Report 2023

ELSA

RESEARCH QUESTIONS:

A. Are there any frameworks, models, etc?
B. What are example questions, dilemmas, etc.
C. What are useful example cases (with a special focus on AI)
D. What are different ways of thinking about how technology develops? (technological determinism, etc)
E. Is technology neutral? Or not?

A. ARE THERE ANY FRAMEWORKS, MODELS, ETC?

Reference paper:

Ethical Explorer Pack: toolkit to itinerate based on risky ethical zones considered as a metaphor to make a journey through what are the points to be analyzed

Ethics for designers: toolkit that engage with the ethical dimension of your designs, and invest in learning the following skill

Ethical dilemma scenarios and emerging technologies: Analysis of ethics as a tool alongside scenarios to make the understanding of the future of technology more understandable for the industry.

Main takeaway:

- Toolkits for the identification of ethical principles **exist but are few and focused on design**

- Consideration of using the **vision of possible scenarios** as a tool

Predicting the future of disruptive technologies: The method of alternative histories
- the paper states that it is not possible to clearly outline a way to predict a single future scenario.
- new method: This method focuses on brainstorming and outlining different future scenarios in a creative expert session.

Scenarios: tools for coping with complexity and future uncertainty?
- focuses on how a future scenario can be determined on the assumption that it is not possible to map out the factors that the future has
- Establish the three ‘golden rules’: credibility, legitimacy, and saliency.

Whole-pattern futures projection, using field anomaly relaxation
- The article elaborates on a framework called FAR (field anomaly relaxation) that aims to design detailed future scenarios.
- This model is based on 3 preconceptions: evaluate your option, explore with an analytic approach, and judgment is basically the same as intuition.

B. WHAT ARE EXAMPLE QUESTIONS, DILEMMAS, ETC.

Reference paper:

Lessons learned from the Ethical, Legal and Social Implications program (ELSI): Planning societal implications research for the National Nanotechnology Program: The ELSI method is not complicated enough to solve ethical problems related to nanotechnology.

Ethics in the quantum age: Ethics for quantum technology must be developed as a field of study. The main need is that it be considered for: fairness, benevolence, nonmaleficence (avoiding harm), autonomy and sustainability. The approach should be multidisciplinary.

Birth of Industry 5.0: Making Sense of Big Data with Artificial Intelligence, "The Internet of Things" and Next-GenerationnTechnology Policy: The article analyzes the company and its relationship with technology and the use of big data in the present and proposes a new method called PETER.

Main takeaway:

It would seem that the ethical questions we are asking today are **too developed for the ELSI system.** From this need new systems like **PETER (surrogate of post-ELSI) are born.**

Sub-question:

How can we create equal access to a socially responsible quantum internet in developing countries?

How should we use intellectual property and open-source instruments in an ethical way?

C. WHAT ARE USEFUL EXAMPLE CASES (WITH A SPECIAL FOCUS ON AI)

Reference paper:

Smart product-service systems design process for socially conscious digitalization: The article highlights the ethics problem that occurs in the Smart product-service systems design process and solves it with a co-creative approach.

Ethical governance of artificial intelligence: An integrated analytical framework: The paper addresses the topic of ethics in AI. The focus is on building a new framework that can ensure ELSI principles. The framework must be done with a holistic approach.

ELSA in Industrial Robotics: Analysis of the use of robots within the industry through ELSA. The context in which robots are inserted is very different.

From ethics of restriction to ethics of construction: ELSA research in Norway: It analyses the quality of life in Norway and finds an unclear method in the ELSI method. The article mentions that you try to use Post-ELSI.

Main takeaway:

- The **co-creative approach** could be considered as a method of preventing ethical problems
- The user should always be considered by the expert group
- It is preferable to always have a **mix of experts during ethical analysis**
- The **context and social environment** can totally change the ethical output

MIX OF A/B/C

Reference paper:

Designing for ethical innovation: A case study on ELSI co-design in emergency: The article addresses the issue of AI and IoT ethics by analyzing ethics in a case study called BRIDGE with creative co-creation during the design process.

Ethical, legal, and social considerations of AI-based medical decision-support tools: A scoping review: The paper summarizes the use of artificial intelligence in medical decisions with the aim to use ethical questions as a tool lasting the process of ideation itself.

Expanding ELSI to all areas of innovative science and technology: The article invites a multidisciplinary approach and suggests three methodologies to create a single policy for companies/ngo/access.

Main takeaway:

- Often when you bring together **different people with different backgrounds** you have a **communication problem**
- Ethics should be considered in **relation** to a person competent in one area - a person competent in another area
- In addition to academic research there should be the **involvement of research through meetings and communication** through the media such as TV series, films and **science fiction**

Science fiction prototypes: Visionary technology narratives between futures:

The paper elaborates on science fiction's role in creating future prototypes. Creating these prototypes presents the model of Mannermaa, based on:
- Descriptive // historicism that assumes that laws of historical evolution can be used to present a view of the future.
- Scenarios // that assumes that the future is not wholly predictable and constructs alternative futures.
- Evolutionary // that assumes complexity and conceives of the future as multiversal realities that are examined and developed through prototypes.

D. WHAT ARE DIFFERENT WAYS OF THINKING ABOUT HOW TECHNOLOGY

Reference paper:

Does technology drive history? The dilemma of technological determinism: Summary of the various perspectives that are analyzed in the book. In particular, the difference between hard and soft technological determinism is made. Moreover, the author comments that in technological determinism, utopia and dystopia are too often confused.

Ideological persuasion and technological determinism: article analyzes Ideological persuasion and Technological determinism separately and concludes that ideology and the preference for technology have inevitable consequences for the implementation of that technology in the future society.

Main takeaway:

- Technological determinism is the idea that **technology shapes social change.**
- **Hard determinists** hold that technology plays a complete and totalizing role in shaping human society.
- Soft determinists believe that while technology is an important factor in shaping the course of human history, the manner in which humans interact with society also needs to be considered.

E. IS TECHNOLOGY NEUTRAL? OR NOT?

Reference paper:

Tech causes more problems than it solves: The article republishes a series of quotes from several academics around the world who express their opinion on the relationship between technology and the future. Almost everyone speaks of technology as a means and of man as the destroyer and creator of his own problems. Everyone, on the other hand, seems to share a bad vision of the future.

Tech is (just) a tool: The article brings together different opinions of academics about technology neutrality. The common opinion in the article, however, is that technology is in itself a neutral element, the use that man makes of it is what determines its final output.

Technology: Good, bad, or neutral?: The article declares technology as neutral, arguing that it is man's aptitude to give it a positive or negative aspect.

Main takeaway:

- **technology is neutral,** man interacts with its possibilities and makes it negative and/or positive

Utopia and Dystopia:

Farm robots: ecological utopia or dystopia?: The article starts with the technology of robots for the agricultural industry 4.0 and elaborates on two different scenarios. A completely positive one (utopia), where small robots and nature live in symbiosis, and a completely negative one (dystopia) where mass production takes over and sweeps the ecosystem of the place. In addition, the technology is also defined here neutral with respect to its possible common uses.

Utopian and dystopian thought in climate change science and policy: Utopia and dystopia are considered as tools. In particular, utopia is linked to the sustainable development of society while dystopia is more of a “worst-case scenario”.

General conclusion:

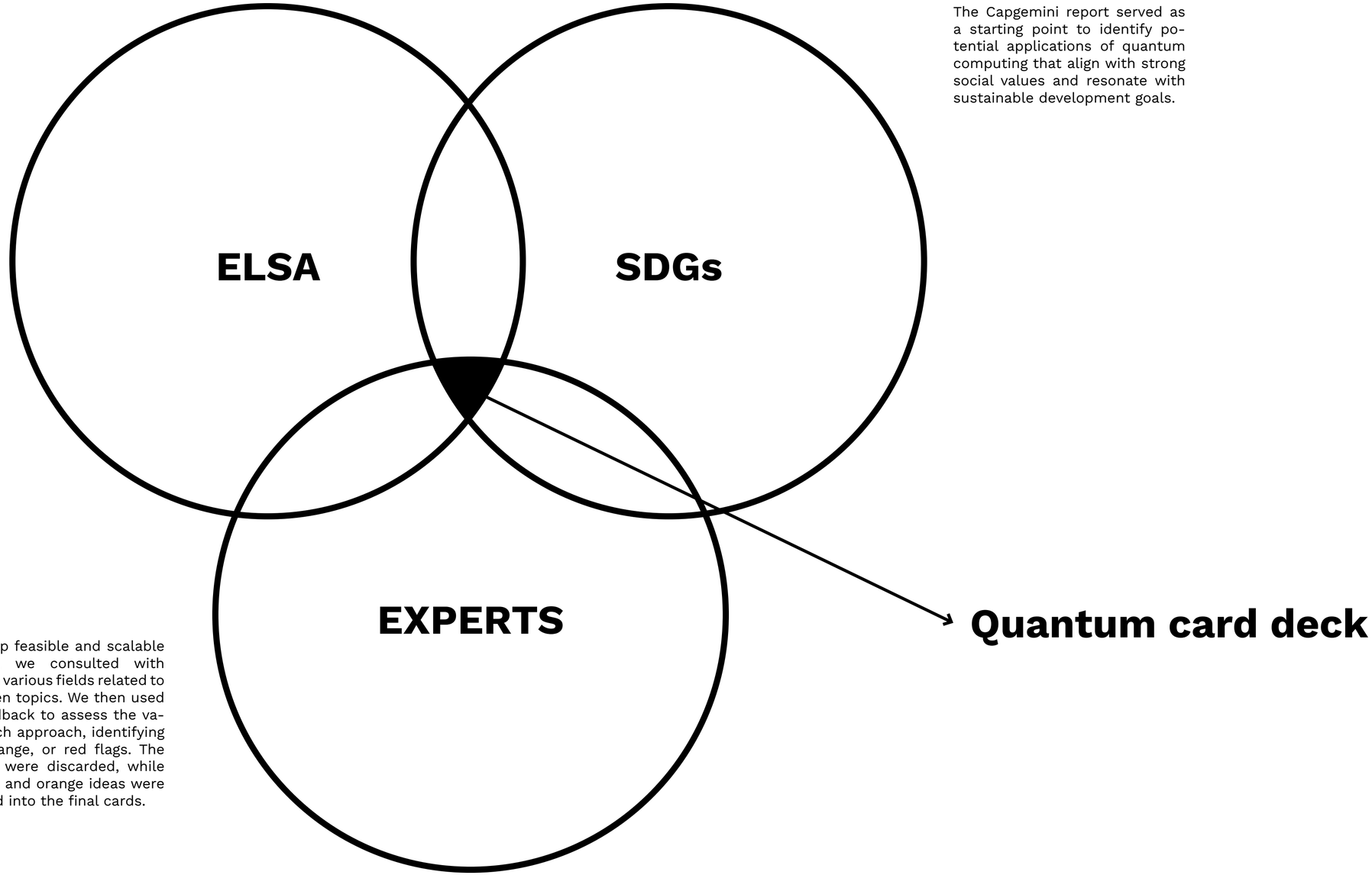
- ELSI is **no longer enough**, with a new system, researchers have identified post ELSI
- in the **post elsi methodologies there are many of the new alternative** approaches used in the paper such as: **alternative histories and consideration of the context**
- among the alternative methods there are both some from the **field of Design** and others from **futorology**
- Scenario elements (+ utopia and dystopia) are useful to make the future of technology **more accessible to non-experts.**

CARDS

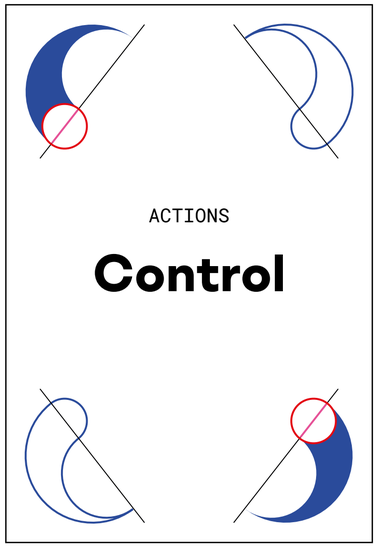
*Sustainable development and quantum technologies: a point of view

The ethical challenges faced by AI inspired a shift in the approach to quantum computing. Rather than waiting for technology to develop and then creating regulations, it makes more sense to anticipate potential issues and incorporate discussions on the ethical and social implications of its applications from the outset.

The Capgemini report served as a starting point to identify potential applications of quantum computing that align with strong social values and resonate with sustainable development goals.

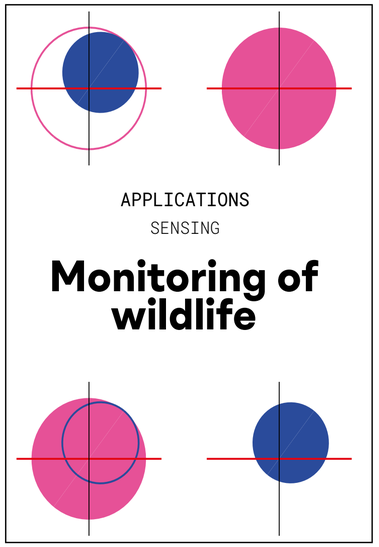


To develop feasible and scalable solutions, we consulted with experts in various fields related to the chosen topics. We then used their feedback to assess the value of each approach, identifying green, orange, or red flags. The red flags were discarded, while the green and orange ideas were integrated into the final cards.

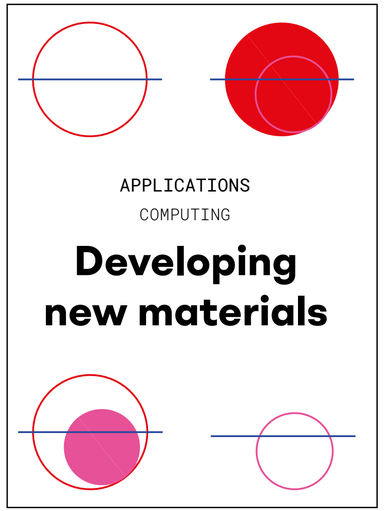


Use active verbs to inspire practical usage of the application, encouraging users to engage with and explore its potential.

By integrating values such as sustainability, inclusivity, and fairness, we ensure that the technology not only serves its purpose but also creates a better world for all.



The applications of quantum computing are categorized into three main areas: computing, sensing, and communication. These represent the real-time capabilities of quantum computing, with each area offering unique potential to revolutionize industries and solve complex problems.



Each card includes a category (and a subcategory, when necessary), a title, and a description.

Developing New Materials

Intro on card:

The possibility to simulate the behaviour and interaction of molecules at atomic level provides a new way to develop new or better versions of materials. New material development or enhancement can be useful in several fields: think of creating better catalysts to help improve chemical processes, creating new polymers to improve concrete, enhancing fertilisers for agriculture or developing an effective measure against corrosion.

Expert Opinions:

There are no negative papers on the matter ([1], [2], [5]), applications have already been found ([3], [4]) and it has been shown that quantum computing gives a significant advantage. Quantum computing can probably be used for material development on a very short timeframe, if not already.

Potential algorithms:

- **Variational quantum eigensolver (VQE):** a hybrid algorithm that uses both classical computers and quantum computers to find the ground state of a given physical system.
- **Quantum phase estimation (QPE) / quantum eigenvalue estimation:** a quantum algorithm to estimate the phase (or eigenvalue) of an eigenvector of a unitary operator.
- **Quantum Annealing (QA):** a heuristic quantum optimisation algorithm that searches a global minimum, going from a quantum superposition to a classical solution.
- **Quantum Approximate Optimisation Algorithm (QAOA):** an algorithm that uses both classical and quantum computers to minimise a given cost function using parameterisation.

References:

[1]: "Materials by design and the exciting role of quantum computation/simulation", A.J. Freeman, Journal of Computational and Applied Mathematics, Volume 149, Issue 1, 2002, Pages 27-56, ISSN 0377-0427, https://doi.org/10.1016/S0377-0427(02)00519-8.
[2]: "Quantum Computing and Simulations for Energy Applications: Review and Perspective", Hari P. Paudel, Madhava Syamlal, Scott E. Crawford, Yueh-Lin Lee, Roman A. Shugayev, Ping Lu, Paul R. Ohodnicki, Darren Mollot, and Yuhua Duan, ACS Engineering Au 2022 2 (3), 151-196 DOI: 10.1021/acsengineeringau.1c00033
[3]: "Quantum computing enhanced computational catalysis", Vera von Burg, Guang Hao Low, Thomas Häner, Damian Steiger, Markus Reiher, Martin Roetteler, Matthias Troyer, 2021, Physical Review Research, DOI: 3. 10.1103/PhysRevResearch.3.033055.
[4]: " Low-Depth Quantum Simulation of Materials", Ryan Babbush, Nathan Wiebe, Jarrod Mcclean, James McClain, Hartmut Neven, Garnet Chan, 2018, Physical Review X. DOI: 8.10.1103/PhysRevX.8.011044.
[5]: "Quantum Algorithms for Quantum Chemistry and Quantum Materials Science", Bela Bauer, Sergey Bravyi, Mario Motta, Garnet Chan, 2020.

This section contains a detailed explanation of the card, expert opinions, and information about startups and large companies already focused on the topic.

Startups:

HQS Quantum Solutions (2018, 14.3 million):
Formed in 2018 and based in Karlsruhe, German, HQS Quantum Simulations (formerly Heisenberg Quantum Simulations) is developing quantum algorithms to predict molecular properties for performance materials, specialty chemicals and pharmaceutical companies. They also have developed a port between ProjectQ and Cirq, called CirqProjectQ. This port is a ProjectQ backend which can convert a ProjectQ algorithm to native Xmon gates that can be used to simulate a Google quantum computer with ProjectQ.

Molecular Quantum Solutions (2019):
Molecular Quantum Solutions (MQS) provides computational tools to accelerate research & development efforts by the pharma, biotech and chemical industry. Their tools make use of super- and quantum-computers with computational models and algorithms to calculate the properties of materials and chemicals in a fast and efficient way. The company was founded in September 2019 and is located in Copenhagen, Denmark.

Quantum Generative Materials/GenMat (2021):
Generative Materials Quantum Generative Materials, LLC is a company still in stealth mode, but has a primary goal of commercialising new quantum computing technologies to accelerate material science discovery and development. The company is partially owned by Comstock Mining and was founded in May 2021. They are based in Cheyenne, Wyoming.

Qunova Computing (2021, undisclosed funding):
Qunova Computing builds software for clients in the pharmaceutical discovery and materials industries. Current methods require large amounts of trials to identify a material or drug with the desired property. Using their quantum software solutions, Qunova will allow clients to save large amounts of time in their R&D processes, identifying candidate materials or drugs with the desired properties much faster, freeing up resources and reducing costs. The company is located in Daejeon, South Korea and was formed in January 2021.

Quantistry (2018):
Quantistry develops the next level of chemical simulations, powered by quantum simulations and artificial intelligence. Their cloud-based chemical simulation software has an intuitive user interface and the highest security standards. The algorithms range from Density Functional Theory (DFT) to Post-Hartree-Fock over to classical force fields and advanced machine learning prediction models. Currently, their algorithms run on classical computing architectures but they expect to start utilising quantum computers in the near future. The company is located in Berlin, Germany and was founded in August 2018.

Large companies:

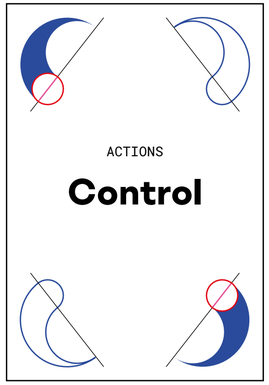
Ford is using quantum computing to find new materials to use in their EV-powered vehicles
https://www.eetimes.eu/ford-enlists-quantum-computing-in-ev-battery-materials-hunt/

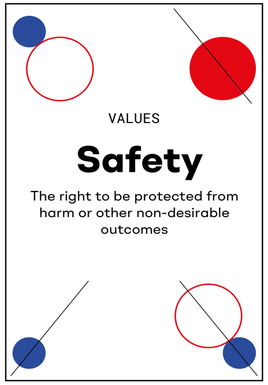
Bosch has partnered with IBM to use the latter's infrastructure to find possible improvements in electromobility, renewable energies and sensor technology
https://newsroom.ibm.com/2022-11-09-Bosch-Partnering-with-IBM-on-Strategic-Quantum-Computing-Materials-Science-Engagement

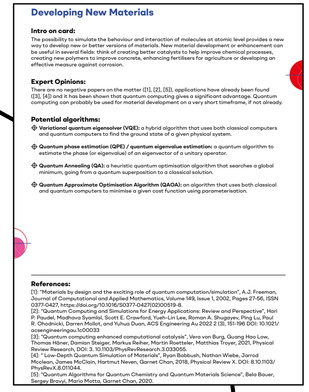
Covestro (one of the world's largest polymer production companies) has partnered with QC Ware to use quantum computing to discover new materials and catalysts
https://www.prnewswire.com/news-releases/covestro-and-qc-ware-partner-to-develop-quantum-algorithms-for-materials-rd-301562290.html

The group can choose to start by creating potential scenarios and use cases with the three initial cards, and then continue as needed by adding more cards.

One value card, one action card, and one application card are placed in the center to initiate the conversation.







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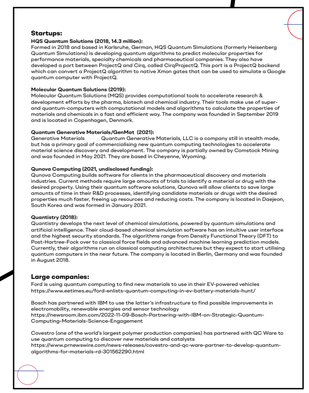

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The A4 sheet serves as supplementary information to support the understanding of the topic.

The final product should be a collection of ideas that represents the convergence of value and real-world application.


Honesty
Accountability
Inclusivity