Ethical Quantum Computing? A Heatmap Approach

Abstract

Over the past decade the field of quantum technology has seen significant growth. Fields such as quantum computing, quantum information, quantum simulation, quantum optics, quantum metrology, quantum clocks and quantum sensors are evolving. However, more needs to happen in energy management, error correction, etc. for quantum computers to be generally available. These quantum technologies will disrupt lives in unpredictable ways and it is necessary to focus on the 'ethical' and 'social' aspects of these technologies. It is necessary to reduce the skill gap within societies and between developed and developing countries. Current social and societal awareness is minimal and this technology development needs to address Equity, Diversity and Inclusion (EDI) aspects.
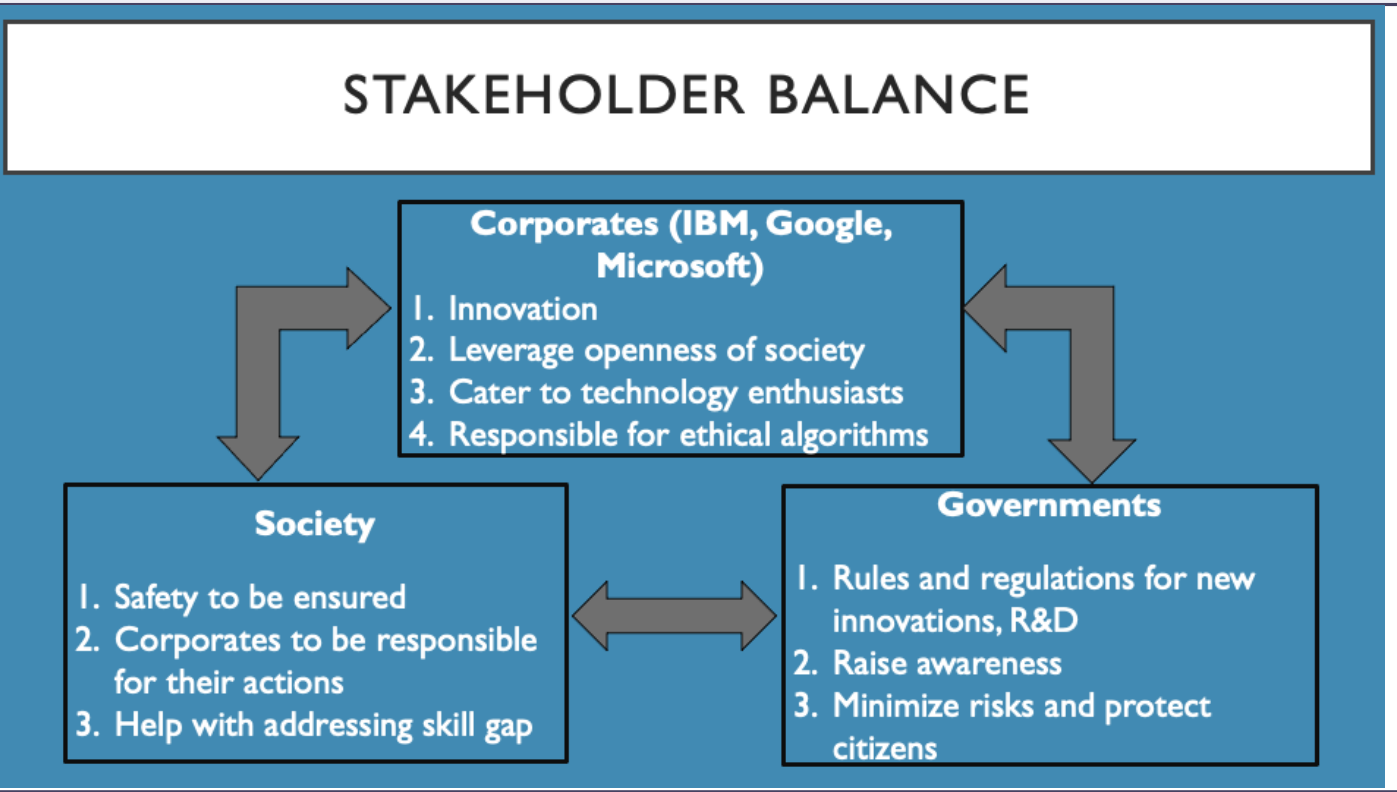
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Ethical Dimensions

- Ethical considerations will play a necessary and quintessential role in the introduction of quantum technology in society
- Different approaches and schools exist, most importantly focussing on either procedures (**deontology**) or outcomes (**utilitarianism**)
- Prior ethical interventions are not transferable
- Perrier (2021): Four C's: **computability, complexity, consistency, controllability** – for ethical inquiries about procedures
- Outcomes are of immense societal impact: **fairness, privacy, distribution and access & simulations**

STAKEHOLDER BALANCE

Corporates (IBM, Google, Microsoft)
1. Innovation
2. Leverage openness of society
3. Cater to technology enthusiasts
4. Responsible for ethical algorithms

Society
1. Safety to be ensured
2. Corporates to be responsible for their actions
3. Help with addressing skill gap

Governments
1. Rules and regulations for new innovations, R&D
2. Raise awareness
3. Minimize risks and protect citizens

Key Stages in the Quantum Computing Timeframe

- Innovation, with Peak of Inflated Expectations and Trough of Disillusionment
- Enlightenment and Commercialization
- Creative Anarchy
- Plateau of Productivity

Where should the 'Rules and Regulations' be introduced in this timeframe?
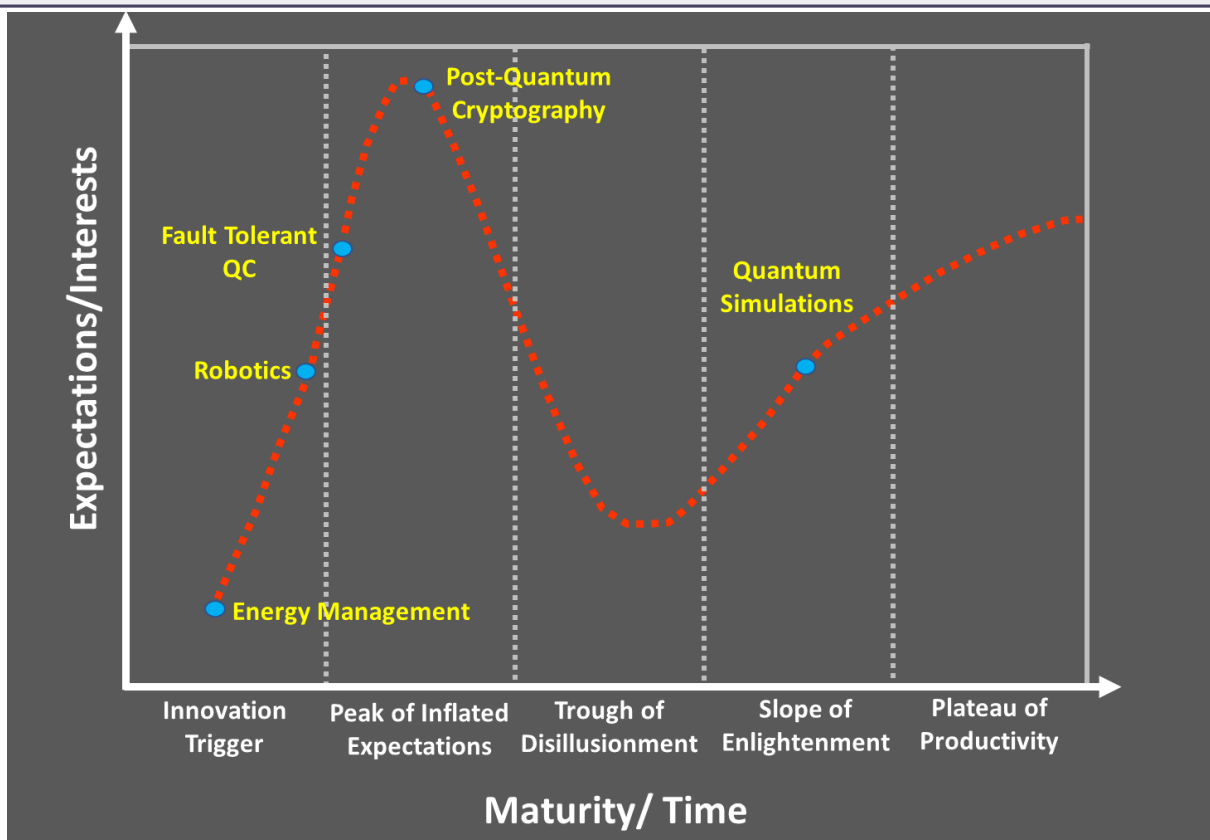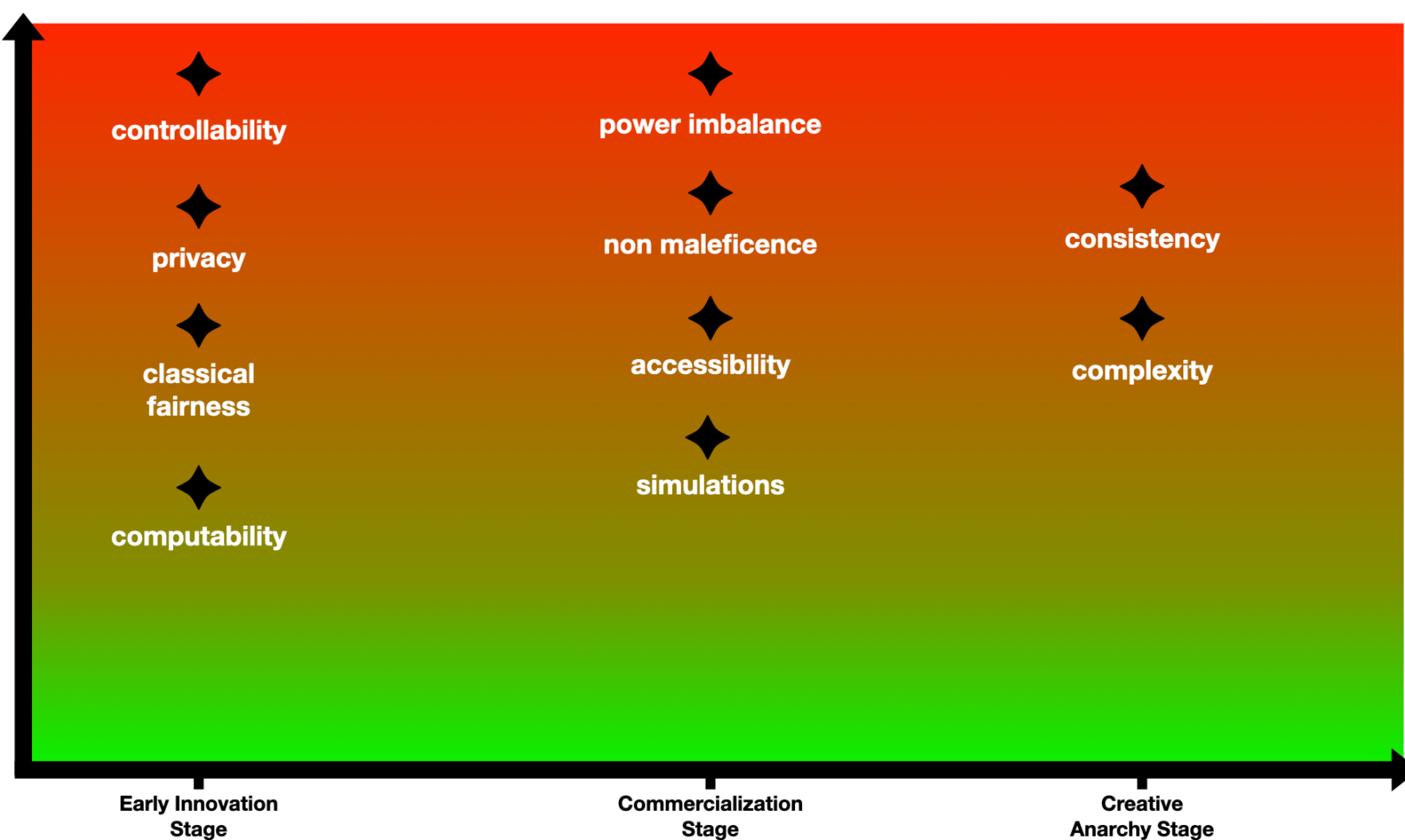

Figure adapted from Gill et al. (2022)

Our Heatmap

- Ethical challenges will come up during different stages of the development of quantum technologies
- Displayed here on the x-axis is the **time development**, on the y-axis the **urgency/risk of the ethical challenge**
- Prior challenges are not necessarily solved in a later period of time but are here not displayed again for reasons of clarity
- Certain approaches to first challenges already exist (e.g. classical fairness) but others are speculative by nature or have not been approached by researchers yet

Conclusion

1. Oversight organizations are needed at national and international levels
2. Impact on society will be decided on how various parties will use the available quantum technologies
3. Necessary to introduce specific legislations regarding these technologies as and when the need arises
4. Essential for governments, society and corporates to work together to maintain a balance between innovation and ethics

Related Literature

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