



MONASH
University

QUANTUM FUTURE WORKFORCE

Understanding
Australia's quantum
journey to 2050 for
a quantum ready
workforce. Identifying
skills, capabilities
and opportunities.



MONASH
EMERGING
TECHNOLOGIES
RESEARCH LAB

Quantum
Australia

Prepared by

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Acknowledgement of country

Monash University and Quantum Australia acknowledge the First Nations peoples of Australia, the traditional custodians of the lands on which this research was conducted. We pay our respects to ancestors and Elders, past and present.

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Participants in the Quantum Sensing for Healthcare group

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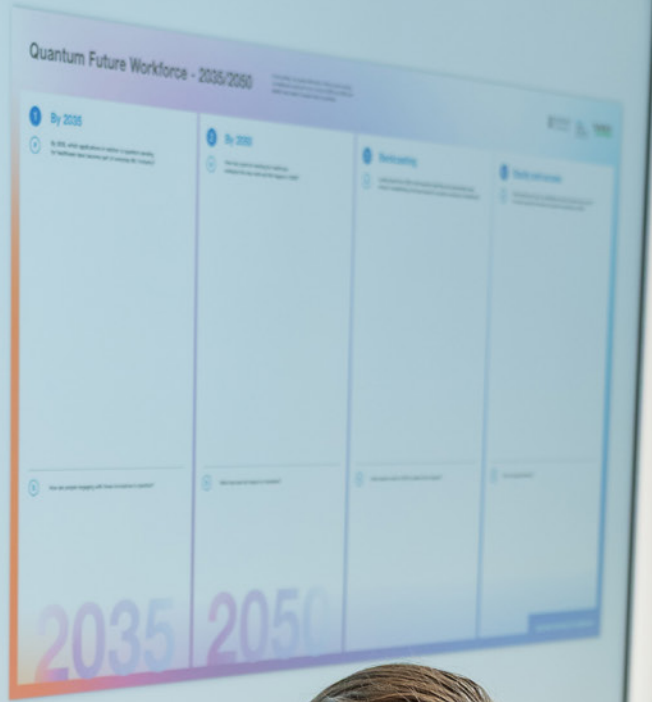
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🕒 45 min 2:30 - 3:15

MONASH UNIVERSITY QUANTUM

Quantum Future Workforce 2035/2050

In this activity, your group will envision what your quantum scenario could look like in the future (2035 and 2050) and identify what needs to happen today to get there.



Participants in a Quantum Low Energy Devices group

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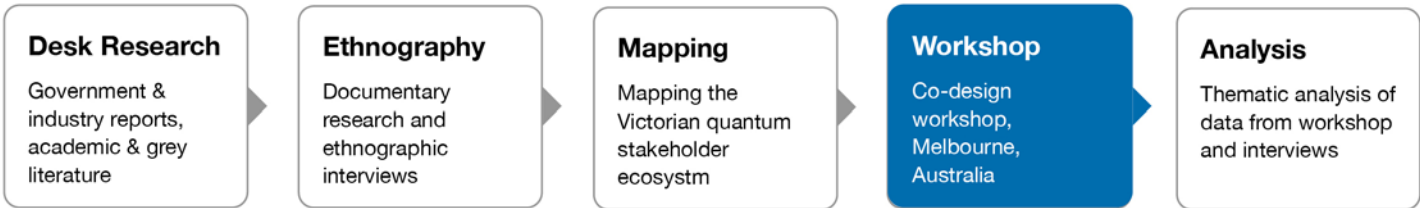
Context

Australia stands at a pivotal moment in the development of its quantum technology sector. With the release of the National Quantum Strategy (2023) and increasing investment in research, start-ups and infrastructure, attention has turned to how the country can build a workforce capable of supporting quantum innovation over the coming decades.

Unlike more established technology sectors, quantum remains technically emergent, with uncertain timelines, evolving applications and no clearly defined pathway from education to employment. This makes workforce planning both urgent and complex, requiring approaches that go beyond traditional models of skills development.

The infographic below depicts the project method and this is followed by the insights and recommendations from the research. These outline how a quantum future workforce is being imagined and assembled across research, industry, education and policy.

These insights and recommendations highlight the central role of multidisciplinary collaboration, hybrid capabilities and flexible pathways, as well as the importance of strengthening the broader ecosystem that supports workforce development. The insights and recommendations illustrate the interconnected conditions, actors and processes required to build a quantum-ready workforce and society in Australia.



Key findings

The findings from the interviews and workshop process highlight the complexity of planning for quantum futures towards 2035 and 2050, as well as the associated challenges and opportunities for workforce development. Rather than pointing to a single, stable pathway, participants described a field still in formation, where technical uncertainty, emerging applications and uneven timelines make workforce planning a particularly dynamic task.

Across the research, four interrelated themes stood out. These include the need for a multidisciplinary workforce, the growing importance of hybrid backgrounds and quantum-ready capabilities, the role of education and training pathways, and the current fragility of the quantum workforce pipeline. Together, these findings show that preparing for a quantum future is not only a matter of producing more specialists, but of building broader capacities across research, industry, policy and education.

Findings include:

- Multidisciplinary workforce
- Hybrid backgrounds, quantum ready
- Education and training pathways
- Quantum workforce pipeline

Insights were articulated in relation to five scenarios (Appendix 1) explored in the workshop that relate to the following areas:

- Quantum sensing
- Quantum communications
- Quantum and classical computing



Participants in the Quantum Infrastructure for Cities group

Future Workforce - 2035/2050

INSIGHTS AND RECOMMENDATIONS

This section presents the key insights and recommendations emerging from the research. Drawing on the findings discussed in this report, it outlines practical and organisational steps to support the development of a quantum-ready workforce and ecosystem in Australia. The recommendations recognise that quantum workforce development is not a single-sector challenge, but one that requires coordinated action across research, education, industry, entrepreneurship, policy and public communication.

1

Building and maintaining a thriving quantum ecosystem

Key insight

Australia has the foundations for a thriving quantum ecosystem, with investment in Centres of Excellence, Quantum Australia and start-ups, technologists, policymakers and industries (such as the semiconductor industry) all contributing to shaping the ecosystem as it continues to develop. Quantum Australia plays a crucial role in articulating the emerging ecosystem at the national level and in connecting Australian developments to the global quantum landscape. At the same time, the quantum ecosystem operates at both State and interstate levels, with different dynamics in each State. Currently the Australian quantum ecosystem lacks cohesion and communication and excludes ongoing, sustained engagement with Australian society.

Recommendation

Work is required to map and bridge, involving both existing stakeholders, whose current roles and capacities could be extended into new domains, and new stakeholders who are not yet participating in quantum to the extent they should be. Citizens must be actively engaged in this process.

2

Fostering awareness of quantum technologies, possibilities and impacts

Key insight

Awareness of quantum technologies, their possible applications and their wider societal implications should be fostered across education, industry, government and the broader public.

Recommendation

This requires a coordinated approach to quantum competence that goes beyond specialist training, making quantum more visible, understandable and relevant to different sectors and communities, while supporting informed engagement with its opportunities, limits and likely impacts.

3

Building quantum-ready capability

Key insight

The research suggests that a quantum-ready workforce will not be built through a single disciplinary pathway. Instead, it will depend on hybrid backgrounds that combine technical knowledge with translational, commercial, organisational and communication capacities.

Recommendation

Education, training, and workforce planning should support hybrid capability across research, engineering, entrepreneurship, and policy, without focusing solely on a single technical specialisation.

4

Sustaining the quantum pipeline

Key insight

The pipeline is not only about producing talent through universities. It also depends on whether the sector is attractive to skilled workers, visible across educational levels and supported politically as a strategic national priority.

Recommendation

A quantum workforce strategy should extend beyond higher education to include talent attraction, public signalling of the sector's importance, support for start-ups, and awareness-building across schools, universities, and adjacent industries.

5

Translating research into industry

Key insight

A recurring finding across the research was that scientific excellence does not automatically translate into commercialisation. Researchers and engineers often require partnerships with co-founders, entrepreneurs, accelerators and incubators to move innovations into industry-ready applications.

Recommendation

Greater support should be provided for research translation through accelerators, incubators and partnership models that connect researchers with commercial and entrepreneurial expertise at earlier stages.

6

Scattered quantum workforce throughout the industrial spectrum

Key insight

The quantum future workforce will span the quantum industry, chip manufacturing, security, policymaking and research. Jobs will not necessarily be similar across these contexts.

Recommendation

Educational and training pathways, as well as funding support, should not be designed around a single work context or industry. Given that the future quantum workforce will span the quantum industry, chip manufacturing, security, policymaking and research, planning needs to account for diverse occupational settings and skills requirements. This requires engaging stakeholders early from across the industrial spectrum in order to identify the infrastructural, organisational and human resource conditions needed for a quantum workforce to thrive across sectors.

7

Education and training pathways

Key insight

Participants consistently stressed that formal education alone will not be enough to support the growth of the quantum sector. Short courses, targeted upskilling, conversion pathways and on-the-job training will be essential in an industry whose future skill needs are still emerging.

Recommendation

Australia should develop flexible, layered education and training pathways, including undergraduate foundations, short quantum modules, professional conversion programmes, and cross-sector and industry upskilling opportunities.

8

Replenishing the quantum pipeline

Key insight

The research suggests that a sustainable quantum workforce pipeline depends not only on supporting commercialisation and spin-outs, but also on replenishing the pool of scientists and technologists from which these innovations emerge.

Recommendation

Workforce and innovation strategy should support the quantum pipeline as a continuous system, ensuring that efforts to commercialise research are matched by sustained investment in basic science, research training and the renewal of scientific and technical talent. This is necessary to maintain long-term momentum and avoid weakening the research base on which future innovation depends.

Supporting entrepreneurs, funders and co-founders for a new deep tech scenario

Key Insight

Entrepreneurs and funders were seen as critical to the growth of the sector, not only because they bring capital, but because they help carry technologies from research into deployment. At present, participants described venture capital interest in quantum as limited. They also refer to new strategies needed for quantum that don't follow business as usual due the disruptive nature of quantum.

Recommendation

Support should be given to the development of a stronger quantum entrepreneurship ecosystem, including founder support, investor education, long-term commercial roadmaps and mechanisms that strengthen venture interest in the sector. These should be tailored to the specific opportunities that quantum brings to the Australian start-up ecosystem.

Engaging and informing policymakers

Key Insight

Participants repeatedly identified policymakers as crucial actors in a quantum-ready future, but also highlighted a lack of quantum understanding within policy settings. This has implications for standards, infrastructure, regulation, funding and public communication.

Recommendation

Strategic efforts should be made to educate and engage policymakers at the state and federal levels, including through embedded expertise, targeted policy briefings and long-term planning frameworks for quantum-safe, ethical and inclusive futures.

Building quantum literacy, engagement and outreach

Key Insight

Quantum remains unevenly visible outside specialist circles. Participants suggested that awareness of quantum as a field of future work, public relevance and national importance is still limited across educational, governmental and industrial contexts.

Recommendation

An ecosystem of quantum literacy, engagement, and outreach should be developed across schools, universities, industry, government, and the broader society to make quantum more visible, understandable, and socially meaningful and to foster capable professionals for a new workforce.

Manufacturing scale and communication of quantum: key blind spots

Key insight

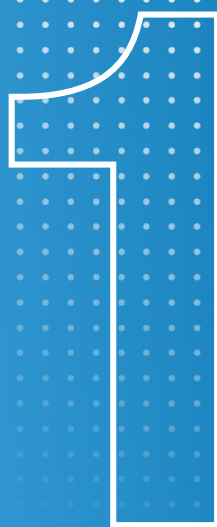
The research highlights two critical blind spots in building Australia's quantum future: securing sufficient manufacturing scale for key components, such as chips and diamond-based products, and strengthening communication of quantum. Participants saw both as essential to translating research into industry, attracting support and funding, and making quantum visible as a field of work and innovation for professionals and students.

Recommendation

Quantum strategy should include both manufacturing readiness and communication of quantum. This means supporting pathways to build and scale key components in Australia, in the short-term and mid-term, and investing in communication, outreach and engagement that make quantum more understandable, fundable and visible across education, industry and society.

Participants in the Quantum Communications group (top) and the Quantum Sensing for Healthcare group (bottom).





INTRODUCTION

1.

INTRODUCTION

Australia stands at a decisive moment in the international quantum technology landscape. With the release of the National Quantum Strategy (2023) and growing investment in quantum research, start-ups and infrastructure, the question of how to build a workforce prepared to achieve Australia’s quantum ambitions has become urgent.

Unlike more established technology sectors, quantum does not yet have a clear occupational map or a settled pipeline from education to employment. The quantum field is still technically emergent, its commercial applications are not yet fully defined, and the skills it will require extend far beyond standard physics and engineering expertise. Planning for quantum technologies is therefore uniquely challenging.

The scale of the workforce challenge facing the quantum sector has already been identified by government, industry and think-tank stakeholders in reports and papers such as the National Quantum Strategy Theme 3: A skilled and growing quantum workforce (2023), the Sydney Quantum Academy’s National Quantum Industry and Workforce Development Review (2023), as well as in frameworks such as the World Economic Forum’s Quantum Computing Governance Principles (2022). Together, these reports highlight the urgent need for quantum capability, the importance of diversity and inclusion, and the risks of a scattered approach to talent development. Australia’s tech start-ups and universities are already recruiting and training an emerging quantum workforce, yet existing accounts tend to focus on workforce projections, skills categories or high-level principles. Less attention has been given to how the people building Australia’s quantum future — researchers, engineers, entrepreneurs, government officials and educators — understand the skills, conditions and pathways required.

This report addresses that knowledge gap. It presents the findings of the Quantum Future Workforce study, designed to understand Australia’s quantum journey towards 2050 and to identify the skills, capabilities and opportunities needed for a quantum-ready workforce and society.

This report asks not only what roles a quantum workforce will require, but also how education, training, entrepreneurship, policy engagement and public communication must evolve to support an inclusive, ethical and sustainable quantum future. The journey to a 2050 Australian quantum-ready society starts with envisioning — and deliberately building — a quantum workforce.



Adrian Gertler from Quantum Australia addressing the Quantum Future Workforce workshop.



Participants from workshop groups listening to the shareback of the Quantum Communications group.



A participant writing on sticky notes in the Quantum Future Workforce workshop.



Participants from a Quantum Low Energy Devices group during shareback.



Top: Participants listening during shareback.
Bottom: Workshop canvases and materials

2

METHODS

2.

METHODS

Through desk research, ethnographic fieldwork, documentary enquiry and a structured co-design workshop with 26 participants from Victoria's quantum stakeholder community, the research surfaces the perspectives of those actively forming Australia's quantum ecosystem.

2.1: Desk research and report review

We undertook desk research, including review of government documents, academic and grey literature, to understand the current state of understanding in relation to Australia's quantum journey and workforce development priorities (see Table 1). The review identified concerns, possibilities and challenges that Australian industry, startup sector, research and government are experiencing in relation to the current quantum workforce and challenges they foresee in the future. These findings were translated into key questions that informed the design of the Quantum Future Workforce workshop and ethnographic interviews and fieldwork.

2.2: Ethnographic interviews and documentary

Desk research informed the development of an ethnographic and documentary enquiry process aimed at capturing Australia's journey towards a quantum-ready future. Drawing on a design and futures anthropology approach (Pink, 2022; Pink et al, 2022), this involved ethnographic interviews with leading thinkers, quantum developers, quantum researchers and quantum strategists, alongside video documentation of the people, events and innovations shaping Australia's quantum future. Debora Lanzani and Sarah Pink undertook seven months of ethnographic research across the following sites: industry events, online meetings and forums, and quantum labs. The physical locations included Sydney and Melbourne, alongside interviews with stakeholders located in other parts of Australia and in Europe.

The ethnographic interviews and fieldwork are ongoing. To date, we have conducted 11 interviews and engaged across 18 sites. We have also collaborated in diverse activities of Quantum Australia as a privileged site through which to observe the constitution of the national quantum community and sector.

The research documentary, led by Sarah Pink and Bianca Vallentine, follows the emergence of the Australian quantum ecosystem, engaging with people, companies and with quantum labs, to communicate our research findings to public, stakeholder and academic audiences.

Reports reviewed

Report name and details

National Quantum Strategy	Department of Industry, Science and Resources. (2023). Theme 3: A skilled and growing quantum workforce. In National Quantum Strategy. Australian Government.
State of Australian quantum report 2024	Department of Industry, Science and Resources. (2024).
The National quantum industry and workforce development review	Sydney Quantum Academy. (2023).
Getting to 1.2 million: Our roadmap to create a thriving Australian tech workforce	Tech Council of Australia. (2022).
Quantum computing governance principles	World Economic Forum. (2022).
Embracing the quantum economy: A pathway for business leaders	World Economic Forum. (2024).
Quantum technologies: A European perspective	European Commission. (2023).
Quantum technologies flagship: Strategic research agenda	European Commission. (2018).
A European strategy for quantum technologies (supporting documents and communications)	European Commission. (2022).
National Quantum Strategy	Government of Canada. (2023).
Quantum technologies: Talent and skills report	National Research Council Canada. (2022).
Bringing quantum sensors to fruition	National Science and Technology Council (USA). (2022).

Table 1. Reports reviewed as part of Phase 2.1



Participants in the Quantum Communications group

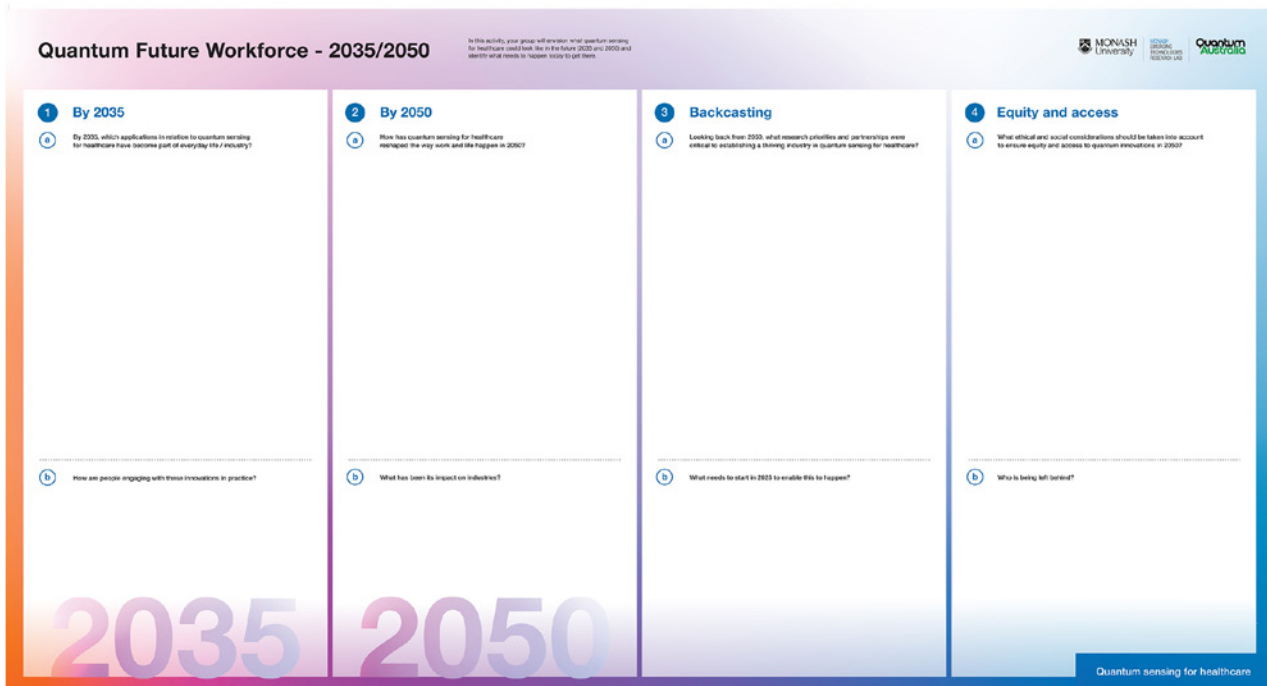
2.3: Convening stakeholder engagement and collaboration

Monash University researchers worked with Quantum Australia to collaboratively map the actors in the Victorian stakeholder community, identifying software engineers, materials scientists, theorists, researchers, start-up entrepreneurs and policymakers to be part of the Quantum Future Workforce programme of work. This phase was also focused on developing the quantum scenarios that were used in the workshop (see example on page 10 and Appendix 1).

2.4: Structured co-design workshop

The co-design workshop was led by Leah Heiss and built on the Monash team's experience in leading co-design processes in complex contexts (Heiss et al., 2025), and in developing participatory tools to engage interdisciplinary teams in addressing challenges and ideating on possible futures (Heiss & Kokshagina, 2021; Page & Heiss, 2023).

The workshop was conducted over three hours and provided structure to support small groups of 4-5 participants to collaboratively engage with two activities. Activities were structured around five quantum scenarios: quantum sensing for healthcare, quantum infrastructure for cities, quantum materials for low-energy devices, quantum-resistant cybersecurity and quantum communications (page 10 and Appendix 1) and each group worked with one scenario. The first activity asked participants to envision how the quantum sector described in their scenario would evolve between the present and 2035 and 2050, and to use backcasting methods to identify research priorities for 2025 (page 9 and Appendix 2). Groups were also asked to consider what equity and access issues might be encountered in relation to their scenario. In activity two, teams mapped the skills, capabilities and requirements for a Quantum Future Workforce in relation to their scenario (see page 10 and Appendix 1). In this activity groups interrogated what the role of technologists (engineers, software developers etc.), scientists (physicists, materials scientists), entrepreneurs and policymakers might be in relation to their scenario in 2035 and 2050 and questioned what skills and capabilities this workforce needed to flourish.



Activity one: Quantum Futuring Canvas 2035/2050

2.5: Analysis process

We analysed the data produced in response to the workshop scenarios—quantum sensing for healthcare, quantum infrastructure for cities, quantum materials for low-energy devices, quantum-resistant cybersecurity and quantum communications—and visions for 2035 and 2050 as articulated by participants. Data was collected through audio recordings of the workshop discussions (including sharebacks), canvases and sticky notes, professional photographs as well as facilitator notes. This information was analysed using qualitative thematic analysis (Braun and Clarke, 2006) and taking each thematic group separately and the correspondent shareback to all the participants.

The ethnographic data was analysed, in response to the research questions derived from the reports review, and new hunches emerging during the fieldwork process, to identify patterns, novel developments and futures focused anticipatory perspectives across the participant groups.

A note on the limitations of the research

This report is the outcome of an exploratory, design ethnographic and futures-oriented study rather than a predictive labour-market model.

Quantum sensing for healthcare

Quantum sensing opens a new frontier in medical innovation, transforming diagnostics, therapeutics, and healthcare delivery. By exploiting quantum phenomena to detect minuscule changes in biological systems, these sensors enable faster discovery, earlier diagnosis, and more personalised treatment. Quantum sensors detect disease markers in extremely low concentrations, providing continuous monitoring of disease progression with compact, even wearable, devices. Applications of quantum sensors include early-stage cancer detection, leveraging quantum innovations to differentiate healthy from unhealthy tissue, and next-generation brain imaging, allowing for more detailed and dynamic observations of brain activity. Diamond-based quantum sensors can also support detection of free radicals in virus-affected cells, and measure the magnetic fields produced by iron atoms contained in ferritin, essential for treating low-iron conditions.

Quantum Future Workforce Workshop
Organised by: Monash University Emerging Technologies
Research Lab in collaboration with Quantum Australia



Example of workshop scenario.
See Appendix 1 for all scenarios.

3

FINDINGS

3.

FINDINGS

In this section we examine how a quantum-ready workforce is being imagined and assembled in the context of Australia’s still technically uncertain, multidisciplinary and institutionally emergent quantum ecosystem.

We found that future quantum workforce capability is increasingly understood in terms of hybridity: the capacity to move across research, engineering, entrepreneurship, policy and communication. This challenges the assumptions that have guided the business-as-usual approach to emerging technologies represented in the reports we reviewed, which assume a single pathway defined solely by deep quantum expertise.

We report on how participants articulated the roles, pathways and conditions required to build a future quantum workforce, and how questions of education, translation, commercialisation and public readiness are becoming central to the making of Australia’s quantum future. We follow this with a set of recommendations for actions on what to build and what to avoid to create a thriving and resilient quantum workforce for Australia’s future.

3.1 Multidisciplinary workforce

3.1.1 *Anticipating a future quantum workforce*

Anticipating future quantum workforce needs by 2035 is a significant challenge for governments, start-ups and technology providers. Quantum ecosystem development is driven by two interrelated issues: first, the multidisciplinary nature of the emerging quantum ecosystem; and second, the inherent uncertainty of technical development—such as when quantum chips will become reliably operable at scale, or how quickly sensing technologies (for example, magnetometers) will achieve the precision needed for deployment. Until recently, workforce planning largely assumed that deep expertise in quantum physics would be the primary requirement. Increasingly, however, stakeholders expect a shift towards hybrid capability: a foundational understanding of quantum physics remains valuable, but it is no longer treated as the decisive pathway to acquiring the practical know-how needed to build, integrate and deploy quantum technologies. In this framing, “quantum-prepared” talent is defined less by disciplinary exclusivity and more by the capacity to work across interfaces,



Participants in the Quantum Communications group.

translating between research and engineering, hardware and software, and technical performance and application requirements and, most importantly, communicating quantum to the broader society.

3.1.2: Building a future quantum-prepared workforce

To build a quantum-prepared workforce, it is therefore necessary to recognise the multipolar character of quantum jobs: demand will not consolidate around a single occupational profile, but will distribute across diverse roles and evolving combinations of skills. This is consistent with broader labour-market expectations that a substantial share of near-term job descriptions will be new or significantly reconfigured by 2030 (Sydney Quantum Academy Report, 2023), and with participant views from our workshop:

It's not just workforce skilling, but it's basically everybody's upskilling. I don't know what the skills gap is at the moment, [and] what the talent, and what we're building today is ... because we don't know what we actually will be working [towards] tomorrow.

Workshop participant, Quantum Infrastructure for Cities group.

3.1.3: Educational pathways for a multidisciplinary quantum workforce

A defining feature of a multidisciplinary quantum workforce is the need for educational pathways that enable people to build expertise without being confined to a single disciplinary track. This requires learning environments that cultivate agility and support movement between technology, science and entrepreneurship. These capacities need to be developed early—during undergraduate education—requiring a rethinking of degree structures so that students can move more flexibly from deep scientific training through to translation, product development and venture creation. The multidisciplinary quantum workforce is not only made up of scientists, engineers and technologists but also of technicians who will build the infrastructure to enable the development of quantum innovations (for e.g. to install cooling systems).



Participants in the Quantum Communications group discussing workshop prompts. Bianca Vallentine pictured filming for the Making Quantum Futures Visible documentary.

This technical workforce will require a level of quantum literacy but not necessarily be trained to do quantum calculations, as described by a workshop participant:

So in terms of technologists, one thing we talked about was that we would not only need every single type of engineer to be working in quantum technologies. So electrical, chemical, welding, mechanical, civil but also technicians. So you want the welders, electricians, people (who) can put in the cooling systems. We thought it would be really good for those people to have a knowledge of quantum basics, so for everybody to have a sort of a level of understanding, even if they're not going to be doing the calculations

Workshop participant, Quantum Communications group.

Participants repeatedly emphasised the need to incentivise multidisciplinary education “so that scientists know how to communicate their science to the rest of the world.” The idea of incentives was also raised in relation to collaboration, and in considering how government mechanisms could be leveraged to “incentivize industry to undertake more R&D, whether that be through some sort of equity purchases which whereby any of the profits the government make gets fed back into the R&D pipeline and the companies involved have to ... commit to using that for that purpose.”

3.1.4: Entrepreneurship, commercialisation and policy skills for a quantum workforce

Beyond skilling up the interdisciplinary workforce, industry engagement from the outset is critical to ensure that quantum innovations ‘land’ when finally commercialised and to ensure that markets are being prepared for quantum, “You know... people are spending years and decades working on a solution without going out there and speaking to industry.” At the same time, entrepreneurs need a sufficient grounding in quantum to commercialise its potential, while policymakers require a basic understanding to develop policy that supports quantum readiness.

3.1.5: Summary

Taken together, these insights suggest that building a quantum workforce is less about predicting a fixed set of roles than about developing quantum-prepared capability: agile pathways, cross-sector mobility, and incentives that normalise translation and communication across disciplines.

The next section therefore turns to the question of who, in practice, constitutes this workforce—and how these roles are being articulated as the ecosystem takes shape.

Participants in a Quantum Low Energy Devices group discussing workshop prompts.





Participants in the Quantum Sensing for Healthcare group presenting during the shareback



Participant interacting with design materials in the workshop

3.2 Hybrid backgrounds, quantum ready

Quantum near futures are difficult to assess on the basis of our existing knowledge about quantum technologies and their possible impact in everyday life. In this context “quantum-ready” capability involves the development of multidisciplinary backgrounds that combine technical capabilities and literacy with translation, commercial and organisational skills, rather than single-discipline expertise.

3.2.1: Commercialisation and business development capability

Translating quantum science into industry-ready applications requires capability in commercialisation and business development, and corresponding time and capacity. Yet academic funding cycles rarely allocate dedicated time for commercialisation or for building research translation skills. As a result, university researchers can find themselves investing excessive energy and resources in moving from one grant to another in order to keep projects moving, teams employed and technical infrastructure in place.

Accelerators and incubators can play a pivotal role in supporting scientists and technologists to move research towards industry applications. However, our workshop found that the skills required for commercialisation are often distinct from the practices needed to advance quantum science itself. In comparable commercialisation contexts it is recognised that scientists and technologists do not necessarily become entrepreneurs, and that partnership is critical to translate innovations into market-ready applications:

You know, quite often those scientists don’t go on to be the entrepreneurs. So we’re talking about hiring co-founders who have that commercial acumen, you know, educating some of those co-founders and scientists about how to speak to investors, how to set up long-term commercial road maps.

Workshop participant, Quantum Sensing for Healthcare group

3.2.2: Transferable commercialisation skills for quantum readiness

Many of the skills and capabilities required for a hybrid, quantum-ready workforce are moreover not uniquely “quantum” at all, but resemble skills needed to develop, commercialise and market other technology innovations. While there will remain an ongoing need for deep quantum expertise—particularly in ‘blue sky’



Participant interacting with design materials in the workshop

research—the surrounding roles, from product development and programme management through to marketing and education, largely map onto existing occupational categories across the broader technology sector:

One overarching thing that we started ... to discuss was that there's actually not a lot of quantum specific things in any of these ... there's always going to be the deep blue sky research aspect which requires the deep deep (knowledge) of the mechanics and the quantum knowledge.

Workshop participant, Quantum Sensing for Healthcare group

3.2.3: Transferable quantum skills for a future workforce

Our workshop found that the future quantum workforce would also need transferable skills across quantum fields. For example, participants suggested that cryptographers currently working in quantum-ready technological systems are, for now, largely experts in classical cybersecurity, but will need to move rapidly into quantum computing and quantum security. This is an area of expertise that is not yet fully defined, but one that will build on the know-how they are already developing, alongside early upskilling across those sectors most likely to be affected by quantum.

Do we need less people working with cybersecurity because of quantum? Well, I think it will raise new threats that will need to be addressed due to all these quantum technologies, so there will be new research problems to be solved, how to defend against the new threats.

Workshop participant, Quantum-resistant Cybersecurity group

3.2.4: Summary

The workshop found that the quantum workforce will depend on hybrid capability and collaboration: deep technical expertise (depending on which part of the industry this would be more engineering, physics or materials oriented) remains essential, but translation skills, commercial leadership and partnership structures will increasingly determine whether innovations reach deployment.

The next section focuses on the educational pathways required to cultivate these hybrid profiles and, more importantly, how training can enable movement across science, engineering and entrepreneurship from the start.

3.3 Quantum Workforce roles

A quantum future workforce needs a workforce strategy that prioritises permeability rather than exclusivity: maintaining pathways for scientific and technical quantum specialism alongside expanding routes for engineers, technologists and domain experts to become “quantum-ready” through targeted training and collaborative work. In practice, this means designing education and upskilling options that support/enable movement across roles and sectors, and that strengthen the translational capacity of teams, so that quantum research can be converted into technological deployment, services and infrastructures as the industry matures and bridges with other industries incorporating quantum.



Participants in the workshop listening to sharebacks

3.3.1: Researchers and technologists

Translation between research and industry is considered to support the sector’s growth. Therefore researchers and technologists are understood as playing related roles and as being key enablers of Australia’s quantum industry. They are expected to lead translation between research and industry and to drive innovation in quantum technologies, particularly in quantum computing.

The workforce currently relies heavily on specialised PhD-level researchers, with extensive quantum expertise. However, the need for rapid commercialisation of quantum technology—projected to create up to 19,400 jobs by 2045 (Sydney Quantum Academy report, 2023) has driven a search for a more diverse talent pipeline. Participants emphasised that the future workforce will need to be more flexible and able to collaborate across sectors and disciplines. For example:

For scientists, this may entail greater mobility across specialisations and fields, and closer working relationships with non-scientific professionals. For example, participants suggested it would be “a good thing” if scientists, including, chemists, physicists, and medical researchers would work across multiple fields, including with non-science professionals.

Workshop participant, Quantum Communications group

Software engineers working in quantum-ready contexts, including quantum-resistant cybersecurity, would need to learn to implement new algorithms by building on their existing competences in working with “old algorithms”—such as abstraction, verification, optimisation, and systems integration. Thus suggesting upskilling and contextual literacy would enable



Participants in the Quantum Infrastructure for Cities group

engineers to translate between classical approaches and emerging quantum methods (workshop participant, Quantum-resistant Cybersecurity group).

For many engineering roles, deep quantum knowledge may not be necessary. Instead, people “could just have sort of a basic... semester training kind of thing. So that they kind of understand it but couldn’t actually do the software and other stuff” (workshop participant, Quantum Low Energy Devices group). “Lowering the bar on education” would encourage mobility between disciplinary areas, and respond pragmatically to industry needs. For example, an industry participant in the quantum diamond industry suggested:

I don’t need someone with a PhD in nitrogen vacancy diamond. I need someone who understands the quantum phenomena in nitrogen vacancy diamond and I can teach them the rest.

Workshop participant, Quantum Infrastructure for Cities group

3.3.2: Entrepreneurs and Investors

The role of entrepreneurs and investors in the future quantum workforce is multifaceted. It involves: using baseline quantum knowledge to communicate complex innovations to potential entrepreneurs and investors (but not necessarily highly technical expertise); cultivating a community of ‘sophisticated investors’ in a context where venture capital investment was seen as rare due to both the complexity of quantum and the current artificial intelligence bubble.

Quantum entrepreneurial skills were perceived as broadly transferable and should bridge the gap between research and investment, from government support to venture capital. Because many researchers and engineers do not have the required skills to manage products and commercialise quantum innovations, partnerships with startups were seen as critical for translating research into industry-ready applications.

Participants reinforced the need to build a quantum entrepreneurship talent pool with transferable, cross-sector skills that anticipates the future needs of the industry. For example participants discussed the role of entrepreneurship capable of creating what will/could become essential in the near future:

In terms of entrepreneurs we will need various companies to develop hardware and software to enable these quantum-resistant algorithms. So for example you might have (a) chip that accelerates these cryptography operations for particular algebra, so that could be useful.

Workshop participant, Quantum-resistant Cybersecurity group

In 2050 funders aren't going to be investing in quantum communication because that will just be communication by then. They'll be investing in whatever it is that has come out of quantum communication.

Workshop participant, Quantum Communications group



Participants in a Quantum Low Energy Devices group

3.3.3: Quantum pipeline builders

The role of Quantum Australia, accelerators and incubators was highlighted as central to supporting research translation partnerships. Startups and entrepreneurs are seen as building the pipeline for both new opportunities and mature technologies. To sustain the quantum pipeline participants considered it important to continually replenish the pool of basic scientists in universities as more senior researchers leave to commercialise their innovations:

Now, they're ... starting to spin out companies and things we need to keep replenishing that pool of basic scientists that can feed this pipeline ... otherwise we'll lose the momentum that we've had.

Workshop participant, Quantum Sensing for Healthcare group

3.3.4: Building bridging relationships between researchers, entrepreneurs and industry

Whether operating in universities or research centres, ensuring market fit for research-led innovations was highlighted as critical to their uptake by industry. This can be supported by technologists and researchers working closely with industry. Participants emphasised that building bridging relationships between researchers, entrepreneurs and industry is something that accelerators, incubators and Quantum Australia could actively promote.



Professor Sarah Pink addressing the workshop group

3.3.5: The role of policymakers

While policymakers' roles exist outside the quantum sector, they were seen as playing a crucial role in preparing for a quantum-ready society and quantum-ready workforce:

The roles of policymakers in the quantum ecosystem span from essential support in the early stages to backup, creating a safe space through the adoption of and expansion of knowledge of the importance of advanced cryptography to policy design for the needs that will surge as technological development and the adoption of quantum by industry and government advance.

Workshop participant, Quantum-resistant Cybersecurity group

Workshop participants noted that a lack of understanding of quantum makes it difficult for policymakers to develop the standards and guardrails required for a quantum-safe future or advocate for funding and support for the sector. They called for a strategic, deliberate approach to educating State and Federal government policymakers.

Participants identified the following roles for policymakers:

- Establishing a long-term vision for quantum, articulating the economic and investment opportunities associated with quantum and its potential for job creation and supporting citizen awareness, as articulated by a participant in the Quantum Sensing for Healthcare group:

I think the role of policymakers is to articulate the economic opportunities that come from quantum computing, the jobs that can be created. I think without that, then you're sort of behind, so you need ... [a] bipartisan and long-term vision.

- Supporting citizens in a safety role, in understanding quantum-resistant cybersecurity, the risks of quantum cyber attacks, and vigilance against commonplace 'social engineering' approaches to cyber attacks
- Anticipating the challenges and potential pitfalls of future quantum innovations. For example in countering misinformation about quantum to avoid citizen disengagement or mistrust, as has occurred with 3G and AI. This communicative role would help to position the advantages of quantum and draw attention to new laws and standards
- Developing laws and non-competing standards to govern quantum innovations and industry across State and national borders.



Sticky notes from one of the workshop activities

3.4 Education and training pathways

This section reports on participants' views regarding what the education system can realistically achieve, what it should be doing, and how these goals might be realised. Across the discussions, participants valued educational provision with not only quantum-specific content, but for broader capabilities across different roles and sectors. For example, lateral thinking, agility, and the capacity to work across technical and non-technical interfaces and communication processes.

3.4.1: Higher education and training

Tertiary education remains a cornerstone of quantum workforce development. Simultaneously training is emerging as an essential mechanism to meet the future demands of an industry that is still taking shape. In stakeholders' accounts, training is not a single pathway but a set of diverse, evolving learning environments, ranging from short courses and micro-credentials to on-the-job upskilling and cross-disciplinary retraining programmes. From a training perspective, a recurring view was that progress will depend on building from existing technical foundations. Having an undergraduate base in a technical discipline (for example, engineering) and then completing a short segment on quantum fundamentals was widely seen as a realistic route for training at scale.

3.4.2: The role of secondary education

Participants consistently emphasised the role of earlier intervention. They saw secondary school as the first step for building basic awareness and foundational knowledge of quantum, and encouraging students to see quantum as a future career. Examples from the UK and Europe suggest that early exposure can play a material role in normalising quantum literacy and widening participation beyond those young people already oriented towards physics (Rashidi, ARC Centre of Excellence in Quantum Biotechnology [QUBIC], 2024). This could, in part, be achieved by supporting the connection between industry and education:

We brought up the idea of having more communication between schools and groups and industries and sectors, much like what we're doing right now [in the workshop]. I think this is actually very important.

Workshop participant, Quantum Low Energy Devices group

3.4.3: Educating policy makers

Participants saw educating policy makers on the capabilities of quantum technologies as vital but not straightforward, and proposed strategies that had worked effectively in other sectors, such as embedding PhD students to work directly with policymakers and other decision-makers in government departments.

3.4.4: Summary

A quantum-ready workforce is composed of people with hybrid backgrounds, upskilling workers from other fields, and capabilities across research, engineering, entrepreneurship and policy. In this still-forming ecosystem, education and training are valued for producing technical expertise, enabling translation, collaboration and adaptability across domains. A quantum-ready future depends on cultivating people, relationships and institutions able to work across boundaries as the industry, and its social worlds, continue to take shape.

Participants interacting with design materials in the workshop





Participants in a Quantum Low Energy Devices group

3.5 Quantum workforce pipeline

In existing strategies, reports, and other white and grey literature on the Australian quantum ecosystem (see Table 1) the quantum workforce pipeline is presented primarily in educational and training terms, focusing on talent flowing from universities and the technically skilled workforce currently employed in start-ups (Sydney Quantum Academy Workforce report, 2023). Our research suggests the pipeline should be understood more broadly, beyond the university and research system.

3.5.1: Factors required for a successful pipeline

Workshop participants suggested important factors would be: for the quantum sector to be attractive to highly skilled workers; making quantum visible across educational levels as a possible future pathway; generating awareness of quantum within universities beyond those already studying physics and cognate disciplines; ensuring institutional support for communicating the wider societal importance of quantum; and political support for funding, signalling the value and future relevance of the sector.

3.5.2: Factors limiting the existing pipeline

Participants noted the following current limitations:

- quantum is strongly tied to the university system, through scholarships, funding structures, and academic career pathways, which can limit broader talent attraction due to unfamiliarity with the potentials of quantum;
- because quantum is not yet seen as a ‘hot’ sector, potentially due to longer timelines to deployment (as distinct from AI); and
- government support for attracting talent into start-ups is limited, despite the importance of start-ups to the future industrial ecosystem.

3.5.3: Summary

The quantum workforce pipeline is currently structurally, institutionally and politically limited. A clear pathway ahead will involve broadening scope, generating awareness and collaboration between stakeholders.

4

ANTICIPATING QUANTUM FUTURES

5.

ANTICIPATING QUANTUM FUTURES

Workshop participants worked with a series of quantum scenarios through the workshop (page 10 and Appendix 1). In this section we present a selection of their responses to the scenarios to demonstrate: first, how the participants anticipated the quantum societal futures which future quantum technologies and a future quantum workforce would support; and second, how they anticipated work futures. This is not intended to be exhaustive, but is important as it offers a means to contextualise and create connections between how future work is anticipated in relation to the broader context it is expected to impact.

4.1 Anticipating future quantum society

4.1.1: Quantum sensing

Participants imagined quantum sensing as one of the most immediate and socially legible areas of quantum development. By 2035 and beyond this would be particularly salient in the healthcare context where portable diagnostics, wearable devices, continuous monitoring and non-invasive imaging may reshape healthcare towards more personalised, preventative and distributed models of care. Care responsibilities will be distributed across institutions, clinicians and households.

4.1.2: Quantum communications as enabling infrastructure

Quantum communications were imagined as having implications across multiple sectors, including secure data transfer, navigation, transport systems, pharmaceuticals and utilities, as well as enabling experiments conducted across distance, including in space. Beyond these applications, it was framed as enabling infrastructure, with the potential to shape new standards, transform how communication operates, and contribute to public planning, sovereign capability and future societal systems.

4.1.3: Quantum computing in everyday life

Quantum computing was imagined less as a distant specialist technology than as part of a broader ecosystem involving quantum-safe cybersecurity, new materials, interfaces, cloud services, connected devices and infrastructures that could become part of everyday life, integrated with classical systems, as much as on advances in computational power itself.

4.2 Anticipating the future quantum workforce

In this section we outline how in response to the five scenarios (Appendix 1) participants anticipated a future quantum workforce. We note that these findings consolidate and reiterate several points made in earlier sections.

4.2.1: A more hybrid workforce

Across the scenarios, the future workforce was imagined as more hybrid, mobile and collaborative, with people moving between science, engineering, entrepreneurship, policy and adjacent sectors and avoiding remaining within narrow disciplinary tracks. This entailed more permeability across roles and sectors, and institutional willingness to support movement, collaboration and translation.

4.2.2: Entrepreneurs as future pipeline builders

Participants imagined entrepreneurs, co-founders and funders as playing an increasingly central role in building the quantum pipeline, carrying technologies through from basic science to application, scale and maturity. These quantum entrepreneurs carry the role of developing the quantum industry and strengthening Australia's entrepreneurial context/capabilities/infrastructure and of bringing other industries to create new modalities for the Australian startup sector to grow sustainably.

4.2.3: Policymakers as future shapers

Policymakers were imagined as active shapers of the future quantum landscape through development of standards, protection, infrastructure decisions, public communication, safety frameworks and long-term national strategy.



Participants sharing back from the Quantum Infrastructure for Cities group

4.4.4: Quantum as a public and societal issue

Participants suggested that by 2050 quantum technologies may no longer be perceived as exceptional or niche, but as embedded within communication systems, diagnostics, cybersecurity, infrastructure and industry. Participants also highlighted the societal engagement with the outcomes, services and infrastructures that quantum enables.

4.4.5: An inclusive, safe and ethical quantum future

Across the research, participants did not imagine a desirable quantum future as one driven by innovation alone. They repeatedly connected future success to safety, trust, standards, accessibility, workforce preparation and socially meaningful deployment as well as inclusion and institutional ethical governance of change.

5

CONCLUSION

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CONCLUSION

Australia's quantum future will not be built through technical innovation alone. As this report has shown, a quantum-ready workforce depends on the development of multidisciplinary capability, hybrid pathways across research, engineering, entrepreneurship and policy, and stronger connections between education, industry and government. In a field still marked by uncertainty, long timelines and uneven development, workforce readiness must be understood as an ongoing process of building skills, relationships, institutions and public awareness.

The findings demonstrate that quantum readiness is not simply a matter of producing more specialists. It also requires creating the conditions for translation, collaboration and mobility across sectors, focusing on sustaining the research base, supporting start-ups and entrepreneurs, and equipping policymakers and citizens to engage with quantum futures. Building a thriving quantum workforce therefore means strengthening the full pipeline: from school education and university training to commercialisation, public communication, infrastructure planning and long-term policy support.

The journey towards a quantum-ready Australia is already underway, but it remains open, uneven and in formation. This creates both responsibility and opportunity. If Australia is to realise the promise of quantum in ways that are inclusive, safe and socially meaningful, deliberate action is needed now to support the people, partnerships and institutions that will carry this future forward.



Above: Participants in the Quantum Sensing for Healthcare group



Left: Sarah Pink filming for the Making Quantum Futures Visible documentary

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Participants in the Quantum-resistant Cybersecurity group



APPENDIX 1

This section provides representations of the five scenarios used in the workshop.

Quantum sensing for healthcare

Quantum sensing opens a new frontier in medical innovation, transforming diagnostics, therapeutics, and healthcare delivery. By exploiting quantum phenomena to detect minuscule changes in biological systems, these sensors enable faster discovery, earlier diagnosis, and more personalised treatment. Quantum sensors detect disease markers in extremely low concentrations, providing continuous monitoring of disease progression with compact, even wearable, devices. Applications of quantum sensors include early-stage cancer detection, leveraging quantum innovations to differentiate healthy from unhealthy tissue, and next-generation brain imaging, allowing for more detailed and dynamic observations of brain activity. Diamond-based quantum sensors can also support detection of free radicals in virus-affected cells, and measure the magnetic fields produced by iron atoms contained in ferritin, essential for treating low-iron conditions.

Quantum infrastructure for cities

As cities evolve toward smarter, more sustainable systems, the transition to renewables, increasing grid decentralisation, demand for energy storage, and the urgent need to decarbonise are reshaping how infrastructure is designed, operated, and secured. Quantum technologies are emerging as critical enablers for managing this complexity, offering unprecedented precision in sensing, timing, and computation. Quantum receivers and networks could provide ultra-reliable, interference-free communication channels for synchronising urban systems—from energy grids and transport networks to environmental monitoring and emergency response. Quantum sensors and metrology will enable real-time mapping of urban dynamics, measuring vibration, temperature, and magnetic fields at atomic precision to support safer, more adaptive infrastructures. Meanwhile, quantum computing offers the prospect of optimising traffic flows, energy use, and logistics across entire metropolitan systems. Yet significant challenges remain, including integrating quantum with classical networks and addressing governance, ethical, and access issues.

Quantum materials for low energy devices

Quantum materials have potential to reduce the energy requirements of information and communication technologies, supporting efforts towards environmental transitions. Current silicon-based technologies (CMOS) have reached the limits of their efficiency. Quantum computing supports the development of new and ultra-thin materials, including 2-dimensional materials such as graphene, and enables innovators to design novel materials at the atomic level, reducing the need for costly physical prototyping. Such materials, including those that switch at much lower energy than silicon, pave the way for future low-energy devices. Quantum computers may help in simulating the complex molecular structures of future high performance materials, supporting carbon capture, thermoelectric devices or high-efficiency photovoltaic solar cells.

Quantum communications

Quantum communications promise to revolutionise secure data transmission by leveraging the principles of quantum mechanics—superposition, entanglement, and measurement—to ensure unprecedented levels of security and information integrity. Yet, the path to real-world deployment remains complex. Quantum receivers, essential for detecting and interpreting quantum signals, face significant challenges in sensitivity, scalability, and integration with classical communication infrastructure. Environmental noise, decoherence, and signal loss continue to limit performance, while standardisation and interoperability remain unresolved. At the same time, breakthroughs in quantum receivers could unlock new opportunities in ultra-secure global networks, space-based communication systems, and next-generation internet architectures.

Quantum resistant cybersecurity

With 99.9% of global transactions now occurring online, the security of digital systems is more critical than ever. The advent of quantum computing poses both a profound challenge and an unprecedented opportunity for cybersecurity. The increase in processing power promised by Quantum computing will enable more thorough risk assessments of high dimensionality data and improved finance sector resilience. Quantum key distribution (QKD) offers secure transmission of data, safe-guarding transfer of private information and ensuring security based on physical (quantum) phenomena. On the other hand, scalable quantum computers can make today's traditional cybersecurity mechanisms vulnerable as they are able to efficiently break the underlying mathematical problems. Quantum-safe (a.k.a. post-quantum) cryptography addresses this quantum-vulnerability challenge by developing new cryptographic schemes based on quantum-safe mathematical problems.

APPENDIX 2

This section provides representations of the two design canvases used in the workshop.

Quantum Future Workforce - 2035/2050

In this activity, your group will envision what quantum sensing for healthcare could look like in the future (2035 and 2050) and identify what needs to happen today to get there.

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<p>1 By 2035</p> <p>a By 2035, which applications in relation to quantum sensing for healthcare have become part of everyday life / industry?</p> <p>b How are people engaging with these innovations in practice?</p>	<p>2 By 2050</p> <p>a How has quantum sensing for healthcare managed the way work and life happens in 2050?</p> <p>b What has been its impact on industries?</p>	<p>3 Backcasting</p> <p>a Looking back from 2050, what research priorities and partnerships were critical to establishing a thriving industry in quantum sensing for healthcare?</p> <p>b What needs to start in 2025 to enable this to happen?</p>	<p>4 Equity and access</p> <p>a What ethical and social considerations should be taken into account to ensure equity and access to quantum innovations in 2050?</p> <p>b Who is being left behind?</p>
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2035 2050

Quantum sensing for healthcare

Mapping skills, capabilities and requirements for a Quantum Future Workforce

In this activity we are considering the specific skills, education, capabilities and needs of our future technologists, scientists, entrepreneurs and policy makers.

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<p>1 Future technologists</p> <p>a What is the role of technologists (e.g. engineers, software developers etc) in relation to quantum sensing for healthcare in 2035? What are the skills and capabilities they need to flourish in the field? What needs to be in place by 2025 to build this workforce?</p> <p>b How will the role of engineers change in the quantum sensing for healthcare industry by 2050?</p>	<p>2 Future scientists</p> <p>a What is the role of scientists (e.g. physicists, materials scientists) in relation to quantum sensing for healthcare in 2035? What are the skills and capabilities they need to flourish in the field? What needs to be in place by 2025 to build this workforce?</p> <p>b How will the role of scientists change in the quantum sensing for healthcare industry by 2050?</p>	<p>3 Future entrepreneurs</p> <p>a What is the role of entrepreneurs in relation to quantum sensing for healthcare in 2035? What are the skills and capabilities they need to flourish in the field? What needs to be in place by 2025 to build this workforce?</p> <p>b How will the role of entrepreneurs change in the quantum sensing for healthcare industry by 2050?</p>	<p>4 Future policy makers</p> <p>a What is the role of policy makers in relation to quantum sensing for healthcare in 2035? What are the skills and capabilities they need to flourish in the field? What needs to be in place by 2025 to build this workforce?</p> <p>b How will the role of policy makers change in the quantum sensing for healthcare industry by 2050?</p>
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Quantum sensing for healthcare

APPENDIX 3

Following is a list of workshop participants, their organisations and allocated groups.

Workshop participants, organisations and allocated group

Quantum Sensing for Healthcare

Lincoln Turner, Monash University
Chris Vale, CSIRO
Charlie Nave, Monash University
Tapio Simula, Swinburne University

Facilitator: India Read, ETLab

Quantum Infrastructure for Cities

Lachlan Hyde, Quantum Brilliance
Daniel Lai, Deakin University
Julie Martin, Suburban Rail Loop Authority
Travers Wailes, Transport Victoria
Mariella Smids, Monash University Precincts

Facilitator: Debora Lanzeni, ETLab

Quantum materials for low energy devices (A)

Michael Fuhrer, QLIME, Monash University
Kris Helmerson, QLIME, Monash University
Stephania Castelletto, RMIT
Francesco Campioli, RMIT

Facilitator: Daniel Hunter, Quantum Australia

Quantum materials for low energy devices (B)

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Haoran Ren, QLIME, Monash University
Fiona Broussard, Monash University
Meera Parish, QLIME, Monash University

Facilitator: Adrian Gertler, Quantum Australia

Quantum-resistant cybersecurity

Ron Steinfeld, FIT, Monash University
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Jefrey Abraham, Swinburne University
Alex Tritt, QLIME, Monash University

Facilitator: Eva Otto, ETLab

Quantum Communications

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Sophie Crouch, Monash University
Errol Hunt, QUBIC
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Facilitator: Leah Heiss, ETLab

