

"A book on deeptech is an idea whose time has come"
-Foreword by Kris Gopalakrishnan
Co-founder, Infosys

Book
Preview

FUTUREPRENEURS

10 Deeptech & AI startups
redefining tech in India
- stories and lessons



NISTHA TRIPATHI & VARUN AGGARWAL

Pixel | Strand Life Science | Skit.ai | GreyOrange | Ati Motors | SocialCops
Niramai | Cropln | InnAccel | Invento

 publishing

ADVANCE PRAISES

This is a must-read for innovators and entrepreneurs looking to build their next startup as to why deeper tech is better in the long run. A clarion call for science and technology startups to push the frontiers of Indian entrepreneurship.

– Dr. Desh Deshpande

Chairman, Sparta Group LLC and Founder, Deshpande Foundation

The transition from “just” IT services and eCommerce to embracing technologies more generally is an absolute imperative for India. This is not just because of its economic potential but because it would be a shame if we didn’t unlock our massive reservoirs of talent. We can innovate with the best in the world in agriculture, health, material science, space, synthetic biology and what-have-you. Varun and Nistha’s stories encourage our youth to act on the dreams they have in these arenas.

– Prof. Tarun Khanna

Jorge Paulo Lemann Professor, Harvard Business School and
Director, Lakshmi Mittal South Asia Institute, Harvard University

This is a timely book that goes beyond the hype of a growing number of unicorns in India and dives into a critical question of technology leadership. Through inspiring stories of entrepreneurs who have taken the road less travelled by, it showcases a diverse set of deeptech startups being built out of India. It distils nuggets of valuable lessons from the experiences of these startups. The book should be read by all aspiring entrepreneurs, policymakers and (the millions of) people who would love to see India realise its true potential as a technology leader.

– Dr. Manish Gupta

Director, Google Research India

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FOREWORD

If India needs to grow faster and solve its socio-economic problems, it can only happen via innovation-driven economic development. This needs high-quality research in universities and deeptech startups that can translate the research into innovative technologies.

We need to prioritise strategic research areas where India can compete globally and those, which can help advance our industrial and social development. I have been particularly interested in supporting life sciences research in India. One project I support studies how the brain ages by studying a sample of 10,000 people over 10 years. This can help us better understand diseases such as Alzheimer's and Dementia. In another, scientists are working to build a reference genome sequence for the Indian population. This is a necessity if we are to properly address genetic diseases for Indians.

This book contains the story of Strand Life Sciences, a pioneer in genetic testing and diagnosis in India. It is one of the earliest deeptech companies in the country. Started by Professors from IISc, it is a prime example of how the strong connection between university research and entrepreneurship can lead to successful deeptech ventures.

To replicate what Strand Life Sciences has achieved, we need mechanisms to take research from labs to products in markets. This can be enabled by incubators and accelerators, research translation grants and a suitable regulatory environment. My fund, Axilor, has been supporting several deeptech startups, including Niramai, one of the startups in this book. Niramai helps in low cost, non-touch and

painless breast cancer screening using Artificial Intelligence. It is but one example of the huge number of startup opportunities in medical diagnosis, devices (check out InnAccel's story) and instrumentation.

The final onus falls on the entrepreneurs who will help shape this future. That is where Varun and Nistha's book makes a difference. The name "Futurepreneurs" says it all. They narrate the stories of 10 deeptech companies from India that are building technologies anywhere from driverless cars to launching satellites, automatically predicting farm yield to building voice bots. These stories are exciting and, if I may say, are the new *thrillers* of our age. They must be read by all budding technologists and entrepreneurs.

The book does a fine job of demystifying the seemingly complex technology behind these ideas. For instance, everyone uses the word AI but seldom understands what it is and, more importantly, what it can solve. This book provides several AI use cases and a primer on the technology behind them. Similarly, it explains things such as DIY, chatbots, genetics, crowdsourcing and technology ethics, all the things a modern entrepreneur must know.

They also make an important contribution by highlighting business lessons through the journey of deeptech startups. Deeptech is built differently from a mainstream startup, let alone a conventional business. This is a first insight into what are some do's and don'ts while building deeptech companies in India. They summarise these as Mantras in the final chapter—a worthy cheatsheet for entrepreneurs in moments of dilemma.

A book on deeptech is an idea whose time has come—it is a need of the hour. Someone had to write this book. At the same time, not everybody can write it. It requires a deep study of the ecosystem and a thorough understanding of the technology to write a book like this. I congratulate Nistha and Varun to have taken up the challenge and deliver it with flourish and triumph.

– Kris Gopalakrishnan

Co-founder, Infosys and Chairman, Axilor Ventures

PREFACE

We have come to this book from two different yet overlapping areas of interest. Nistha has a deep interest in startups, their journeys and personal stories. Varun has an active interest in the science ecosystem in the country and has built and sold a successful AI-led startup.

Nistha wrote *No Shortcuts* that shared the little-known stories of a few of India's most popular and successful startups (including Zerodha, Freshworks, Unacademy, Faasos), and it went on to become a bestseller in 2018. As she talked to more readers, she consistently came across the sentiment that India does not innovate. That we are a bunch of copycats who can only copy successful ideas and business models from the West is a notion not only harboured by sceptics but also investors and the media alike.

Her memory flashed back to the time she visited her friend and a fellow Wall Street techie in New York City in 2008. That was the first time she had watched the little *Roomba* autonomous robotic vacuum cleaner whirring around the room. It may have taken more than a decade for India to embrace similar technologies, but it was clear to her that India should be and is becoming home to more than a bunch of eCommerce and IT services companies.

Varun, on the other hand, is someone who knows how to build such research-based products. As the co-founder of Aspiring Minds, he built AI-led skill assessment products starting in 2012, much before the AI hype gathered steam. These products can automatically evaluate one's spoken English (pronunciation and fluency), programming skills, written essays, quality of emails and video interviews. One of their kind

globally, these tests were built in India and are used across the world, including the USA, China, the Middle East and the Philippines. The world's largest eCommerce companies, IT service companies and banks use these products. Further, his team publishes research papers at top AI conferences, some of which have garnered a high number of citations.

With this experience, plus having seen what an MIT like institution has been able to accomplish, Varun has an active interest in developing India's research ecosystem: the creation of new knowledge and its commercialisation. To this end, he has spearheaded India Science Fest, India's largest festival of science and, more recently, a philanthropic foundation for reforming science policy in India.

We would catch up often, and in one such coffee conversation during the winters of 2019, we mulled over the idea of writing a book together. However, we didn't want to write something that had already been written about. After much deliberation, we knew the one thing that we wanted to bring to our readers—a glimpse of the new-tech sun that is rising on the horizon of Indian startups. Deeptech is this new tech. Deeptech startups are what we decided to focus on.

So, we present to you a glowing snapshot of Indian deeptech via interviews of ten path-breaking startups. Our intent is to go beyond the buzzwords and decode the fundamental reasons why these startups managed to get off the ground when others didn't. We also give a primer on the complex-sounding technologies that power these startups so that you can appreciate the gruelling experience that they have gone through to build something like this. But also, build something exciting of your own!

Other than telling adventurous stories, the book also demystifies what deeptech is and is not. It provides success mantras for new entrepreneurs and technologists. Finally, it provides a glimpse into the challenges in the ecosystem and what we must all collectively do.

The next time somebody asks if India can innovate, we will not only have an assertive affirmatory nod but also a list of names to prove our case. With this book, we want to scream out loud that exciting things are happening in Indian startups.

Rest assured, we are heading in the right direction; the future is bright and Indian tech is coming of age. Of course, we are on the tip of the iceberg and need to do a lot more. That is the reason why we wrote this book—to inspire, pollinate ideas and spread deeptech.

If you are an engineering student, someone who wants to learn technology, a tech founder, a tech developer or a person looking to keep abreast of the latest tech—you will find something of value in the following pages. We would consider the book a success if it can inspire even one dreamer to take a moonshot at building India's next big technology company.

It's time to dive in.

PIXXEL

The Space Photographers

Featuring interviews with Awais Ahmed (Co-founder and CEO)

It was 1972 when the world saw the Earth's picture as a vivid "blue marble" hanging in space. The crew of Apollo 17 had photographed this artistic picture of the whole earth. Who has not stared at the night sky and wondered what stunning world lies beyond this blue marble? Mankind has made giant leaps in outer space over the last 60 years, and India is catching up fast. With a budget of USD 70 million, India's Mangalyaan mission was proclaimed to be cheaper than the 2013 Hollywood film Gravity and also cheaper on a per-kilometre basis than an auto-rickshaw fare.

Recently, private companies such as Blue Origin and SpaceX have achieved this feat, but they are backed by multi-million dollars and the US technology stalwarts. Do we Indians, private citizens, even have a chance? Previous spacetech attempts in India did not make much progress, and investors are wary of the sector that is known to be a capital sucker. Awais Ahmed and Kshitij Khandelwal are all set to change that.

When Awais stepped foot at BITS Pilani in 2015, he was a space nerd and Elon Musk fan. In 2020, he started his first startup, Pixxel, and has raised a funding of USD 8 million since then. Prior to this, he led his student team into the finals of the SpaceX Hyperloop Pod Competition in 2017. Pixxel is all set to launch its first satellite in 2022, and that too

at a surprisingly low cost. Needless to say, a lot has happened in 6 short years.

2015	2017	2018	2019	2021
Started college at BITS Pilani.	Reached the final round at the Hyperloop competition, LA.	Kshitij joins as a co-founder. Find manufacturing partners. Pitch to BITS alum in Silicon Valley.	Raise \$700k pre-seed. Graduate and start Pixxel fulltime. Go through Techstars Space Accelerator, LA.	Raise seed round of \$5 million in Nov 2020 and \$7.3 million in Mar 2021. Satellite is ready to be launched.

Space Dreams Fuelled at BITS

Awais spent his formative years in the Chikkamagaluru district of Karnataka, where his father runs his pharmacy. His father often bought him encyclopaedias and books about outer space. Always an avid reader, he devoured those books with little effort. The plan was to focus on “good” education and get a “good” job. So, he moved to Mangaluru for his 11th and 12th class education since his town did not offer any good schools. It was in Mangaluru that he first heard of IITs and BITS.

Without any formal coaching, he cracked BITSAT and enrolled in a dual degree programme in Mathematics (his second preference after Computer Science) in 2015.

‘In college, I came to know of this interdisciplinary BITS student team called Team Anant that was working with ISRO (Indian Space Research Organisation) in its student satellite programme. ISRO had offered to launch student satellites from universities for free. I gave the examination and became one of the few people selected in the first year to be a part of it,’ adds Awais.

As part of this club, Awais attended a few sessions in which ISRO representatives taught what it takes to build something to be put in space. Over the next few months, the team had built a few prototypes.

What Does it Take to Build a Student Satellite?

Building a student satellite is like building an autonomous computer that can operate by itself in orbit. It could just be a computer-on-chip like an Arduino or a raspberry pi. Together with it, one needs radio transmitters and receivers to receive commands from the Earth and send back data. The satellite needs solar panels and batteries for power. Sensors such as cameras, light sensors, or even a thermometer collect data of interest and transmit it back to a ground station. There are control aspects to it as well. For instance, one uses actuators or apparatus using the magnetic field of the Earth to point an imaging satellite towards a particular point. Today, we have satellites as small as 5cms x 5cms x 5cms and weighing less than 250 grams. There are companies that provide kits or help build one. It is generally expensive, upwards of USD 20,000, to launch it in orbit.

While Awais' love for space had rekindled with Project Anant, things were moving slowly. There were design sprints, redesigns but nothing was moving to the execution phase. Awais wanted to speed things up, but when that didn't materialise, he moved away from the team.

Being in the Same Room as Elon Musk

One day, he stumbled into the room of one of his seniors, Sibesh Kar. Sibesh had scribbled something about Hyperloop on his whiteboard. A fan of Elon Musk himself, Awais got talking to Sibesh and realised that he wanted to participate in SpaceX's competition called Hyperloop. They joined hands and started building a student team to participate in the same.

In 2012, Elon Musk came up with this white paper that proposed a new mode of transportation known as Hyperloop.

Awais explains, ‘Instead of tracks, Hyperloop would use vacuum tubes that would reduce air friction, thereby achieving much faster transportation. Instead of present-day vehicles, this would employ small pressurised capsules that could travel at almost the speed of sound. The competition stated that SpaceX had built a one-mile-long vacuum tube in the road beside their headquarters and teams from around the world had to build a vehicle that could travel as fast as possible inside the tube.’

Awais attended the finale of the 2016 competition and participated in the 2017 competition.

Awais’ team ended up figuring out from scratch how to build the levitation and braking systems for the pod. To their delight, the team became one of the 24 teams that cleared the first two stages of the 2017 competition, beating 2,400 teams—the preliminary design review and the critical design review stage.

The last stage was the crucial one—they had to now manufacture the actual pod for the hyperloop.

‘The problem was that we were in Pilani. It was April 2017 when we got to know that we had made it to the final round. We finished our final examinations in May and decided we couldn’t do this on any of the three campuses. So, all of us (around a 40-member team from all three campuses) decided to go down to Bengaluru and start manufacturing there. Being the aerospace hub, there were better facilities and resources that we could avail. We had estimated that manufacturing would require roughly INR 1 crore (USD 130,950), and transporting it to Los Angeles, where the finals would be held, would need another INR 25 lakhs (USD 32,750). So, we had to figure out a way to raise that money.’

Parallely, the student team also participated in the Hyperloop One Global Challenge (not run by SpaceX). The competition involved submitting a case study to show where it made economic sense to build the Hyperloop. The BITS team proposed the Mumbai-Pune, Bengaluru-Chennai route in the competition and became one of the 25 semi-finalists and eventually one of the 10 winning teams. The prize money paid for 1/3rd of the cost of building the pod. They still had to raise INR 66 lakhs (USD 86,450) for manufacturing.

Once the BITS student team reached Bengaluru, they immediately started looking for funding.

‘The first half of my day was spent on calls and meetings for getting sponsorship. The second half of the day would be about travelling to the place where the manufacturing was happening and help with the manufacturing and fabrication of things.’

With some hustle, the team raised INR 1 crore (USD130,950) in sponsorships and INR 25 lakhs (USD 32,750) in a crowdfunding campaign on a platform called Ketto. After all, people knew the name Elon Musk and were happy to support the kids who could make India proud.


“ Business Lesson 1: Building hardware products is capital intensive and needs funding upfront. The funding ecosystem for hardware is much less developed in India. One needs to have strong fundraising talent in the team, with a penchant for networking and persistence. ”

Then came the D-day in August when the team reached Los Angeles for the final showdown.

‘There were a series of 50 tests that each team had to undergo before SpaceX put their pod in the tube. Only three teams managed to complete all the 50 tests. We were not one of them,’ Awais shares.

‘Our shipping ran into a lot of trouble. For example, we needed to ship very strong magnets that would enable the pod to lift up. These strong magnets were usually classified as very hazardous material, especially for air travel. We shipped the magnets from Bengaluru to Los Angeles, but when we went to receive the magnets, the paperwork had not come with it. The shipment was stuck at Los Angeles airport, which meant a delay of about seven days to get the magnets out and put it together, which is why we didn’t have enough time to complete all the tests.’

To put it in perspective, the teams that made it to the top two were from heavily funded German universities, TU Munich and TU Delft.

 *Countries like the US, Germany, Israel or China have universities running dynamic research programmes and plush with funds. Indian universities are*

*greatly wanting in this regard. For being a leader in deeptech, India needs major policy intervention and capacity building earlier than later.*⁶

The SpaceX engineers looked at their pod and liked its electrical part and few other components, a good validation for their team.

And, of course, they got to see Elon Musk!

‘SpaceX headquarters is on One Rocket Road, and they have a road running parallel to the factory, which they had cordoned off completely for themselves. That’s where the tube was set up. After the tube ended, there was a carnival type thing, and each team had a different booth. I remember Elon sort of came in the evening, and everyone started running around here and there behind him. He had a bunch of bodyguards. He went to each stall, quickly glanced at the things these teams had built and sort of went his way and gave a speech later.’




Awais Ahmed at the Hyperloop Competition, Representing the Indian Team from BITS, 2017

6. The interested may refer to the book, *Leading Science and Technology: India Next?* Sage Publications. It has been written by Varun, one of the authors of this book.

After coming back from the competition, the team members went their ways. But the biggest takeaway for Awais was to realise that a bunch of students had the potential to build a complicated pod in 3 months with no guidance. Imagine if they could get proper guidance and resources.

‘I started thinking that I should probably do something of my own in space because space was my ultimate calling.’

Awais took a couple of months’ time out and started reading about space. He was exploring what kind of problems existed and what could be his contribution.

 *Hardware looks more difficult to do than actually doing it. A lot of people just don't do it for fear of it! The way out is to just start building stuff, and one soon realises sky is the only limit!*

Rockets or Satellites?

His research led him to believe that he could either build rockets or satellites. ‘But it didn’t make sense to build rockets because it would take up a lot of money and time, and there were a lot of companies that were already doing it such as SpaceX, Rocket Lab, etc.’

Having seen how potent competitions could be in motivating student teams to achieve something in tight deadlines, Awais started looking at the next competition a student team could participate in.

He zeroed on the IBM XPRIZE and started researching possible challenges that they could solve using AI.

‘One of our ideas was to analyse satellite imagery. For example, illegal mining in Rajasthan was very rampant at that time. Another issue that we could utilise the space imaging in was the pollution in Delhi that was breaking all record levels.’

However, he found glaring gaps in the technology itself.

‘If you are looking at methane leaks from factories or natural gas pipelines, that is something you could not detect with any satellite up there currently, or if you were looking to distinguish between different

kinds of minerals to detect illegal mining, current satellites couldn't identify that either.'

What gave further momentum to Awaits' efforts in satellite imagery was the palatable cost of launching a satellite. In the 90s, it took a company—Digital Globe—which spent USD 100 million to put a satellite in the sky. In 2012, Planet Labs managed to do it for USD 20-30 million. Awaits believes they could do it in less than a million being in India and doing it lean.

History of Spacotech in India

Spacotech in India has been dominated primarily by the government till recently. ISRO was founded in the 1960s and started with putting satellites into space for the country's broadcasting and telecommunication needs. This was followed by satellites for imaging and, more recently, for aiding navigation. Another area that it pioneered was low-cost launch vehicles to put satellites into space. Since 1979, the PSLV (Polar Satellite Launch Vehicle) has made 47 successful launches. An area that caught the public imagination was that of space exploration through missions such as Mangalyaan and Gaganyaan. While serving considerable space needs of the country, ISRO just contributes to 2% of the global space economy.

The private space sector in India has primarily worked as suppliers to ISRO for many decades, with ISRO owning the IP. The sector did not see much development due to lack of clarity on space policy—what private companies could and couldn't do, long time cycles to get any approvals and failed experiments of public-private partnerships causing lack of trust.

Also, space needs patient big capital and an appetite for failure, which the Indian private sector could not stomach for a long time. TeamIndus, one of the first spacotech companies in India, is an example. They raised USD 30 million to participate

in the Lunar XPRIZE yet fell short of capital and had a non-yielding partnership with ISRO.

A new renaissance is coming in the space sector. There have been dramatic reductions in costs, say of building rockets/launching satellites. Different parts of the ecosystem have come together, such as vendors for building satellites, those offering ground stations and others that offer launches. The Indian Government has also come up with new policies and formed new organisations to encourage private sector partnerships. A number of space startups have come up, those building launch vehicles, satellites, analysing space data and many more. VCs (Venture Capitalists) have shown a greater appetite for supporting such startups than before. How this great experiment among the government, private players and society works is yet to be seen—it is much more than just stargazing!

Validating the Idea

The next step was to validate the commercial merit of the idea.

The market research showed that there were few global players like Planet Labs who were providing satellite imagery. ISRO was the only Indian organisation in the field. Awais studied the open-source data from Landsat and Sentinel satellites and limited datasets made available by Planet Labs and Digital Globe.

‘I was confident that our data would contain 50 times more information than theirs. Our imagery would be able to identify methane leaks from carbon monoxide leaks or something else. We would be able to tell the soil health status, crop nutrient status and crop species and pest species and things like that, whereas the existing data could only tell the crop health status.’

Then, he reached out to a few companies who were using the imagery by Planet Labs and started enquiring how his proposed specifications of imagery compared to what they were getting. The question was—would they pay for Awais’ better images, and how much?

One company that Awais researched was Planetary Resources. Bayer Crop Sciences was willing to pay Planetary resources USD 6 million for the imagery of a few crops. This little piece of information gave Awais more confidence that a market exists where bigger players like Bayer will be willing to pay for his images. In the end, he ended up talking to Bayer, Climate Corporation, an Indian company named Satsure and some weather forecasting companies like Skymet.

‘We had assumed that the companies wouldn’t want to pay anything higher than what they were paying Planet Labs, which was the cheapest solution in the market so far. Since we can keep our costs very low, we can still charge the same for our much better imagery. To our pleasant surprise, some of them said that they would be willing to pay even two to three times what they were paying for the added value. Some of them were willing to pay four to five times in exchange for exclusive rights to our proposed data.’

By the end of 2017, all these conversations had given him enough conviction. All he had to do was to deliver on the technical promise and launch the satellites.

“ Business Lesson 2: An engineer’s mind can comprehend rockets, spacecraft, space missions, extra-terrestrial life with ease. But to build a company, one has to relentlessly understand the commercials and figure out viable business models. ”

Pixxel is Born

‘I knew Kshitij because we used to play FIFA at college, and later, we worked at Hyperloop together. In February 2018, I asked him, “Do you want to join me on this space idea?” He said, “Yeah, cool, let’s do this.” So that’s when he came on as a co-founder.’

Awais gathered a few more interested students and went to Bengaluru in July 2018. The idea was to gather some sponsorships and crowdfunding for this new space idea. Perhaps they could replicate their Hyperloop success story in the space arena this time.

This is where their efforts started falling flat. They were trying to raise sponsorship of INR 1 crore (USD 130,950) to launch the satellite, but unlike the Hyperloop episode, people were not so interested this time. The brands that had sponsored their Hyperloop team had not seen much return on their investments.

Although the funding didn't work out, their three months in Bengaluru helped the team come a long way in their understanding of the space (pun intended). In particular, Awais had found contacts for the relevant suppliers they would need.


If you want to launch a satellite, you need to take care of three things—manufacturing, testing and actual launching. And then there are ground station operations to do whatever you want to get from the satellite.

Awais explains, 'We decided to manufacture the satellite in-house. For launching, we will pay someone like SpaceX or the Russian Space Agency or ISRO to launch it for us. We just tell them this is the orbit we need to be dropped off, and they will do that. For the ground station operations, you can either build your ground station or lease out someone else's antennas. We are leasing it out with an Italian company called Leaf Space. The advantage of leasing is that these leasing companies have a global network of ground stations. So, Leaf Space has stations in Europe, South America, North America, the Atlantic Ocean and the Pacific Ocean. That way, we get to access multiple different ones, rent it out, and we don't have to spend on the infrastructure to set it up in the first place. Also, renting works out cheaper—you pay for what you use.'

Once the process was clear in his mind, Awais started finding manufacturers.

'ISRO has helped create a good supply chain of companies that have been providing military-grade and space grade hardware to DRDO (Defence Research and Development Organisation) and ISRO for quite some time. We showed our ideas to these companies, and a few of them became interested in helping us out. They knew how to manufacture

something that would work in space which we didn't—so that was good. We came back to campus with these business partnerships in place to manufacture and put the satellites together.'

 *There's always a right time when technology becomes ripe to be commercialised. As noted before, space technology costs have come down tremendously. Second, an ecosystem exists where one could get someone to launch, someone to provide a ground station and someone to manufacture. The time for spacetech is "now." Smart entrepreneurs must focus on where they can create value in the ecosystem and build that narrow product/service with the right collaborations.*

At the end of the day, a lot of what Pixxel is promising hinged on its ability to get better quality images. Awais explains what better images mean.

'When I say 50 times better quality, it is literally 50 times the information contained in a Planet Labs' image. Let me give you an example. If I was looking at an agricultural field today with a Planet Labs' image, I would only be able to tell the crop health status, whether it's green, yellow or red, but nothing more. With our data, you will be able to identify the exact crop species, whether it's corn, wheat or even minute differences in the strains of crop species and also the soil nutrient content and moisture content in the area.

Fundraising: How Did Two College Students Convince the VCs?

Back in college, Awais started contacting the Venture Capitalists, but things were not progressing far. Even after talking to the VCs for months and several follow-ups, nothing went ahead.

A glimmer of hope came in October 2018 when all BITSians (alumni of BITS institutes) in Silicon Valley arranged a get-together. The event also included a pitch event in which BITS founded startups could pitch for fundraising. Awais applied for the pitch event and got selected. The question was how to fund his ticket to San Francisco.

At that time, Awais and his team were working with MapMyIndia. MapMyIndia's Senior Vice President Ankeet Bhat was a BITS alumnus. Awais convinced Ankit to fund his ticket! Awais not only pitched at the BITS alumni event but also individually met other alumni in Silicon Valley during his trip.

'I sent out cold emails to Raj Reddy and Prem Jain, who are BITSians who have sold their companies in Silicon Valley. They are busy people, but they were happy to give me time separately to meet and talk, which I did after that alumni event. Those meetings turned into angel investments.'

In January 2019, Awais started his final semester at BITS. Since BITS has no attendance criteria, they all moved to Chennai to continue working on Pixxel because that is where the manufacturers were located. The team had 4 people at this point—Awais and Kshitij (co-founders) and Manas and Teja (founding engineers). With the angel funding raised from BITS alumni, they were able to start the manufacturing process.

The student efforts had caught some attention from the media as well. In April 2019, Manish Gupta, Principal at GrowX Ventures, reached out to Awais. Managing his final semester examinations, Awais and Kshitij travelled back and forth between Pilani and Delhi to meet Manish and the team at GrowX. Things moved quickly this time, and by May 2019, Pixxel had closed its pre-seed round of USD 700K that included angel funding from BITS alumni and institutional funding from GrowX Ventures.

Managing to convince investors while you are in college is itself a rare occurrence but to do that for a spacetech startup is unthinkable. Awais reflects on a few things that he felt he did right in order to make this happen.

'Before going to San Francisco, I had already talked to a few Indian VC investors here. Then, I had collected emails as part of business research that showed that a market exists for our proposed product. The fact that I was part of Hyperloop in India helped in showing that

we had the technical aptitude to do it. Since we could build out this pod, maybe we could build out a satellite as well. So, that showed that we were thinking about both the aspects, the technology and the business.’

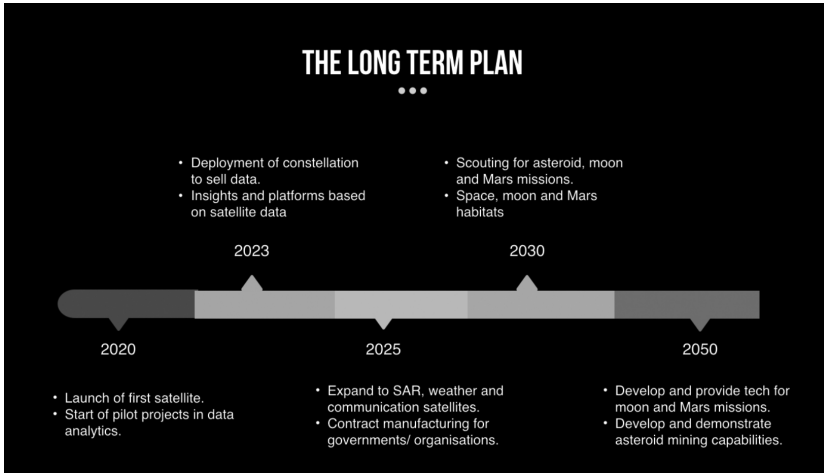
Awais had gone a step further and also done a thorough risk assessment.

‘We created a document which clearly stated all the risks that we had as a company. We told them that if you were investing in us, these are the risks you’re signing up for. There was a regulatory risk, business risk, technology risk and team risk. For example, we were upfront that there is no clarity on regulations in India. We might be able to pull off the technology, but it might take too long for the market to pick up. We also went on to answer how we were going to tackle those risks. I think that helped build trust and confidence.’

Manish Gupta shares his views. ‘The only startup that we have made an investment in after a single meeting is Pixxel. I remember meeting Awais and Kshitij in the morning and calling for the Investment Committee (IC) meeting right away. We rented a room at a co-working space in Aerocity to make sure everyone could join. As they presented, the IC liked them so much that they offered to invest right then and there.’

Manish was impressed with the team’s understanding of not only the product and technology but also the business aspects. Having customer conversations at this early stage and also having a vision till 2050 bowled over Manish.

Awais shares more about his vision, ‘We had come up with 5-year plans for the next 30 years. By 2050, we projected a vision where our satellites could be used for monitoring the asteroid belt and things like that. A lot of it will have to be developed step by step, but we knew what we needed to do in years to come, and that was interesting to the investors.’



The Vision Slide from Pixxel's Pitch Deck

Sole Asian Startup Making it into Techstars Space Programme

In June 2019, the Pixxel team was selected for Techstars Starburst Space Startup Accelerator⁷ Programme in Los Angeles.

‘Kshitij and I went there for three months, and that gave us perspective on the space industry. The rest of the team continued to work here. Before we went there, we hired a couple of senior engineers from TeamIndus as well. We were no longer just a student team. We had people with space experience, and we had a couple of consultants as well who had been working at ISRO and TeamIndus to provide us with the right guidance.’

The dots had started connecting, and Awais was steadily making inroads into his domain. One of the advantages of a global accelerator programme is the network and human capital you get access to.

‘One of the mentors at TechStars introduced us to Ryan Johnson over email. Ryan was a CEO at a satellite imagery company that was acquired by Planet Labs, which is one of the biggest players in the earth imaging industry today. I had a phone call with Ryan, and I invited

7. <https://www.techstars.com/accelerators/starburst-space>

him to our TechStars demo day on October 15th. So he came and also brought in his technical right-hand person.’

Liking what the team was doing, Ryan became an advisor.

Awais explains how Ryan added immediate value, ‘They brought a lot of more structure to our business development side of things. He knows what company is buying in which geography, be it Brazil, be it Japan. He knows the exact person in the exact company to talk to. He has helped speed up things by a lot, which is beneficial. We improved the specifications of our camera for the satellite because he thought what we are currently building might not be good enough in future. We said, ‘Okay, let’s not take a risk there; let’s make it better.’ That is the critical kind of information you need from someone in the industry.’

“ Business Lesson 3: You might be working in a “space” where the Indian ecosystem is not well-developed. In such cases, it is very important to develop a deep connection with countries where a more advanced ecosystem exists to get business understanding, advisors and funders. ”

Once back from the accelerator, Awais and the team started looking for fresh funding. Things were easier this time.

‘We got the term sheet for a USD 3.5 million round in February 2020 being led by GrowX. Ryan was participating as well. Kshitij and I were in the USA back then, but by the time we landed back in March to close the financing, the COVID lockdown had happened. We had a chat with the investors, and we thought it might be good to raise as much as we could. In a couple of weeks, we reached out to both Lightspeed and Blume, and both of them moved really fast. We had conversations with their investment committee, and they did their diligence over video calls. A few investors who had committed earlier went out. These two new investors came in. Overall, we managed to raise USD 5 million in this round.’

And that was only the beginning. Pixxel raised a fresh round of USD 7.3 million from Techstars, Omnivore VC and others in March 2021.

Putting the Satellite Together

To deliver the improvement in images, Awais researched what enables a camera to take better images. The main components of a camera are its optics, its sensor and the electronic circuitry that enables it all. So, Pixxel engineers asked themselves—how do we innovate each component and come up with much better end results?

‘The electronics part was easy because things have been getting miniaturised year on year. It is the optics and the sensors that add to the bulk of the cameras. So, we looked at what companies like IMEC (Interuniversity Microelectronics Centre) in Belgium are doing, making the sensors thinner and less power-hungry, much lighter. When we put all of this together, we believed that we could build a compact camera that was very high in performance but also not very bulky or costly.’

The bulk of the camera matters because every kilogram that you add on to the satellite means paying an extra USD 25,000 in the launch cost. Let that sink in!

They contracted the camera design work to a South African enterprise specialising in building cameras. Another key decision to take was where and how to put the satellites together.

‘We decided to have the entire integration in-house because that will allow us to manufacture them very rapidly while also keeping them very lightweight. So, the camera, batteries and solar panels came to our facility in Bengaluru, and we put it all together. We are the only ones that know how one thing is connected to the other. This also helps us be modular so that we can only replace the components we want to. It also lets us have better control over the weight of the satellite. So, the lesser your weight, leaner your size, the more cost-effective it is.’

So far, the total weight of Pixxel’s first satellite is coming out to be 15 kgs. Although it is decisively heavier than Planet Labs’ 5 kg-satellites, Pixxel can still keep its costs lower.

‘The manufacturing plus launch cost of our satellite does not exceed the manufacturing and launch cost of their satellite. One, because we

are manufacturing in-house. Two, our satellites have a wider coverage like each individual satellite has a much wider coverage; so, what would require a 130+ satellite constellation from Planet Labs to have a 24-hour coverage would take only a 30 satellite constellation on our end. And in the end, each of our camera images is 50x richer than theirs.’

And the best part is that Awais thinks he can keep improving on quality and costs going forward.

‘The current version will run at least till the end of 2022. The next version of the constellation that goes up in 2023 should be much better than this.’

Right now, the team is nimble and hungry for success. Most of the expenses are for manufacturing and integrating the satellite itself.

Taking Off

Things are in place to enable Pixxel to launch its first satellite in early 2022 using an ISRO rocket. By striking a deal with ISRO for the launch, they have become the first Indian startup to do so. By the time this book reaches the hands of the readers, we are hopeful that Awais and his team will already be collecting data from their satellite.

Then, the second satellite and the rest of the constellation is slated to be sent soon thereafter.

Their first satellite is yet to be tested. Awais explains how it works.

‘There are private testing facilities that we rent out. They put the entire satellite inside the vacuum chamber, and we can change the temperature as it would be in space. We can vary them from very cold temperatures to burning hot. We simulate space-like conditions and see whether all components work as expected. There’s the shock table that shakes it very vibrantly like it would in a rocket. We also have something called a three-axis motion simulator which simulates the motion that a satellite would face up in orbit, etc.’

For the complex tests in India, Pixxel will have to work with DRDO or ISRO. Awais hopes to have his testing facility at some point.

‘The plan is to do what Ford did with the production of cars when they had an assembly line where they could rapidly create these cars very cost-efficiently and rapidly. Similar thing for the satellites. We need to churn out 30 satellites a year, and we can do that only if we have that sort of an assembly line. It also means we need to rapidly check out if a component is faulty.’

Assembling the Team

Needless to say, building a team that can help launch a satellite is not for the faint-hearted. How is Pixxel assembling a team that can pull this off?

Awais shares, ‘We need to make sure that we have a young team with the energy and passion to move fast and not follow what was traditionally followed in organisations like ISRO, which can be sluggish. But we also need to couple that with experience so that we are not doing everything from scratch. That’s the delicate balancing act we have to master.’

On the engineering front, Pixxel has 25 full-time engineers. Apart from fresh college graduates, they have hired senior people from TeamIndus and ISRO.

‘Because of working with TeamIndus, these people had the mindset of working in the extreme environments of a startup. This was crucial to us. We hired our Chief Innovation Officer, Richa, to lead the data side of things. She led the data platform at CropIn (also covered in this book) for satellite imagery. We work with consultants on things where we need niche expertise, such as ground station operations. For example, we work with Mohini Permeswaran, who is 70-years-old and has previously worked with ISRO as well as the European Space Agency.’

Awais adds that in some specific areas, it is hard to find talent in India, and they need to find people in the US.

The success of Pixxel means extending the very frontiers of India’s presence in spacetech. The next time Awais meets Elon Musk, it probably won’t be a fanboy moment but that of meeting a peer visionary.

FUTUREPRENEURS

10 Deeptech & AI startups

redefining tech in India - *stories and lessons*

“ A constellation of imaging satellites detecting gas leaks, voice bots mirroring your accent, portable breathing devices to save infants—this is not Silicon Valley—these are Made-in-India startups.

MIT trained scientist, Varun Aggarwal, and a bestselling startup author, Nistha Tripathi, come together to investigate a world of startups beyond e-commerce, payment gateways, hotel and cab aggregation. They interview 10 deeptech and AI founders in India who are not only creating space technology, genomics tools, robots, self-driving vehicles but also building successful business models around them. Many of them already have global clients and are getting closer to the unicorn valuations.

The book demystifies complex-sounding technologies that power deeptech and AI startups. A must-read for anyone passionate about startups and technology. ”

NISTHA TRIPATHI is a Wall Street techie turned storyteller who is on a mission to make business books interesting to read.

VARUN AGGARWAL successfully built and sold *Aspiring Minds*, India's largest job skills testing company. He is an active AI researcher and angel investor.

A clarion call for science and technology startups to push
the frontiers of Indian entrepreneurship
- **Dr. Desh Deshpande** (Life Member, MIT Corporation)

Nistha and Varun have put together very powerful
stories of Indian deeptech innovation
- **Prof. K. VijayRaghavan** (Principal Scientific Advisor to the Govt. of India)



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