Q&A: Quantum computing researcher Matthias Troyer on his move from academia to industry

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The main mindset change, he says, is the focus on making things work rather than on understanding why they don't.


MATTHIAS TROYER (Photo courtesy of Mark Villanueva Contratto/Filmateria.)

"Combining chemistry and physics with computing is basically the story of my life," says Matthias Troyer, corporate vice president at Microsoft Quantum, where he leads the company's efforts in quantum system architecture, applications, and software.

Troyer earned his PhD at ETH Zürich in 1994 for work on computational approaches to high-temperature superconductors. After a stint as a postdoc in Japan, he joined the faculty at ETH as a professor of computational physics.

For years, Troyer resisted offers from industry. It was, he says, "always a question of, Should I go to a company that is doing computational science and engineering? Or should I stay in academia and continue teaching and writing papers?" Staying in academia was the familiar, easier path, he says. But eventually, in 2016, Microsoft convinced him to join its quantum computing team.

On top of his job at Microsoft, Troyer just completed a turn as president of the Aspen Center for Physics, which hosts physicists for conferences and workshops. He is also on the board of the Washington State Academy of Sciences. In that role, he says, he offers policymakers advice on a broad range of topics, including science policy, economic development, and ecological preservation.

Over the course of his career, says Troyer, his choices have often been met by colleagues with skepticism and warnings. When, in 2011, he started thinking about applications of quantum computers, one colleague scoffed, "You think quantum machines are real." When he left his tenured position at ETH to move to Microsoft, another warned, "You are a traitor. You won't be able to return to academia." But Troyer says he sees himself as a trailblazer who is willing to break from convention. "A leader doesn't just jump on the bandwagon," he says. "A leader dares to head out into the wilderness and do things that nobody else does."

PT: How did you get into physics?

TROYER: In high school, I won a gold medal in the International Chemistry Olympiad. But when it came time to choose what I wanted to study, I didn't fully understand quantum mechanics, so I chose physics. When it came to selecting a topic for my master's thesis, there was one where I could use a Cray X-MP supercomputer. It was totally clear that I would go for that topic.

PT: What were your next steps?

TROYER: I started my university studies in Linz, Austria, where I am from, and then moved to ETH Zürich in Switzerland. I got my diploma and PhD there. After the PhD, there was the question, Should I go into banking or stay in physics? I had friends in Japan. Spending two or three years there sounded intriguing and fun. That, combined with Japan having at the time the world's fastest supercomputer, convinced me to go to Tokyo for a postdoc.

Writing codes and implementing new algorithms on the world's fastest machine let me work on interesting physics problems that nobody else could do at the time. The combination of new machines, new algorithms, good codes, and new physics problems led to a breakthrough: I simulated a model with 20 000 quantum spins. Being at that scale enabled me to study phase transitions in quantum systems.

PT: How did you end up back at ETH?

TROYER: I accepted an offer from ETH to build up a new curriculum for computational science. At the university, I could teach and work with industry. I started consulting on the side, about one day a week. I was helping banks and companies, teaching programming techniques to them, writing software for them. It was a nice balance.

PT: Why did you end up moving to Microsoft?

TROYER: In 2004, Microsoft asked me to join its new quantum computing program. They were starting it on the campus of the University of California, Santa Barbara. I decided not to go. I was working in computational quantum physics, developing new algorithms, using them on the latest supercomputers to solve interesting science problems. Why should I leave one of the best tenured positions in the world? Why would I trade an excellent academic team to work there?

But one of my postdocs joined the Microsoft program, and I consulted for it. At some point, I realized that my contact to the corporate setting was giving me interesting scientific questions: What could be the commercial value of a quantum computer? Which companies might be interested in investing in quantum computing? What are the applications? That was in 2011, a time when nobody really worked on those things.

In 2016, Microsoft made me an offer I couldn't refuse.

PT: How did your colleagues react?

TROYER: There were three interesting reactions. When *The New York Times* reported that I was moving, the European Commission complained about US companies poaching Europe's quantum talent. My response was that I was not being poached. Rather, I was taking opportunities that I didn't have in Europe. Academic colleagues told me to be very careful: Why would I give up tenure to go to a company, where you can be fired?

Financially, it was an easy calculation: If the company pays a multiple of the academic salary, and if I have the job for four or five years, I will break even, compared to my lifetime income in academia. The risk didn't seem too high.

The third response came from university presidents. Five of them, in the US and Europe, reached out to tell me that if in the future I wanted a job at a university, I should call them first. That means that while some faculty might consider me a traitor, the academic leadership understands that knowing both industry and academia adds value.

PT: What are the similarities and differences of working in academia and industry?

TROYER: At first, it was surprising that the differences were not that great. For me, the main difference was more one of big science versus small science than academia versus private sector. In big science—on experiments at CERN, for example, or in industry—one is part of a team and thus has less freedom to choose what one will do. At ETH, I had been working with smaller teams.

As we started building quantum computers and hardware, there was a shift from being a research team to being a product team. We still do research, because we are inventing things. But the focus has shifted to making things work. When things don't work, let's not get stuck finding out all the details. Let's jump to something that works. In industry, it's about building products. It's about making devices that work. That is the main mindset shift.

There is more structure in industry. But that helps you become more efficient. My family likes that since I moved to a company, I can take weekends off.

PT: How do you spend your time?

TROYER: As a professor, I was talking to people, helping them understand things, and charting a path forward. As corporate VP and a technical fellow at Microsoft, I am doing the same thing. I use my teaching skills when I talk to politicians, diplomats, business leaders, engineers on my team, graphic designers, and marketing people. The skills of a good professor come in handy.

PT: Can you elaborate on the interesting questions that you found in industry?

TROYER: Early on, there were basically three quantum computing communities: people doing quantum physics in the lab, building quantum devices; people working on the concepts and math behind quantum computers; and people at companies that were getting interested in quantum computing. But you needed someone who could look at applications and see how new hardware or new algorithms could lead to breakthroughs. I realized, "Hey, that's exactly what I've been doing for 20 years!" I have always used the fastest classical computers to look for new algorithms and run them to solve interesting science problems.

With quantum computers, it was the same approach but with theoretically new hardware. Microsoft is developing its own topological qubit and is also building a universal quantum computing platform in partnership with other hardware providers.

PT: Where do you expect quantum computing to have the greatest impact?

TROYER: One area is combining quantum computing with AI. We use AI now to predict the properties of materials and to design them. AI can screen a bigger chemical space and is much faster than the simulations we do. But AI models are never better than the data they train on. And classical simulations are approximate. By refining those models with better data from quantum computers, one can make the models faster and more accurate. Our goal is for generative AI to design materials. That requires quantum computers. The big impact is perhaps five years out. But it's coming.

Toni Feder