University of Colorado **Boulder**

Colorado Quantum Workforce Report

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Contents

Executive summary

The Mountain West, and Colorado in particular, is one of the nation's quantum hubs. Colorado's quantum industry is evolving rapidly. To stay competitive, the state must align its education, workforce development, and industry growth strategies.

The findings in this report summarize insights from interviews with quantum industry employers across Colorado that address one of the recommendations from the 2024 OEDIT Roadmap Recommendations [1]. The results highlight quantum industry job roles, current workforce strengths and weaknesses, opportunities for stronger industry-academia collaboration, and recommendations for how to systematically track workforce needs. The goal is to ensure Colorado sustains its competitive edge as the quantum industry evolves from research-based to market-ready applications.

Key findings and recommendations

- **Talent landscape:** The Colorado quantum industry features a multidisciplinary workforce spanning a wide range of job roles, combining varying levels of quantum expertise with both deep technical specialization and strong professional skills.
- **Workforce strengths:** Graduates from Colorado institutions of higher education are well prepared and the regional talent pool is dynamic and growing.
- **Workforce weaknesses:** There are shortages in specialized areas, such as interdisciplinary roles that require both quantum and business expertise.
- **Collaboration needs:** There is a need to strengthen industry–academia partnerships, expand experiential learning, and formalize upskilling programs.
- **Industry projections:** Employers anticipate a need for talent across educational levels and they anticipate a need for professionals in application-focused roles.
- **Workforce metrics:** Employers suggest establishing a system that tracks quantum sector funding, education, and hiring data, which links educational training, internships, and actual hiring numbers to strengthen education-to-employment pathways and refine workforce development strategies.

Context: data collection and analysis

As part of a project to understand the national quantum workforce landscape [2], we conducted 42 interviews with 23 different companies across the United States in 2025 to learn about the knowledge, skills, and abilities (KSAs) needed for various individual positions. Eighteen of those interviews with 10 different companies have a Colorado presence, which are the interviews we focus on in this report to examine the KSAs needed, as well as workforce trends in the region. In other words, our analysis centers companies with a strong Colorado quantum workforce presence, but also draws on insights developed as part of the larger study about the national quantum workforce.

The interviews conducted were with both managers and employees. The manager interviews explored each company's role within the quantum industry, the skills and knowledge of specific positions, and the interviewee's perspective on the industry's future. The employee interviews examined each individual's position, the specific tasks they perform, and the associated knowledge and skills needed to carry out those tasks. We had a few interviewees from the same company and most companies self-reported participation in more than one type of activity. We adopted definitions consistent with prior literature [3, 4, 5] for company types. Figure 1 presents the breakdown by type and size of the 10 Colorado-based companies we focus on in this report.

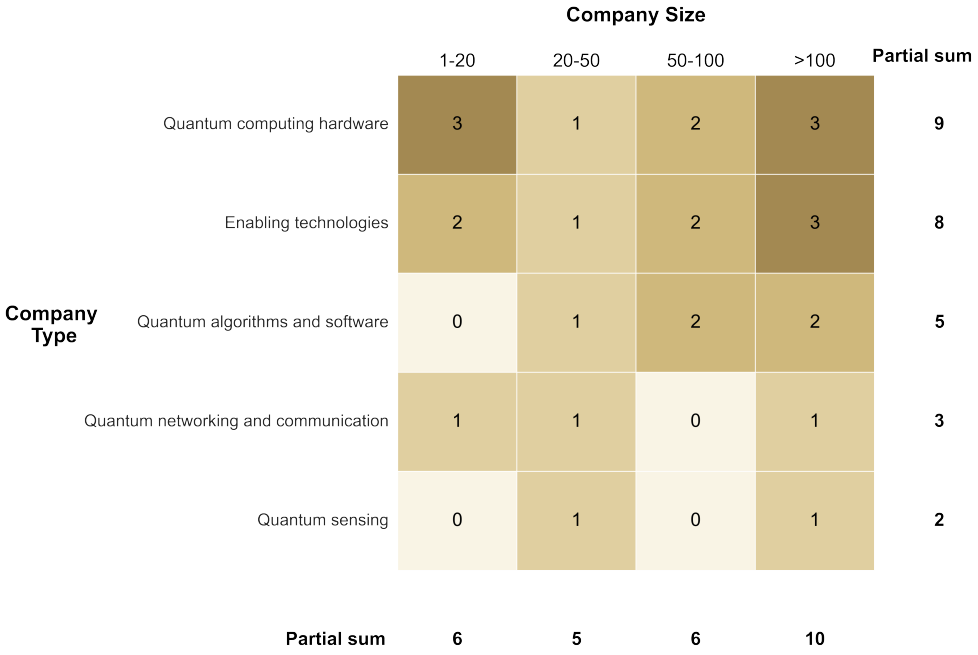

Figure 1. Distribution of interviewed companies by type and size. Company size corresponds to the range of employees working in quantum-related technologies in these companies. We had a few interviewees from the same company and most companies self-reported participation in more than one type of activity.

Key Question

What are the knowledge, skills, and abilities (KSAs) most needed by the Colorado quantum industry?

To answer our key question, we first analyzed our interview data to identify the KSAs needed for each individual position. A total of 29 individual positions were identified. We have more individual positions than interviews because the 10 Colorado managers interviewed discussed multiple positions at their companies. We categorized these positions functionally across hardware, software, business and public facing, as well as bridging across domains, which fit into 17 role categories. For each role, a detailed profile was developed following the O*NET framework structure [6].

In parallel, we did a thematic analysis to identify themes for each of the following questions asked of the managers in our dataset pertaining to Colorado:

- From your experience, are there regional trends in the strengths or weaknesses in quantum skills or knowledge of applicants?
- Are there specific support, resources, or connections with local higher education institutions that you would like to have? If yes, what would those look like?
- Thinking of the quantum industry as a whole, what are potential trends you foresee in future job opportunities in the quantum industry in Colorado?
- What potential metrics do you think would be relevant to track workforce needs and the progress of the quantum industry in the area?

Individual positions and roles

In this report, when we use *individual positions*, we refer to a specific job at a company. When we use *roles*, we refer to a job family that may fit multiple people's job titles across companies. In other words, multiple individual positions can be part of one role. The reason we distinguish these terms is because the data we collected showed that individual position titles are not always reflective of similar job functions for a position. Two individuals holding the same title (e.g., "quantum engineer") at different companies may perform very different tasks. Since our dataset for this report is part of a broader study investigating the landscape of quantum industry across the US [2], we were able to examine these positions in depth and categorize them based on their actual function and tasks rather than by title.

Our role categorization led to four main categories, with subcategories within each. The categorization is illustrated in Figure 2 and described in detail in our report about *Categorization of Roles in the Quantum Industry* [7].

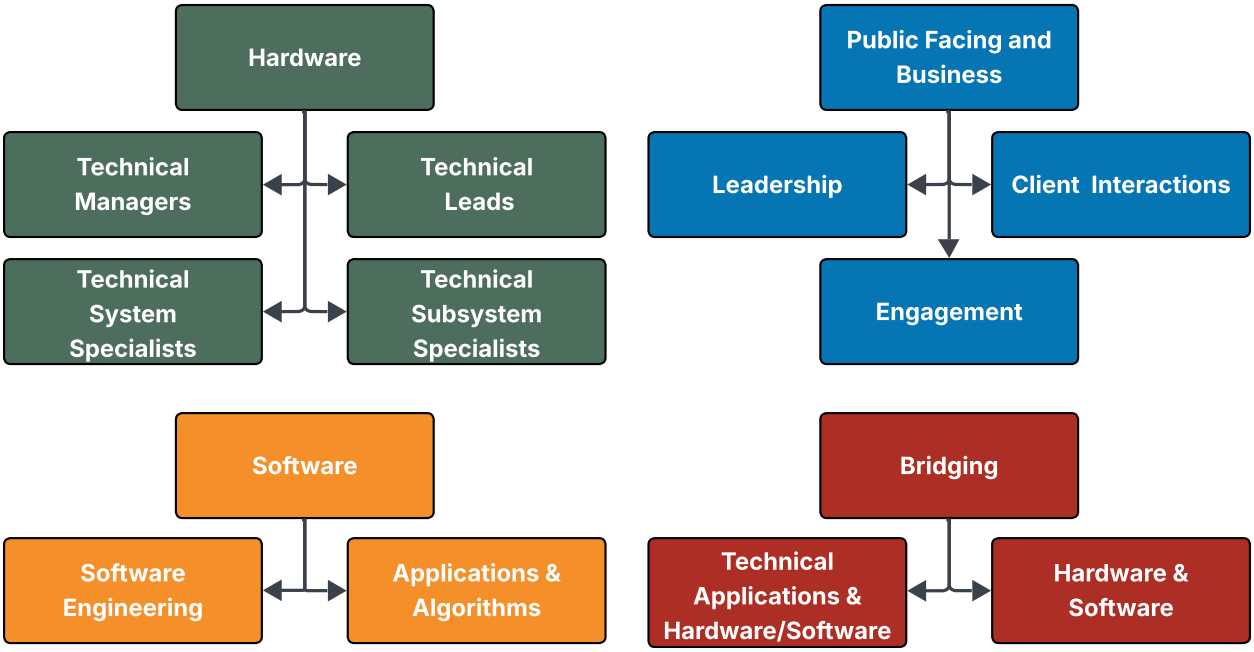

Figure 2. Overview of the role categorization, showing the four main categories and their subcategories.

- **Hardware** roles engage in hands-on work designing, developing, refining, and manufacturing hardware for quantum technologies.
- **Software** roles engage in the work of designing, developing, and optimizing software for quantum systems and applications.
- **Bridging** roles focus on connecting teams within an organization (e.g., bridging the gap between technical applications and the underlying hardware or software).
- **Public facing and business** roles are on business strategy, leadership, partnerships, public engagement, and government relations.

Table 1. The four primary categories into which roles were sorted, as well as the codes and titles for each individual role

Category	Code	Role
Hardware	H1.1	Senior scientists
	H1.2	Engineering managers
	H2.1	Commercialization leads
	H2.2	Systems engineers
	H3.1	Experimental scientists
	H3.2	Quantum hardware system engineers
	H3.3	Field deployment engineers
	H4.1	Superconducting quantum engineers
	H4.2	Device characterization & measurement specialists
	H4.3	Design engineers, EE circuits, RF specialists
	H4.4	Optics & photonics experiment specialists
	H4.5	Optics & photonics assembly specialists
	H4.6	Cryogenics specialists
	H4.7	Nano/microscale specialists
	H4.8	Lab and construction technicians
Software	S1.1	Traditional software engineers
	S1.2	Quantum software engineers
	S2.1	Quantum information science algorithms theorists
	S2.2	Quantum algorithms programmers
Bridging	B1.1	Quantum software application developers & trainers
	B1.2	Quantum technology end users
	B2.1	Device & system hardware computational scientists
	B2.2	Quantum computer operators
Public Facing & Business	P1.1	Company executives
	P1.2	Project overseers
	P2.1	Hardware applications & technical sales Specialists
	P2.2	Business & partnerships specialists
	P3.1	Education advocates
	P3.2	Government–industry advocates

Within each main category and its subcategories, we developed role profiles by grouping individual positions with similar functions and tasks. Table 1 presents the resulting list of roles within each main category, which reflects the data from the broader national project. Additional details about the role-categorization process are provided in [7]. Focusing specifically on Colorado, Table 2 presents each individual position from our interviews with Colorado companies along with its associated role category.

Table 2. Each individual position from our Colorado-focused interviews and its associated role category.

Individual position	Role
Hardware	
Senior Advanced Physicist	Senior scientist
Principal Investigator	Senior scientist
Quantum Engineer	Senior scientist
Quantum R&D Engineer	Engineering manager
Staff Scientist	Commercialization lead
Quantum Engineer	Commercialization lead
Senior Advanced Physicist	Experimental scientist
Quantum Experimental Algorithms Researcher	Experimental scientist
Quantum Optics Engineer	Experimental scientist
Quantum Hardware Scientist	Experimental scientist
Research Scientist/Quantum Systems Engineer	Experimental scientist
Quantum Engineer	Quantum hardware systems engineer
Research Engineer	Design engineer, EE circuits, RF specialist
Laser and Optics Engineer	Optics and photonics experiment specialist
Photonics Assembly Technician	Optics and photonics experiment specialist
Fabrication Engineer	Optics and photonics assembly specialist
Assembly Technician	Optics and photonics assembly specialist

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Individual position	Role (continued)
Nano Fabrication Engineer	Nano/microscale specialist
Lab Technician	Lab and construction technician
Construction Specialist	Lab and construction technician
Software	
Senior Quantum Application Engineer	Quantum software engineer
Research Scientist/Algorithm Developer	Quantum algorithm programmer
Bridging	
Quantum Theoretical Scientist	Device and system hardware computational scientist
Photonics Engineer	Device and system hardware computational scientist
Public-facing and business	
Founder/Scientist at quantum-related start-up	Company executive
Chief Operating Officer	Company executive
Project Manager	Project overseer
Technical Sales	Hardware application & technical sales specialist
Quantum Business Development Specialist	Business & partnerships specialist

For each position listed in Table 2, interviewees reported the level of quantum expertise required, using the quantum expertise scale defined in the 2024 OEDIT Roadmap Recommendation [1]. Using these self-reported levels and the role categories in Table 2, we mapped each position to the quantum expertise scale as shown in Table 3.

Several roles (e.g., *company executive*, *quantum hardware system engineer*, *experimental scientist*) can be filled by individuals with varying levels of quantum expertise, which showcases multiple entry points into the industry depending on one's quantum knowledge.

Table 3. Level of quantum expertise as categorized by the interview for each role category.

	Business & public facing roles	Bridging roles	Software roles	Hardware roles
Quantum Expert	*Company executive*, Business and partnerships specialist	Device and system hardware computational scientist	Quantum software engineer	Senior scientist, Commercialization lead, *Experimental scientist*
Quantum Proficient	*Company executive*, Hardware application & technical sales specialist, Project overseer		Quantum algorithm programmer	Engineering manager, *Experimental scientist*, *Quantum hardware system engineer*, *Optics and photonics experiment specialist*, *Optics and photonics assembly specialist*, Nano/microscale specialist
Quantum Conversant				*Quantum hardware system engineer*, *Optics and photonics experiment specialist*, *Optics and photonics assembly specialist*, Design engineer, EE Circuits, RF specialist
Quantum Aware	*Company executive*			*Optics and photonics assembly specialist*, Lab and construction technician

In italics are the roles that can be filled by individuals with varying levels of quantum expertise.
Quantum Expert: those who may typically hold a PhD in physics, engineering, computer science, or other subjects connected to the basic study of quantum phenomena.
Quantum Proficient: those who may hold physics or engineering degrees in quantum-specific topics at either the undergraduate or master's degree levels.
Quantum Conversant: those who may or may not hold a traditional four-year degree, but should be able to have a conversation in quantum information science topics.
Quantum Aware: those who are new to quantum concepts and simply have general awareness of the subject matter.

Profiles of roles in the Colorado quantum workforce

The full set of profiles can be found in the report *Profiles of Roles in the Quantum Industry* [8].

Representative profile for a hardware role

Profile H3.1: Experimental Scientists

Findings in this profile are not presented in order of importance, nor does any individual position in the data include all listed elements.

Individual positions: Quantum Optics Engineer, Quantum Hardware Scientist, Research Scientist, Senior Advanced Physicist, Quantum Experimental Algorithms Researcher, Senior Photonics Experimenter

Company types: Quantum computing hardware (platforms: trapped-ion, superconducting), Quantum algorithms and software, Quantum sensing, Quantum networking and communication, Enabling technologies

Occupation-Specific Information

Description: Experimental scientists plan and run the experiments (e.g., doing quantum optics experiments, device testing), perform analysis, and report results either internally (e.g., report) or externally (e.g., publications).

Tasks: On the job, they would...

- Characterize hardware performance by taking and analyzing data
- Communicate results and plans within the organization
- Contribute to relocation of large scale quantum experiments
- Perform and plan experiments
- Review scientific literature
- Write reports and publications

Worker Requirements: Knowledge, Skills, Abilities (KSAs)

Knowledge of:

- Decoherence
- Device physics
- Error mitigation techniques
- How quantum networks scale in practice
- Ion trapping

- Non-quantum electronics
- Photon counting and device physics
- Probability theory
- Qubit hardware
- Quantum algorithms
- Quantum design and control
- Quantum imaging techniques
- Quantum networking and optics
- Quantum technology implementation

Occupation-specific skills and abilities:

- Able to align optical elements
- Able to characterize and calibrate lasers
- Able to communicate effectively about technical topics
- Able to do some programming generally, without specifying whether it is for data processing, data representation, or other purposes
- Able to network multiple computing platforms together
- Able to perform quantum optics experiments
- Able to troubleshoot hardware and software
- Able to work with vacuum systems

General skills and abilities:

- Adaptability, collaboration, critical thinking, leadership, problem solving, and project management

🎓 Experience Requirements

Education:

- Degrees: Bachelor, Master, or PhD
- Disciplines: Computer Science, Engineering (mechanical or thermal engineering), or Physics

On-the-job training:

- Colloquia and journal clubs
- Conference attendance and training through academic partnerships

- One-on-one mentoring for facility orientation

Prior experience:

- Typically hired directly after PhD
- Internships or industry experience is helpful if individual does not have a PhD

Representative profile for a software role

Profile S1.2: Quantum Software Engineers

Findings in this profile are not presented in order of importance, nor does any individual position in the data include all listed elements.

Individual positions: Senior Quantum Application Engineer, Quantum Computational Scientist, Software Developer, Quantum Software Developer, Quantum Software Engineer

Company types: Quantum computing hardware (platform: neutral-atom, superconducting), Quantum algorithms and software, Quantum sensing, Quantum networking and communication, Enabling technologies, Consultants

Occupation-Specific Information

Description: Quantum software engineers design and develop software directly related to quantum computing.

Tasks: On the job, they would...

- Develop and integrate classical and quantum software
- Develop research code into shareable packages
- Ensure compatibility of code across different computing environments where the software will be used
- Plan and organize quantum software development projects
- Read, write, and present research
- Translate domain knowledge into quantum algorithms to bridge technical and application areas
- Write code for quantum applications, which includes qubit control, web app development, and language design

Worker Requirements: Knowledge, Skills, Abilities (KSAs)

Knowledge of:

- Classical computation and high performance computing (HPC) centric languages

- Cloud platforms used in quantum computing environments
- Data science
- Foundational knowledge of AMO physics
- General programming tools (e.g., Python, Rust, and Git)
- Quantum algorithms and their applications
- Quantum circuits, including mathematical operations, the measurement process, normal operators in quantum, and expectation values
- Quantum computing theory and its practical challenges
- Software package design (SPACK)

Occupation-specific skills and abilities:

- Able to read and write scientific papers
- Able to work with ambiguity

General skills:

- Adaptability, critical thinking, documentation, problem solving, and project management

Experience Requirements

Education:

- Degrees: Bachelor, Master or PhD
- Disciplines: Chemistry, Computer Science, Engineering, or Mathematics

On-the-job training:

- One-on-one mentoring
- Participation in external courses

Prior experience:

- Experience at another company or an industry internship is preferred

Representative profile for a bridging role

Profile B2.1: Device & System Hardware Computational Scientists

Findings in this profile are not presented in order of importance, nor does any individual position in the data include all listed elements.

Individual positions: AMO Theorist, Quantum Theoretical Scientist, Photonics Engineer, Computational RF Scientist, Quantum Research Scientist, Quantum Error Correction Scientist

Company types: Quantum computing hardware (platform: trapped-ion, neutral-atom), Quantum

algorithms and software, Quantum sensing, Quantum networking and communication, Enabling technologies, Consultants

Occupation-Specific Information

Description: Device & system hardware computational scientists computationally model quantum devices and systems to support design, validation, and optimization.
Tasks: On the job, they would...

- Model and analyze real-world systems to identify performance issues and determine theoretical adjustments or control parameters that lead to actionable results
- Model and simulate dynamics in qubit devices
- Perform benchmarking studies primarily through numerical simulations
- Perform literature reviews to identify methods, theories, or results to improve ongoing experiments
- Perform quantum error correction simulations
- Simulate light behavior in optical cavities

Worker Requirements: Knowledge, Skills, Abilities (KSAs)

Knowledge of:

- Device physics
- Large scale and efficient simulation, programming, and debugging of physical systems
- Noise models
- Open systems theory
- Process matrices
- Quantum error correction theory
- Quantum software
- Randomized benchmarking theory
- Stabilizer codes
- Statistics
- System integration principles and hardware operation
- Theoretical quantum information science grounded in physical implementations

Occupation-specific skills and abilities:

- Able to do some programming generally, without specifying whether it is for data processing, data representation, or other purposes
- Able to effectively collaborate with system integration engineers
- Able to perform numerical and physical simulations of quantum and optical systems
- Able to use AI (Artificial Intelligence) tools to assist in literature review

General skills and abilities:

- Adaptability, collaboration, communication, critical thinking, data analysis, debugging, leadership, modeling, problem solving, project management, and troubleshooting

Experience Requirements

Education:

- Degrees: Bachelor, Master, or PhD
- Disciplines: Applied Science and Technology, Electrical Engineering, or Physics

On-the-job training:

- Attendance at professional conferences
- One-on-one mentoring and collaborative learning with experienced team members
- Participation in external courses

Prior experience:

- Experience at another company or an industry internship is expected

Representative profile for a public facing and business role

Profile P1.1: Company Executives

Findings in this profile are not presented in order of importance, nor does any individual position in the data include all listed elements.

Individual positions: Chief Operating Officer, Founder/Scientist at Quantum Startup

Company types: Quantum computing hardware, Quantum networking and communication, Enabling technologies

Occupation-Specific Information

Description: Company executives make strategic decisions and are responsible for vision, growth, and overall management of the organization.

Tasks: On the job, they would...

- Create the company roadmap
- Develop financial projections
- Guide research and product development
- Make key decisions for the company
- Write proposals

Worker Requirements: Knowledge, Skills, Abilities (KSAs)

Knowledge of:

- Specialized technical knowledge aligned with the company's mission
- Statistics

Occupation-specific skills and abilities:

- Able to do some programming generally, without specifying whether it is for data processing, data representation, or other purposes
- Able to apply specialized knowledge to guide technical and operational activities in a startup environment

General skills and abilities:

- Collaboration, communication, critical thinking, data analysis, general experimental skills, leadership, problem solving, project management, and troubleshooting

Experience Requirements

Education:

- Degrees: Bachelor, Master, or PhD
- Disciplines: Chemistry, Computer Science, Engineering, or Physics

On-the-job training:

- External courses, workshops, and mentoring in business development
- One-on-one experiential learning and mentoring
- Participation in quantum conferences and workshops

Prior experience:

- Candidates without a PhD are expected to have relevant work experience
- With a PhD, prior industry experience is not required

Regional trends

Regional trends are based on 10 Colorado manager interviews and should be interpreted as indicative rather than consensus.

Regional Strengths and Weaknesses in the Quantum Workforce

Interview Question: *From your experience, are there regional trends in the strengths or weaknesses in quantum skills or knowledge of applicants?*

Key Insight: Interviewees view Colorado's quantum workforce as increasingly well-prepared, with candidates showing greater familiarity with the field and willingness to relocate to the region. However, interviewees note that persistent gaps remain in interdisciplinary preparation, communication skills, and specialized technical roles. Frequent movement between companies both strengthens knowledge and skills exchange and poses challenges for workforce stability.

Theme	Key Insights from Interviews
Strengths	Five interviewees highlighted that applicants from Colorado-based institutions are seen as highly prepared to enter the quantum workforce. Compared to five to six years ago, applicants demonstrate broader exposure to quantum and higher familiarity with the field. Two interviewees observed that candidates are increasingly willing to relocate to Colorado to join the region's expanding quantum ecosystem.
Weaknesses	While general quantum knowledge is strong, interviewees mentioned some weaknesses: (1) Two interviewees highlighted that applicants lack interdisciplinary preparation that combines quantum science with business or management. (2) Two interviewees highlighted that communication skills are inconsistent across applicants, particularly some applicants struggle with explaining technical ideas to various audiences, and (3) One interviewee highlighted that there is a shortage of optics assembly technicians.
Strength/Weakness	Two managers highlighted that there is a high degree of movement between companies within the Colorado quantum ecosystem, which leads to cross-pollination of skills and experiences, but can also lead to talent retention challenges.

Industry Perspective Quote:

I'd say it's very much a hotspot for lots of quantum companies. As those companies age, I think it will continue to populate the workforce that is aware of quantum at the very least in the region. There's a number of companies regionally that employ on the order of 100 people or at least tens of people. One thing that I found about the industry is people tend to circulate more in and out of jobs. It's not an ivory tower type, get my job, and stay there forever, there's a lot of cross-pollination between the existing companies and the new startups that are popping up.

Recommendations for Strengthening Quantum Industry–Higher Education Collaboration

Interview Question: *Are there specific support, resources, or connections with local higher education institutions that you would like to have? If yes, what would those look like?*

Key Insight: Interviewees emphasized the importance of closer collaboration between industry and higher education to ensure workforce readiness in the quantum sector. They highlighted the need to expand applied experiential learning opportunities, improve coordination between companies and universities, and invest in structured upskilling initiatives that align with evolving needs.

Theme	Key Insights from Interviews
Expand Workforce-Oriented Education Programs	**Recommendation:** Expand workforce-oriented education programs in partnership with community colleges and universities, which includes encouraging and funding joint industry–university experiential learning experiences that address real-world quantum applications (e.g., CU Boulder's Q-Forge [9]). **Justification:** Students gain direct experiential learning experience, which makes them more likely to be ready for the workforce upon graduation.
Enhance Communication and Coordination	**Recommendation:** Establish clearer and more regular communication channels between quantum companies and higher education institutions to improve coordination between academic preparation and workforce needs. **Justification:** Interviewees highlight fragmented communication as a barrier to effective partnerships with academic institutions.
Invest in Upskilling Initiatives for the Evolving Technological Landscape	**Recommendation:** Support structured upskilling programs in addition to managerial training. **Justification:** Companies currently lack formalized technical training, relying instead on conferences or ad-hoc learning opportunities. Partnerships with educational institutions can provide foundational quantum skills to non-quantum-focused employees and leadership or business training to quantum-focused employees.

Industry Perspective:

We send people out to conferences to be aware of the latest and greatest, and also just attending conferences is the way we keep up to speed with the latest and greatest on AMO physics and quantum computing. We don't really have any programs for technical upskilling.

Projected Quantum Workforce Needs

Interview Question: *Thinking of the quantum industry as a whole, what are potential trends you foresee in future job opportunities in the quantum industry?*

Key Insight: Interviewees anticipate continued a need of a range of educational levels and disciplines for the quantum. Future hiring trends are expected to emphasize application-oriented skills as the industry moves from research and development toward scalable products and deployment. This finding aligns with the results we reported on for the broader project about the national landscape [4].

Theme	Key Insights from Interviews
Range of Educational Levels	Managers anticipate a growing need for employees across a range of educational backgrounds, from bachelor's to Ph.D. degrees, in physics, engineering, and computer science. These varying levels of training will support roles spanning the full innovation spectrum, from manufacturing and development to research and system integration.
Application-Focused Roles	Managers expect an increasing need for professionals who not only understand quantum principles, but can also translate them into practical, real-world applications. These application-oriented positions are expected to grow as companies shift from research and prototyping toward product development and deployment.

Industry Perspective:

I definitely am foreseeing the move away from primarily PhD-dominated roles. I think that's a pretty well-accepted trend in the industry, and more towards those bachelor's and master's level roles specifically.[...]The area of applied quantum algorithms, I think I expect more growth in these areas.

Recommendations for Tracking Workforce Needs in the Quantum Industry

Interview Question: *What potential metrics do you think would be relevant to track workforce needs and the progress of the quantum industry in the area?*

Key Insight: Interviewees emphasized the need for systematic data collection to monitor quantum workforce trends. They recommended tracking hiring activity, educational pathways, and funding flows to pinpoint where education and policy initiatives can better support the industry's growth.

Theme	Key Insights from Interviews
Hiring and Workforce Metrics	**Recommendation:** Establish a tracking system for job and internship postings across the Colorado quantum sector, paired with data on actual hires per posting (including educational level and individual position). **Justification:** Interviewees highlighted that: • Internship trends can serve as a proxy for company stability and future hiring capacity. • Tracking hires per posting and their educational levels shows which educational levels Colorado's quantum workforce relies on.
Education Pipeline Metrics	**Recommendation:** Monitor the number of students trained for quantum roles and the proportion who enter the quantum workforce within a defined period after graduation. **Justification:** Measuring the transition from education to employment provides insight into how academic programs help students prepare for quantum careers and whether industry settings and opportunities are welcoming and well-matched to student's needs and interests.
Funding Metrics	**Recommendation:** At the state or regional level, record who provided funding, to whom, and when, and link this information to measurable education and workforce outcomes. **Justification:** By connecting funding streams to actual education and employment outcomes, policymakers and companies can identify areas for improvement and refine future investment strategies.

Industry Perspective:

Internship postings are a big tell of the health of an industry. If a company is shrinking or if they're not going to be in a hiring mode, more than likely, the first thing that goes is interns. When I'm looking at companies and if they're in a growth mode, it's likely that they've continued to have an internship pipeline.

Key findings and recommendations

Based on interviews with quantum industry employers across Colorado, this report underscores the state's key workforce strengths and weaknesses, the emerging job roles, and opportunities to deepen industry-academic collaboration. These insights advance the 2024 OEDIT Roadmap recommendations [1] by providing concrete approaches for tracking workforce needs and sustain Colorado's competitiveness as the quantum sector grows.

- **Talent landscape:** The Colorado quantum industry features a multidisciplinary workforce spanning a wide range of job roles, combining varying levels of quantum expertise with both deep technical specialization and strong professional skills.
- **Workforce strengths:** Graduates from Colorado institutions of higher education are well prepared and the regional talent pool is dynamic and growing.
- **Workforce weaknesses:** There are shortages in specialized areas, such as interdisciplinary roles that require both quantum and business expertise.
- **Collaboration needs:** There is a need to strengthen industry–academia partnerships, expand experiential learning, and formalize upskilling programs.
- **Industry projections:** Employers anticipate a need for talent across educational levels and they anticipate a need for professionals in application-focused roles.
- **Workforce metrics:** Employers suggest establishing a system that tracks quantum sector funding, education, and hiring data, which links educational training, internships, and actual hiring numbers to strengthen education-to-employment pathways and refine workforce development strategies.

Acknowledgments

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Appendix

The profiles of roles relevant to Colorado-focused positions are listed below and described in detailed in the report *Profiles of Roles in the Quantum Industry* [8].

- **Senior scientists**: Work in areas closely connected to fundamental research. They oversee technical projects and manage people.
- **Engineering managers**: Oversee teams of engineers building hardware systems
- **Commercialization leads**: Guide a team and drive product development, commercialization, and applications. They coordinate and contribute to the design, construction, and operation of quantum technologies.
- **Experimental scientists**: Plan and run experiments (e.g., doing quantum optics experiments or device testing), perform analysis, and report results either internally (e.g., report) or externally (e.g., publications).
- **Quantum hardware system engineers**: Turn research results into devices. They design hardware subsystems operating within practical constraints and integrates them into larger systems.
- **Design engineer, EE circuits, RF specialists**: Develop and test non-quantum electronic circuits for applications in quantum technologies.
- **Optics & photonics experiment Specialists**: Support experiments, such as maintaining optical systems and performing some data collection and analysis.
- **Optics & photonics assembly Specialists**: Perform assembly, testing, and quality control for optical/photonic systems

- **Nano/microscale specialists**: Fabricate nano/microscale devices, typically in a cleanroom setting. They conduct nano/microscale patterning, utilizing various techniques dependent on the architecture of the devices. They perform characterization of fabricated nano/microscale devices.
- **Lab & construction technicians**: Build and maintain facilities for the fabrication and testing of quantum devices. This includes planning and overseeing the construction of cleanroom facilities, maintaining mechanical connections, and general electrical or plumbing work.
- **Quantum software engineers**: Design and develop software directly related to quantum computing.
- **Quantum algorithms programmers**: Focus on implementing, testing, and optimizing quantum algorithms on quantum computing platforms.
- **Device & system hardware computational scientists**: Computationally model quantum devices and systems to support design, validation, and optimization.
- **Company executives**: Make strategic decisions and are responsible for vision, growth, and overall management of the organization.
- **Project overseers**: Manage timelines, resources, and deliverables for projects involving quantum technologies.
- **Hardware application & technical sales specialists**: Understand the customer's needs and translate them into solutions using quantum hardware. They facilitate the implementation of their company's products in the customer's context (e.g., enabling technologies). They combine technical knowledge with sales and relationship building skills.
- **Business & partnerships specialists**: Focus on strategic business development, partnerships, and market expansion in the quantum space.

References

[1] CUbit Quantum Initiative, University of Colorado Boulder. "Building a Quantum-Ready Workforce: A Roadmap for Colorado and the Mountain West Region (Fall 2024)". In: *University of Colorado Boulder* (2024). URL: https://www.colorado.edu/initiative/cubit/sites/default/files/attached-files/2024_quantum_roadmap.pdf.

[2] Rochester Institute of Technology and University of Colorado Boulder. *Quantum Education and Workforce Development*. https://www.rit.edu/quantumeducationandworkforce/. 2025.

[3] Michael FJ Fox, Benjamin M Zwickl, and Heather J Lewandowski. "Preparing for the quantum revolution: What is the role of higher education?" In: *Physical Review Physics Education Research* 16.2 (2020), p. 020131. URL: https://doi.org/10.1103/PhysRevPhysEducRes.16.020131.

[4] Shams El-Adawy et al. "Industry Perspectives on Projected Quantum Workforce Needs". In: *2025 PERC Proceedings [Washington, DC, August 6–7, 2025]*. Ed. by A. Pawl, J. P. Zwolak, and A. E. Leak. 2025. DOI: 10.1119/perc.2025.pr.El-Adawy.

[5] Shams El-Adawy et al. "Experimental Skills for Non-PhD Roles in the Quantum Industry". In: *arXiv preprint arXiv:2510.12936* (2025). URL: https://arxiv.org/abs/2510.12936.

[6] O*NET Centre and U.S. Department of Labor. *The O*NET® Content Model: Framework for Occupational Information*. https://www.onetcenter.org/content.html. 2025.

[7] A. R. Pina et al. "Categorization of Roles in the Quantum Industry". In: *arXiv preprint arXiv:2511.11820* (2025). URL: https://arxiv.org/abs/2511.11820.

[8] Shams El-Adawy et al. "Profiles of Roles in the Quantum Industry". In: *Quantum Education and Workforce Development RIT and CU Boulder website* (2025). URL: https://www.rit.edu/quantumeducationandworkforce/reports-and-publications.

[9] Kristin A Oliver et al. "Education for expanding the quantum workforce: Students' perceptions of the quantum industry in an upper-division physics capstone course". In: *Physical Review Physics Education Research* 21.1 (2025), p. 010129. URL: https://doi.org/10.1103/PhysRevPhysEducRes.21.010129.