



Report on broad ELSA Exploration of Quantum Computing Ministry of Finance

Quantumcomputing &
Case 1: Internal Planning
Case 2: Financial Statements

Report broad ELSA Exploration Quantum Computing: Case Planning & Annual Accounts

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Ministry of Finance

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Introduction

This report concerns a workshop by the Ministry of Finance and CQS (Centre for Quantum and Society) on the ethical, legal and societal aspects (ELSA) of two use cases in which quantum computing is applied:

1. **Planning:** Matching employees and projects based on constraints (criteria that determine whether an employee is suitable for a project).
2. **Annual accounts:** Detecting deviations in annual reports.

Goal

The goal of the exploration is to give a first impression of the ELSA aspects that can play a role in the application of quantum computing in these two areas.

The exploration is based on a number of short conversations and a workshop with experts from the Ministry of Finance, the Central Government Audit Service (ADR), Schuberg Philis and CQS.

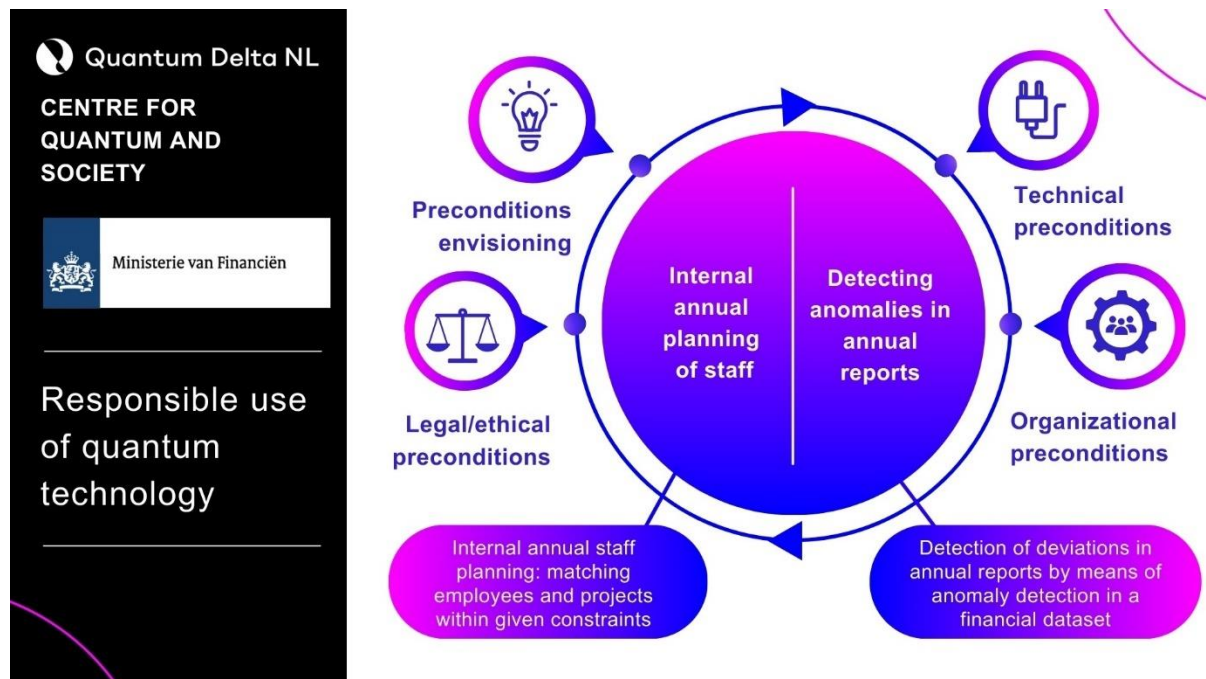
Method

The method for the workshop is derived from the EQTA, the Exploratory Quantum Technology Assessment, from CQS.

The EQTA is a practical step-by-step plan, developed by CQS (Centre for Quantum and Society) to support organizations in inventorying the ethical, legal, societal preconditions for responsible application of quantum technology: (in this report referred to as ELSA: Ethical, Legal, Societal Aspects) and to plan and take those measures that are necessary to arrive at responsible application: to utilize the opportunities of quantum computing and to control and prevent negative effects.

ELSA preconditions

The ELSA exploration of quantum computing distinguishes four categories of conditions that play a role in the responsible application of the technology:



These four categories of preconditions are interconnected. The way people think about quantum computing (precondition envisioning) can, for example, lead to different requirements for the technical infrastructure (technical and external preconditions). And the changes in the organization (organizational preconditions) can lead to new legal and ethical questions (legal and ethical preconditions).

To achieve responsible application of quantum computing, it is important to include all four categories of preconditions in the development and implementation of quantum computing. By paying attention to all aspects, the chance of successful application of the technology is increased and any risks are limited in a timely manner.

Results workshop

In the exploration of quantum computing, many employees of the Ministry of Finance and partner organizations have been involved: they have been informed about the possibilities of quantum computing and have subsequently developed and tested ideas about possible applications with the help of quantum experts. This has resulted in a list of possibilities, from which the two concrete applications mentioned above were finally chosen. These two applications were tested in a 'proof of principle' on real quantum computers and simulators of quantum computers at the end of 2023.

It concerned two applications:

1. Internal annual personnel planning: matching employees and projects given constraints (henceforth **Case Planning**);
2. Detecting deviations in annual reports: using Quantum Computing for the detection of anomalies in a financial dataset (henceforth **Case Annual Report**).

This report examines both applications and explores the question: what kind of ELSA aspects may play a role in these two concrete applications of quantum computing?

Precondition Envisioning

Envisioning is a precondition for being able to responsibly utilize the possibilities of a technology. After all: if the right knowledge is lacking about what a technology can do, about the availability of the technology and in which area the innovations lie, unrealistic expectations easily arise.

- **Case Planning:** there is a risk that quantum computing is seen as a panacea that can solve the problems with planning in the organization through brute computing power. Important in envisioning is the awareness of the strengths and limitations of different planning methodologies. For example, many of the requirements for planning cannot be adequately expressed in numbers. An analysis is probably needed to what extent current planning practice takes sufficient account of the requirements for planning: whether planning contributes sufficiently to goals around quality of work, organizational development, employee satisfaction and customer satisfaction.
- **Case Annual Report:** there is a risk that broad application of this method in control leads to overestimation of the possibilities. With good envisioning,

work is done on a nuanced and validated picture of what these techniques can contribute to control and what the techniques mean for the relationship between controlling and controlled parties.

Technical and External Preconditions

These preconditions concern the technical infrastructure and the external environment necessary for the responsible application of quantum computing. Examples include the availability of technology, standards for the interoperability of equipment, data exchange, and, where necessary, regulations.

- **Case Planning:** quantum computing can lead to lock-in with quantum computer suppliers. It is important to collaborate on the development of standards and interoperability of data, so that organizations are not tied to a single supplier.
- **Case Annual Accounts:** Quantum computing can lead to an increase in the amount of data required. It is important to ensure the availability of reliable and anonymized data.

Organizational Preconditions

These preconditions are about the changes in the organization necessary to successfully implement quantum computing. Examples include the adaptation of work processes, the development of new competencies among employees, and the involvement of stakeholders.

- **Case Planning:** planning algorithms, as in this case, change the way employees are assigned to projects and thus influence the experience that employees develop in the organization and the workload they experience. The career advancement opportunities for employees and the relationship with client organizations are also influenced by changes in planning. It is important to map out the current function of planning methodologies, evaluate them, and improve them where necessary before deploying powerful technology.
- **Case Annual Accounts:** the techniques can influence the nature and number of deviations detected and thus the relationship between the supervisor and the supervised party. One question is how the application of these techniques by the auditor fits into developments around supervision: think of a

development such as "continuous monitoring" where the audited organization itself continuously exercises control (and may start using these techniques itself). Or that the auditing and audited organization work together with the aim that unnoticed deviations are prevented and these audits by the auditing party become superfluous.

Legal and Ethical Preconditions

This category is about the legal and ethical aspects of quantum computing. Examples include privacy, discrimination, explainability of algorithms, and liability.

- **Case Study Planning:** Quantum computing can lead to questions about privacy, discrimination, and explainability of algorithms when personal variables are included in the calculation. Planning contributes significantly to the work that employees do, their future prospects, and thus their job satisfaction. It is important to conduct an ethical analysis of the application of the technology in planning.
- **Case Study Annual Accounts:** Widespread application of these techniques in auditing can lead to a lot of extra work on the work floor of the audited organization. Especially if it requires a lot of effort to explain a deviation found. This can lead to incentives to make decisions in such a way that they do not stand out in the automatic check. Suppose a civil servant has to decide on a complex case. The civil servant consults with colleagues and experts and comes to an exceptional decision. If the civil servant can predict that, despite the care taken, such a decision will still have to be explained again later, it can feel like "even more work" on a case that already took a lot of time. And taking careful divergent decisions can be discouraged in practice.

Conclusion

The aim of this Quantum Computing exploration was to give an impression to the quantum computing project group of the Ministry of Finance of the added value of an analysis on ELSA aspects: the ethical, legal and societal aspects of the technology, in addition to the business and technical case.



The discussions have provided more insight (and more questions) around an area that we had less insight into. In particular, the process from values to practice - the translation of the ministry's values to ELSA values to their translation into practice - provided tools for next steps.

In addition to criteria for future quantum use cases, the values can also lead to frameworks and policies, especially now as we are still at the early stages.

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The short exploration, subject of this report, raised several points of concern that are indicative of the points that an extensive analysis according to the EQTA methodology could yield.

- **Envisioning:** in order to responsibly apply quantum computing, involved employees, those who use the technology, and management need a clear understanding of how these techniques can contribute to problem-solving. This is a cyclical process: as the technology further develops and experience is gained,

the vision on the possibilities and impact of technology becomes more concrete and refined.

- **Technical and external requirements:** it is important for the Ministry and other organizations to analyze the conditions under which investments in quantum computing are justified and how the organizations can contribute to realizing those conditions. Consider data operability, interface requirements, and functionality to ensure that the technology integrates with the existing IT landscape. Or contribute to the development of a transparent and innovative market that provides the products and services the organizations require. Collaboration with other organizations, both within and outside of the government, is crucial for this.
- **Organizational requirements:** concern how technology can optimally contribute to the organization's objectives: a conclusion from this workshop is that it is advisable to evaluate and improve current methodologies and their contribution to organizational goals before deploying powerful tools.
- **Legal and ethical prerequisites:** the application of these techniques quickly intersects with legal and ethical aspects. Consider explainability, proportionality (the balance of organizational and employee interests), and non-discrimination.

Experiences with Artificial Intelligence and automated decision-making show that the impact of technology is rarely "value-neutral": the system of checks and balances within the organization is often affected by new forms of control in unforeseen ways. Gaining experience and evaluating it is an important aspect of the responsible introduction of a technology.

A further exploration of these aspects, in collaboration with the Centre for Quantum and Society, seems justified based on this initial brief analysis.



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