

# Learn to find or build the tools to solve hard problems

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Shilpa Talwar attributes her move into research and innovation to her stint at Stanford. "It was the bedrock for the innovation mindset. I did my PhD there in applied mathematics. Since I loved math, I thought it would be relatively easy to pursue a higher degree," she says.

Shilpa recollects a problem-solving moment during her PhD that left her wanting to take up more of such challenges. "There were a mix of digital signals that went through some wireless channels, and I had to figure out which those signals are without knowing anything about them. So I derived algorithms that showed one can separate the signals, identify them, and that it was mathematically possible. It was a huge aha moment for me to invent something new, and I just wanted to do these things again and again," she says.

Shilpa then had the opportunity to work with Argyaswami Paulraj, now professor emeritus of electrical engineering at Stanford and who had just then – it was the early nineties – moved to the US.

This opened the doors for her in the field of signal processing and wireless communications. Paulraj, a Padma Bhushan awardee, is best known for developing the Multiple Input Multiple Output (MIMO) technology, which is the key to all modern wireless networks. Shilpa went to work in a startup with him, designing the next generation wireless systems in the field of 4G technology, and filed several patents then.

But it has been during her stint at Intel where she has filed the majority of her 60 patents. She currently is a Fellow and leads a research team at Intel focused on evolution of dense heterogeneous networks, and associated technology innovations.

The key goal in 4G technology, Shilpa says, was to use the radio

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FELLOW, INTEL

60 PATENTS

frequency spectrum bands as efficiently as possible, as they are limited resources and also very expensive. "Most of my research was focused on that. We wanted to make sure that the frequency could be used at all the cell towers. There are several ways to make it possible, like controlling the power so that you do not interfere with every cell," she says.

She also worked on 5G millimeter (mmWave), the band of spectrum between 30 GHz and 300 GHz. Wedged between microwave and infrared waves, this spectrum can be used for high-speed wireless communications and is considered as a way to bring 5G into the future by allocating more bandwidth to deliver faster, high-quality video and multimedia content and service.

Shilpa feels a PhD helps in developing an innovation mindset. "What I learnt while pursuing it for six years is you are posed with a hard problem to solve and you do not know the tools to solve it. Because it is a hard problem, one learns the tools, and if you can break through, it is a significant achievement. You get the confidence and can do it multiple times."

That is different from the Master's level, where she finds students are waiting to be told about the problem and the tools are handed to them. "You need to think beyond the problem and look at the intersection of fields," she says.

**HOW TO TRAIN YOUR MIND TO INNOVATE**