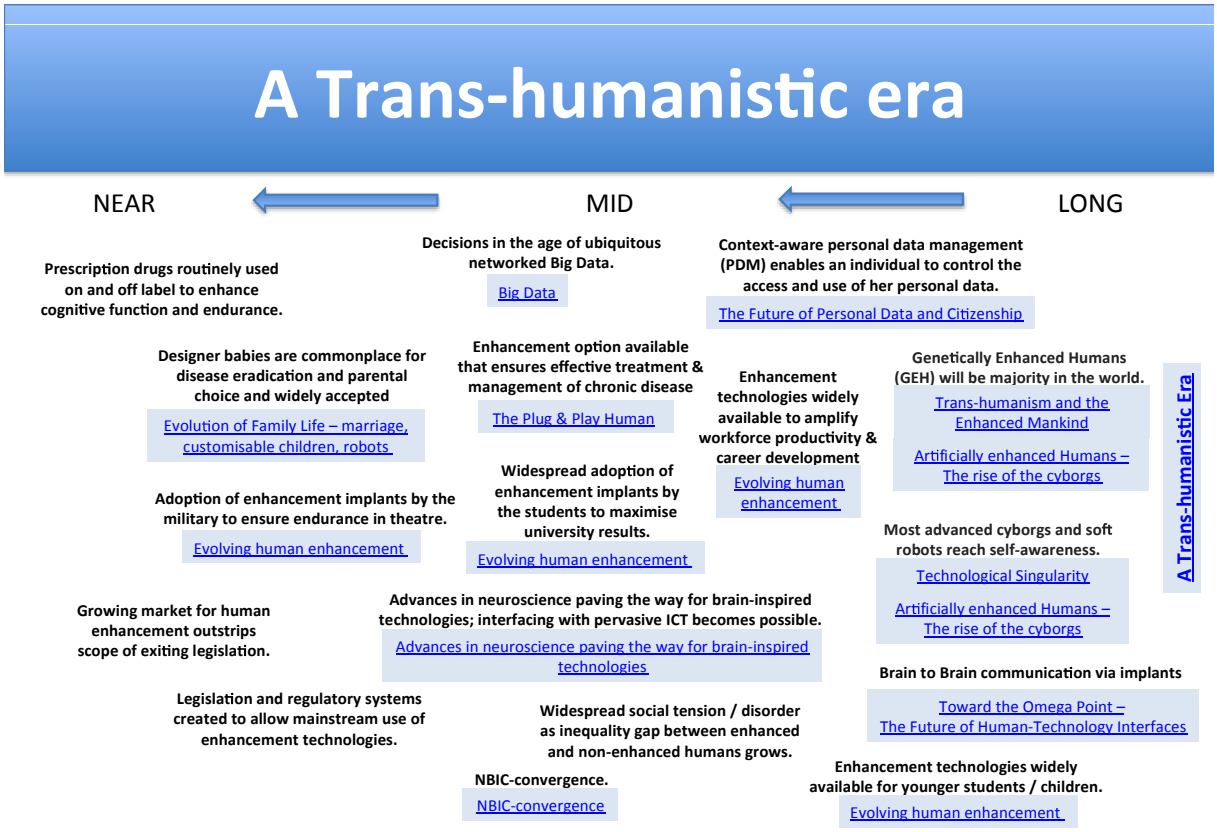


Verge Framework

A Trans-humanistic era could potentially transform how we:

- *Define*: The basic notions about how society defines and resolves issues of equality and civil rights will need to be re-examined. All across society institutions will wrestle with the question of "what defines fairness" and with a seemingly unbounded notion of "progress."
- *Relate*: Dramatically improved health and economic prospects will impact birth rates, driving them down. In addition, the generational shift towards starting families later and starting fewer families will add to the downward pressure on population growth.
- *Connect*: The ability of criminals to access and steal the data underpinning new human augmentation technology means that few, if any, augmentations will remain among a select few for very long.
- *Create*: Digital fabrication and DIY bio-labs will enable the spread of even the most advanced forms of augmentation with relative ease. This will aid in expanding the market for individual inventors of augmentation.
- *Consume*: The already large informal economies of the world will provide ready (and hungry) markets for the vast array of new high-demand augmentation products.
- *Destroy*: Augmenting large numbers of people in the developing world would dramatically close the capability and productivity gaps between countries as comparable augmentations diffuse across populations.

Backcast



Long Term

Brain-to-Brain communication via implants

- Inter-personal communication will be mediated through technology capable of reading information from the brain (for instance through brain waves interpretation) and exchanging this information with other humans according to "trust" profiles.
- Data and information can be shared with other humans or machines through quantum communication links.
- Data will be received by brain implants and actuated instantaneously, i.e. the rational and emotional states of the originating human will be perceived by the receiving human(s) as if they are actually experienced. This will allow achieving the myth of telepathy.
- With increasingly reliable communication between multiple brains and bodies at the speed of quantum networks, thoughts will be instantaneously captured and shared between humans at a global level.

Genetically Enhanced Humans (GEH) will be the majority in the world

- With improved implant techniques and the creation of direct nerve connectors, body and sense enhancing implants are a common practice in 2050.
- They enhance the capabilities in normal functioning humans and provide normal or enhanced capabilities for impaired people. The visual implants make the blind see and the hearing implants make the deaf hear. Muscle implants make the weak stronger. Neural implants make the lame walk.
- GEH will be characterised by better senses and biological capabilities that are in so far prerogative of other species (e.g. speed, resistance, adaptation to extreme conditions, etc.).
- Following the philosophical path of trans-humanism, the augmentation of human's cognitive and intellectual abilities through technological implants, such as memory and energy storage, will be possible.

Most advanced cyborgs and soft robots reach self awareness

- The difference between humans and machines will blur.
- Technology will be closer to humans than ever.
- Implants and easy-to-carry smart objects will be affordable by the majority.

Enhancement technologies widely available even for younger students / children

- Human enhancement here refers to any intervention on or in the human body by technological or natural means for overcoming the limitations of an individual's capacities or for adding new capacities, while preserving this individual's relative sense of autonomy and unity.
- The main demand side drivers for human enhancement come from the medical domain (rehabilitation and prosthetics to counter the effects of disease, injury or natural degradation), and in particular aging (to counter the effects of natural degradation, like from neurodegenerative diseases).
- Defence will also be a main driver, particularly in the U.S. (achieving a better soldier for battlefield domination, intelligence or mission accomplishment).
- The public image and societal debate around human enhancement is fuelled by numerous movies, books and comics featuring super heroes and super enemies.
- Gaming is adding an extra dimension of direct experience by giving players all kinds of superpowers in simulated settings. These reflect an underlying discourse on the role, opportunities or limitations of human enhancement. For instance, the idea of creating a super human by the convergence of the natural and the technological at the nano-scale has been the driving idea behind trans-humanism which, independent of any specific application, is argued by some to be the next logical and rightful stage of human evolution.
- Spin-offs of these developments are starting to be visible in high-tech mass consumer markets for life-style, sports and leisure. Thus market pull may soon be driving forms of human enhancement in more segments than it is now.

Context-aware personal data management (PDM)

- Personal data, identity and privacy are controversial issues in policy development for the Digital Society.
- Context-aware personal data management (PDM) enables an individual to control the access and use of her personal data in a way that gives sufficient autonomy to determine, maintain and develop her identity as an individual
- Includes presenting aspects (attributes) of her identity dependent on the context of the transactions (communication, data sharing, etc.) that she will engage in, and enabling consideration of constraints relevant to cultural, social, and legal norms. Trustworthy data practices are foundational to enabling Appropriate PDM.

<u>Mid-Term</u>

Enhancement technologies are widely available to amplify workforce productivity and career development.

- Highly competitive global economy drives more and more workers to use enhancement technologies.
- Companies begin to support use of a wide range of human performance enhancement technologies – pharmaceutical, embedded computing, exoskeleton – and many even provide them as a benefit.

Widespread social tension / disorder as inequality gap between enhanced and non-enhanced humans grows

- Tensions within national populations and internationally between countries arise between those able to take advantage of enhancements and those not.

Decisions in the age of ubiquitous networked Big Data

- Pervasive ICT forms an unprecedented medium for social interaction and sensing, as well as providing prospects for new means to assimilate, analyse and interact with functioning societal systems.
- Crowdsourcing and technologies to support it play an integral role in bringing Big Data to use in policy and societal challenges: now individuals, small communities and organizations (i) can provide an important source of near real-time information, (ii) can be involved in the active computation process and (iii) can participate in the entire decision making process in a manner that was not possible earlier.

Enhancement option available that ensures effective treatment & management of chronic disease

- Nano devices and bio-computers provide life extending treatment.
- Nano-robots will help diagnosis and treatment of diseases at any age, including pre-birth surgery. They will be able to read from and write into our biology. They can also detect and destroy neoplasms, thus defeating cancer forever.
- Similar to nano-robots, bio-computers will be inoculated into the human body to perform complex tasks, for instance sensing and monitoring the status of organs or repairing tissues and organs in real-time, in-situ, at a micro and nano scale.

Widespread adoption of enhancement implants by students to maximise university results

- Use of performance enhancement pharmaceuticals among students began at the turn of the 21st century and accelerated as competition for university placement, scholarships, and then jobs grew fiercer.
- Digital natives proved comfortable with the notion of not just wearable computing, but also embedded computing, accelerating the adoption of brain-computer interface technology as learning assists.

Advances in neuroscience pave the way for brain-inspired technologies

- New interfacing with pervasive ICT becomes possible.
- Humans may create machines which are capable of emulating human cognition (neuro-morphic computing).
    - While Artificial Intelligence (AI) has produced excellent machines or algorithms for a very specific number of concrete tasks (chess playing, pattern recognition), we are still missing one machine that is capable of the wide-range of tasks we associate with cognitive abilities as found in nature; a machine that can deal simultaneously and flexibly with all of these tasks at different levels of organisation, functionality and all at the same time.
- Preventing, repairing or compensating psychiatric and neurological damages (from genetic predisposition or birth related complications, from illnesses, including those related to ageing, and from accidents).
- Understanding the brain's computing paradigm could lead to a paradigm shift in current models of computing

NBIC-convergence

- NBIC-convergence is the ongoing unification of nanotechnology, biotechnology, information technology and cognitive science.
- NBIC-convergence could allow us to enhance our intelligence, mobility, cognitive qualities or increase industrial productivity.

<u>Near Term</u>

Designer babies are commonplace

- The future family will also likely include "designer babies" who are genetically customized to suit the parents' expectations, for example, gender selection or to eliminate the risk of genetic disease.

- Gender selection of babies has a long history of negative associations with infanticide and child abuse of female babies. It will be important to be aware of these sensitive issues going forward. Similarly, there is a need to be increasingly alert to exploitation of adult women as designer, or customisable, babies become more common.
    - To get around some countries' restrictions on gender selection , one company has truly globalized the process by offering services to "assemble the 'components'.... in a variety of different countries before flying the resulting embryo to India to be implanted in the surrogate."

Legislation and regulatory systems created to allow mainstream use of enhancement technologies

- Playing catch-up, international, regional and national governing bodies develop policy and regulatory systems to respond to the growing usage of a range of different human enhancement technologies.
- The focus of the regulatory regimes is ethical, consumer / public safety and the capture of tax income from new and rapidly growing markets.

Adoption of enhancement implants by the military to ensure endurance in theatre

- Military personnel increasingly provided pharmaceutical and exo-skeletal enhancements to increase and maintain concentration and stamina in battle conditions.

Growing market for human enhancement outstrips scope of exiting legislation

- Market forces; including the misuse of legalized and illegal devices forces governments to consider developing policy and building enhanced regulatory systems.

Prescription drugs routinely used on and off label to enhance cognitive function and endurance

- In a continuation of a long term trend, prescription drugs (as well as illegal drugs) are increasingly used across society to enhance cognitive function and endurance.
- Students, sports people, military are the main legacy users but the practice has spilled into a number of competitive high risk / high reward careers.

European Commission

Shape the Future

Super-centenarian societies

In 2050 people will live longer and healthier lives than ever.

Organs will be re-generated in vitro and implanted with 100% success rate, similar to plugging new devices into 20th century computers. Unlimited stem cells will be used to grow or repair any type of organ, in-vitro or in-situ. Transplant rejection will no longer be an issue, and with the exception of the brain, amputated organs will be replaceable by new ones.

Digital Agenda for Europe

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Nano-robots will help diagnosis and treatment of diseases at any age, including pre-birth surgery. They will be able to read from and write into our biology. They can also detect and destroy neoplasms, thus defeating cancer forever. Similar to nano-robots, bio-computers will be inoculated into the human body to perform complex tasks, for instance sensing and monitoring the status of organs or repairing tissues and organs in real-time.

The complex mechanisms of life and the very inner biological processes will be fully understood thanks to increasingly accurate computational models of human anatomy and physiology. This will enable the detection and prevention of diseases at genetic level, or treating them before they evolve into actual sicknesses. Such virtual models will also enable in-silico test of drugs before the actual treatment, thus allowing fully personalised medicine with 100% accuracy and no side-effects.

Thanks to these advances and the improved living standards, the world's current population of about 7 billion people will grow by more than a third and reach 10 billion in 2050. Contrary to today's forecasts, the average life expectancy at birth will reach 90 years, and most of the population will live longer than one century. Society will be driven mostly by the needs of ultra-centenarians.

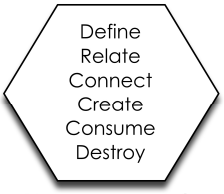
The key issues will be sustainable healthcare systems; inter-generational dialogue and integration; issues arising from an increasing population competing for limited resources; opportunities arising from of an ageing population; and how society could benefit from the wisdom and expertise of the elderly.

Key issues

- How can we prepare for generational shift? What changes will calibrating cities, societies, governments and institutions to deal with much longer human life spans require?
- Disruptions: demographic imbalances and consumption patterns will create major disruptions if lifespans lengthen drastically.
- Cost/risk issues: what are the risks that nobody may pay the upfront costs for creation of diagnostic databases (personal data profiles etc.) and preventive therapeutics, thus not harvesting predictive and preventive potentials (resulting in high 'avoided costs'), to save treatment costs later on?
- Insurance issues: insurance premiums today are based on actuarial statistics that apply to large, predictable populations. By contrast, personalized medicine targets small populations, which are far less stable and predictable from an actuarial standpoint. What new reimbursement models may be needed, perhaps based on performance instead of treatment costs?
- Market liberalisation: what are the risks of new monopoly-like positions for institutions with regards to personal (big) health data?
- Business models: primary care providers may have to build new service lines around prevention and wellness in order to replace revenues from traditional medical procedures and refund costs.

- Market failure: how might we catalyse investments when there is no incentive for private investors? e.g. developing a companion diagnostic would generate less income for industry than conventional medicine.
- Privacy and data protection: will genetic profiles induce discrimination from insurers or employers?
- Training issues: doctors will need a solid background in genomics and proteomics to make the best use of new data.
- Inclusion: how will we ensure that there is sufficient public investment to make life-extending technologies (e.g. bio-artificial implants, 3D printed organs, gene therapies, etc.) available to all?
- Divides: How might life-extending technologies broaden existing divides (western countries/ developing world) or create new divides (e.g. between counties with less/more restrictive regulatory, ethical or religious barriers)?
- Complex regulations: impacts on health and safety regulatory environments, as well as the structure of health and life insurance could be complex, far-reaching, expensive, and controversial.
- Ethical rules: how do we establish policies on wise use of stem cells, without impeding research but preventing tragedies or major ethical violations? How do we achieve safe use of stem cell therapy?
- How can we best engage the wisdom and expertise of the elderly to benefit the whole society by fostering inter-generational dialogue and integration?
- An end to terminal illness/disease and the guarantee of living long lives on earth could alter the relationship of humans to the planet, creating new worldviews embracing long-term thinking and sustainability.
- People will enjoy better living and health conditions; they will be increasingly aware of the concepts of quality of life and well-being.
- A healthy and independent elderly population will be more productive and less costly for society; it will induce social cohesion and contribute to value creation.
- Alternative and conventional medicines may converge and thus deliver more effective, 'whole patient' therapies through the use of advanced technologies and science.

Verge Analysis



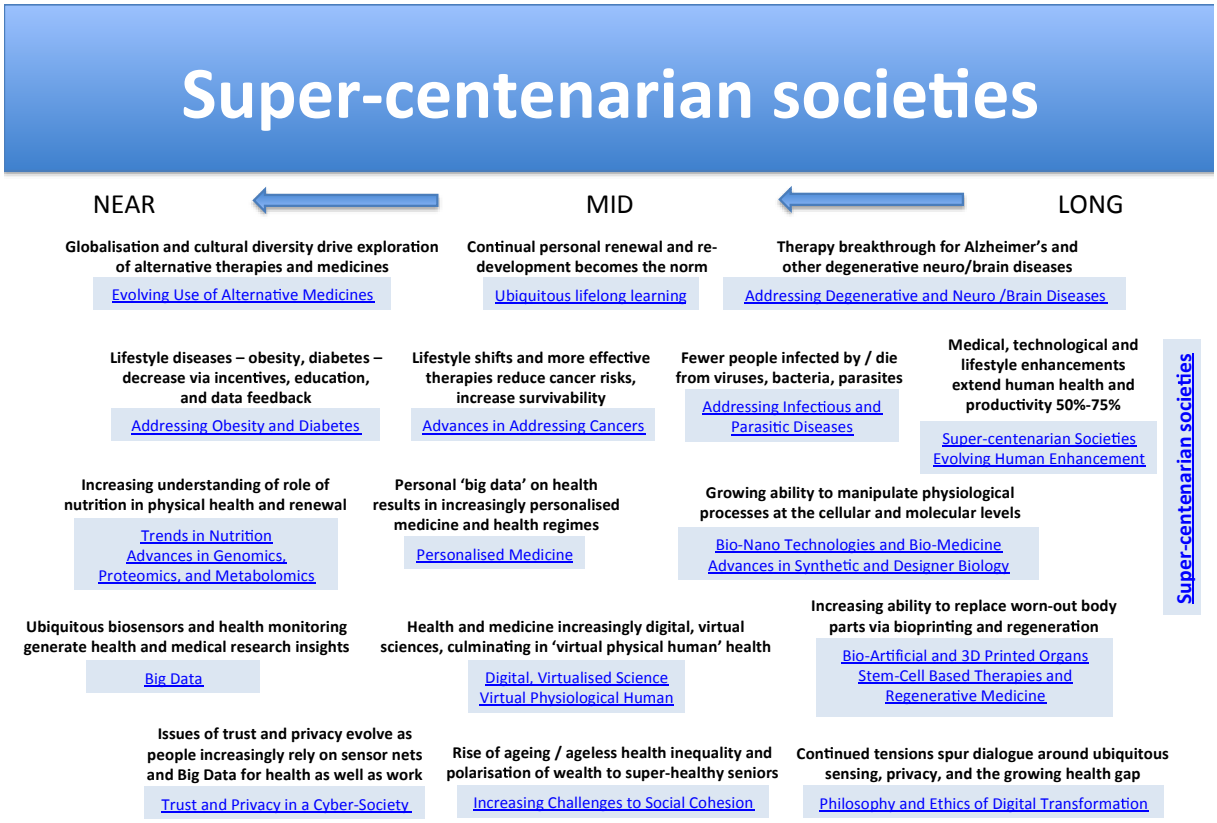
Verge Framework

Super-Centenarian Societies could potentially transform how we:

- *Define*: Traditional notions of wisdom will change as older generations live much longer than today. The reverence traditionally accorded to the wisdom of elders will fall somewhat as more elders remain living and productive.
- *Relate*: Family and household patterns will change with households having an unprecedented 4 or 5 generations living under a single roof. Larger and more diverse family structures as longer-lived and health individuals have more marriages and children over longer life spans.
- *Connect*: The practice of history and historical research will change with burgeoning subfields around biographies, living history, stories, and trans-generational narratives.
- *Create*: Coupled with rising global connectivity and accelerating rates of general innovation, the experiences and ideas of older generations still living and productive will dramatically expand the world's creative talent pool.
- *Consume*: With so many different generations as consumer markets, there will be many more niches for companies to fill in marketing to different consumer segments.

- *Destroy*: Aging, but healthy and productive older generations in positions of power are unlikely to simply hand over the reins of leadership to younger generations. They may in fact work at disabling the rise of younger generations.

Backcast



Long Term

Medical, technological and lifestyle enhancements will extend human lifespans, health and productivity by 50%-75%.

- The convergence of advances and innovations in addressing external disease factors such as viruses, bacteria, and parasites alongside discoveries in addressing internal disease factors such as genetic abnormalities, lifestyle diseases, and trauma, will dramatically increase human health over a significantly extended lifespan.
- Human capabilities over the course of that extended lifespan will be augmented by a range of performance enhancement technologies, ranging from wearable and embedded computing and exoskeletons, to pharmaceutical and genetic enhancements.

Continued tensions arising from unequal access to life-extending therapies and technologies will spur public dialogue around ubiquitous sensing, privacy, and the growing health gap

- With a disproportionate number of early adopters of anti-ageing health innovations being wealthy, the public debate about the new 'right to [extended] life' will grow more heated.
- This debate will draw on the argument that many of the insights and discoveries leading to age extension treatments were generated on the back of public health 'big data' drawn from everyone's health files and biosensors. With the increasing awareness of the value of personal data in an era of commercial mining of big data, the public dialogue will increasingly point to the tension between maintaining data privacy – or giving it up for adequate recompense such as the provision of life extension treatments.

Medical practitioners will increasingly replace worn-out body parts via bioprinting and regeneration

- Printing replacement organs from a basic feedstock of personal stem cells will be increasingly common place, perhaps to the point of being a high street pharmacy service.
- The gold standard of organ and body part replacement, however, will be in vivo replacement: triggering the body's own healing processes to replace a thymus, or a liver, or a kidney internally.

Neuro-medicine will achieve therapy breakthroughs for Alzheimer's and other degenerative neuro/brain diseases

- An extended life without memory is arguably no life at all. The great challenge in addressing ageing will be addressing neuro-cognitive decline.
- Non-invasive imaging and monitoring of brain processes will support research breakthroughs, as will the increasing availability of in-vivo bio-monitors based on bio-nano technology, big data analytics, and high performance computing, to assist in modelling neuro-cognitive processes.

Medical research confirms the ability to manipulate physiological processes at the cellular and molecular levels

- The ability to virtually model and analyse basic cell structures and interactions heralds new capabilities in synthetic and designer biology: the increasing ability to manipulate cellular processes and to create new cells from scratch for specific purposes.
- This overlaps with advances in nanotechnology, which increasingly borrows 'designs' from cellular mechanisms, blurring the boundaries between nanobots and nanosensors, and synthetically generated cells and organisms.

<u>Mid Term</u>

Fewer people are infected by and die from infection by virus, bacteria, or parasite

- Medical research and medical outreach programmes finally eradicate many of the endemic illnesses of the developing world, e.g. malaria, river blindness.
- The rising incidence of antibiotic-resistant viruses and bacteria (e.g. MRSA) are increasingly targets of synthetic biology and bio-nanotech research, with the goal of creating treatments to which resistant organisms cannot adapt.

Rise of ageing/ageless health inequality and polarisation of wealth to super-healthy seniors

- The initial cost of every advance associated with the new agelessness and with human performance enhancement will be high, creating immediate have/have-not dynamics and tensions. While some of these treatments and technologies will subsequently fall in price, not all will. For at least a decade it is likely that only the wealthy will afford life extending medical treatments, meaning they will have a longer span to consolidate and extend their wealth.
- Governments will wrestle with equitable right to access to these lifespan and performance enhancers, with the incentive for undertaking the cost of their provision the undeniable bump in extend workforce productivity they might create.

Continual personal renewal and re-development becomes the norm

- A healthier population is a more energetic, productive, and long-lived population. Maintaining health and extending the lifespan is not solely about physical well-being; it requires mental well-being as well. A paradigm shift emphasising greater balance in all aspects of living and working became a strong component of moving society from ageing to agelessness.
- With the possibility of an increase in productive years over the course of a life, life-long learning and personal and professional renewal grew in emphasis as critical life skills.

Lifestyle shifts and more effective therapies reduce cancer risks and increase survivability

- Increased popular awareness of lifestyle contributions to cancer in particular, coupled with personal digital 'health coach' software and personal health avatars, enabled more people to manage their lifestyles to increase their capacity to avoid serious illnesses, particularly cancer.
- Advances in understanding and manipulating cell processes at the molecular level, and in targeting cancer cells using specialised nano-bio-technologies rapidly increased the numbers of cancers that were survivable.

Personal 'big data' on health results in increasingly personalised medicine and health regimes

- As more and more people used digital biosensors and created personal health avatars, personal diagnosis was increasingly a matter of linking a diagnostic database with a patient's personal health database and their local environmental database.
- Treatment strategies could then be trialled virtually within the computational space framed by the avatar's data and the environmental, diagnostic, and pharmaceutical data platforms.

Health and medicine are increasingly digital, virtual sciences, culminating in a 'virtual human' health avatar for everyone

- As more and more people adopted technologies allowing them to quantify and record their daily habits, health software could generate specific personal health profiles combining genetic analysis with live data streaming from personal bio-monitors.
- These profiles could generate 'virtual health avatars' for individuals, which could be used as an interactive, highly personalised health coach.

Near Term

Issues of trust and privacy evolve as people increasingly rely on sensor nets and Big Data for health as well as work

- More of life – social, professional, and leisure – moves onto interactive online social networks and virtual work and play spaces.
- People increasingly depend upon these interactive online platforms, and the personal, community, and professional data they provide. As their dependence grows, so does their personal data exposure – and the tension over the convenience and usefulness of an increasingly digital life versus its potential for exploitation by government, corporate, or criminal interests.

Lifestyle diseases – obesity, diabetes, heart disease – decrease via incentives, education, and data feedback

- Lifestyle diseases are an increasing drain on public health expenditures, and governments ramp up both educational programmes and incentives to reduce their incidence.
- Wearable computing and personal bio-monitors provide immediate feedback and the potential to game health improvements by competing within social networks for increased fitness.

Globalisation and cultural diversity drive exploration of alternative therapies and medicines

- Increased mobility and an increasingly competitive global economy drive heightened cultural diversity within the workforce and throughout communities. This diversity brings with it new paradigms and worldviews encompassing what it means to be healthy and how to achieve that.
- With increased public interest in exploring all avenues to health, science looks at a widening range of alternative therapies and medicines to evaluate their effectiveness.

Increasing understanding of the role of nutrition in physical health and renewal

- Nutrition and biosciences experts increasingly work together to understand how what people eat affects their health at the metabolic and cellular level: how do particular foods and nutrients affect genetic expression?
- More work focusses on high-nutrient, calorie-restricted diets to explore their impact on boosting immune systems and extending healthy lifespans.

Ubiquitous biosensors and health monitoring generate significant health and medical research insights

- Decreasing costs and growing uptake of personal health and fitness monitors such as the Nike+, Fitbit, Jawbone UP, and Wello gives everyone a daily databurst on their physical condition, that are shared on social networks for comparison and morale-building – but may also be uploaded to a personal electronic medical record.
- Consolidating the data drawn from such devices creates a real-time epidemiological database that can be mined for information on the context of lifestyle diseases such as obesity, diabetes, heart disease, and respiratory diseases.

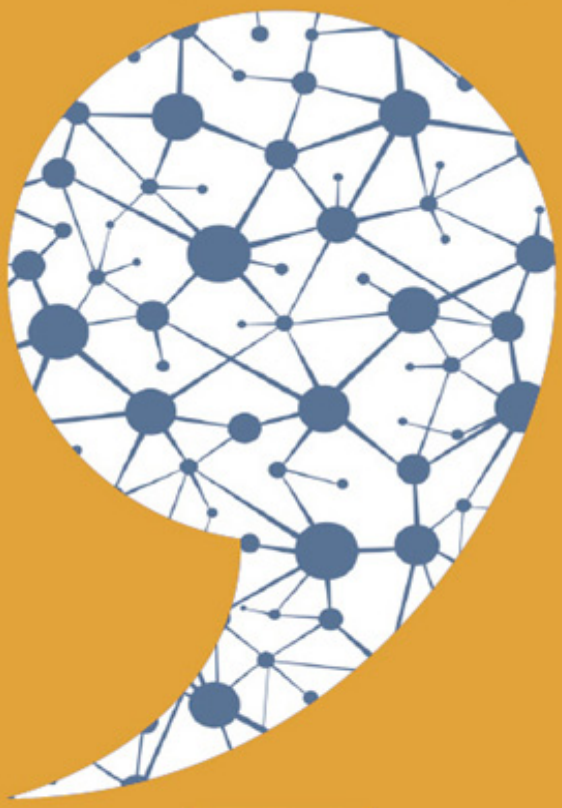
European Commission

Shape the Future

Hyper-connected human

The Internet will continue its expansion as global connector, pushed by the advances in underlying technology foundations (e.g. photonic networks, quantum, organic computing) and by the need to support more sophisticated application scenarios bridging the physical and virtual worlds instantaneously.

Its complexity will dramatically increase as we move to the new era of nano sensors and devices, and of virtual spaces and 3D social networks exchanging zillions of bytes of data every month..



Digital Agenda for Europe

The Internet will continue its expansion as global connector, pushed by the advances in underlying technology foundations (e.g. photonic networks, quantum, organic computing, etc.) and by the need to support more and more sophisticated application scenarios bridging the physical and virtual worlds instantaneously. Its complexity and significance will dramatically increase as we move to the new era of nano sensors and devices, and of virtual spaces and 3D social networks exchanging zillions of bytes of data every month.

This will require a continuous re-engineering, development and regulation of the technological, social and economic fabric of the future digital world.

In the medium term, the ICT industrial ecosystem will continue to grow around a few leading companies who will build their strategy around proprietary technological stacks and/or siloed infrastructures. This may be re-balanced, in the long term, by the emergence of new business models leveraging hyper-distributed (e.g. peer-to-peer) computing architectures and data, open-hardware and software, new communities of prosumers and entrepreneurs who create new dynamics in the global business landscape.

The key issues will be how to harness the potential of hyper-connectivity and ensure that European industrial and business players find their way to compete in the hyper-dynamic global marketplace; how to ensure that the development and governance of the future super-internet is still compliant with shared norms and values; and how to capitalise on the opportunities of the digital transformation and ensure that the future hyper-connectivity is brought to every EU citizen.

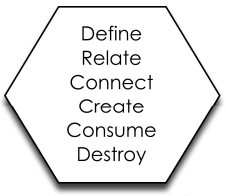
Key issues

- Investment: How can we sustain R&I public and private investments in Europe to consolidate and expand its market supply leadership across ICT industries?
- Innovation: How do we support efficient innovation for ICT industries that interconnects creative activities across the multiple sectors of ICT and with academic research?
- Faster networks: How do we support development and deployment of new and faster broadband networks, leveraging the advances in photonics, quantum and other advanced technologies; overcoming the limits of fibre-optic systems through new optical network technologies; and increasing fibre capacity and providing a dynamic software and control environment around it?
- Storage and data: What new storage technologies might emerge that remain stable over the long term; and new approaches to capture and mine data at ultra-large scale?
- Increasing demands placed on mobile communications networks: the number of new applications is exploding as ever more smart mobile devices become personal connectivity hubs; how will we ensure an always-on shared infrastructure for any-to-any communication?
- Trustworthy and secure technologies: how will we ensure the security and resilience of increasingly complex infrastructures integrating ICT with the real world, including people? The Future Internet will comprise a complex web of services that requires each service to be accompanied by inherent security and identification guarantees.
- Privacy: How will we guarantee proper management of personal information and individual privacy rights in an increasingly connected digital society relying on Big Data and distributed computing infrastructures (cloud and beyond)?

- Consensual governance: What new types of consensual governance frameworks can we build to provide an open architecture for managing online identity, security, personal data, and community's rights?
- Infrastructure investment: How will we develop adequate (infrastructure) investment for broadband deployment and digital services that underwrite robust, equal, society-wide access to connectivity?
- Standards: How will we ensure that the regulatory and standards environment keeps pace with innovations?
- Common protocols: How will we meet the need for common communication standards and protocols across public and private networked systems?
- 5G Definitions: How will we negotiate and agree standards and definitions for 5G (and thinking about what comes next)?
- Spectrum availability: How will we agree on and free up spectrum to allow for greater speeds?
- New business models are needed to take advantage of the possibilities opened up by hyper-connectivity. How will we involve users in the development of products and services around the technology?
- The radio spectrum is one of the most valuable resources of the digital age. As more and more devices and objects become wireless-enabled – including the whole new universe of smart things' – congestion in relevant parts of the wireless spectrum is becoming a key bottleneck.
- Optimising spectrum usage: effective use of technologies will be highly dependent on wireless connectivity and mobility.
- Open standards: How will we implement open standards in wireless networks to simplify everyday life, provide additional convenience and save energy and time?
- Stakeholder conflicts: How will we address potentially incompatible positions and strategies held by different stakeholders?
- Regulatory incompatibility: As we move around Europe we still encounter many different regulatory regimes and legal cultures – how will we harmonise them to enable information and content to be fully mobile?
- Ensuring effective data retrieval and cheap connectivity. Capturing the object and exploiting it within a system requires devices that are able to retrieve the raw data and connect to service centres where the data are converted into information and services.
- Storage: Storage technologies are crucial in being able to capture and mine data at this ultra large scale. How will we develop new storage technologies/approaches that are stable over the long term?
- Anticipate energy consumption drivers: How might the advent of cheap solid state memory open up new challenges to data centres (that have based their business offer on optimising client's OPEX and CAPEX)?
- Need for increased fibre capacity: Optical network technologies will need further development as fibre-optic systems now also start approaching the limit of their capacity. New research is needed to increase fibre capacity and to provide a dynamic software and control environment around this.
- Shared infrastructure: How will we develop common / shared infrastructure enabling any-to-any communication independently of the physical access technologies (wireless, wireline), capacity/resource usage, user utility, host/device movement and density, existing infrastructure?
- Proliferating demands on mobile networks: The demands placed on mobile communications networks are constantly increasing. The growth in the number of new applications running on the networks is accelerating as ever more mobile devices become the preferred device for Internet access for both people and machines.

- How can we recover Europe's competitiveness gap by leveraging new consumer-suppliers value chains that are centred on EU's norms, values and strengths?
- What new business models leveraging increasing access to personal data, preferences and behaviour might emerge?
- Will it boost entrepreneurship and innovation if network neutrality is guaranteed?
- Can we leverage the potential of a single market and political decision making system in the EU by creating an EU App Store based on a single EU Open Platform?
- Proper and full use of the cloud and post-cloud technologies will enable economies of scale for quick up or downscaling of required processing power, storage or network resources. It will enable businesses to pay as they need, thus lowering OPEX and CAPEX.
- Unprecedented digital network bandwidth can be achieved through new broadband solutions based on advanced photonics.
- How can we ensure reduced energy consumption throughout the information infrastructure?
- Reduced carbon emissions via decreased business travel as photonics advances enhance the collaborative communication experience.
- Cutting present-day electricity consumption for lighting by about 70%.
- How can we fully tap the potential for transformative change in the more traditional paper and plastic industries via innovations in flexible displays?
- How do we deploy these technologies to create better warning, preparation and response systems for natural disasters?
- How do we ensure increased citizen participation in civic decisions such as community resource allocations and priorities?
- How can we build an inclusive smart society by regulating strategic levels of the Future Internet architecture?
- Organisations can infer data by connecting pieces of information – e.g. credit scores – finance info / browsing to enhance user services and their own efficiencies.
- How do we develop new applications for integrating networks, smart networks, and the Internet of Things – huge upside for SMEs and businesses in Europe?
- How do we enable the future network paradigm: "anything, anybody, anytime, anywhere on any device"?

Verge Analysis



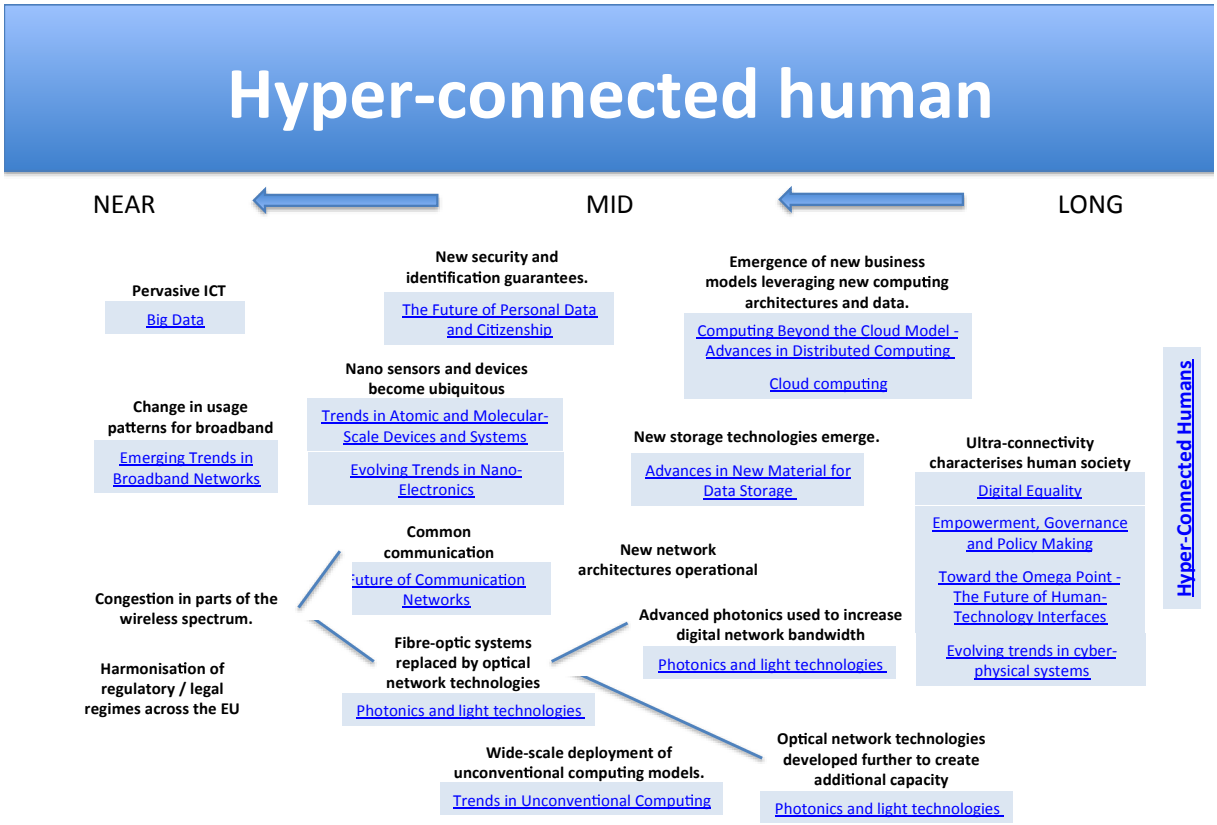
Verge Framework

Hyper-connected human could potentially transform how we:

- *Define*: Net neutrality would be an even more important issue to many people. How far will people truly come to see their lives in terms of networks and flows?
- *Relate*: The hyper-connected future will further drive the trend towards virtual micro multinational firms, where each individual is capable to running a one-man shop with global reach and industry-standard competencies.
- *Connect*: Key elements of infrastructure that will shape this future include peer-to-peer networks, ad hoc networking, and ubicomp/the internet-of-things.
- *Create*: Such a pervasively connected and software-enabled future will see algorithms, automation, and cognitive computing become indispensable elements of productivity. Importance of evolution in distributed work, micro tasks and micro payments.
- *Consume*: Adaptive learning platforms pushing information and services to individuals in anticipation of their needs. Alternative currencies and the shift to a service economy.

- *Destroy*: Cyber threats will become a normal part of daily life. There will be continuing, and evolving, attempts to reduce individuals to hyper-modelled individual "actors" in massive networks of consumers and producers.

Backcast



Long Term

Ultra-connectivity characterises human society

- Potential to trigger greater empathy between social groups and to facilitate much higher levels of debate across dividing lines of locality, gender, class and nationality.
- By 2050, citizens have a much better sense of the public interest and are able to distinguish it from the clientelism that currently characterises democracy in the West.
- Much of the impetus comes from the demos of networked communities that make up civil society. People reach into themselves as much as they expect "solidarity" from other groups, no longer anonymous, as they are now. "The rich" are always someone else today, never ourselves.
- "The Singularity" when computers will surpass the human brain and humans will begin to augment and improve themselves (known as trans-humanism or H+).
- Cyber-physical systems (CPSs) are dynamic integrations of computers, networks, and physical processes. In practical terms, a CPS acts to coordinate, choreograph and control a network of physical objects that contain embedded technology used to communicate, sense or interact with the external environment.
- Advances in cyber-physical systems will fundamentally change how humans interact with and control the physical world. By transforming the world of everyday objects into a designable environment, cyber-physical systems will accelerate revolutionary advances in industries such as healthcare, transportation, infrastructure, manufacturing and energy.

Emergence of new business models leveraging new computing architecture and data

- New players will enter the service market.
- The global cloud computing market will grow from $40.7 billion in 2011 to more than $241 billion in 2020, according to new Forrester forecast data reported in Sizing the Cloud by Stefan Ried and Holger Kisker.
- Leveraging hyper-distributed (e.g. peer-to-peer) computing architectures and data.
- Cloud computing describes computing systems and platforms in which the hardware and storage devices are owned by a services provider.
- Distributed computing (or grid computing) goes beyond the cloud and scales this further by using under-utilised (or idle) resources via a single interface. It is a system that coordinates resources that are not subject to centralised control using standard, open, general-purpose protocols and interfaces to deliver nontrivial qualities of service.
- Grid computing aims to solve budget and infrastructure constraints by using thousands or even millions of networked computers' spare CPU time, allowing big problems to be solved in small pieces.
- Distributed Computing requires a different type of programming as complex tasks have to be broken up into many subtasks that run in parallel with the results being combined when the subtasks are completed.
- Many facets of life are moving to 'Massively Online' such as MOOCs (Massively Online Open Courses).
- Reliability of computing – Distributed Computing increases the reliability of computing resource.
- Cost of computing – you pay for what you use.
- Mobile computing is on the increase which increases the loads on current systems.

Optical network technologies developed further to create additional capacity

- Optical network technologies developed further to create additional capacity.
- Fibre optic systems replaced by optical network technologies.
- Advanced photonics used to significantly increase digital network bandwidth.
- Based on various traffic measurements and predictions, traffic volume in core networks is expected to grow by roughly a factor of 10 within the next 5 years, and by a factor of 100 within the next 10 years. Peak throughput at core network nodes is expected to reach several hundreds of Terabits per second (Tbps) by 2020.
- Demands for connectivity and data will continue to grow exponentially. In 2030 it is expected that everything will be interconnected. Connecting trillions of things will require unprecedented bandwidth that can be achieved through new photonics-enabled broadband solutions, both wired and wireless.
- Information storage, management and security will require new, dedicated solutions to match demands.
- Challenges will call for broadband access to network resources, a high capacity flexible network, and a large number of network environments, such as data-centres, power grids and research infrastructures.
- Photonics technologies will provide the solutions needed to concerns related to bandwidth capacity, energy efficiency and carbon emissions.

New storage technologies emerge

- New storage technologies emerge support new approaches to capture and mine data at ultra large scale.
- The explosive growth in data collection, processing, and availability – the advent of 'Big Data' – is driving the search for alternative materials for data storage.
- Innovations in physical materials, such as the alloy of aluminium and antimony developed by the Chinese, will soon transform data-storage technology. This environmentally friendly material will advance the use of phase-change memory, which is being actively researched as

an alternative to the ubiquitous flash memory for data storage. It is faster than current flash memory and has a greater storage density.

- Continuing innovations in materials science will result in other new phase change materials like the nanocrystal alloys of a metal and semiconductor, or "BEANs" (binary eutectic-alloy nanostructures), that are currently in development.
- As nano-engineering and bio-engineering converge, approaches to storing data on molecules of DNA will be perfected. It is believed that only 1.5 milligrams of DNA will be able to store a petabyte of data. DNA is stable over time, so this may be the most robust, compact storage medium of the mid-21st century.

Mid Term

New inherent security and identification guarantees

- New inherent security and identification guarantees support explosion of increasingly complex web of services.
- "Context-aware PDM" can be thought of as belonging in three "layers"; this model can also provide a useful frame of reference to debate questions regarding future developments on technological, economic, social, and policy issues relevant to PDM. These elements must be balanced and co-exist at every level in the model below:
    - Secure infrastructure – the elements required to establish the trustworthy infrastructure needed to support Context-aware PDM.
    - Data management – the elements (apps, services, etc.) required to enable individuals to effectively control the flow, access, and use of their personal data. This includes consideration of new business models of service providers that would leave control of personal data to end users.
    - User interaction – the elements that enable end users to specify the permissions and policies associated with the personal data they are providing in a simple, intuitive, and meaningful manner. The user experience provided would need to take into consideration the users' mental models on personal data, reflecting potential differences in personal preferences, social, and cultural norms.

Nano sensors and devices become ubiquitous

- The trend towards miniaturisation in the size of semiconductors, electronic circuits and systems, together with technology convergence (NBIC – Nano Bio Info Cognitive) means that nanofabricated devices are now being built to operate at the quantum frontier.
- These nano- and bio-molecular systems exhibit quantum mechanical features in their dynamics as they approach the mesoscopic scale. Fabricating systems at this scale will enable future production capabilities that minimise power use, noise, and heat generation, and significantly lower production costs. Micro-electric-mechanical systems (MEMS) could in future be used to manufacture goods from the basic molecules up, resulting in zero-waste manufacturing.
- New features are becoming available with these advances, such as the graphene transistor with 1000 times higher on/off switching ratio developed at the University of Southampton. These evolving capabilities will enable us to embed molecular-scale systems in more devices and in more places throughout the built environment. They will also greatly expand the types of problems that can be addressed, as computing power increases exponentially despite the reduction in the size of the systems.
- These will contribute to the widespread use of quantum computing systems and massively increased computing power produced via the parallel processing ability that is available at the quantum level.
- Nano-electronics will be part of the continuing miniaturisation of semiconductors (electronic circuits and systems) together with a decrease in power utilisation (power/speed trade-off), noise, heat generation(heat removal/reduction), cost of production; technology convergence (NBIC – nano-bio-info-cogno).

New network architectures operational

- Greater integration and convergence between wireless and wired infrastructures, moving toward a common/shared infrastructure enabling any-to-any communication independently of the physical access technologies, capacity/resource usage, host/device density, and legacy constraints.
- Evolution of mobile communication and networks towards 5G: new generation of wireless technologies will ensure download and upload rates around 1 Gbps to all terminals.
- Higher bitrates will be ensured by combining multiple concepts and technologies such as concurrent data transfer, cognitive and smart radio technologies, wireless mesh network, etc.

Common communication protocols

- Common communication protocols developed across public and private networked systems.
- New network architectures, protocols and technologies integrating flexible and cognitive network management, and supporting Internet mobility and scalability at all levels.
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- Higher bitrates will be ensured by combining multiple concepts and technologies such as concurrent data transfer, cognitive and smart radio technologies, wireless mesh network, etc.
- New performance targets for optical networks thanks to flexible optical spectrum approaches, programmable transceivers and switching nodes, and the use of multiple wavelength bands. They will support multi-Gbps access rates, optical network and IT convergence, self-management and energy efficiency.
- A new generation of satellite technologies characterized by reconfigurable, resilient and secured broadband connectivity, will ensure higher performances and the support to wider application scopes.

Change in usage patterns for broadband access.

- Rapidly increasing use of video and music streaming.
- Virtual spaces and 3D social networks create an explosion of data and associated data handing requirements.
- More global internet users.
- Increase in sensors/devices which can be connected to the internet. This includes the Internet of Things (IoT) and Machine-to-Machine (M2M) networks.
- Sustainability: the need for lower cost, lower electricity usage etc.
- Highly reliable, robust and available systems to support critical infrastructure.
- Support for collaborative working which will evolve to include 3D visualisation and immersive technology to allow people who are physically distant to work better together.
- Integration of heterogeneous technologies across networks and devices

<u>Near Term</u>

Pervasive ICT

- Big Data becomes part of the solution to pressing global challenges.
- Pervasive ICT forms an unprecedented medium for social interaction and sensing, as well as providing prospects for new means to assimilate, analyse and interact with functioning societal systems.
- Individuals, small communities and organizations can provide an important source of near real-time information; can be involved in the active computation process; and can participate in the entire decision making process in a manner that was not possible earlier.

Congestion in relevant parts of the wireless spectrum

- Congestion in parts of the wireless spectrum is becoming a key bottleneck threatening to block effective deployment of new technologies and associated economic implications.

Harmonisation of regulatory regimes across the EU

- Harmonisation of regulatory regimes and legal cultures across the EU.
- Increasingly global harmonization will evolve to support shared approaches across the international landscape.

European Commission

Shape the Future

Cradle-to-grave, work and play

In 20-30 years, people will be able to work throughout their lives and change jobs according to varying personal needs and aspirations.

The idea of the steady, permanent job will become a relic of the 20th century. Only a minority of the population will still experience linear/sequential life cycles (i.e. study => job => family => retirement). Citizens instead will do what they like, irrespective of their age..

Digital Agenda for Europe

In 20-30 years, people will be able to work throughout their life and change jobs according to varying personal needs and aspirations. The idea of the steady, permanent job will become a relic of the 20th century. Only a minority of the population will still experience linear/sequential life cycles (i.e. study => job => family => retirement). Citizens instead will do what they like, irrespective of their age.

Technology will continue to transform the very nature of work and the dynamics of organisations and labour markets. For instance, part-time work, teleworking, virtual meetings etc. will become common practices at all levels.

The idea of a shared workplace as a fixed, physical location will change considerably as work becomes more distributed through technology and as new technologies will allow working remotely with realistic experiences (mixed and immersive reality technologies).

Work will be modularised into discrete projects and sourced not just with current employees but also with external ones. Companies will use concurrent sourcing to identify talent, generate new ideas and knowledge, and define strategy. Sharing work experiences and aspirations will become common practices. Entrepreneurship will be characterised by more self-responsibility and life-long training.

New materials will allow the production of ultra-resistant soft robots that will be resilient to physical shocks and exhibit unprecedented cognitive capabilities. They will be employed in all manual jobs, from agriculture to construction. Systemic industrial automation will significantly reduce the need for human intervention in workflows.

There will still be new types of jobs created but at a rate far lower than the rate at which old jobs disappear. The turnover will not have a linear relationship and many more jobs will become obsolete than are created.

This will affect economies and cultures, which in turn will likely force governments and unions to review employment strategies and initiate welfare systems characterised by much higher degrees of flexibility and adaptability.

The key issue will be how to manage this epochal change at both European and planetary levels.

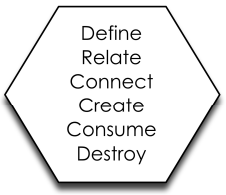
Key issues

- Social tensions: as people will increasingly remain active, working and learning, the demography of the global labour force will grow steadily, stressing the balance between the active and inactive populations. Diverse intergenerational worldviews and values might give rise to social tensions.
- Technology aversion: as robotic systems will do most of the routine work traditionally done by humans, an increasingly negative attitude to robots could spread across society.
- How will society respond to ever more powerful feedback loops between technology and its consequences? The metabolism of change will accelerate dramatically not only because of new scientific advances and technologies but especially because of the decreasing costs of adoption.
- Erosion of job markets: finding new employment opportunities will become increasingly difficult and will push people to acquire high education skills to better compete in smaller job markets.
- Lifelong learning to all: a rapidly changing knowledge and skills ecology will challenge people with the need for continuous education and constant development of their workforce skills; how will people learn quickly and efficiently to adapt to emerging and unforeseen contexts?
- Flexible welfare system: longer life expectancy will have an impact on the welfare system in Europe which may lead to tensions between those who want changes and reforms in the Europe's retirement system, and those who want to preserve the status quo. Will it be possible to ensure that pensions can be refunded across all generations?
- Illegal jobs and unreported employment: governments may face difficulties in funding welfare systems if large and growing amounts of economic activity are untaxed, for instance because of

Illegal jobs and unreported employment. Higher taxes and social charges will however erode tax morale, i.e. willingness to pay, unless empathy improves across society. Preserving incentives remains an issue.

- Finding the balance between two extremes: high unemployment rates with few working hard, for risking possible societal divides, or low unemployment rates with many working less?
- New types of jobs will emerge in areas where intellectual capacity and creativity cannot be delivered algorithmically by machines.
- Job sharing could emerge to mitigate tensions and to embrace new lifestyles.
- Entrepreneurship at all ages will increase human productivity.
- Improving educational systems will be a challenge, in order to serve a society of super-centenarian workers and young leaders.
- Building the foundations for changing lifestyles and smoothing tension across generations: how can we generate new insights about a job-sharing society and its dilemmas?
- Liquid welfare: will it be possible to build new and sustainable welfare systems that cater for different employment/activity periods over the whole lifespan of individuals?
- Paving the way to a new era of universal social growth based on non-material values may mean overcoming the Darwinian principles of the biosphere.

Verge Analysis

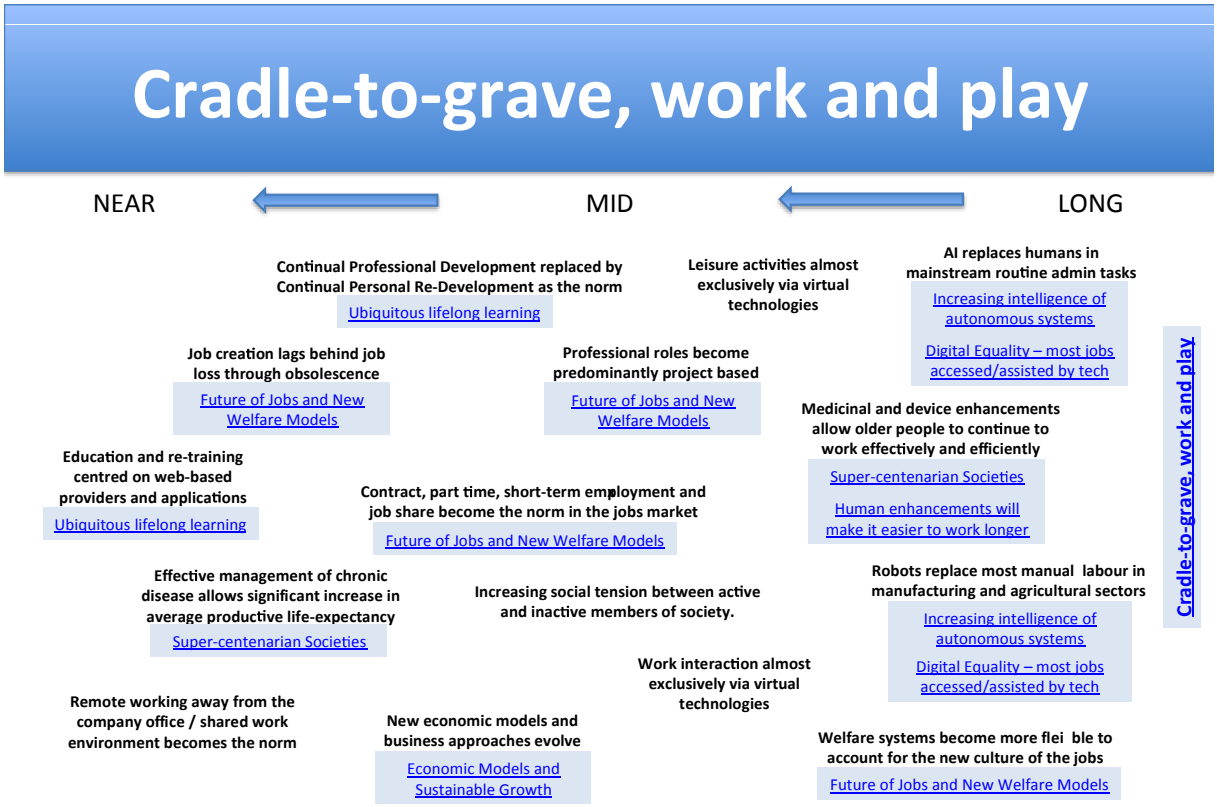


Verge Framework

Cradle-to-grave, work and play could potentially transform how we:

- *Define:* Social contract issues will arise with changes in the nature and notion of career, of life stages and life cycles. Where you work, how you work, with whom you work, will change and call into question what the essential social contracts are between people and the state, people and their communities, and workers and their organisations. Does this require exploring new connections between labour and economic value such as guaranteed basic income, or the 'end of work'?
- *Relate:* Hierarchies within businesses and organisations will become more fluid, as supervisors one day may be employees the next. Affective computing, intelligent systems, and advanced flexible robotics will be valued members of teams in distributed global networks of virtual organisations and work.
- *Connect*: With robots the new migrant and temp workers, fewer of us are working as much, which opens up space and time for people to get together and create new art forms, new media, new social conduits through which to trade the output of increased leisure.
- *Create:* In addition to opening the economic sphere up to new forms of product and service creation, this transformed future also opens up the creative and artistic spheres to new forms of collaborative arts, entertainment, and crafts, and new leisure and sports activities as well.
- *Consume:* With a rising rate of unemployment, consumption among initially disenfranchised workers will fall, while the employed and wealthy hyper-consume with intelligent systems and robots available to manage their avalanche of personal goods. This consume-consume not gap will close if new models of the 'end of work' emerge involving guaranteed income.
- *Destroy:* This will destroy the old social contracts, and create massive disruption particularly among the 99%, as both blue-collar and white-collar workers find jobs re-tasked and job availability gutted.

Backcast



Long Term

AI replaces humans in mainstream routine admin tasks

- Artificial Intelligence replaces human intervention in most routine administration tasks. For example work allocation, work flow, assessing and analysing data, decision support and decision making, predictive coding, E-discovery.
- Development of commoditised professional, consumer and administration services.

Robots replace most manual labour in manufacturing and agricultural sectors

- Future robotic systems will operate autonomously alongside humans and assist them in complex manufacturing and agricultural tasks.
- Robots will be able to conduct certain service tasks such as cleaning or maintenance completely on their own.

Welfare systems become more flexible to account for the new culture of the jobs

- Welfare systems will become more flexible to account for the new culture of the jobs market, ageing workforce and polarisation of those in regular employment and those not.
- Wealthy European countries provide a baseline stipend that guarantees the provision for basic needs to all citizens.

Medicinal and device enhancements allow older people to continue to work effectively and efficiently

- Creates a level playing field with younger colleagues and greater competition in the jobs market.
- Average life expectancy at birth will reach 90 years and most of the population will live longer than one century.
- Society will be driven mostly by the needs of ultra-centenarians.

- Roles and lifestyles as well as education, learning and working patterns will be age-independent and personal aspirations will evolve dynamically across age classes.

Mid Term

Leisure activities almost exclusively via virtual technologies

- Virtual technologies will provide the majority of leisure interaction through enhanced social media platforms that include broader physical experiences.
- Holographic technologies will particularly replace face to face interaction.

Work interaction almost exclusively via virtual technologies

- Work interactions between colleagues and stakeholders will take place through virtual technologies.
- Holographic technologies will particularly replace face to face interaction negating the need for travel and traditional meeting venues.

Professional roles become predominantly project based

- Work will be modularised into discrete projects and sourced not just with current employees but also with external ones (including former colleagues).
- Other companies will use concurrent sourcing to identify talent, make predictions about the future and generate new ideas and knowledge. Sharing work experiences and aspirations will become common practices.
- Management mind-sets will emerge to cope with an increasingly dynamic working environment.

Increasing social tension between active and inactive members of society

- Despite the stipend put I place by many nations, intergenerational worldviews exacerbate the tension.
- There is an increasing divide between “haves” (work, relative wealth) and “have nots” (little / no work, little or no disposable income)

New economic models and business approaches evolve

- The economy will be based on a more optimised and customised consumption where individuals are informed and empowered.
- Individuals and enterprises are able to decide in which economic model(s) they want to participate, depending on their needs, values and lifestyle.

Contract, part time, short-term employment and job share become the norm in the jobs market

- The era of steady and permanent jobs for life is seeing as a relic from the Industrial 20th Century.
- Systemic automation has significantly reduced the need for human intervention in manufacturing most products and then made humans redundant also in intermediation jobs and in jobs where software could take over intellectual tasks.
- Working patterns today typically change throughout one's lifetime according to varying personal needs and aspirations.
- The culture of employers looking for evidence of long term employment in their candidates has changed; different – but relevant – experience is the critical factor.

Continual Professional Development replaced by Continual Personal Re-Development as the norm.

- Learning will be integrated into daily lives and will take place in many places – not only in class rooms directed by teachers.
- Continual Personal Development / life-long learning will be central to successful careers and the boundaries between school, university and work will be blurred.

- New technologies have been deeply integrated into teaching. Traditional, physical lectures and tutoring will still happen, but will to a large extent take place online.

Near Term

Job creation lags behind job loss through obsolescence

- The pace at which new jobs driven by new technology have been introduced to the economy has not kept pace with the reduction driven by systemic automation; reducing the need for human intervention in manufacturing, intermediation jobs and in jobs where software could take over intellectual tasks.

Effective management of chronic disease allows significant increase in average productive life-expectancy

- Medical and health gains have proved to be the basis of an ageing global population that supports an increase in average productive life-expectancy.
- Centenarians will be active and creative. They will live independently and will communicate seamlessly within physical and virtual spaces. Their interaction with youngsters, irrespective of geographical location, will accelerate knowledge-sharing and cross-fertilisation of experiences across generations. This will boost wisdom in the global society.

Remote working away from the company office / shared work environment becomes the norm

- Increasingly, technology will provide the opportunity for remote working; reducing the reliance on funding expensive real estate and other infrastructure related to traditional business models.
- Location ceases to be a potential blocker for and enterprise employing a particular individual.

Education and re-training centred on web-based providers and applications

- The wide range of educational innovations and experiments occurring today, many of which are linked to the new physical technologies now becoming widely available, will shape this future.
- New technical platforms (augmented reality, pervasive mobile computing, adaptive learning platforms, and gamification) and new approaches to teaching (place-based learning, connected learning, and blended learning) will all contribute to this significant transformation in learning.

European Commission

Shape the Future

Learning

The education landscape in 2050 will be characterized by a "blurring of boundaries" between the different levels and directions of education, between higher education and industry.

It will provide greater flexibility in designing educational pathways tailored to individual needs, and combining several education methods into a life-long and stimulating learning experience.

Digital Agenda for Europe

The education landscape in 2050 will be characterized by a "blurring of boundaries" between the different levels and directions of education, between higher education and industry. It will provide greater flexibility in designing educational pathways tailored to individual needs, and combining several education modalities into a life-long and stimulating learning experience.

Technology will support new forms of learning, for instance using virtual spaces and enhanced classrooms for experimentation and full immersion in learning settings not achievable otherwise, including powerful simulations, intelligent conversational agents, and brain-to-machine or even brain-to-brain interfaces.

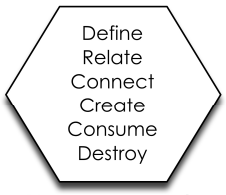
The key issues will be how to achieve universal access to learning; how to maintain quality within a 'liquid' learning system; designing a reliable global accreditation system; exploiting greater synergies between work, education and leisure, but also between society and education to foster a world worth living in; and how to make sure that education leads to better jobs and innovation.

Key issues

- Social networks, media and software are not currently designed with the goal of learning in mind and their use cannot be defined as a mainstreamed phenomenon in education and training, particularly in primary and secondary schools as well as vocational education and training.
- Personal Learning Environments, which are explicitly designed for learning, are still under-used or misused. Major obstacles are the lack of awareness on the side of both teachers and learners coupled with lack of digital skills (by both) and interoperability issues.
- Simulations and serious games have gained market shares in some areas of corporate training and professional development, whereas their take up by the education sector is marginal.
- How will we ensure universal access to and use of rapidly emerging digital technologies, particularly by currently under-served populations?
- How can we renegotiate the role of the state or public education systems in determining what citizens should learn? What conversations might emerge on the evolving roles of schools and professional educators?
- How can we maintain standardised and harmonised educational systems in a world of continuous changes, managing possible inequalities between educated and non-educated people?
- How can we meet the need for mainstream educational institutions to keep pace with the broad and rapid shifts in technologies and individual preferences?
- In what ways might we measure the learning efficacy and sustainable business (operating) models of the new technologies and the educational approaches they inspire?
- How can we put Big Data to use in evolving education? Big Data create opportunities to support new learning (by-doing) paradigms and to enhance the productivity and competitiveness of educational systems; they can support a new set of personalised eLearning and education applications, enabling best-matching between individual learning needs, cognitive capabilities and other contextual factors (e.g. learning on the move); data produced by future learning systems will provide much greater and deeper insight into the interests, talents, and skills of the citizenry.
- Revealing new insights: human learning and pedagogy could be supported by sophisticated algorithms which unearth valuable insights that would otherwise remain hidden.
- What performance improvements in learning might emerge thanks to technical augmentation of cognitive capabilities (e.g. neuro-implants) and widespread adoption of psychology?

- How do we tap the creative potential of those communities and populations not currently connected to and participating in online activities?
- Virtual and online education might produce greater short-term returns on investment due to the increase in student access and the lower logistical costs.
- If personalized and life-long learning prove effective, then society might gain a better educated, more adaptive citizenry.
- How might new educational systems emerge in which learning is conceived as a flow and where learning resources and opportunities are widely available?

Verge Analysis

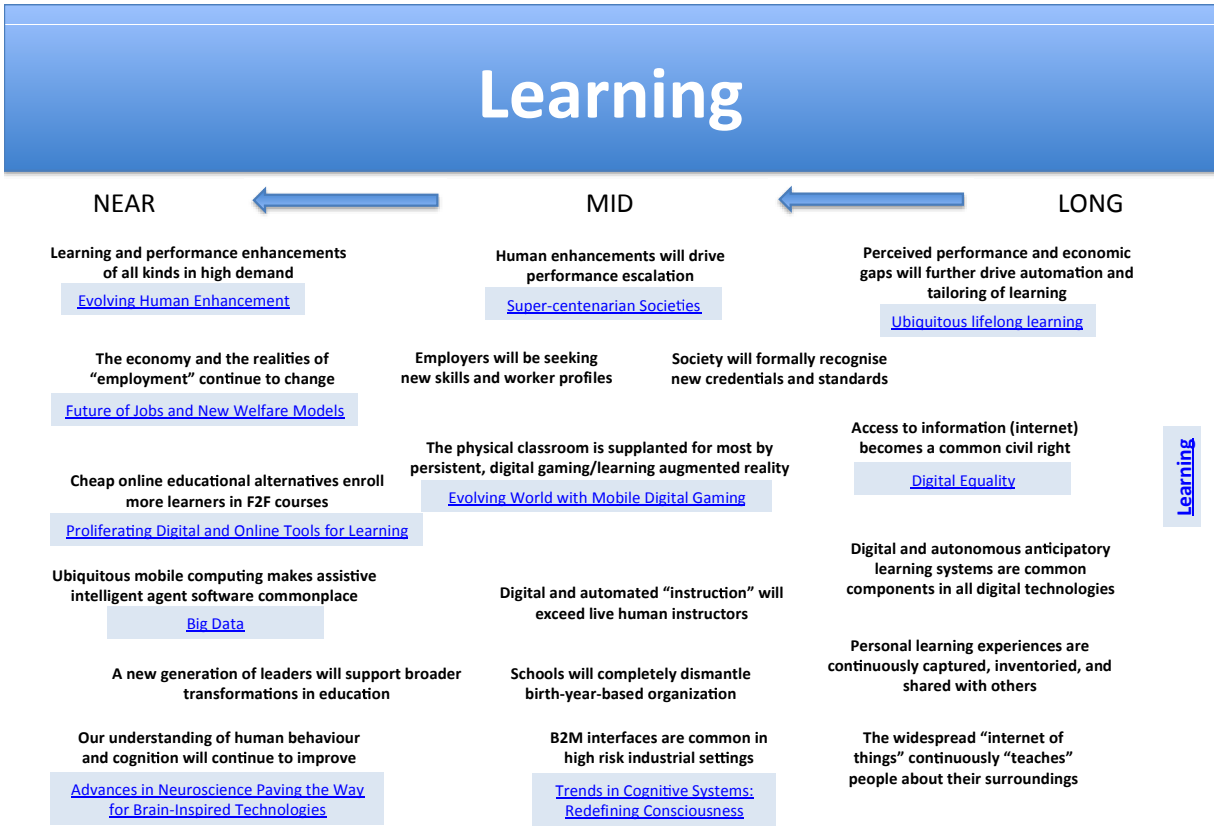


Verge Framework

Learning could potentially transform how we:

- *Define*: Society's institutions and businesses will come to expect and demand life-long learning of all citizens and workers.
- *Relate*: Co-learning will become one of the major ways in which individuals, across their lives, gain education and knowledge.
- *Connect*: More and more individuals will find each other through social interactions around shared learning interests.
- *Create*: The number of "talented amateurs" as teachers will grow as technology and social networks make it ever easier to share and co-learn and as methods for receiving compensation for teaching evolve.
- *Consume*: Thanks to a variety of predictive analytics and adaptive software platforms, relevant education will increasingly find individuals when and how they need it. Pervasive computing and the internet of things will mean that more education will be "embedded" into the processes individuals engage in on a daily basis and the in the places where those processes take place.
- *Destroy*: Governments with declining budgets will increasingly offload the "responsibility" for learning onto individuals, creating greater performance disparities.

Backcast



Long Term

End state:

- Blurring boundaries (between levels, directions, and between education and industry)
- Educational pathways tailored to individual needs
- Life-long learning
- Virtual spaces
- Enhanced classrooms
- Full immersion
- Simulations
- Intelligent agents
- Brain-to-machine interfaces
- Brain-to-brain interfaces

Perceived performance and economic gaps will further drive automation and tailoring of learning

- Policy makers will be pressured to address the ever-widening gaps in society.
- Digital learning systems will hold out the promise of closing those gaps.

Access to information (the internet) becomes a common civil right

- As "learning" shifts to pervasive, internet-based, mobile-enabled services, lack of access to information tools will be tantamount to lack of access to education.
- "Access" will include not just internet access but the skills for using it as well.

Digital and autonomous anticipatory learning systems are common components in all digital technologies

- Anticipatory learning systems will become ubiquitous in daily life.
- Technology makers will have great incentives to ensure that their products mesh with these learning systems.

Personal learning experiences are continuously captured, inventoried, and shared with others

- Brain-to-machine (B2M) interfaces will enable routine recording of what and how we experience things.
- "Successful" human experiences (like learning moments) will be used to improve other people's experiences.

The widespread "internet of things" continually "teaches" people about their surroundings

- Devices, objects, and sensors within the built environment will provide learning systems with both technical and historical information about places.
- Beyond simply learning where something is, individuals will now be able to understand the history of objects and places and their relationships with other objects, places, and people.

Mid Term

Human enhancements will drive performance escalation

- The more some individuals use enhancements, the more others will feel compelled to use them as well – especially in an increasingly competitive global labour marketplace.
- This engenders an escalating upward spiral of human performance.

Employers will be seeking new skills and worker profiles

- Businesses will need individuals with either very high-end knowledge and innovation skills (with technical competencies) or demonstrated high-touch skills.
- New work patterns will require individuals capable of greater project management, self-management, and collaboration competencies.

Society will formally recognize new credentials and standards

- New standards for "proving" competencies will have to evolve in order for businesses to have reliable proxies for selecting new hires.
- Governments and accrediting bodies will eventually adapt to the new "real world" conventions for validating expertise and competency.

The physical classroom is supplanted for most people by persistent, digital gaming/learning augmented reality layers

- It will be easier and cheaper for most people to access learning through digital platforms.
- It will be cheaper and more effective for educational institutions to reach more "students" through digital platforms.

Digital and automated "instruction" will exceed live human instructors

- Mobile devices and pervasive wireless high speed internet access will increase the ubiquity of access to information.
- The capabilities of intelligent agent software, combined with ever-growing data and more sophisticated adaptive learning systems, will make digital "instructors" the most effective and cheapest option to reach the most people.

Schools will completely dismantle birth-year-based organization

- Advances in understanding human learning will decisively discredit strict birth-cohort educational practices.
- Advances in learning theory coupled with evolving technology will enable sophisticated arrangements based on competency and individual development.

Brain-to-Machine (B2M) interfaces are common in high-risk industrial settings

- Industrial and military settings are the first to see interfaces for telepresence work.
- B2M interfaces are increasingly coupled with assistive technology from "smart" systems to heighten effectiveness, reaction time, and anticipate problems.

Near Term

Learning and human performance enhancements of all kinds will be in high demand

- Economic challenges will drive people to learning and to new advantages in order to compete in the market.
- Cognitive and physical enhancements of all types will be in high demand.

The economy and the realities of "employment" continue to change

- Daily work will be more project-based and routinely depend upon external collaboration.
- Individual "career paths" will be much more unpredictable and idiosyncratic.

Cheap online educational alternatives enrol more learners than F2F courses

- Online education continues to grow at substantial rates.
- Virtually all accredited institutions of higher education offer online courses and degree courses.

Ubiquitous mobile computing makes assistive intelligent agent software commonplace

- Smart device ownership reaches near 90%+ penetration in the developed world.
- Digital assistance software (like Siri) is a core element of mobile operating systems.

A new generation of leaders will support broader transformations in education

- Millennial educators and administrators occupy the majority of leadership positions.
- Millennials will imprint their organizations with their attitudes and preferences for things like constant communication, social media, and distributed collaboration.

Our understanding of human behaviour and cognition will continue to improve

- Neuroscience will continue to make advancements.
- We will continue to make advancements into genetics, genomics, metabolomics, and related fields.

European Commission

Shape the Future

New actors, new polarities

In the coming 20-30 years, people will be more empowered than ever to share knowledge, become aware of their environment, and take informed and responsible decisions. They will become active players in the global scene.

New platforms for social networking will allow citizens to self-organise into communities which will emerge as new powers able to exert influence and address shared problems in a more structured, responsible, and concurrent manner.

Digital Agenda for Europe

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New platforms for social networking will allow citizens to self-organise into communities which will emerge as new powers able to exert influence and address shared problems in a more structured, responsible, and concurrent manner.

Communities of empowered individuals will likely challenge the roles of the representative decision makers currently running politics, information, education, and welfare systems. Politicians will interact with their citizens and networks differently and their leadership will become more participatory.

Representative democracy will evolve and its actors will rely on online participatory practices to harness collective knowledge and create co-ownership around it. New forms of democracy may emerge where elected representatives are given agile, mission-oriented mandates to address particular challenges.

Big Data will record the multiple dimensions of systems. They will provide the evidence to inform policy decisions at all levels. Systems' principles and rules will be encoded in resilient algorithms that will take into account the aspirations of individuals (e.g. to build a new house) and the system-level constraints (e.g. the need to comply to security rules and urban plans). This will lead to new decision making models combining scientific evidence elicited from big data with the emotional and rational intelligence of people.

The increased individual and community empowerment could generate potential new threats. Individuals could undermine national security systems, for instance through do-it-yourself weapons. They could switch seamlessly between multiple digital and physical identities and use this to hide themselves or escape from control. New tensions between individuals, communities and state powers could emerge.

The pervasiveness of digital technologies will bring more data collection, at higher scales and heterogeneity. Personal data management, privacy and identity, and trust will therefore become even more critical factors for individuals and for the global ecosystem's stability.

Principles such as openness, transparency, fairness, and trust will be encoded into future technologies and services 'by design'. However, this will not overcome the long-cherished problem of finding optimal trade-offs between the need to protect individual's rights, the need to ensure security, and the right of business actors to pursue their legitimate goals.

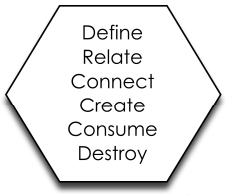
Key issues

- Right balances: increased empowerment of individuals cannot be at the expense of other individuals or states (e.g. security risks), and the need to protect personal rights (e.g. privacy) cannot undermine security. How do we reconcile the continuous tension between individual and collective interests? How can people recognise emergent power structures?
- What kind of regulatory approaches are needed for a society characterised by new forms of spontaneous organization and polarities? Are new bills of rights needed to ensure that EU values are preserved and leveraged?
- Right timing: a too-rapid development and adoption of empowering technologies may lead to fragmented regulations and generate social or geographical divides; a too-slow adoption may

generate new forms of oligarchic power able to exert societal manipulation through control of Big Data and media. Are individuals, communities and states prepared for change?

- Excessive conservatism: re-thinking social contracts to adapt to the digital transformation may destabilize socio-technical eco-systems; stakeholders may find it too risky and may prefer perpetuating the older frameworks, where their role is clear.
- Barriers: the difficulty in finding universally accepted trade-offs and reflecting them in future data laws and jurisdictions may be a barrier to the practical implementation and deployment of future citizen empowerment technologies and infrastructures.
- Can co-creation of ideas and emergence of consensus/disagreement co-exist with the need to take faster decisions? Can all have the possibility to co-decide on all issues? What's the importance of the "wisdom of the crowd"? Is there a risk of individual conformity?
- Digital literacy: information overloading could undermine people's capability to assimilate and participate, co-create and decide in a community. How do we ensure that all people have the education, skills, and necessary awareness of their rights and duties in the future digital world?
- What are the ethical implications of the empowerment of individuals and communities? How important will ethics be in decisions?
- Transparency: we may already use a number of tools and services provided to us for free on the basis of a trade-off, that is, we do not have to pay but we agree to give our data in return. Given how significant some of these services are, how might our relationship with them change in the future if we alter how we would like our data to be handled?
- How do we ensure the right to grant and revoke decisions on private digital assets (including the right to disconnect or be forgotten)? How do we ensure awareness of the data flows and the algorithms that process personal data (e.g. profiling)?
- Big Data: personal data is currently perceived as lacking a coherent set of trading rules, behavioural norms and policy frameworks to support it which, in turn, have contributed to a reduction of trust in this area. How can this be overcome?

Verge Analysis

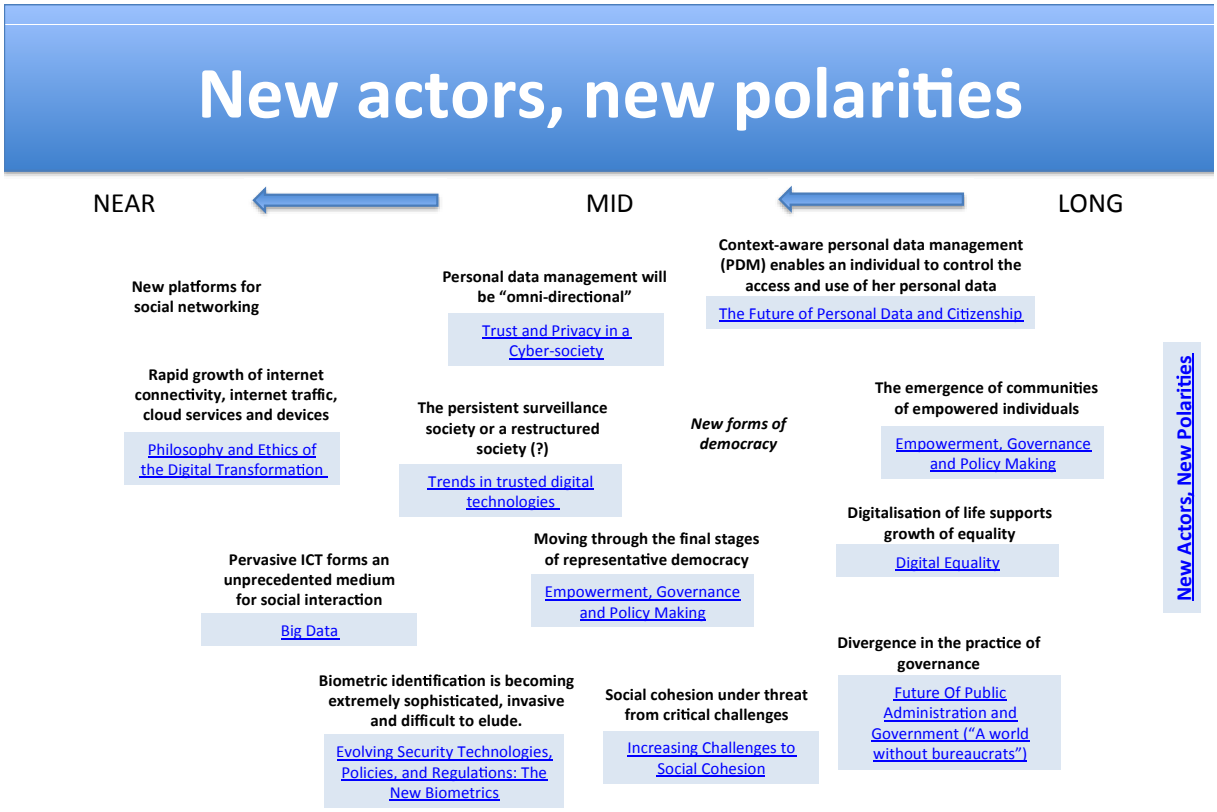


Verge Framework

New actors, new polarities could potentially transform how we:

- *Define*: Such a fundamental reordering of political life will encounter considerable institutional inertia and generate significant individual resistance from those privileged under the current systems.
- *Relate*: Greater democratization will mean more demands on individuals to pay attention to and participate in their collective governance structures, leaving less attention available for work and play.
- *Connect*: What will connect people more than ever will be political life as a daily experience: issues, learning, debate, and deliberation.
- *Create*: Cognitive computing will be combined with the available "big data" to augment decision makers and to assist citizens.
- *Consume*: Products and services to assist citizens and communities with sense-making and political strategy will emerge
- *Destroy*: Elites will find innovative ways to appropriate democratization movements (and technologies) to maintain power and influence.

Backcast



Long Term

The emergence of communities of empowered individuals

- In 2050, people will be more empowered than ever to share knowledge, be aware about their environment, and take informed and responsible decisions.
- The emergence of communities of empowered individuals will challenge the roles of the representative decision makers currently running politics, information, education and welfare systems.
- There will be a shift in democracy, particularly in the democratic process and the underlying principles. Citizens will express their opinions in a more immediate, direct way on the issues that count for them.
- A new model of decision making will take account of the particularities of a street, village, community, region, country, block, or the planet in a flexible and adaptable way. This would enable direct consultation on issues, large or small, across different scales and for different implementations.

Digitalisation of life supports growth of equality

- The access all people will achieve to education, culture and other people's networks will support equality, because only by having all those connections and knowing more, will we enhance our empathy and see how minimal our differences are compared to our commonalities.
- With increased digitisation it will become more difficult to define "who" (what?) deserves equal treatment, along with all the persistent challenges of power-balance that the struggle for equality entails.
- Women and under-represented interests have a greater voice in a digitised world, in theory, due to digital media disturbing, democratising and distributing the power balance.
- Instrumental to any vision of equality is the ultra-connectivity that characterises human society by 2050. This has the potential to trigger greater empathy between social groups and to

facilitate much higher levels of debate across dividing lines of locality, gender, class and nationality.

- The role of professional politicians is less significant than today as everyone is a politician. The most difficult aspects en route are the transformation of democracy and the role of the state itself.
- By 2050:
    - citizens have a much better sense of the public interest and are able to distinguish it from the clientelism that currently characterises democracy in the West;
    - redistribution is targeted at achieving equality in a more focused way, rather than being manipulated in the interests of the electoral cycle;
    - improved policy-making through big data means that the success and failure of policies is much better known and publicised than today;
    - capture of the means of the provision of public goods such as health and education by producerist lobbies on the one hand, and their over-provision or inefficient provision by politicians trapped in an electoral cycle on the other gradually becomes less of a factor;
    - well-meaning, well-mediated policy outputs are no longer a substitute for achieving impact.

Divergence in the practice of governance

- The future of government, and in particular of the "executive branch" agencies that normally fall within the domain of public administration, will be shaped by the confluence of several trends.
- Elected officials, career public servants, and citizen advocates will compete over how best to respond to these emerging changes, with the result that the mid-term future will see a period of divergence in the practice of governance as different governments pursue different strategies to resist or adapt to change.
- As global integration continues, governance of society and the provision of collective goods will pose increasingly complex challenges for contemporary administrations.
- Successive waves of technology will generate considerable pressure for change within government institutions. Currently, popular movements concerning "open data", "open government", and "civic media" are drawing considerable interest and public and government attention. These will be rapidly followed by "big data", machine learning and automation, and machine-to-machine communication.
- A central tension that arises from this confluence of trends that will confront all public administrations is the conflicting array of opportunities and preferences for centralising governance in the formal institutions of the state versus decentralizing governance away from the state and government.

New forms of democracy

- Representative democracy will evolve and its actors will rely on online participatory practices to harness collective knowledge and create co-ownership around it. New forms of democracy may emerge where elected representatives are given agile, mission-oriented mandates to address particular challenges.

Context-aware personal data management (PDM)

- Personal data, identity and privacy are controversial issues in policy development for the Digital Society.
- Context-aware personal data management (PDM) enables an individual to control the access and use of their personal data in a way that gives sufficient autonomy to determine, maintain and develop their identity as an individual.
    - This includes presenting aspects (attributes) of her identity dependent on the context of the transactions (communication, data sharing, etc.) that she will engage in, and enabling consideration of constraints relevant to cultural, social, and legal norms.

    - Trustworthy data practices are foundational to enabling appropriate PDM.
- From a socio-political perspective, the general trustworthiness of the infrastructure, institutions and applications is an issue. The challenge will be to construct a digital world in which individual members can have confidence that they will find their place as respected members of the many online communities within and across jurisdictions.
- The concepts of identity, PDM and privacy come from a physical world governed by sovereign states within national borders. Dealing with them in a "borderless" digital world needs international agreements and standards, and hence a debate that also considers the relevant global cultural blocs.

Mid Term

Social cohesion under threat from critical challenges

- A considerable increase in demand for energy is expected. By 2030, natural gas will be of increasing importance as states struggle to maintain energy supplies. The majority of this gas will probably come from a few world regions, namely the Arctic, Central Asia, the Persian Gulf (especially Qatar and potentially Iran), Russia and Africa. New gas supplier countries may come in the market from Northern America, especially with recent development of shale gas. Many boundary disputes, such as those in the Arctic, Gulf of Guinea and the South Atlantic will become inextricably linked to the securing of energy supplies
- The effect of climate change, mostly limited for the time being, will begin to be felt in the next decade, with the following features: an increase in the mean temperatures, the acceleration of thawing, the rise, warming and acidification of oceans, an increase in precipitation, more frequent natural disasters, and a growing scarcity of clean water along with the emergence of new pandemics threats.
- As we approach the 2030s, agriculture will likely remain the source of greatest demand for water worldwide, accounting for 70 % of total water usage. In comparison, industry will account for only 20 %, while domestic usage will likely remain steady at 10 %. Improved agricultural techniques could further increase the amount of land under irrigation, and increase yields per unit of water used. By the 2030s, at least 30 developing nations could use even more of their water for irrigation.
- Global consumption of food has increased. In China, the volume consumed has more than doubled for almost all food types from 1990. According to FAO, projected population and socioeconomic growth will double current food demand by 2050.

Moving through the final stages of representative democracy

- As a consequence of the digital and social transformation, representative democracy will evolve and its actors will rely on online participatory democracy practices to harness collective knowledge and create co-ownership around it.
- New forms of liquid democracy will emerge where elected representatives are given agile, mission-oriented mandates to address particular challenges or opportunities.
- New e-Democracy tools will be adopted by governments and communities at all levels. They will implement customisable policies to govern the sharing of resources similarly to the algorithms used by computers' operating systems (e.g. time sharing). A new societal operating system will therefore emerge as a federation of multiple operating systems (e.g. city operating systems).

Personal data management will be "omni-directional"

- It will be a fundamental right for people to choose what information to convey about themselves in different contexts, protected by global regulation. Basically, "omni-directional" means that users are controlled, but at the same time they can check the data controller. As biometrics and data encryption (notably code morphing) improve, it will be increasingly difficult for hackers to attack data collected on personal devices.

- In the global information society, personal data are increasingly becoming a real asset and thus "the new currency".
    - Currently, users are not conscious of the value of this kind of information and they often disclose this data for free.
- Personal data are more and more the raw material for services providers and the marketing industry. This will lead to economic assessment of personal information.
- New system architectures that support privacy by design, new security instruments and infrastructures aiming at prevention, protection and recovery are being developed. This will lead to standardisation and harmony in privacy settings management.
- Thanks to attribute-based credentials access, system development will enable people to separate personal information from general information.
- Users should be able to track and manage all the personal data and – if need be – to choose what to keep and what to delete.

The persistent surveillance society or a restructured society

- By 2020, one of two scenarios will unfold, driven by these wildcard disruptions, and organizations' and governments; choice of response to addressing them:
    - a persistent surveillance society will govern all aspects of life and culture, driven by human beings who misuse technologies to support fear-based command and control structures, if existing practices are not corrected systems-wide, or
    - a restructured society will implement systems-wide changes in governance that place the emphasis of trust back on accountable human beings, instead of the technologies themselves.

Biometric identification is becoming extremely sophisticated, invasive and difficult to elude

- Innovative new identification systems are moving toward the extreme in the hunt for distinctive physical characteristics that can be detected.
- Facial blood vessel mapping with thermal imaging is more than 97% accurate. The blood vessels form a pattern as unique as fingerprints or iris scans, but are much more difficult to falsify.
- Video representation of a person walking can reveal a "unique mark" of that individual based on their gait using a new technique developed at Universitat Jaume I (Spain).
- A research team at Carnegie Mellon University are working on shoe insoles that, by monitoring pressure and gait, can confirm the identity of the wearer.
- MRI imaging of kneecaps has potential for identifying people in an airport queue or walking into a building.
- The new biometrics can be used as complementary to fingerprints and / or facial recognition.

<u>Near Term</u>

Pervasive ICT forms an unprecedented medium for social interaction

- Individuals, small communities and organisations can provide an important source of near real-time information; can be involved in the active computation process; and can participate in the entire decision making process in a manner that was not possible earlier.
- Big Data will record the multiple dimensions of systems. They will provide the evidence to inform policy decisions at all levels.
- Systems' principles and rules will be encoded in resilient algorithms that will take into account the aspirations of individuals (e.g. to build a new house) and the system-level constraints (e.g. the need to comply with security rules and urban plans).
- New decision making models combining scientific evidence elicited from big data with the emotional and rational intelligence of people will be implemented.

Rapid growth internet connectivity, internet traffic, cloud services and devices

- According to Cisco IBSG, the number of internet-connected devices will increase from 500 million in 2003 (0.08 per person on the planet) to 50 billion by 2020 (6.58 per person)
- Cisco Systems forecasts that global data centre traffic will increase from 1.8 zettabytes (ZB) in 2011 to 6.6 ZB in 2016, with approximately 2/3 of that coming from cloud computing traffic
- Research firm IDC expects that global public spending on public IT cloud services will be more than $40 billion in 2012 and should approach $100 billion by 2016, with one of every seven dollars spent on packaged software, server, and storage offerings by 2015 for cloud-based services.
- Sales of "smart" products are expected to grow from more than $500 billion in 2011 to more than $1 trillion by 2016.
- 50,000 augmented reality (AR) glasses were shipped in 2012; that total is expected to rise to 124,000 by the end of 2013, and potentially to 10 million by 2016.

New platforms for social networking

- These allow citizens to self-organise into communities that will emerge as new powers able to exert influence and address shared problems in a more structured, responsible, and concurrent manner.

European Commission

Shape the Future

Re-inventing media

Social media will replace traditional editorial media as the dominant media arena over the next 20-30 years.

The evidence is already accumulating: people like to curate their own lives through social media. They become ever more expert in creating their own user-generated content, as new cohorts of youth become active, dramatising and exploiting it through social media. Scarcity of attention means less time for editorial media and fewer resources.

Digital Agenda for Europe

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European media companies' difficulties in engaging with the "consumer internet" space, which converges with media in the run-up to 2030, trigger political pressure for action. US platform operators incubate a new generation of European media companies to operate in the new arena, following pressure to require the sharing of data collected by commercial entities on fair, reasonable, and non-discriminatory terms by law.

Editorial media will continue to exist, but only insofar as they become part of the conversation in the social media arena. Increasing defiance of copyright driven by the sharing culture of social media and user-generated content cannot be overlooked by 2020. The underlying objection is not to payment but to the opaque legalism of copyright structures as regards sharing and content mash-ups versus the friction-free interactions on the web.

The key issue is whether policy makers decide to sustain traditional culture policies based on cosseting a minority of creators or whether they will run with the trend, seeking to reboot culture policy with the objective of maximising universal creativity across whole populations. The plurality of society is expressed through vibrant debate in social media, rather than through intermediation of editorial media.

Television is a dying form by 2030; there is only video in many forms and on many devices: at one extreme projected on to individuals' retinas through eyeware and at the other end high resolution 4K/8K high resolution images viewed collectively on massive film-based displays that are purchased on a roll and heat-sealed to your wall by 2030. Immersive 3D is back but still does not sweep all 2D video out of the way. Game media evolve as open source platforms for players to create their own worlds, action rules, and plot dynamics – the boundaries between gaming and movie-making blur even more as motion capture 'libraries' of famous actors enable anyone to insert them via CGI into games, videos, and personal content. Older policy makers continue to defend terrestrial radio even as audiences fade away, in face of widespread availability of audio on the web.

Key issues

- Media prosumption: Spread of social media and the increasing capability of younger people to create their own media products using ever cheaper, high performance tools blurs the traditional distinction between media producers and "the audience".
- Vested interests: How can societies develop the creativity of their entire population rather than focusing on protective measures for a minority elite of creators? This may take a long time to encourage as vested interests in cultural institutions and agencies are strong.
- Awareness: social media means that people devote more time to their own interactions and media and less time to the products produced by editorial media. The challenge for remaining editorial media companies is to ensure that their products become part of the conversation.
- Entrenchment: As commercial media shrink, will European society seek to maintain and reinforce public service media, which has the effect of diminishing opportunities for nascent new media business models arising out of social media?
- Partisan voices: New media arising out of social media may initially be very shrill and partisan,

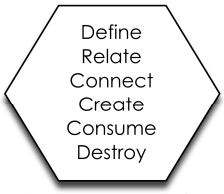
neither cross-cutting nor inclusive.

- Copyright lobbies: Traditional media's strong lobbying power in respect of policy-making means that existing copyright structures last much longer than they otherwise would have done had market forces been able to change them more incrementally. Would enforcement attempts lead to public protests for reform of copyright?
- Interventionism: Media plurality concerns incentivise politicians in many countries to try and sustain legacy media market structures. The possibility of a hiatus between the fading of legacy media and the rise of a mature, new media sector with its own model of pluralism triggers interventionism whose perverse effect is to delay the emergence and sustainability of new media markets based on social media.
- Equitable access to new services across the community.
- Difficult for European media companies to obtain a share of the "consumer internet" space, consisting of a converged media and ecommerce market place, in face of US giants.
- Differential rates of technology development: the key system building blocks are evolving at different speeds.
- How will companies boost employees' creativity? companies will need a paradigm shift in management (fewer mechanistic measures and control) to generate and sustain a creativity boost – a shift to a more open company culture, which is a challenge for many of today's "traditional companies."
- Valuing artistic output: How can we ensure that arts, music, and human-generated knowledge will continue to be valued in social and/or monetary terms even while guaranteeing open use?
- Two views struggle going forward: (1) Creativity that goes unpaid leads to a novelty- and diversity-impoverished intellectual world dominated by material that takes minimal effort to produce—creative artists get cut out, and all that remains are corporate content distributors; (2) User-generated content and mash-ups coupled with sharing are the way forward in a friction-free consumption mode. Can this tension be resolved?
- Trust and security: If brain-to-computer interfaces may evolve to the point where they transmit not just data but emotions, how will we address issues of trust and security that will be essential in building the emotive web?
- Authenticity: Apps and media in this me-centric society will push personalised products. In the resulting media flood, it may be difficult to distinguish authentic and new art products from mash-ups.
- Generational decline in creativity: Some concern exists that in the evolving, highly distracting immersive media environment, children will not be trained in creativity and that creativity itself may decline in the next generation.
- The media are no longer able to distort political debate through their own agendas, driven by the linked needs to sensationalize and sell. There is no longer a quasi-monopoly on reaching the public, given the pre-eminence of social media.
- Will we see improved political debate at the grass-roots and a more realistic assessment of what government can and can't achieve, plus greater accountability thanks to a combination of social media and big data?
- A more distributed approach to creativity raises cognitive levels in Europe and helps Europeans to both to compete internationally and to feel more self-actualized and content, despite their shrinking wealth.
- How will we channel the creativity of Europeans in the new social media driven space, enabling them to pioneer new ecommerce opportunities linked to media?
- Personal communications, social networking, entertainment, information searching and provision are converging and providing significant opportunities for exploiting strategic, technical and commercial synergies.
- The morphing of products into services has profound implications for organizations and consumer. In various respects it makes them more open. Perceiving an offering as a service rather than a product creates a different and more direct relationship with the producer / manufacturer, omitting the reseller. This process of 'disintermediation' – removing the middleman – is an existing trend which is likely to accelerate radically as value chains evolve.

- Upcoming technologies will allow almost every object to have an associated memory, just like a digital diary. In addition, such objects provide the possibility to provide additional information automatically when the user is looking at or interacting with an object.
- In education, we will be able to sift through our experiences and tailor both new knowledge and the way it is delivered according to our preferences and learning styles. We will be able to gain new knowledge a morsel at a time, when we need it most and are most receptive to it.
- In retailing, we will benefit by knowing exactly what we bought before. This can steer our buying and the way we customise new services and products.
- New businesses will evolve to leverage personal information. Major businesses will develop around this Internet of personal information.
- New companies will emerge offering services to capture, analyse, structure and store the personal information in our digital "black boxes".
- The Internet of Things will generate an enormous market space and this market can be filled, in principle, by enterprises and individuals independently of their physical location. Furthermore, the Internet of Things will change significantly the way an enterprise can reach a customer, accelerating the transition from products to services.
- New industries will emerge from the creative sector, leveraging novel innovations like (personal) digital fabrication in fab labs that enable fast builds of new art or commercial output. While fab labs have yet to compete with mass production and its associated economies of scale in fabricating widely distributed products, they have already shown the potential to empower individuals to create smart devices for themselves. These devices can be tailored to local or personal needs in ways that are not practical or economical using mass production.
- Other new applications of art may be in health as alternatives to placebo drugs or as pain reduction or pain management techniques. In the near future we may see doctors prescribing music therapy to aid healing.
- Events and arts will be communicated through visual means instead of through text and consumers will participate as producers of vivid original content.

Verge Analysis

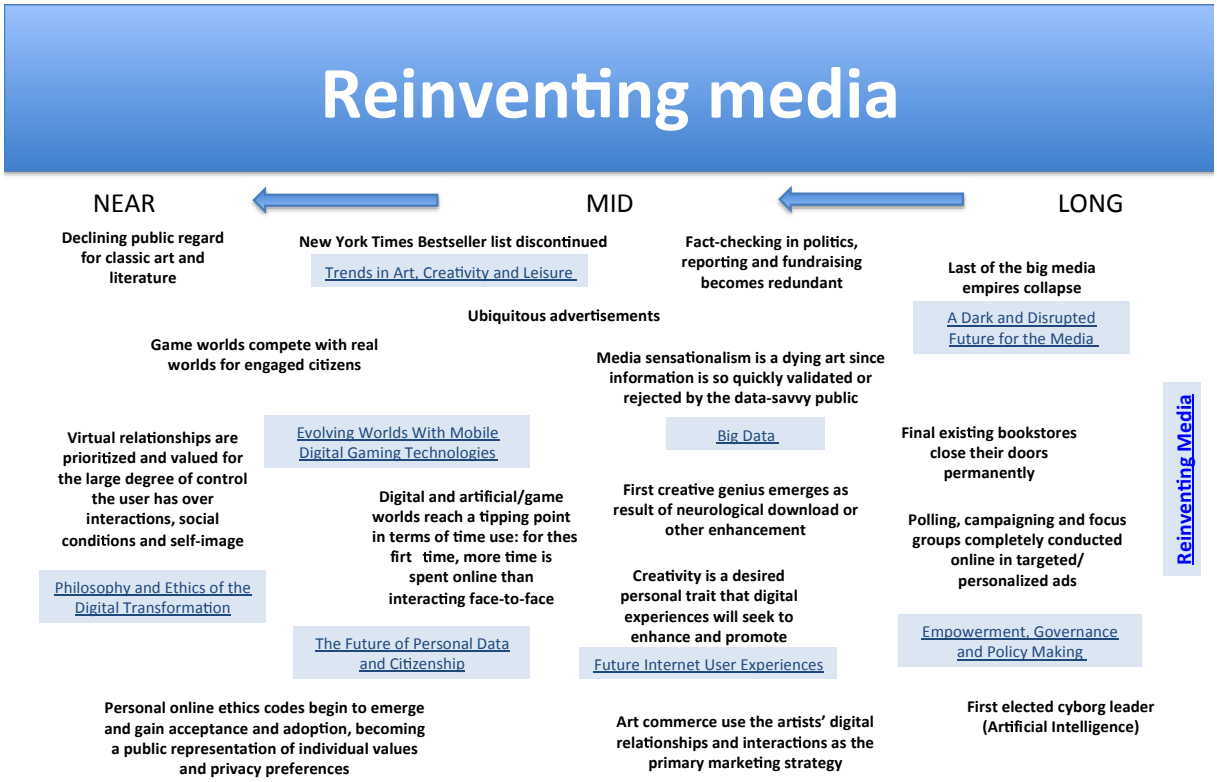
Re-inventing Media could potentially transform how we:



Verge Framework

- *Define*: Humans will remain interested in truth and authority, so “markets” for validated authority figures and sources of information will remain.
- *Relate*: Information overload will always drive interest in the curation of information, a function that necessarily creates a bottleneck, with implications for the shape of networks that form around content and for the organizational structures needed to support curation.
- *Connect*: Individuals will (perceive themselves to) connect over shared interests rather than common platforms.
- *Create*: Algorithmically-generated content will enter this space, while platform owners and internet access providers will exert both subtle and powerful influences over the content that individuals choose to access.
- *Consume*: The shape of the personal (online) networks and the media platforms individuals choose to use will dramatically impact the “news” that reaches them. Gaps in news come more from idiosyncratic reasons than from editorial decisions.
- *Destroy*: There will be a greater ability for individuals and groups to spread erroneous or intentionally misleading information to populations less equipped to differentiate good information from bad.

Backcast



Long Term

The last of the big media empires collapse

- Fall of the final international media giant signals the close of hierarchical media era.
- Decentralized media occupy a number of different formats and business models.
- The lack of large organizations or institutions at the top allows rules to be rewritten for the arts, media and creative fields, impacting education and professional standards.

The last few bookstores close their doors permanently

- The (digitally) written word is becoming a currency in and of itself more valuable than cash.
- Paper or tangible media becoming extinct.
- Personalization of media is at odds with the retail format.

Polling, campaigning and focus groups are conducted completely online in targeted/personalized ads

- Election turnouts are not suspenseful at all anymore; votes are not secret except as a formality.
- Election results are no longer newsworthy, but strategies to profile voters generate hype.
- Grassroots social movements are nearly instantaneously formed around issues.

First cyborg leader (Artificial Intelligence) is elected.

- The ability to quickly crunch the numbers and make fact-based decisions was a major part of the winner's platform.
- This was a victory for public acceptance of cyborgs/AI, a major social justice issue.

Mid Term

Fact-checking in politics, reporting and fundraising becomes redundant

- Role of media as watchdog, fact-checker and reporter of social mood during elections has shifted to the digital citizen.
- Truth is much easier to identify and validate, but more difficult to encounter consistently among a cacophony of voices.

Media sensationalism is a dying art since information is so quickly validated by the digitally-savvy public

- Real-time fact checking is part of the entertainment of politics, arts, and public discourse of all kinds.
- Journalism shifts toward removing the subjective element from reporting, eliminating art and literature reviews, editorials, columns and opinion pieces from mainstream news outlets.
- Bursts of internet activity/social media replace breaking news bulletins.

Creativity is a desired personal trait that digital experiences will seek to enhance and promote

- Social transactions online are considered expressions of individuality.
- Digital experiences are designed to spread a message or advance an idea.

Art commerce uses the artists' digital relationships and interactions as the primary marketing strategy

- Social relationships of all kinds are becoming commoditised.
- Ideas, beauty and creativity are shared freely among social media "friends".

First creative genius emerges as a result of neurological download or other enhancement.

- Creativity as innate is considered an outdated view.
- Public opinion mostly positive, but some contest authenticity, starting a debate similar to controversial steroid use by athletes.

Ubiquitous advertisements

- With so much media material available, it is constantly and continuously pushed onto public awareness.
- It becomes difficult to shut off constant media inflows.
- Products are able to market themselves through Internet of Things.

Near Term

Digital and artificial/game worlds reach a tipping point in terms of time use: for the first time, more time is spent in virtual worlds online than interacting face-to-face.

- Census finds that more individuals engage with virtual reality more hours per day than with flesh-and-blood people.
- Work and leisure are both increasingly simulated activities.

New York Times Bestseller list is discontinued.

- Media and consumer preferences have become so diverse that few titles are able to appeal to the masses.
- Prosumerism puts mass-marketing of media in the past.

Game worlds compete with real worlds for engaged citizens

- Some people are simply much more invested in the virtual worlds they inhabit, becoming apathetic in real life.
- Addressing social ills through gaming advances as a strategy to deal with real world problems.

Declining regard for classic art and literature

- Fewer students major in arts and humanities in universities.
- Although creativity is treasured, novelty is much more valuable.
- "Artist" is becoming part of the personal identity of most people engaged in digital media, despite whether they actually produce anything that appeals to others.

Codes of personal online ethics begin to emerge and gain acceptance and adoption, becoming a public representation of individual values and privacy preferences.

- Some internet users respond to an influx of media by developing personal statements that establish criteria for information flowing to the user.
- Limiting exposure to inappropriate material for children is realized technologically and formalized by laws.
- Overwhelming amounts of digital information are made manageable by defining limits, morals, likes, triggers, standards, other criteria.

Virtual relationships are prioritized and valued for the large degree of control the user has over interactions, social conditions and self-image.

- Face-to-face or "real life" relationships are much more difficult and high-maintenance than virtual spaces where partners, friends and rules of conduct can be negotiated to match the user's preferences.
- Heavy users seek ways to replicate conditions from artificial worlds and avoid real-life encounters with views or facts that would threaten the stability of favourite virtual communities.

European Commission

Shape the Future

Art, sciences, humanities

The challenges facing humanity are revealing themselves as increasingly global and highly interconnected.

The next few decades will give us the tools to start mastering this complexity in terms of a deeper understanding, but also in terms of policy and action with more predictability of impacts.

Digital Agenda for Europe

The challenges facing humanity are revealing themselves as increasingly global and highly interconnected. The next few decades will give us the tools to start mastering this complexity in terms of a deeper understanding, but also in terms of policy and action with more predictability of impacts.

This will result from a combination of thus far unseen Big Data from various sources of evidence (smart grids, mobility data, sensor data, socio-economic data) along with the rise of dynamical modelling and new visualisation, analysis, and synthesis techniques (like narrative). It will also rely on a new alliance between science and society.

The virtualisation of the scientific process and the advent of social networks will allow every scientist to join forces with others in the open global virtual laboratory. Human performance enhancement and embeddable sensors will enable scientists to perceive and observe processes in the real world in new ways. New ICT tools will allow better understanding of the social processes underlying all societal actions.

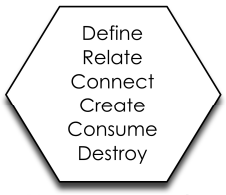
Digital games will increasingly be used as training grounds for developing worlds that work – from testing new systems of governance, to new systems of economy, medical and healing applications, industrial applications, educational systems and models – across every aspect of life, work, and culture.
Digital technologies will also empower people to co-create their environments, the products they buy, the science they learn, and the art they enjoy. Digital media will break apart traditional models of art practice, production, and creativity, making production of previously expensive art forms like films affordable to anyone.
The blurring boundaries between artist and audience will completely disappear as audiences increasingly 'applaud' a great work by replying with works of their own, which the originating artist will in turn build upon for new pieces. Digital media creates a fertile space for a virtuous circle of society-wide creativity and art production.
Art practice will gain a whole new status and role in future societies. Creativity will be the key for harnessing the new possibilities offered by science and technology, and by the hyper-connected environments that will surround us, in useful directions. Art, science and humanities will connect to help boost this wave of change and creativity in Europe.

Key Issues

- How do we engage policy makers and civic society throughout the process of gathering data and analysing evidence on global systems? How do we cross-fertilise sciences, humanities and art?
- How do we ensure reward and recognition in a world of co-creation where everyone can be a scientist or an artist from his/her own desktop? How do we deal with ownership, responsibility and liability?
- How do we keep scientific standards alive as peer-reviewed research and quality standards are challenged by the proliferation of open-access publication? How do we assure the quality and credibility of data and models?
- How do we channel the force of creativity into areas of society that are critical but often slow to change, like healthcare, education, etc.?
- How do we ensure universal access and competency with emerging digital and creative technologies? Greater engagement of citizens in science and the arts? How do we disseminate learning about creativity and the arts to currently underserved populations?
- Equitable benefit distribution: how do we ensure that the benefits scientific discoveries and innovations are distributed evenly in society?

- Clear, effective communication, across multiple languages: how do we communicate insights from complex systems analyses to people who were not participants in the process in ways that create value shifts and behavioural changes to achieve solutions to global issues?
- Can the development of new narratives and metaphors make scientific results accessible to all humanity to reframe global challenges?
- Can the virtualisation of research and innovation lifecycles, the multidisciplinary collaboration and the cross fertilisation with arts and humanities help improve the impact of research?
- Transformation of education: how might the roles of schools and professional educators evolve in the light of the science and art revolution? What might be the impact on jobs and productivity?
- How do we respond to the increasing demand for data scientists and data analysts?
- How do we cope with unintended and undesirable effects of pervasive digitization of society such as media addictions, IPR and authenticity, counterfeiting, plagiarism, life history theft? How do we build trust in both artists and audiences?
- How do we ensure that supercomputing, simulation and big data are not invasive to privacy and support free will and personal aspirations?
- Can crowd-financing platforms for art initiatives balance the roles in current artistic economies (e.g. arts granting agencies, wealthy patrons)?
- How do we harness digital gaming technologies, and developments in live gaming, to allow users to create imagined worlds that empower them and the communities they live within?

Verge Analysis

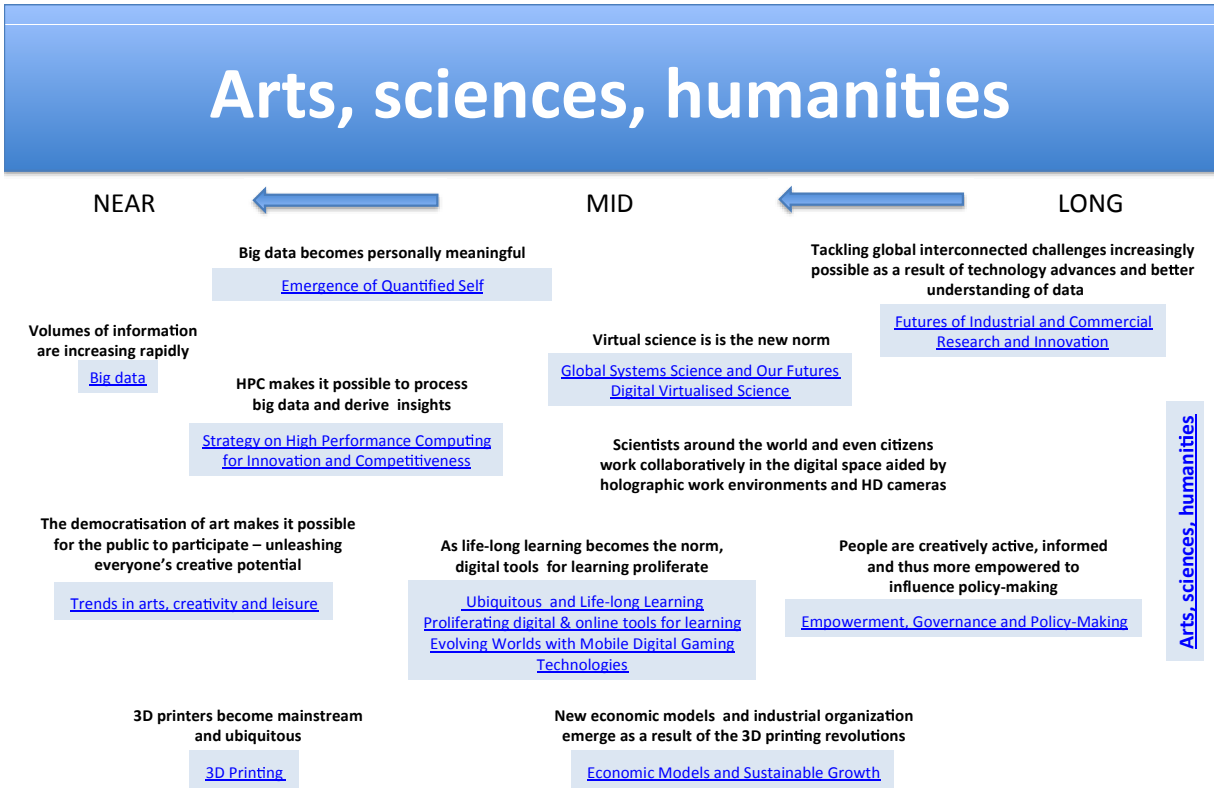


Verge Framework

Arts, Sciences, Humanities could potentially transform how we:

- *Define*: The increasing importance and recognition of the power and prerogatives of non-state actors and networks of actors in mobilizing resources to address shared challenges.
- *Relate*: Issue-focused networks for innovation and problem-solving will be dominant form of organizing and connecting global talent and advocates.
- *Connect*: Big data, pervasive computing, and the ubiquity of social networking will allow advanced analytics to identify stakeholders, relevant resources and competencies, and key interconnections that drive the formation of successful projects and teams.
- *Create*: Intelligent systems will provide important cognitive and analytic augmentation for individuals and teams. Social financing will funnel increasing amounts of resources directly to innovation and problem-solving efforts.
- *Consume*: The hyper-connectedness of the world, combined with rising machine autonomy across technical platforms, means that individuals and groups will increasingly appeal directly to "the world" for assistance and for options.
- *Destroy*: Individuals and groups pursuing divisive or destructive ends will benefit from all of the same shifts in information, connectivity, and capabilities.

Backcast



Long Term

Tackling global interconnected challenges is increasingly possible as a result of technology advances and better understanding of data

- Significant technological advances have taken place. Examples include high performance computing (HPC), increased capacity for data storage, and highly efficient batteries.
- Innovative methods for data visualisation and modelling enable scientists to analyse massive datasets and complex systems, and communicate results easily

People are creatively active, informed and thus more empowered to influence policy-making

- Digital media has enabled people to inform themselves on any issue of interest.
- People regularly express their interests or opinions in online forums and discussion boards for community, city, regional, and national issues.
- These opinions are then channelled to policy-makers and influence their work.

Mid Term

Virtual science is the new norm

- Science is increasingly digitised and virtual, global scientific networks link not only data and research papers, but sensor nets and 'internet-of-things'-linked instrumentation.
- Experimental lab results are recorded and uploaded online immediately to widen analytic perspectives and involve peer review from the beginning as a result of the Open Science movement.
- High performance computing systems capable of managing and analysing big data enable much experimentation to take place virtually, with models of molecules, living systems, buildings, cities, energy flows, etc.

Scientists and citizens around the world work collaboratively in the digital space aided by holographic work environments

- High-bandwidth ICT systems worldwide are interconnected and scientists are able to collaborate effectively.
- Citizen scientists access and engage in the scientific process as well.

New economic models and industrial organization emerge as a result of the 3D printing revolutions

- 3D printing has enabled the DIY movement and created the new maker revolution.
- As a result industrial organisation has changed significantly – now people produce the goods they need in their homes, using a 3D printer, or in their neighbourhoods at a local manufacturing centre or maker space.
- Old manufacturing bases are obsolete.
- New economic models have emerged to accommodate these changes.

As life-long learning becomes the norm, digital tools for learning proliferate

- Internet access is ubiquitous in most parts of the world and digital tools for learning proliferate.
- These include virtual environments, specialised social media discussion forums and freely available massive open online courses (MOOCs).

Near Term

Big data becomes personally meaningful

- "The quantified self," the continuous collection of personal and physical data, is an accepted part of life. People are recording individual habits ranging from miles run on the weekend to the volume and variety of food they consume.
- Epidemiological breakthroughs in public health are resulting from analysis of these massive individual health datasets that reveal hitherto unsuspected patterns in human behaviour.
- These patterns offer insights into issues such as variations in food demand, water use, and medical needs across a large segment of the population, as well as pointing to strategies for improving public and personal health.

High Performance Computing (HPC) makes it possible to process Big Data to identify previously unrecognised patterns

- High performance computing coupled with mathematical innovations increase the efficiency and decrease the time required to analyse massive datasets.
- HPC improves the rapidity and volume of scientific turnover, and also the rapidity with which computing itself is improved – as high performance computers are used to design their own next generation.

Volumes of information are increasing rapidly

- Massive increases in global data volumes are generated by data collected from a growing global population of mobile telephones, power and ICT grids, and smart sensors.
- Business, non-governmental organisations, and government agencies are all prioritising infrastructure to collect, analyse, and manage massive datasets.

The democratisation of art makes it possible for the public to participate – unleashing everyone's creative potential

- People feel more empowered to create art as the boundaries between artists and audiences are starting to disappear.
- Anyone equipped with the relevant digital tools can now easily express his or her creativity across almost all media.
- A virtuous circle of creativity results, generating a new renaissance in the arts and design.

3D printers have become mainstream

- 3D printing has entered the mainstream.
- Most people are now able to print their own customized objects.
- New industrial models are emerging.

European Commission

Shape the Future

Cities, villages and communities

Cities will grow into megacities, which will be highly vascularized by eco-friendly and energy-sustainable transportation means, and filled with new dwellings and buildings made from innovative construction materials.

All elements of the city will be connected to a higher supra-network, the future Internet, on which a whole new service-economy will thrive. Cities throughout Europe will compete among each other as places to be, developing their own forms of participatory citizenship to drive a continuous co-creation of the city-scape and its multi-cultural social fabric.

Digital Agenda for Europe

Cities will grow into megacities, which will be highly vascularized by eco-friendly and energy-sustainable transportation means, and filled with new dwellings and buildings made from innovative construction materials. All elements of the city will be connected to a higher supra-network, the future Internet, on which a whole new service-economy will thrive. Cities throughout Europe will compete among each other as places to be, developing their own forms of participatory citizenship to drive a continuous co-creation of the city-scape and its multi-cultural social fabric.
Villages will be only seemingly detached from this, as they link themselves into the same web of connectivity, and develop their own specific offerings for work, living, socialising or leisure. However, they will also need to face higher sensitivity to seasonal fluctuations and to forces of attraction and repulsion from neighbouring cities.
Key challenges will be how to avoid a split between communities developing in the villages and those of the cities; how to maintain cities and villages as hubs for open streams of people and ideas to move between them, rather than as closed protective environments for social classes or the like-minded; how to manage and optimally use information on these habitats, with full respect for the privacy of all; how to make sure a vibrant urban experience is shared across Europe; and how to develop a fair competitive landscape throughout the territory, and that investments are equitably distributed geographically.

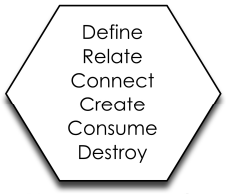
Key issues

- Decentralising manufacturing**:** 3D printing and distributed manufacturing become mainstream in the market, enabling vibrant small-town economies; they may require lower price points, higher functionality and better ease of use. How can we ensure such favourable conditions are created?
- Speeding up production: In order to completely transform the way in which global industry works, 3-D printing must be able to mass produce goods in the same volumes as traditional manufacturing techniques. Achieving this kind of critical mass requires one of 3-D printing's key disadvantages to be effectively overcome – namely, speed of production.
- Creating and sourcing competitive substitutes: can a graphene "killer app" – with distinct advantages over current technologies – be commercialised and scaled up to fulfil its perceived promise? Can rare earth elements (REEs) be sourced, processed in cleaner, less hazardous ways and used more frugally?
- Bio-mimicry challenges: imitation of models derived from nature is a promising technical approach that is already mainstream – Velcro fastening copies the way a bur seed attaches itself, for instance, but has a low public profile. Its extension into areas like DNA and genetic manipulation will raise a range of concerns: ethical, health and safety, also conflicting patent and IPR claims on multiple uses of 'lessons' from the same piece of nature.
- Mobility: How will we integrate currently separated transportation services with different *passenger, demand, rate-of-return, and risk profiles?*
- Investments: Improved access to risk finance, especially for SMEs.
- Crime and resilience: use of intelligent transport systems will raise issues such as security in the face of terrorism and risk perception and trust, as regards driverless trains for instance.
- Food divides: Avoiding the emergence of high-quality food 'food oases' among the rich while low-quality food 'food deserts' proliferate among marginalised communities.
- System limits: How will Europe and other regions address a triple systems-limit crisis created by too little land, water, and energy, greatly limiting food production?
- Water scarcity: Innovations leading to affordable, reliable desalination might make water available to all, but could create a paradigm shift in governance and forecasted migration flows.

- System vulnerability: How will our needs for security be addressed as systems become increasingly integrated?
- Communication standards: How will we meet the need for common communication standards and protocols across public and private networked systems?
- Resident security: How will it be possible to attain the right balance between the individual rights to privacy and security?
- Migration: Given the continued rise of emergent economies (and especially new South-to-South migration patterns) and emergent xenophobic and identity-based political trends (of various agendas, levels of popular support and longevity) could the EU become a less favoured destination in the future – and its communities less diverse and creative?
- Economic refugees: The economic crisis prompted a nascent trend of South-to-North intra-EU migration. Should recovery take longer how might such underlying regional economic disparities influence this trend over the longer term?
- Border controls: The ability of the EU to control immigration 'flows' has been described as an 'illusion'. How does the EU need to adapt in order to address both existing and emergent challenges in this area?
- 3-D printing will fuel innovation and creativity especially as the techniques increasingly allow creating parts so complex they were either previously impossible or extremely difficult to make. This opens new areas for brand new products to emerge, perhaps with entirely new properties, driving new urban and community economic dynamism.
- Might we enter a future in which products are always available and never become obsolete? How might 3-D printing further drive 'long tail' niche consumption markets?
- There is growing research into how 3-D printing can be used in the medical sciences, food production and architectural construction areas. These themes are sometimes less recognised than ideas about industrial production but successful innovations in these areas could have significant social opportunities for communities, especially in housing and social care.
- Breakthroughs on graphene or REEs could successfully combine or be integrated with other emerging production and manufacturing technologies, like 3D printing; there could be transformative social effects reaching much further than any technology on its own; for example, how might cheap and highly effective solar panels change the lives of 1.4 billion people currently without *access* to *electricity* worldwide?
- New ideas for product development based not on what material can be supplied but on what can be found locally may have profound impacts on notions such as sustainability or developing world innovation approaches like 'Jugaad', a style of improvised, frugal engineering or the design of cradle-to-grave product cycles.
- Reduction in commute times as work and productivity are decentralised.
- Fuel savings – support for building alternative energy generation and energy harvesting infrastructure in tandem with – and embedded in – integrated intelligent transport systems (e.g. Solar Roadways).
- Reduction in single-owner automobiles – more walking, shared transport, mass transit.
- Healthier urban environments.
- Better land use.
- Emerging businesses using perennial / renewable production processes borrowed from biology, such as grain crops that mimic prairie ecosystems.
- Potential for transformative new market niches built around radically novel food products and services.

- Europe could become a haven for various gene-based health and wellness solutions (such as personalized nutrition) due to its genetically homogenous population.
- Better nutrition and diet choices could contribute to lowering the huge healthcare cost Europe is facing by 2030.
- Local food: "city" food production and regional food demand might reboot the local economy and shops.
- Regionalism and co-creation with customers of city food factories.
- Increased citizen participation in civic decisions such as community resource allocations and priorities.
- Immigrants have long been regarded as a key catalyst group in creating and successfully commercialising new products and services with a concomitant longer-term effect of new job creation and overall economic growth. Europe could offer vibrant cities and small communities to both attract and then support non-EU citizen entrepreneurs.
- The "economy of common good", an online economic system built on values that embed the economy into the local social context, into the set of constitutional values, and into the ecological foundations of life, will emerge. Individuals, companies, and polices will interact in a participatory way to contribute to the "Common Balance Sheet" and thus to a sustainable future.

Verge Analysis

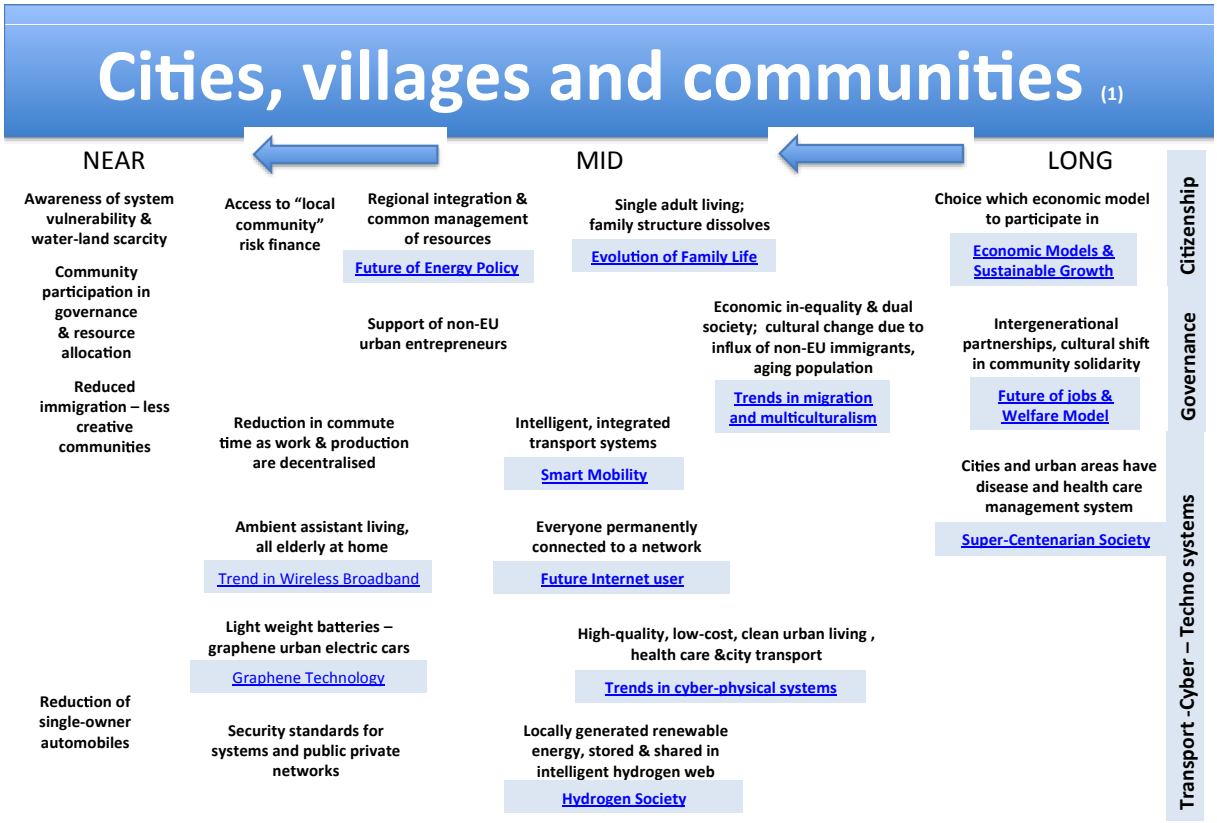


Verge Framework

Cities, Villages and Communities could potentially transform how we:

- *Define*: As a greater percentage of all populations are "urban" the underlying cultural archetypes will undergo shifts to account for the challenges of daily life faced by megacity urbanites.
- *Relate*: Within megacities the combination of forces driving "sorting effects" and socio-economic segregation will be critical patterns that cannot be avoided.
- *Connect*: "Sharing" economy business models and base levels of entrepreneurship will be key elements in the evolution of transportation networks within megacities.
- *Create*: Urban farming, urban foraging, and vertical farming will all be key innovations pursued in urban environments.
- *Consume*: "Collaborative consumption" and sharing economy business models, combined with hyper-accurate urban data on the location and flow of goods and services.
- *Destroy*: The emergence of social and economic forces that tear at a common identity and shared social fabric, or that inhibit its growth, will be impossible to prevent.

Backcast



Part 1

Citizenship Cluster

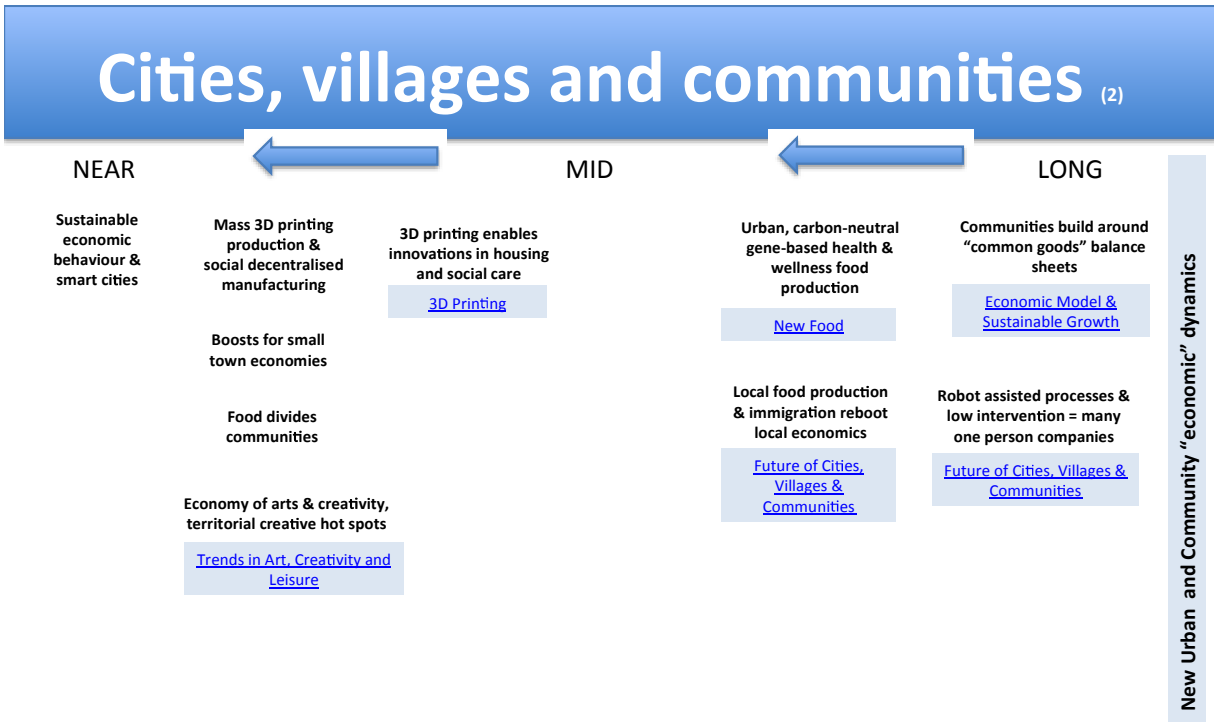
- In 2050 our economy will be based on a more optimized and customized consumption in which individuals are informed and empowered. They are able to decide in which economic model(s) they want to participate, depending on their needs, values and lifestyle.
- The OECD study on families to 2030 notes the rise of the single adults, new households and the fluidity of family structures.
- The use of domestic energy resources will be carefully planned, and regional integration more thoroughly explored, to sustainably manage common natural resources.
- Improved access to risk finance, especially for SMEs and local community investments.
- Growing awareness of the vulnerability and scarcity of water and land.

Governance Cluster

- Cities and urban areas will design their own health care management systems and portfolios depending on needs and local health issues and diseases.
- Intergenerational partnerships and cultural shifts will transform patterns of community solidarity as a new mixed culture evolves.
- Economic inequality has the greatest impact on migration. Migration and multiculturalism are key factors in social change and development.
- EU governments invest heavily in non-EU entrepreneurs in order to fill the gap as established European entrepreneurs age.
- Given the continued rise of emergent economies and emergent xenophobic and identity-based political trends, the EU could become a less favoured destination in the future for high potentials and creative people – and its communities less diverse and creative.
- Increased citizen participation in civic decisions such as community resource allocations and priorities.

Transport, Cyber and Techno Systems Cluster

- When using hydrogen as the necessary storage medium and as an energy carrier (in addition and complementary to electricity) in the grid, a "Hydrogen Energy Web" (HEW) that enables peer-to-peer energy sharing can be implemented.
- Cyber-physical systems will have a huge impact on the quality and cost of urban life. Smart city infrastructure will integrate information from public and private spaces to create cleaner, healthier, more efficient living conditions.
- Advanced networking technologies will connect higher numbers of objects, higher data transfer rates, pervasive access to information, and richer content. The future network paradigm will connect anything, anybody, anytime, anywhere on any device.
- Intelligent Transport Systems and rapidly evolving ICT technologies will play a key role in transforming transportation and delivering safe, efficient, sustainable and seamless transport options for freight and people across Europe. High-speed communication networks, crowdsourcing, cloud storage, social networks, "internet of things/vehicles", advanced data analytics, multiplication of mobile applications and massive amounts of data made available by proliferation of sensors are the connectivity components that will provide many new opportunities for personal mobility and for transport of goods.
- Security standards will make it possible to attain the right balance between the individual rights to privacy and security and the useful gathering of data.
- The high surface-to-mass ratio of graphene makes it suitable for ultra-high capacitors and light-weight batteries. The prospect of rapidly chargeable lightweight batteries would give environmentally friendly transportation a major push and advance the large scale implementation of electric cars as a key component in urban and suburban transportation in Europe.
- Smart home and smart city networks will enable people to stay in their own homes for elder care and health care (ambient assisted living – AAL).
- Reduction in commute times as work and productivity are decentralised.
- Reduction in number of single-owner automobiles – more walking, shared transport, and mass transit.



Part 2

New Urban and Community Economic Dynamics Cluster

- Large-scale robot-assisted processes, with minimal human intervention: "one-person companies" will be common.
- Communities are built around individual, local or/ and common interests. The "economy of common good" will evolve: an online economic system built on values that will embed the economy into the social context, local values and natural local resources.
- Local food: "city" food production and regional food reboot the local economy and shops. Immigrants are a key catalyst group in creating and successfully commercialising new products and services.
- Better nutrition and diet choices lower the healthcare cost in Europe.
- Carbon neutral cities and green cities will assist their citizens in producing healthy gene-based food in urban areas, including co-creation of regional city food "factories," urban orchards, urban vertical farms, and cooperative ownership of food production (e.g. "cow shares"). This will partly resolve logistics issues in cities and meet the need for regional community building initiatives.
- 3-D printing will transform communities, especially in regards to housing and social care.
- Cities: territorial creative hot spots. Town centres are likely to continue to lose shops as people do ever more shopping online. Developing street art and community arts provide new ways to fill those spaces and create activity, connection and experience. The resulting transformation of spaces can in turn spark economic revival.
- Food divides communities: high-quality food 'food oases' arise among the rich while low-quality food 'food deserts' proliferate among marginalised communities.
- A mass production breakthrough with 3D printing will make products always available. Decentralised manufacturing close to living centres and fast times to market will boost small-town economies.
- Sustainable economic behaviour**,** whereby cities learn to exist on less of today's sources of energy (e.g. switching to carbon-neutral forms of energy) will lead to smart cities.

European Commission

Shape the Future

New economic models

In 20-30 years the world's economy may change significantly, driven by the advent of new technological and societal innovations.

Advanced robotics, automation, and manufacturing will bring most of today's production back to a local sustainable dimension. 3D printers will make possible the self-production of many consumer items like clothes or furniture. Only large artefacts (e.g. aircraft) will still be produced in a few centralised plants.

Digital Agenda for Europe

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As products will be more and more self-designed and manufactured just-in-time, the roles of consumers and producers will become indistinguishable. The concept of participation in a "shared economy" will be reinforced by consumers extracting maximum value from produced goods as well as by the flourishing of a Do-It-Yourself economy.

New materials and ICT technologies will significantly reduce our dependency on scarce resources. The take up of big data analytics and of increasingly accurate simulation models of the global ecosystem will make it possible to predict the availability, production and consumption of raw materials and energy sources, and to inform decisions at all levels.

Entrepreneurs will contribute to tackling major social issues and offer new ideas for wide-scale change. New finance models such as crowd funding will grow in significance and new and alternate currencies, and non-monetary systems such as internet-based bartering systems, will become an integral part of the economy. Individuals will contribute to new perspectives on collective "ownership".

Communities will evolve around local and global interests. The market will be shared between multi-national companies and small local enterprises, operating across borders within a new governance framework.

New lifestyles and behaviours will emerge as a result of an increased awareness of the sustainability challenges and sharing of values. The concept of money as a means of economic exchange will change to leave space for non-material values.

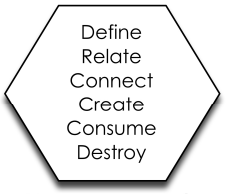
This will facilitate the transition from GDP-based linear models to new non-linear, circular economic models fitting the sustainability equation and centred on new metrics and indicators (e.g. domestic wealth index, happy planet index).

Key Issues

- How can the current economic crisis be turned into an opportunity to experiment with new paths beyond long-cherished economic concepts (productivity, growth,…)? Is it possible to manage change and ensure peaceful and sustainable "co-growth"? Can we define indicators that are more future-proof and accurate than today's indexes (e.g. GDP)? Can we experiment with new economic models and systems and pilot-test them on a small scale?
- Is it possible to break the core economic conundrum once and for all: increased national debt => structural reforms, cuts and/or austerity measures => smaller margins to increase consumption and production and for investments in research and innovation => smaller margins to increase productivity, competiveness and growth => increase deficits and debts?
- What kind of economic and political governance can we envisage in a world where everyone can be a global economic player? Are new principles and governance models needed? How can future governance reconcile the multiple interests cutting across global, regional and local scopes? How can we cope with cross-sectoral interests? How might the emergence of new economic powers affect the structure and rules of major economic and financial organisations such as WTO, IMF, Word Bank, G20, IGF, etc.? How can we agree on and enforce new "rules of the game" globally?

- Will the worldwide expansion of the middle-class (and its lifestyles) increase competition for more and more scarce resources? How far can the demand for scarce resources grow and affect prices? Will this lead to more conflicts and instability?
- How can economic power shifts, fluctuations in labour costs, and technological advances create new dynamics in the production and consumption of goods? Can a new geo-localisation of production and consumption be envisaged? Can the diversification of design and innovations based on local and regional biospheres generate opportunities for new product markets?
- What kind of financing approaches are needed to fund research and innovation in times where leading the technological development becomes increasingly critical? Can crowd-financed science or combined funding sources help overcoming possible financial shortages?
- What are the main barriers that could prevent technologies (ICT, bio-technologies, new materials, etc.) from being adopted and delivering on their promise? Can lack of standards, shared frameworks for trust and privacy, intellectual property rights, patenting, liability, costs/benefits issues, but also resistance to transition and legacy issues become severe obstacles?
- Can the take-up of future smart grids and new sustainable energy sources help overcoming the excessive costs of energy bills? What else is needed to make future economies less dependent on energy and other resource shortages?
- Can social innovation help in achieving sustainability and contribute to a more responsible management of natural resources and our environment (e.g. recycling)? What else is needed?
- How can scarce and recyclable technologies and materials help fuel new ideas for product development and sustainable innovation? Can a world in which no products become obsolete create a net improvement in both sustainability, quality of services, and quality of life?

Verge Analysis



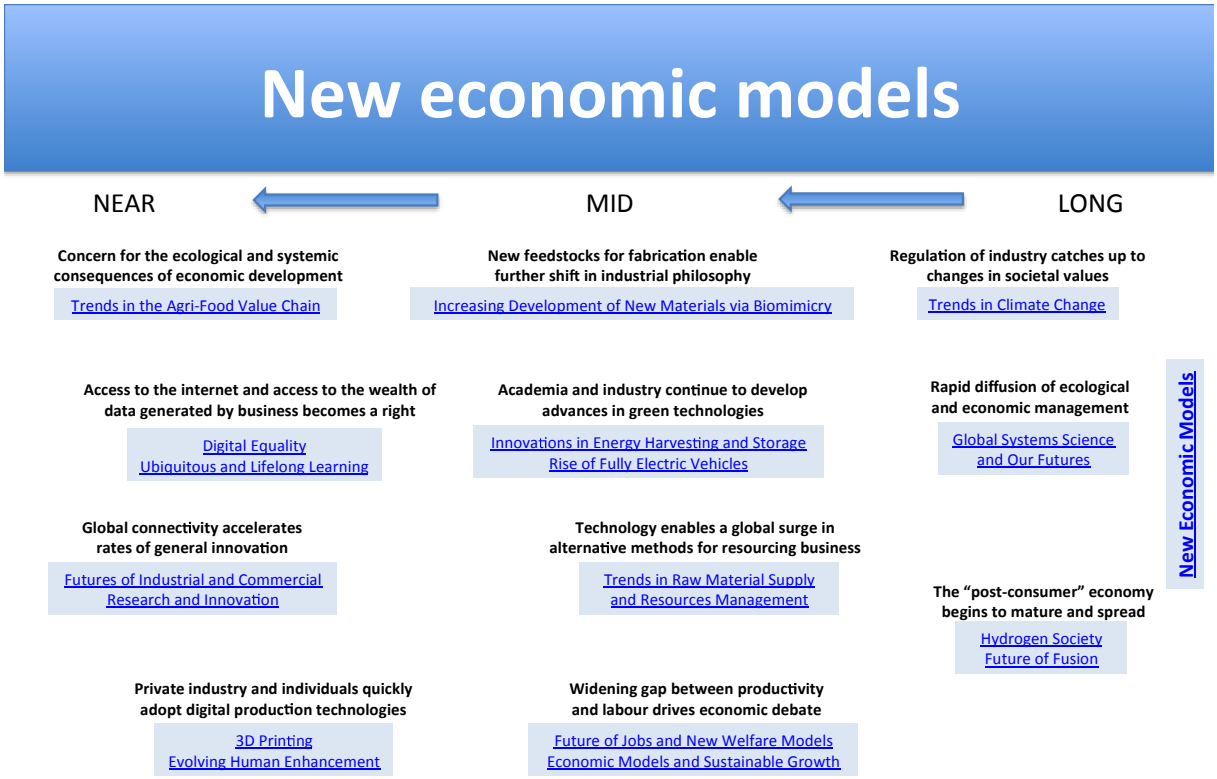
Verge Framework

New Economic Models could potentially transform how we:

- *Define:* These new models will change how people define roles in economics, e.g. producers and consumers. They will also affect how value is defined in this new economy – classic economics values productivity (land, labour, capital); neo-classical focuses on the productivity of labour and capital; this new focus on sustainability means a new valuation of natural systems and ecosystem services.
- *Relate:* What makes this future work is distributed social networks and the hyper-connection of humanity, made possible by ubiquitous ICT and digital networks. Additionally, this signals a watershed in how people relate to nature, seeing themselves a part of nature rather than outside of it.
- *Connect*: This depicts a future of new economic possibilities arising from and amplified by innovations in digital connectivity that will also make it easier to build platforms and conduits to clear diverse and interconnected networks of value, whether currency, social action, or ecosystems services. The shift in emphasis to sustainability would also generate new forms of connectivity in the form of new slang, new artistic media connected to environmental systems.
- *Create:* How people create data, analyses, and services will change profoundly in this future due to innovative analytic algorithms, smart automation, and augmentation of humanity potentially changing how we create creativity itself. Waste will be massively reduced or zeroed, as cradle-to-cradle creation of goods and services becomes widespread. Also critical is considering how food production will change given this shift in economic models, from industrial, centralised agriculture to permaculture, urban agriculture, and more decentralised, pervasive agriculture based on edible landscaping – turning everything around us into a food-producing resource.

- *Consume:* New models of a sustainable sharing economy will heighten awareness of what is being consumed and how; and how consumption may be networked through a community, combined with co-creation of goods, connected to upcycling and recycling of goods.
- *Destroy:* This will massively disrupt traditional business, industry, and economic models, creating a broad, multi-year wave of dislocation and disruption across business and employment.

Backcast



Long Term
End State:

- Non-linear, circular economic models
- Local sustainable production
- Self-production/prosumers
- Dominance of decentralized manufacturing chains

Regulation of industry catches up to changes in societal values and advances in science and technical knowledge

- As climate change impacts increase, political and regulatory systems heighten their focus on maintaining environmental quality and ecosystem services, and supporting evolving economic paradigms.
- New metrics to monitor industrial processes embody a paradigm shift with regard to resources and cradle-to-cradle manufacturing cycles.
- Green energy sources, production, storage and dissemination are prioritised.

Rapid diffusion of ecological economic management

- Simulation models of ecosystems grow increasingly useful with the advent of pervasive environmental smart monitors, biosensors, big data analytics and high-performance computing.
- Econometric forecasting, network analytics, and related techniques enable the development of sophisticated dashboards for resource management and policy-making that enable widespread participation by citizens with online access.

The "post-consumer" economy begins to mature and spread across the developed world

- Collective ownership, the rise of sharing economy and prosumerism signal a watershed shift in personal economic paradigms and values by new generations of economic actors.
- Non-material values rise as people find the material world is increasingly mutable and transformable with micro-power generation and localised manufacturing (3D printing), cradle-to-cradle recycling and upcycling, and augmented reality and virtual world digital overlays.
- Innovations in both fusion production and hydrogen production and storage begin weaning the world from fossil fuels.

Medium Term

New feed stocks for fabrication further enable the shift in industrial design philosophy and ecological business models

- The shift in focus from 'heat, beat, and treat' in creating materials feed stocks to mimicking materials produced by living processes (bio-mimicry) both reduces environmental impact and also opens up new possibilities for product innovation.
- 'Cradle-to-cradle' design values emphasis both recycling and upcycling raw materials and products as basic feed stocks.

Academia and industry continue to develop impressive advancements in green technologies

- Increased funding for both academic and industry R&D produces innovations in bio-mimicking technologies such as artificial photosynthesis methods.
- Increased support also generates breakthrough efficiencies in energy harvesting, heat pumps, photovoltaic materials and products design, biofuel sources and refining, and renewables (solar, wind, wave-power) infrastructure design.

Technology enables a global surge in alternative methods for resourcing projects and business

- Crowd-financing both product development via sites like Kickstarter and also scientific research via sites like Experiment.com and Petridish.org increases steadily, enabling more bottom-up innovation, entrepreneurial activity, and popular involvement in science.
- Experiments in both local currencies and digital currencies continue to expand; crypto-currencies increasingly bridge business initiatives in the formal, informal, grey, and black economies.

Widening gap between productivity and labour drives an escalating debate about the economic future

- The digital transition proves positive for knowledge workers and creatives, opening up entirely new modes of work, but reduces both opportunities and wages in other sectors as automation and smart systems start gutting even white collar administrative jobs.
- The sputtering and extended recovery from the financial crisis that dragged down the world economy at the beginning of the 21st century provides an opportunity for radical system re-design through the development of new economic ideas that address the failures of the past.

Short Term

Concern for the ecological and systemic consequences of economic development become a tent pole issue

- Stresses to the global food supply chain become more common as climate change affects growing conditions, water supply, and habitats, but with better understanding and anticipation of climate and weather impacts throughout supply chains, biotechnology offers solutions that are more frequently applauded than protested by most people.
- Younger generations with different values become decision-makers in business and politics; their holistic, complexity-informed perspective calls traditional approaches into question.

Access to the internet and access to the wealth of data generated by business becomes a right

- Communication and data links are widely acknowledged to be critical for education, business and productivity; and for responsible citizenship as well.
- Citizens lobby for open and transparent access to their own and all public data, and responsible use and access of 'big data' resources and analytics by government, business, and non-profits.

Global connectivity accelerates rates of general innovation and reshapes the contours of the innovation landscape

- The evolving datasphere of high performance computing, high bandwidth communication links, ubiquitous sensor nets, high definition visualisation equipment, and 3D printing are changing how scientists and designers are engaging in research, design and innovation.
- Infrastructure evolution in research, design and innovation is matched by cultural and fiscal changes supporting open innovation, innovation networks, and crowd-sourced innovation.

Private industry and regular individuals quickly adopt digital production technologies

- Digital technologies of production, particularly CAD/CAM software and 3D scanning and printing, support the Maker movement boom in locally organised, locally feed-stocked, locally designed and locally manufactured products developed by entrepreneurs and small businesses.
- The Maker movement is related to and reinforces the "next-shoring" perspective, which emphasizes proximity to demand and to innovation in order to adapt products to different regions, using local supply ecosystems as a differentiator and tailoring products to local culture.

European Commission

Shape the Future

Pursuing global peace

In the coming 30-40 years, societies will be characterised by continuous tension between individual and collective interests, leading to a continuous tension between two opposing models:

1) a society where only a few decide for all, either as elected representatives, or because new forms of oligarchic power emerged to exert societal manipulation; 2) a society with neither classes nor hierarchies, characterised by participatory leadership and new forms of "chaordic" organisation, where all have the possibility to co-decide on most if not all issues that matter to them.

Digital Agenda for Europe

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The former will be characterised by new forms of social control enabled by the mass adoption of technologies and societal manipulation techniques evolving from advances in neuroscience and neuro-cognition. It will follow a Darwinian principle that the stronger prevails over the weaker in the fight for survival. The latter will be characterised by new forms of resource sharing, balanced distribution of values, empathy, and solidarity. The society of the 50s will be massively multi-cultural, due both to physical mobility and the global spread of social networks and knowledge-sharing. The rise of transfrontier cyber-societies is an emerging trend during the period, possibly triggering techno-Luddism in some societies. The family will remain central to society but will evolve towards 'mixed families' containing offspring from successive relationships of the principals.

Inter-generational gaps (occupy movements being early signal), the rise of the global middle-class, resource scarcity, and the spread of fundamentalisms could lead to more conflicts. It may also be that the fragmentations of today's humanity (ethnic, culture, religious, economic, educational divides) will be reconciled and that people realise that their commonalities are more than their differences.

The struggle for resources (including jobs) could trigger strong migration flows, combining with other factors such as the need to escape oppressive regimes. Across the world, approaches to gender will vary significantly, with even a return to traditional specialisation roles between gender and ages driven by conservative values, while gender-specific roles may not exist at all in other communities and cultures because of increased access to education, less complex processes to change gender (progress in bio-medicine), and shifting cultural and religious factors. Technology may be decisive to enable either peaceful or conflictual scenarios.

The issue is how to ensure the responsible development and use of technology to manage tensions and prevent conflicts.

Key issues

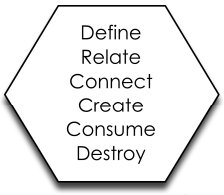
- Balancing rights and security in real and digital worlds: How do we find the right balances between the need to protect the rights of individuals (e.g. privacy) and the need to ensure security in a world of tensions? How will we reflect these new balances in future data jurisdictions, distinguishing between the different stages of the data value chain (sensing, gathering, access, monitoring, control, mining, quality assurance, management...) and powers (states, communities, groups, individuals)? The "hair trigger" response of social media will amplify the public perception of risk, making it harder for policy-makers to achieve that balance unless they are speedily able to master new communication techniques.
- Digital power games: open digital platforms are likely to be adopted by all parties involved in an issue or dispute leading to a 'level playing field' where problems such as the 'gaming of the system or difficulty in differentiating between accurate information and propaganda occur.

- Surveillance: States will exploit new technologies for a wide range of activities from information monitoring, performing security assessments up to and including active exclusion of individuals or groups. The risk is present in all societies given the challenge of democratic oversight even in democratic societies, but will be exacerbated in countries that control domestic versions of social media platforms, for example, China.
- Curating cherished values: How can we ensure that EU values are presented and leveraged at the global scale; for instance, ensuring that principles such as openness, transparency, fairness, privacy, and trust are encoded into future technologies and services 'by design'?
- Innovative political styles: How will future politicians meet the challenges of representing citizens, interests and needs in a different way, adapting to a different way of interacting with their citizens and networks, and with new ways of collecting knowledge for policy-making and win electorates? How will they adapt their leadership and to become more participatory?
- Empowerment trade-offs: Increased empowerment of individuals cannot be at the expense or risk of other individuals, communities and states (e.g. security risks). The difficulty in finding universally accepted trade-offs may be a barrier to the practical implementation and deployment of future citizen empowerment technologies and infrastructures.
- The pace and distribution of empowerment: A too rapid pace of development of empowering technologies and their commoditisation may lead to fragmented regulation and generate social or geographical divides; new ways of mitigating tensions and conflicts need to emerge. One instance of an individual empowerment issue is the set of ethical concerns related to the enhancement and life-extension of people that will make them cyborgs.
- Relationships and meaning: The technologies developed in the 20th century have dramatically extended our outreach and our capabilities, although they do not give a meaning to our life as such. Therefore, the real issue is not Human-Machine interaction but Human-Human relationships mediated by technology.
- Shadow economy and rule of law: Government legitimacy and the rule of law might be rendered ineffective in economies where the illicit economy is dominant. The countervailing need to have good "tax morale", willing tax payers, and to preserve incentives will remain important
- Shadow economy and government resources: Governments might not be able to pay for key services and infrastructure investment if large and growing amounts of economic activity are untaxed. Informal employment might extend unchecked into the future having tremendous impact on tax returns.
- Impacts of xenophobia: Given the continued rise of emergent economies (and especially new South-to-South migration patterns) and emergent xenophobic and identity-based political trends (of various agendas, levels of popular support and longevity) might the EU become a less favoured destination in the future?
- Economic crises and conflict: The economic crisis prompted a nascent trend of South-to-North intra-EU migration. Should recovery take longer how might such underlying regional economic disparities influence this trend over the longer term, and what conflicts or tensions might result?
- Border controls: The ability of the EU to control immigration 'flows' has been described as an 'illusion'. How does the EU need to adapt in order to address both existing and emergent challenges in this area?
- Creating a framework for digital trust: The primary challenge is to create a simple, accountable framework of trust among human beings that ensures that all data, and all digital technologies – are ethically collected, developed, and administered. If this challenge is not met effectively, and quickly – 1] the development of entire industries, from cloud computing to social media, will be

severely curtailed, and 2] the disintegration of systems of governance due to lack of trust – from political to economic to cultural – will compound.

- How do we ensure sufficient capacity to review current governance models and explore new governance paradigms to ensure resilience of the present and future hyper-connected society?
- What will be the scope for EU values to be present and have leverage at the global scale; for instance, ensuring that principles such as openness, transparency, fairness, privacy, trust are encoded into future technologies and services 'by design'?
- What capacity will exist for citizens to learn and adapt to new policy making practices and new ways of exercising political rights? ICT technologies allow a higher level of public participation, with access to devices and networks being a key factor.
- How can we assess how the shadow economy might evolve in established and emerging sectors could help the EU / governments take preventive actions?
- How can we closely monitor the informal economy in order to generate ideas how to innovate in health/ education and other services?
- How can we transform society, the economy, and government with both the solutions to the grand challenges we face, and also with collaborative and creative approaches we use to imagine those solutions?
- Immigrants are a key catalyst group in creating and successfully commercialising new products and services with a concomitant longer-term effect of new job creation and overall economic growth. Europe will increasingly consider how it can create the conditions necessary to both attract and then support non-EU citizen entrepreneurs.
- The primary opportunity is to develop a simple, foundational system of trust that can be administered from home to school to corporation to government, to whole systems.
- The governance and sustainability of cities will be important for peace and harmony, as it touches on many issues such as migration and environmental concerns. For example, by 2020, 25% of the world's protected areas will be within 15 km of an urban city. Cities will have more opportunities and responsibilities to maintain bio-diversity and functioning eco-systems.

Verge Analysis



Verge Framework

Pursuing Global Peace could potentially transform how we:

- *Define*: "Open" as an ethic will be a pervasive and a core element in much of mainstream life, being celebrated and taken for granted by the masses while being appropriated by the technological elite as cover for more intrusive and pervasive data capture of society.
- *Relate*: A concurrent resurgence of "tribes" with significant cross-cutting affiliations and alliances.
- *Connect*: Technologies and platforms that promise to keep private the activities of individuals and groups will rise significantly in importance. Technologies such as encryption and quantum cryptography will be sought after.
- *Create*: There will be a significant devolution of governance responsibilities to localities (cost-shifting) through "Gov 2.0" and open data efforts along with increasingly sophisticated attempts at high level societal steering through surveillance, big data, and advanced modelling and predictive analytics.
- *Consume*: Civic media and social media as news platforms will make it easier for groups to pressure governing elites while those same groups will tend to look to each other for day-to-day issues.
- *Destroy*: Digitization will create increased systemic risks that can be exploited by aggrieved parties of all stripes.

Backcast

Long Term

Population demographics lead to high dependency ratios

- Global population growth peaked at this time, creating the need for new planning perspectives on a longer term future which could be dominated by aging populations, increased sectoral poverty, reduced tax-bases and the potential for intergenerational discord.
- This period also saw the consolidation of previously emergent patterns of migration across the world, with less South-to-North movement and more direct South-to-South activity.

Rise of politically networked but economically interdependent conurbation cities

- Although most urban growth had taken place in mid-sized cities, these now began to merge into larger federated conurbations challenging traditional notions of political affiliation and control and posing significant issues in relation to the security of infrastructure, transport, communications and 'life materials' provision (food, water, shelter).
- These cities are connected to a range of global, local and informal digital networks that have now become the basis for almost all political, economic, social and cultural transactions. Network security is fundamental to the functioning of the city at this point.

Reduction in global income disparities and poverty reduction

- A growing global middle class over the preceding decades had taken advantage of benign economic conditions that enabled them to reduce their relative level of poverty; however, a persistent percentage of most societies working population had consistently remained at the lowest level of socio-economic standing.
- As countries aged, increasing dependency ratios and pension provision issues, began to introduce issues of longer term poverty for those in retirement.

Near universal basic food security achieved

- To offset the detrimental effects of climate change, food production governance had evolved to the point at which market speculation was restricted and each nation adhered to the provision of basic level of access to food stuffs thus promoting greater overall security.
- A combination of new foods and the enhanced nutritional value of food stuffs meant the deleterious effects of malnutrition on both short-term productivity and intergenerational longevity were reduced.

Emerging use of data to enable citizens to dispense resources

- A 'layered' series of ownership and moderation structures began to develop based on the longer term gathering of data from networked sensors as they became embedded into the extraction, production and supply processes of energy and resources. From this, citizens enacted dynamic, real-time control over individual, shared and collective allocation and usage.
- Similar processes emerged within politics, ensuring that decision-making became evermore subject to both the accessible sentiments of networked citizens but also, through big data aggregation and analytics, to the their implicit behaviourally derived needs. Governance became fluid across different scales, from the local to the global.

Mid Term

Access to energy services and rising global energy demand

- While progress had been made in reducing the approximately 1.4 billion people who did not have access to electricity in 2010, by this point, a substantial number still remained without supply with clear impacts on their longer term social and economic development options and overall sense of 'life security'.
- At the same time, driven by economic growth and the increase in the numbers of people occupying the middle class, energy demand had soared to a point where it could not be fully supplied in the future without rapid change in the ways in which it was produced and also in the design and provision of suitable products and services. This was a time of tremendous uncertainty involving substantive change to our energy infrastructures whilst balancing the real threat of scarcity as the 'substitution' process played-out.

Levels of key non-renewable resources reach either supply or cost constraints

- Following the trend which emerged during the first decades of the century in which the overall output growth of oil and gas reserves was not enough to offset declining production from maturing fields, replacement ratios are below 40% and the marginal cost of production has begun to become unsustainable. This starts to introduce real scarcity into the market and threatens core elements of any countries ability to support its traditional manufacturing and transportation systems.

Negative impacts of climate change begin affecting key renewable resources and ecosystem services

- Key changes resulting from climate change begin introducing variable impacts across a range of areas including ocean chemistry, weather patterns, rainfall distributions and growing seasons.
- Traditional levels of productivity for renewable resources begin to be directly affected with decreases in outputs such as agriculture and fisheries. This has significant implications for the food security and livelihoods of some of the most vulnerable populations across the world.
- As a response, social unrest more probable and related issues such as both intra-state and inter-state migration becomes prominent.

Emerging resource, health and climate change issues change the rationale on security

- Since the beginning of the century, security issues had increasingly been considered not just by reference to the direct threat of inter-state military action, but as a result of the interplay of a wider and interdependent range of factors such as economic conditions, migration, climate change impacts, resources availability and the outcomes of disease and disasters (both via natural and man-made hazards).

Emerging commercial scale applications of new materials and energy via nano and biotechnology

- Initial developments in these fields had begun to demonstrate how new forms of materials and energy production which could potentially be used to create new products and services or provide substitutes in order to enable a long term infrastructure replacement process to begin.
- Key to this, is the ability of such nascent technologies to achieve some level of 'mass' commercial uptake to start the process of cost reduction over time and so avoid issues of exclusion.

Post-WW2 global governance arrangements begin decline; emergence of increased multi-lateralism

- The core governance structures formed after the Second World War begin a longer term process of decline and replacement, with institutions such as the United Nations, the World Bank and the IMF coming under increasing pressure.
- The world is now multipolar with a number of 'centres of gravity' displaying variable levels of political, military and economic influence. However, there is an increased level of multilateral regime development designed to assist and promote regional partnerships.

Growth in global middle class ensures continued pressure on traditional resource availability

- As emerging economies strengthen and mature, the absolute number of people able to call upon relative improvements in their levels of disposable incomes is set to increase, driving further levels of overall consumption (and the attendant usage of resources).
- Achieving middle class 'status' also tends to have concomitant effects in other areas; enhancing the role of women, reducing the number of new children and creating a greater uptake of education. Collectively, these tend to be seen as factors which reduce social conflict.

Continuing process of urbanisation

- The trend of ongoing urbanisation continues representing a fundamental shift in human spatial distribution.
- Most of this trend will take place in 'medium-sized' cities with a substantive element of such development being informal in nature in the form of slums and shanty-dwellings. This may have implications for the security of the 'resource flows' needed to support this increase in population such as land, energy, food, water and waste disposal.
- While this influx encapsulates a key migration dynamic and is likely to be an element that drives the general growth of urban economies it may also place increasing strain on wider city infrastructures and supporting social services such as transport, education resources and medical provision.
- How the process of urbanisation further contributes to the shadow economy may play a key role not only in how cities are able to fund themselves through a tax base but also as unofficial support networks that may alleviate social issues should jobs or resource availability be compromised.

<u>Near Term</u>

Increasing trend towards deployment of sensors into the environment

- Designs for updating or building new core infrastructure begin to include sensor technologies as standard as a means to enable performance monitoring, service evaluation and running cost analysis.

- Increased deployment of sensors into the home and consumer goods begin the process of creating a longer term dataset to enable a better understanding of consumption patterns, product performance and longevity and replacement and waste management processes.
- Larger sensor arrays are more frequently deployed into fragile ecosystems or natural hazard environments to provide better risk assessment, change management and early warning information.

Challenges in overall global diseases burdens contribute to social and development instability

- The range of previously treatable diseases which were now effectively 'drug resistant' reached alarming proportions threatening the health security of millions.
- An increasing range of new animal-to-human diseases emerged.

Continued decline in number of large scale state-to-state armed conflicts

- The trend towards an ongoing reduction in the number of large scale state-to-state conflicts continues to decrease, but intra-state and cross-border conflicts continue to evolve.
- There is an increasing fragmentation in the number of key groups or constituencies involved in any particular conflict.
- The security paradigm starts to change with explicit accommodation of areas such as environmental change and human needs.

Trend towards ubiquitous network connectivity for all citizens

- The majority of people are now able to regularly connect to internet services via a variety of devices.
- Both business and government recognise the value in ensuring the highest level of 'digital equality' as a means of promoting wider social inclusion, access to economic opportunities and commercial services and involvement in electronic governance and political processes.
- Younger generations are used to widespread access to data and information and comfortable with conducting digitally mediated social relationships.
- Both individual opinion and collective public sentiment is increasingly expressed, aggregated and monitored directly via online channels.

Onlife Initiative and Manifesto

The final component of the Themes section presents the Onlife Manifesto, an overview statement presenting the goals of the On-Life Initiative and their ongoing exploration of issues arising from our rapidly evolving digital life. The Onlife Manifesto, and the wider Initiative work, are not a Theme in the sense of having been synthesised from related Futurium futures and trends. The Onlife discussions and explorations instead provide an over-all framing for the deep questions of impacts on people and communities and the role of participatory action in managing change and its impacts.

The deployment of information and communication technologies (ICTs) and their uptake by society radically affect the human condition, insofar as they modify our relationships to ourselves, to others and to the world. The ever-increasing pervasiveness of ICTs shakes established reference frameworks through the following transformations:

1. the blurring of the distinction between reality and virtuality;
2. the blurring of the distinctions between human, machine and nature;
3. the reversal from information scarcity to information abundance; and
4. the shift from the primacy of entities to the primacy of interactions.

The world is grasped by human minds through concepts: perception is necessarily mediated by concepts, as if they were the interfaces through which reality is experienced and interpreted. Concepts provide an understanding of surrounding realities and a means by which to apprehend them. However, the current conceptual toolbox is not fitted to address new ICT-related challenges and leads to negative projections about the future: we fear and reject what we fail to make sense of and give meaning to.

In order to acknowledge such inadequacy and explore alternative conceptualisations, a group of scholars in anthropology, cognitive science, computer science, engineering, law, neuroscience, philosophy, political science, psychology and sociology, instigated the Onlife Initiative, a collective thought exercise to explore the policy-relevant consequences of those changes. This concept reengineering exercise seeks to inspire reflection on what happens to us and to re-envisage the future with greater confidence.

The Initiative has a presence on Futurium (http://ec.europa.eu/digital-agenda/en/onlife-initiative) that is open to public participation, debate, and commentary. The members of the Initiative also regularly offer conference presentations, panel discussions and seminars. These live events have included:

- On February 18 Nicole Dewandre spoke at a seminar at L'Atelier organized by Netopia where *Ethics in the Digital World – A Closer Look at Clouds, Big Data and the Internet of Things* were discussed.
- *A philosophical view on hyperconnectivity:* Corina Ciechanow blogs about Nicole Dewandre's presentation about Hyperconnectivity at the Rotary club of Waterloo.
- *The Onlife Initiative: SSH as a source of innovation!, Vilnius, 7 November 2013*; Nicole Dewandre, Mireille Hildebrandt and Judith Simon presented the Onlife initiative at the ICT 2013 Conference.
- *The Onlife Manifesto: rethinking the human condition in a hyperconnected era, Denver, 26 October 2013*; Nicole Dewandre has presented the Onlife initiative at the IR14, The 14th Annual Conference of the Association of Internet Researchers.
- *The Onlife Manifesto: Being Human in a Hyperconnected Era, Montréal, 14 October 2013*; Nicole Dewandre has presented the Onlife initiative at theWorld Social Science Forum.
- *Presentation of the Onlife initiative, Lisbon, 4-6 July 2013*, The Onlife initiative was presented in the context of SPT 2013-Technology in the Age of Information.
- *Presentation of the Onlife initiative, Lisbon, 1-3 July 2013*, A panel on 'The Onlife initiative: why philosophy matters to policy?' took place in the CEPE 2013 conference 'Ambiguous Technologies:

Philosophical Issues, Practical Solutions, Human Nature. The panellists (in alphabetical order) were Nicole Dewandre, Charles Ess, Luciano Floridi, Jean-Gabriel Ganascia, Ugo Pagallo and Judith Simon.

A complete list of Onlife Initiative events is available online (http://ec.europa.eu/digital-agenda/en/onlife-news).
The Onlife Manifesto is available online for download (http://ec.europa.eu/digital-agenda/en/onlife-manifesto), as are the in-depth reports and discussions comprising the initial outcome of the Initiative (http://ec.europa.eu/digital-agenda/en/onlife-original-outcome).

4 What's beyond the digital society?

Waves of change

In *Technological Revolutions and Financial Capital*,[7] Carlota Perez suggests that technological transformations of society and the economy follow a distinctive life cycle. An innovation emerges as a discovery or novelty, and undergoes an 'installation' period. During this time, the new paradigms that accompany the innovation challenge "business as usual" and old paradigms. Investment concentrates around the new technologies, and income polarises in those economic sectors most transformed by the new technology. A technological bubble ensues followed by collapse. But this simply presages a consolidation of the most useful variants of the innovation, and widespread installation and market adoption of the technology. The new paradigms that accompany the innovation undergo a similarly widespread adoption. This results in a 'golden age' that matures, until the next transformative technological installation period.

Arguably the digital society is poised halfway between: much has been deployed, much remains to be installed. But already we can see how the digital infrastructure itself supports the start of the next age, a biotechnology age, even as we move into the 'golden age' of a global digital knowledge society.

In creating that new golden age, ICT is dramatically transforming the global economy and societies at an unprecedented pace. Very soon it will permeate people's lives so deeply that they no longer distinguish digital technologies from their environment, or even from themselves. But what will happen twenty years from now? Today's adults will be elderly, their children will be heading towards retirement, and those "born digital" will be struggling to address the challenges of the next great technological revolution, where ICT and biology blend. What technological innovations are likely to emerge and shape the lives of succeeding generations? Will ICT be capable of continuous rejuvenation, remaining a main transformative socio-economic driver?

No easy answers exist: change creates a volatile, uncertain, complex, and ambiguous environment. But in times of epochal systemic crises, people are obligated to reflect about their futures, to consider promising new scientific and technological advances, and to stimulate positive thinking without neglecting risks and threats. Every crisis reveals new opportunities to fuel progress and build a better world for ourselves and for future generations.

ICT, still a long way - or a long wave - to go

Information and Communication Technologies have been widely recognised as drivers of economic and social transformation. Since the beginning of the digital age fifty years ago, ICT has been instrumental in radically transforming production processes, services, and automation, industrial production, transport, agriculture and environment, and also health, art, cultural heritage, science, religion, politics and social interactions. These innovations have transformed the planet with unprecedented rapidity, scope (basically all mankind and its environment) and levels of disruption.

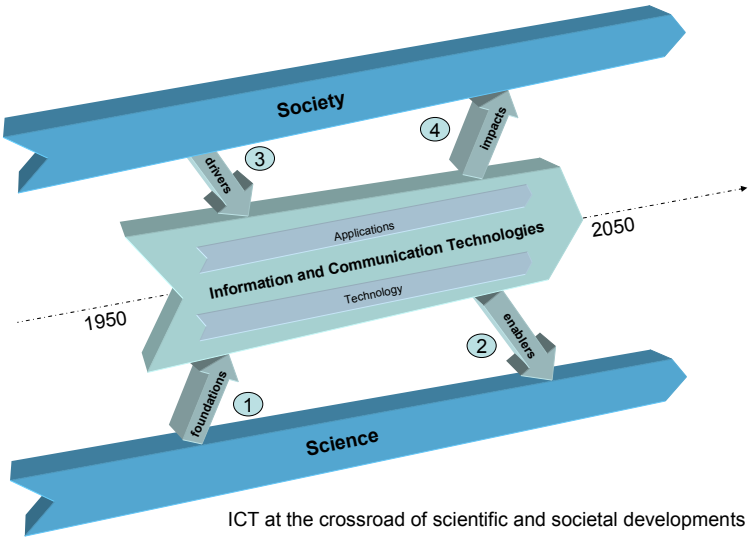
The "democratisation" (or commoditisation) of ICT has been speeding up with the fall of prices that followed an increased miniaturisation of hardware. Consistent advances in software technologies and the advent of the internet, alongside a number of innovations in interface and media technologies, have made ICT increasingly ease to use, powerful and affordable by all.

According to some futures researchers (e.g. Daniel Šmihula), the ICT wave has reached an end and a new technological revolution is emerging, sparked by discoveries in alternative energy sources, bio-medicine

[7] Perez, Carlota. *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. Edward Elgar: 2003.

and new materials. Other experts believe that ICT is still maturing, and that new and even more promising technologies and applications can be foreseen in the future.

ICT, as both an engineering discipline and a pervasive technological infrastructure, is and will still be at the crossroad of many innovations taking place in science and society for the next 20-30 years.



ICT at the crossroad of scientific and societal developments

Long-term advances in ICT will be fuelled by at least four scientific "revolutions" based on radically new concepts and scientific foundations:

11. **New materials** (e.g. graphene) will unleash new possibilities for the development of new semi-conductors, nano-devices or display technologies. These advances may then enable exploitation of the inner properties of matter, at the level of atoms (e.g. spintronics), to build new forms of computing.
12. Progress in **bio-engineering and synthetic biology** will enable designers to build new forms of biologically-inspired hardware and a 'programmable' bio-chemistry. These in turn may be implanted and used to understand complex biological structures at a molecular scale and also to realise new forms of prevention, diagnosis and medical treatment.
13. The capability to build **quantum processors** and communication devices will allow replacing the current internet backbone with a "quantum internet" capable of transmitting data streams orders of magnitude larger than today's technology. Quantum communication will open new doors for a variety of applications, including 100% secure distributed processing.
14. A better understanding of the **cognitive processes** of the human brain will also trigger significant technological advancements in ICT. For instance, by mimicking the operational sophistication of the brain, future ICTs may advance in terms of energy-efficiency, resilience and robustness, memory and storage, transmission and visualization.

These developments, while still only in their early stages, will pave the way to a post-silicon era. They will enable the design of ICT systems with unprecedented processing and communication power, which in turn will provide platforms for transformative applications. We cannot at this stage predict which of these revolutions will be more promising and when they will materialise – but we can anticipate the range of possibilities, and prepare to take advantage of them.

As new generations of ICT become available, they will improve the methods of science itself, and scientists will be the first to benefit. Researchers will be able to build more accurate digital ("in silico") models of the world and to perform detailed virtual experiments and simulations of natural phenomena. They will be able to collaborate at the speed of light using high-bandwidth-enabled participative processes. Indeed, all citizens will potentially be "scientists" using innovative sensor, visualisation, and analysis apps for crowd-sourced research. Participative, transparent research paradigms will bring more and more people into the emerging global knowledge community.

ICT developments will continue to be driven and inspired by social challenges. As new and more ambitious policy targets are set, for instance to further improve quality of life and longevity or to face new sustainability challenges, they will imply new ICT capabilities, generating new rounds of innovation to answer challenging technological requirements downstream in the enabling chain.

Finally, progress in ICT will continue to drive major social transformations. The complexity of society makes those changes the most difficult to anticipate. Beyond the digital society, a new form of humanism (trans-humanism) may evolve, where ICTs and other technologies fundamentally improve the human condition, eliminate aging and enhance human intellectual, physical, and psychological capacities.

In summary, ICT is the technological gateway where advances across science will converge with the requirements posed by an increasingly demanding society. The ICT revolution that has lasted about 70 years will continue for another 20-30 years, spurred by the preceding advances until 2040-50, when ICT will "disappear," to become an integral part of a peaceful and harmonious world.

A glimpse of ICT-enabled futures beyond the Digital Society

The Digital Society (underpinned by the Digital Agenda) will see its apogee near 2020. Beyond today's Digital Society, i.e. around 2030-40, lies a vision (a preferred future) where the border between global and local, virtual and physical dimensions will disappear, where connected machines will perform simple and complex tasks like humans, and humans (and living organisms) will be enhanced with nano-scale devices and functions (cyborgs).

In 2030-40, we will more fully understand the complex mechanisms of life, the interactions of living organisms and cells, and how biological strings express into complex biological functions. This will be made possible by new and more accurate computational models of living systems and by the availability of practically unlimited computing power.

Progress in quantum physics and bio-chemistry will help push the frontiers of computing and communication. Technology will be invisible thanks to the advances in atomic and molecular scale miniaturisation. Computers will be able to mimic the brain, and people will be able to move objects with their net-connected minds, and also play music or exchange information. People will choose between controlling transportation and mobility devices with their minds; or letting the device think for itself, and their interaction with the environment will be mediated by friendly robotic companions.

Technology will become energy-positive and environmentally-friendly, capable of harnessing potential energy sources at the nano and micro scale such as the kinetic energy present in the form of random fluctuations, ambient electromagnetic radiation, chemical energy and bio-inspired energy production and storage systems. People's internal biophysical energy sources will power their implanted devices and sensors.

Advances in enabling technologies (e.g. quantum teleportation) will push the continued expansion of the Internet, as will the need to support more and more sophisticated application scenarios that instantaneously bridge the physical and virtual worlds. The internet and internet connectivity will be a "utility" like electricity. Its complexity and significance will dramatically increase as we move to the new era of nano and micro sensors and wi-fi-connected devices. Virtual spaces and 3D social networks will exchange zettabytes of multimedia data every day. The concept of email may no longer exist and browsing the web will be something only grandmother remembers doing.

In a typical Belgian home of 2040, residents will be able to play tennis with their friends in southern France with the realistic feel of being on the same physical court and entertaining friends and spectators from all around the world. While on the train from London to Rome passengers will be able to meet up with people in China and then share a dinner with friends in Lisbon and Amsterdam, ending the evening by virtually participating in a rock concert in Berlin. When reaching Rome, passengers will be able to don clothes that are instantaneously 3D printed, based on the models they drew during the trip.

Interactions with machines will be mediated by new communication paradigms. Teaching and learning by examples will replace the concept of rote memorisation, and people will be able to customise their

products just by expressing their preferences. The products themselves will adapt in real time or be tailor-made by in-home or neighbourhood manufacturing robots. Users will constantly be part of research and innovation lifecycles and creativity will flourish across science and design as well as the arts.

In this future forecasts and decision analysis will be easier and faster than ever. Collective debate on critical public issues will draw on wider evidence because scientific observations and insights will be open to analysis by all. As a result, governments will be able to shape policies more dynamically and in a more participative way. People will have a voice in policy and decisions regarding public assets, projects, laws and regulations. Interactive public referenda could determine where to build schools or to place stoplights on roads (if such objects still exist in 2040). Policy options could be tested beforehand in the virtual space before collaborative decisions are reached and implemented.

People will able to shape their private spheres in virtual and physical spaces: the ICT-enabled built environment will be more interactive, flexible, adaptive and mutable. People will trust the invisible, embedded, ubiquitous ICT infrastructure that makes it all possible.

This may bring to a close consumerist-materialist society. Jobs and resources may be shared across the population according to real needs and aspirations in new ways, through multi-properties and co-ownership for instance. The inclination of individuals to compete for personal realisation could find its natural expression in arts, sport and games. Individualism (and, with it, capitalism) could find a new balance with collectivism and harmonious resource sharing.

In such a world, social and geo-political imbalances would by definition be flattened. Balanced control and sharing of resources would not be the prerogative of a small subset of states. The concept of state itself would tend to disappear, leaving in its place a new form of social aggregation that mixes local and global dimensions.

This preferred future could dramatically change our existence. It will be characterised by the emergence of new personal experiences, new forms of art and creativity, new psychological contexts, all leading to the new humanism of the 21st century, a trans-humanism.

Can this dream become reality in 30-40 years? What steps would society need to take? Can people influence the future? Who would be marginalised and disadvantaged? What are the ethical, democratic, and human rights issues at stake? What might be the unintended consequences? What are the risks and threats? Is society reaching a "singularity point"?

Humanity has the knowledge and the resources to transform what can be perceived today as fiction into reality in less time than people may imagine. But not everyone may want such scenario, which would generate new tensions, new crises and even wars.

Back to the present

But the second decade of the second millennium marks a period where technology may expand exponentially[8] both in power and diffusion, while at the same time the world is facing a complex systemic crisis unprecedented in human history. As that crisis unfolds, it will continue to generate new conflicts and economic upheavals.

How can and should Europeans cope? How can succeeding generations position themselves to prepare for these scenarios? What we must remember is McLuhan's adage, "First we shape our technology, and then it shapes us." Generations to come will perceive the world differently, value different things, and construct their social reality differently from the adults of the present. In a technological context where specific technologies or software programmes update every few years or few months, the technological generations are cycling faster than the human generations.

How might the changing technological milieu change each successive human generation's perspective? Bear in mind that people take for granted the technologies they had in childhood. Gen X grew up alongside the internet, the World Wide Web, and the emergence of robotics in everyday life, and they

[8] Kurzweil, Ray. *The Singularity is Near: When Humans Transcend Biology*. Penguin Books: 2006.

competed in school robot competitions and hacking code. Gen Y has grown up with Web 2.0, the social nets, touchscreen computing, and MIT's iGem Synthetic Biology competition: they are growing up taking hacking cellular code for granted. Gen Z will grow up with immersive, ubiquitous computing, the internet-of-things surrounding them with a smart interactive environment, and are likely to take hacking their *own* genetic code for granted (tattoos are so 20th C). What lies beyond Gen Z? Whatever social scientists end up calling that generation, with the convergence of planetary crises, technological capabilities and global systems science, they are likely to grow up wanting to hack the planet itself. No matter what lies beyond the digital society, successive generations will burst the boundaries of what present generations imagine is possible, and also perhaps exceed what people of the present would find preferable.

Thousands of sociologists, economists, philosophers, anthropologists, futures researchers and policy makers around the world have written extensive articles, documents and books about the global financial crisis as well as the global *problematique* - the environmental and climate crisis - analysing their origins and identifying possible ways forward. States and international organisations are taking austerity measures, a typical reactive strategy attempting to avoid the worse instead of planning for the best. But crises demand courageous thought and action. They may generate instability, uncertainty and depression, but they also provide critical opportunities to point the wind of progress in a new direction.

Digital Futures will continue to focus on anticipating these opportunities.

5 Conclusions

Lessons learned from crowd-sourcing

The Futurium is designed to attract and support public participation in co-creating Europe's future. The platform provides a wide variety of options, from creating entries that describe emerging change, from posting visions of preferred futures and encouraging commentary and discussion, to running formal polls and Delphi-like surveys. The platform also enables participants to build a shared library of critical resources, with entries annotated to highlight their usefulness for particular topics.

If you build it, they will come - maybe. The first hurdle in any public engagement or crowd-sourcing campaign is garnering attention and eliciting participation. In an age of mass distraction[9], indeed what some analysts characterise as an age of distraction addiction[10], it is increasingly difficult to secure the public's attention for anything. The fact that websites, videos, twitter streams, and news topics do go viral perhaps misleads us with a mirage-like promise of effortless public attraction. Creating a website that people will share means first of all creating a website that is effortless to use for its intended purpose. Futurium's score in this regard is uneven, as the initial platform design did not perfectly complement all of its intended foresight processes; it has evolved both in terms of visual design and user interface. Second, people must share something personal; and third, they must share an idea or message for which they have strong positive feelings.[11] Futurium does better here, as it asks people to share their personal perspectives about the evolving future, and what that means.

Crowds are diverse, maybe wise even; but they are not always well-informed. The strengths of crowd-sourcing include diversity of perspective; independence of perspective; decentralisation of power and production; and aggregated insight.[12] However, sustained exploration of long-range futures arising from advanced science, technology, and engineering discoveries requires a level of subject knowledge that the average citizen may lack, even if that person voices quite detailed opinions on the topic. Futurium offers a solution to this difficulty by providing a growing evidence library, and authors of entries on the platform often provide hot-linked citations as well.

Another underlying difficulty is not ignorance of specific topics or issues, but rather ignorance of the actual process: because futures research deals with uncertainty, ambiguity, and emerging change, its methods rely on maintaining clarity regarding conceptual categories, processes, and distinctions within different foresight categories. Both lay people and scientific and technical experts often lack familiarity with the paradigms, concepts, and methods of futures research. Any crowd-sourcing site for robust futures thinking needs to guide participants with basic conceptual definitions and simple explanations of the processes and how they combine. This aspect of the Futurium design is also still evolving.

Crowds and scientists do not easily mix. Because popular, public participation on technical topics is by definition less well informed than scientists and technical experts, the latter may be dismissive of the resulting content. By definition, crowd-sourcing content is serendipitous in structure: a scattershot of input can impact more than one topic, or affect one topic profoundly and others more superficially. In order to blend crowd-sourced input with scientific input, the crowd-sourced data and content must be reviewed; augmented with additional evidential detail; and organized for consistency and depth of annotation and analysis, comparability of structure, and clarity of presentation. It consequently requires a considerable investment of time and resources to upgrade crowd-sourced content even to minimally acceptable technical levels.

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9 Rosen, Larry. "Rewired: The Psychology of Technology," *Psychology Today*, December 18, 2012 at http://www.psychologytoday.com/blog/rewired-the-psychology-technology/201212/weapons-mass-distraction.

10 Pang, Alex Soojung-Kim. *The Distraction Addiction*. Little, Brown & Co.: August 2013.

11 Shepherd, Jack. "How to make something go viral: tips from Buzzfeed," in *The Guardian*, 17 March 2014 at http://www.theguardian.com/media/2014/mar/16/how-to-make-something-go-viral-tips-buzzfeed.

12 Surowiecki, James. *The Wisdom of Crowds*. Anchor: August 2005.

Futures research and scientists do not easily mix. Foresight as a discipline suffers from a related problem, which is that there are no future facts. Futures research deliberately searches out weak signals of change, where the landscape of hypotheses, results and insights is conflictual rather than paradigmatic. This allows early exploration of possibilities and their impacts, but does not endear the process to those who are more empirically-minded. The basic concepts and methods of futures work, as well as the output, must be communicated clearly to avoid misconceptions about the difference, e.g. between a weak signal and a trend, or between a trend and a vision, and of course between futures extrapolation and empirical prediction.

Uncertainty and politicians do not easily mix. Multiple articles have been written on the difficulties of engaging in foresight work within a policy context.[13] Further, the emphasis on 'evidence-based policy research' compounds several concerns, politicians' discomfort with uncertainty, scientists' discomfort with lay opinions, creating a potentially chilly reception for crowd-sourced foresight. Futurium as an exploration in Policy-making 3.0 simultaneously challenges several paradigms and aspects of European policy-making notably 'business as usual'.

Futurium is constantly growing and changing. A final difficulty is also the chief opportunity: an on-line foresight platform allows for continued discussion, revision, creativity, and growth. Because all futurizens are empowered to add comments, references, library entries and indeed revisions to the Futurium content, what is described in this document may have evolved by the time you have finished reading this, and go to explore the Futurium as it currently exists online. Any written report on the Futurium will only ever be a snapshot in time.

Three messages from futurizens

The Futurium content emphasised the following:

1. The world is changing rapidly and it will change even faster in the future. Europeans need to embrace change and look at the future with mindfulness and responsibility.
2. The best way to predict the future is to create it. This requires more visionary and agile policies. Policy makers need to seize the opportunities ahead and put science and technology at the centre of future policies.
3. Every citizen holds a stake in shaping our digital futures. Futurium enables us to harness our collective intelligence and aspirations to co-create compelling visions.

Ray Kurzweil estimates that by the end of the 21st century humanity will have experienced the equivalent of 20,000 years of progress at today's rate. Indeed, we live in times of "accelerated returns," where the exponential rate of technological progress affects societies at an unprecedented pace.

Where this long wave will take us as humans, as Europeans? What will happen thirty-forty years from now? What are the technological innovations that will shape the lives of our grand-children?

The Futurium initiative asked these questions to thousands of thinkers from all around Europe, including scientists and innovators, students and policy makers. Three illustrative visions are emerging from this journey:

The singularity is approaching. In 2050, human cognitive and physical capabilities will be enhanced with bio-technological add-ons. Cyborgs will perform complex tasks like humans; they will take over all routine jobs, from agriculture to construction, from office to industrial automation. People will live longer and healthier lives due to pre-birth prevention and organ regeneration and repair. We will be able to learn, work and play from the cradle to the grave, and that will be a very long arc.

[13] Voros, Joseph. "Reframing environmental scanning: an integral approach," *Foresight* vol. 03, no. 6, 2001; and Schultz, Wendy. "The cultural contradictions of managing change: using horizon scanning in an evidence-based policy context," *Foresight* vol. 8, no. 4, 2006.

Imagine this happens. What would happen to jobs? To welfare systems? To our free time? What are the norms and values in a world of enhanced humans?

The matrix is no longer fiction. In 2050 the internet will connect bits and atoms at the speed of light. Its algorithms will orchestrate zillions of smart objects that will share zettabytes of data every day, thus bridging the physical and virtual worlds instantaneously. In such a scenario, forecasting and decision-making will be easier and faster than ever, based on scientific evidence and people's aspirations. Interactive public referenda could determine where to build schools or to place traffic lights on roads, if such objects still exist in 2040. Policy options could be tested beforehand in the virtual space before collaborative decisions are reached and implemented.

How well will today's decision systems apply to a world where everything is trackable? What should be the rules of the game in a hyper-connected society?

New economic models. In 2050 automation and three-dimensional printing make possible the self-production of goods like clothes, watches or furniture at home (Philippe Starck is suggesting this now[14]), just-in-time. The roles of consumers and producers will become indistinguishable and a do-it-yourself economy will flourish. We will live in a world of user-generated and personalised everything, including content and media, where algorithms will tailor unique learning experiences to each student individually, as well as providing individually personalised healthcare, travel routes and energy plans.

Could this reverse today's globalised production? Can the diversification of innovations based on individual needs, local and regional biospheres, and local cultures generate new opportunities for Europe? What kind of economic shifts can be envisaged? Can we envisage a European model becoming the reference for other regions?

These futures could materialise in less time than we think. How can Europe ride the long wave of the digital transformation? What can we learn as citizens or policy makers?

The Futurium did not provide unique answers to those challenges, but stimulated all concerned to reflect deeply on them. This complemented and enriched the usual approach to think incrementally to policy planning.

Insights from the Futurium experience

Looking through the lense of history, humanity is at a turning point. We could soon be in a "shared economy" where people no longer need to work for survival or fight for resources. This could lead to a better world, but also to new tensions in society and between world regions. As digital technologies are cornerstones of this change, they should be at the centre of political debate, and provide a foundation for the political agenda at all levels.

Europeans need a shared sense of the challenges ahead, and the ability and will to embrace change with mindfulness and responsibility. For example, human performance enhancement may increase productivity, but at the same time it creates new risks, e.g. offensive use of bio-technological add-ons. We need to ensure that future technologies are always compliant with European norms and values, 'by design.'

Accelerated technological progress always risks creating new divides; it can heighten inequalities between enhanced and non-enhanced humans, across regions with different connectivity rates, among populations with different skillsets. To prevent or mitigate these emerging divides, digital literacy and infrastructure penetration should become constant priorities of future policies.

We also need to be ready to capture the opportunities ahead. For instance a new geo-localisation of production and consumption could make European villages and cities the nurseries for a new European renaissance; but for this to happen, EU policy makers should:

[14] Fingas, Jon. "Philippe Starck wants you to make 3D-printed custom furniture," *Engadget*, April 11, 2014 at http://www.engadget.com/2014/04/11/philippe-starck-3d-printed-furniture/.

- **Be courageous** and put their hands into the promethean flame of disruptive innovation. It is very simple: "the best way to build the future is to create it." The time for action is now. Horizon 2020 can be seen as the bridge to the future. Actions launched at the end of Horizon 2020 will affect our lives in 2025-30. Long-term actions may generate impacts through the middle of the century and beyond!
- **Create favourable conditions** for EU industry and SMEs to lead this digital transformation into the future. The EU can lead if it is able to create ecosystems at the local level with the ambition to break through globally. This could mean setting goals for technological innovation, e.g. building future supercomputers, or social innovation goals, e.g. facing a societal challenge. Horizon 2020 supports these favourable conditions and should be exploited as much as possible.
- **Be more agile and forward-looking** when designing future policies. Make "anticipation" an important ingredient of future policies. Ensure a sound base of scientific evidence and public discussion for every decision.
- The future belongs to everyone. We need to **embrace participation and ensure that no one is excluded** when it comes to shaping future policies. We need to challenge ourselves to move beyond public discussion of policy to public co-creation of policy, creating an ever-widening community of active stakeholders. This would provide a robust answer to calls for citizen engagement in policy-making. We need to understand people's dreams and fears, because the most compelling ideas in the future may emerge from them!

Scientists, entrepreneurs, policy makers, and citizens should all prepare for the coming challenges in order to societal growth and prosperity. Choices made today will have a lasting impact into the future. Combining the best of scientific evidence, foresight, and citizen engagement is the best way to ensure that the benefits of the digital transformation are brought to every EU citizen.

Who worked on Digital Futures

Digital Futures was implemented by a DG CONNECT Task Force composed of internal staff members from several services. Due to the very dynamic nature of the foresight project, the team evolved over time to face emergent needs. The Task Force was enriched also by a few interns who provided significant support from an operational as well as content point of view.

The task force was also supported by the following external contractors:

Fast Future Research Ltd, with TCS Digital World NV;

The Joint Institute for Innovation Policy (JIIP), with Technical research Centre of Finland (VTT), Louis Lengrand & Associes Sarl, Ramboll Management Consulting Oy Ltd;

Ernst & Young Special Business Services cvba/scrl, with Tech 4i2;

Rand European Community Interest Company.

The project management approach was also an experimental effort from an organisational point of view, combining both agile developments with more traditional silo-ed approaches to oversight. Lessons learned were shared across the Commission to prove that Task Forces can be very useful to de-silo traditional hierarchical organisation, while ensuring the needed degree of flexibility and autonomy that is needed in foresight projects like Digital Futures.

The Futurium was one of the priorities of the Digital Futures Task Force. It was entirely developed in-house, relying on open source components, contributed by thousands of developers.

Last but not least, the Futurium content was co-created by a community of 3500 people involved in the Digital Futures 'journey'. Those inputs were the most stimulating ones and impact continues to reverberate through the policy community within DG CONNECT and beyond. Although the Digital Futures Task Force ended in December 2013, DG CONNECT's new foresight sector, based in the Knowledge Management unit, is making foresight inputs to help prepare the Horizon 2020 2016/17 work plan, building on the eleven themes delivered by Digital Futures. The Futurium experience is currently being considered for wider deployment across Member States through the ISA programme, Interoperability Solutions for European Public Administration.

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Futurium site archive

http://ec.europa.eu/archives/futurium/digital-agenda/en.html