Entrepreneurship
Professor C. Bhaktavatsala Rao, Ph.D.
Department of Management Studies,
Indian Institute of Technology Madras
Lecture 38
Education and Entrepreneurship – Part 3

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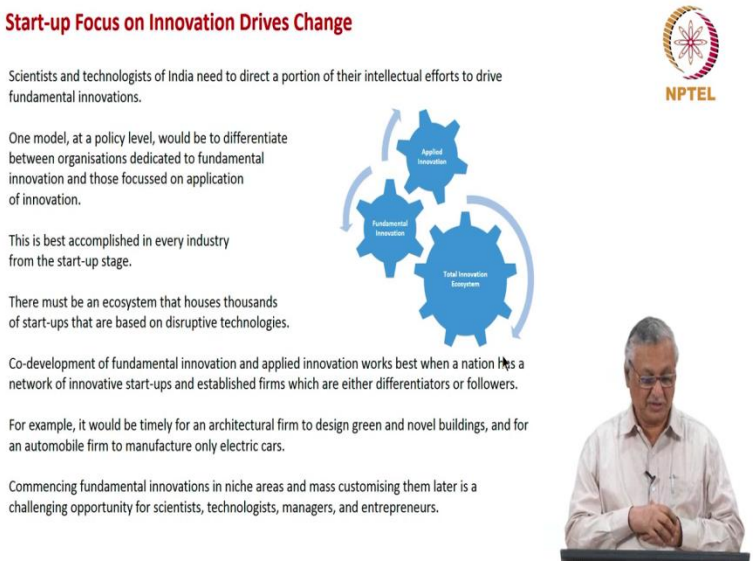

So, when we look at start- ups and when their focus on innovation drives change, we will have a total innovation ecosystem which is completely oriented towards start-up development.

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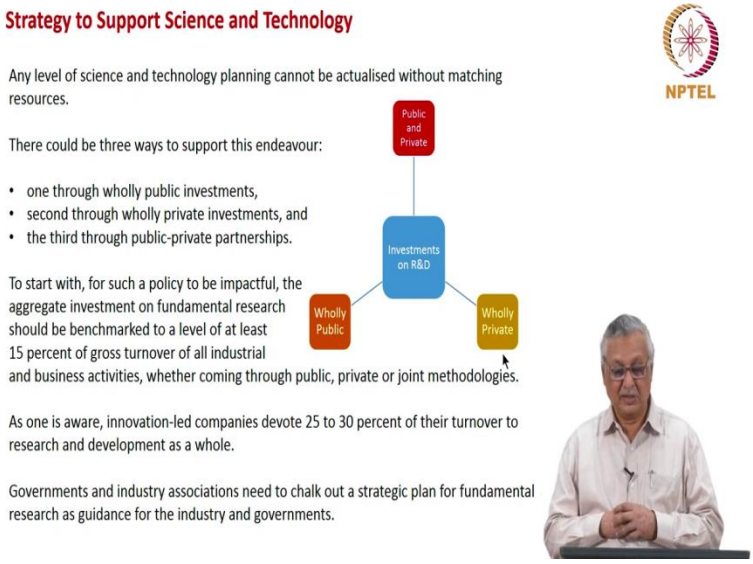

So, we have investments in R and D, which are in public sector, we have investments in R and D which are in private sector, and we also have investments which are joint. To be able to achieve the level of advanced countries, one estimate is that we need to have 25 to 30 percent of our turnover on research and development as a whole. That is how we can bridge the gap which is existing between our systems as well as the advanced country system.

As of now, Indian companies adopt a benchmark of 1 to 6 percent of their sales turnover on R and D. So, to increase it to this level is a herculean task. However, we have to ensure that at least an interim level of 15 percent of our sales and turnover being utilized for R and D that seems to be a very important goal as we go forward.

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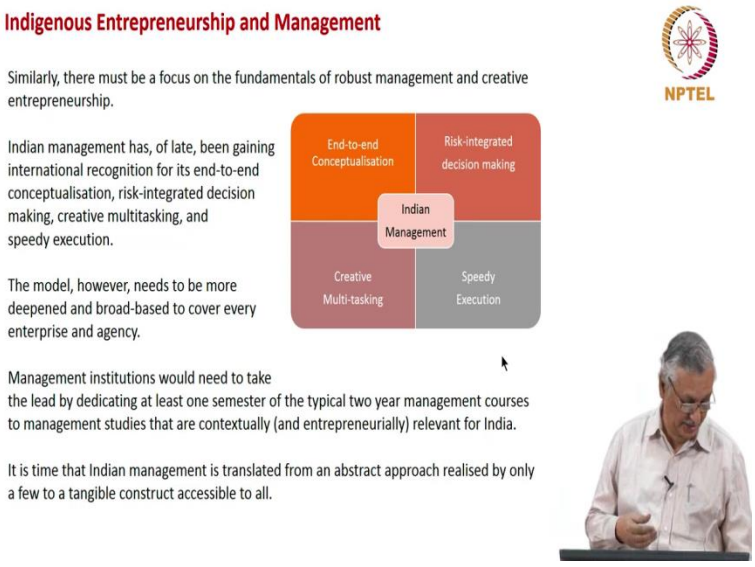

So, how does Indian management help in this aspect? How do management institutions figuring this. Is can we say that there is an Indian management which is required. We heard about Jugaad, which is frugal engineering, that is economical way of doing things as effectively as very advanced or sophisticated technology or management would do.

So, there could be four facets by which Indian management could work in this entrepreneurial revolution. One, it could be end-to-end conceptualization. Not necessarily looking only at the goal or not looking only at the activities, but ensure that if you want to achieve this target, what all we need to do at various stages and what all the support services we need to have. That is one aspect.

Second is risk-integrated decision making. All decisions involve certain risks. So, we do have to have certain models of risk-integrated decision making. If you want to be a global power in the new drug discovery, we got to invest, as I said, 25 to 30 percent of our turnover on R and D or have a special funding lens created for this, but there is a huge risk involved in it. So how do we integrate that risk into decision making?

The third one is creative multi-tasking. One of the biggest advantages we have in the Indian system is the ability to do many tasks together. Western thought has specifically supported creation of stage gates, completion of certain work by certain activity before you take on the other activity, whereas we have a kind of project mode of working where our minds and our actions think of doing many things in parallel. Parallel processing is one of the inherent natives of Indian DNA. So, how do we use this creative multi-tasking capability which is there in the Indian system? How do we make it help in our enterprise and management systems? That is one of the tasks we have.

Then, of course, speedy execution. We have execution, but execution with several resources committed to the same task. So, how do we ensure man power productivity, how do we ensure capital productivity? So, Indian management is a good cliche, but how do we really translate from abstract approach to a tangible construct that is also our challenge as we go through.

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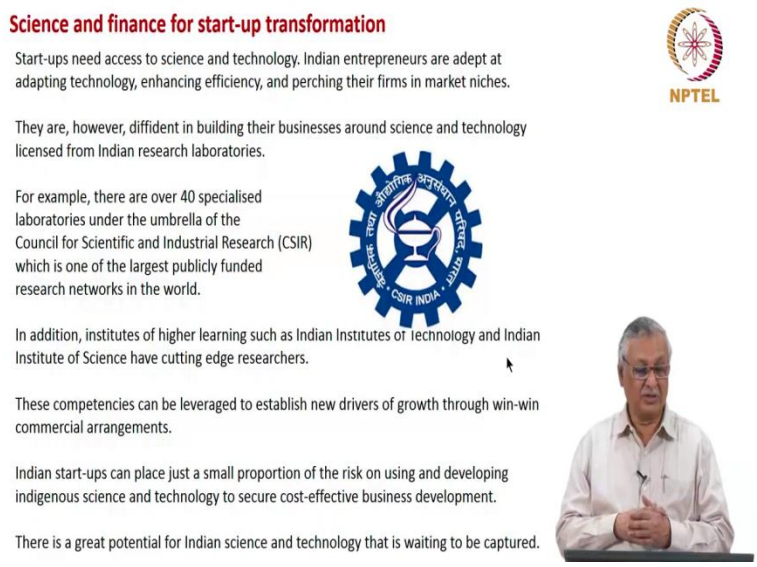

So, design, manufacturing, quality, these are important aspects for good delivery. But to ensure that, we have to boost our entrepreneurship with management and it can occur at every level. And how do we do that is a function of science and finance for start-up transformation. So, we are very clear that entrepreneurship needs a major boost from the very student stage so that we can transform the Indian industry and economy. And we also saying that entrepreneurship can occur at any level and at any age. It could occur at 7 years, it could occur at 70 years as well.

But most importantly, given that we have got as millions of young graduates coming every few years, how do we really encourage entrepreneurship. The only way in which we can encourage entrepreneurship is to convert the mindset from jobseekers to job creators and the whole employment and retirement system should have flexibility and fluidity to encourage entrepreneurship at any point of time in ones career, including post retirement. Even working managers and leaders could be encouraged to take up parts of industrial value chain as entrepreneurial ventures. And corporate entities need to establish endowment funds and corpuses to support an entrepreneurial foray's.

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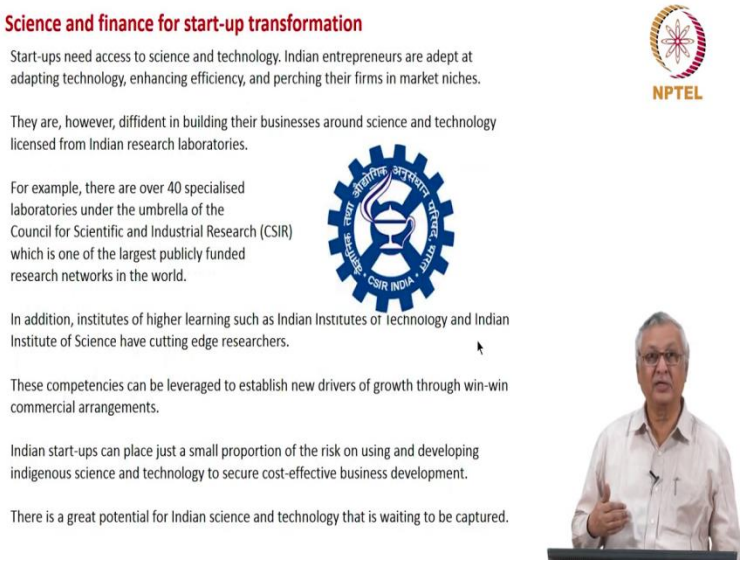

We have got lots of R&D infrastructures already established. CSIR has got over 40 specialized laboratories under the CSIR umbrella. It is one of the largest publicly funded research networks in India. The access to those technologies must be much more fluid and much more speedily done, so that the technologies and scientific developments which are already developed and patented should be available for developing of Indian start-up system.

And typically, Indian start-ups tend to develop their own technologies from ground up, but certain level of risk taking could also be there in terms of Indian start-ups by taking on the technologies which has already developed and then perfecting them there as they go through the start-up process. So, there is a great potential for Indian science and technology which needs to be captured.

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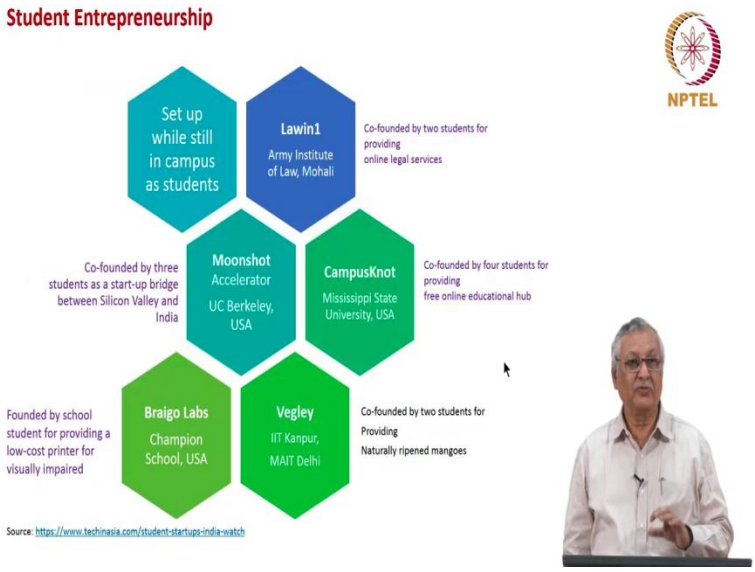

There are different ways in which student entrepreneurship is encouraged. So, we have got, in India itself, certain examples, globally also we have got certain examples. We have got Lawin1 which is set up in on Army Institute of Law, which is co-founded by two students who are providing online legal services. Student entrepreneurship typically looks at students collaborating to set up entrepreneurial ventures.

CampusKnot is a co-founded student enterprise in USA, Mississippi State University, which works as a free online educational hub. Then we have a Moonshot Accelerator set up at UC Berkeley, USA, which is co-founded by three students as a start-up bridge between Silicon Valley and India. Braigo Labs at Champion School, USA is another student start-up which developed the low cost printer for visually challenged or impaired persons. Vegley, IIT Kanpur it has a start-up founded by two students for naturally ripening mangoes, not through any other chemical process or physically enclosed process.

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So, given these kinds of develops, the Government of India has done a great service to the entrepreneurship movement by establishing a National Innovation and Startup Policy for students and faculty, NISP. It was first formulated in 2016 and updated in 2019. It is available as a policy document which can be accessed.

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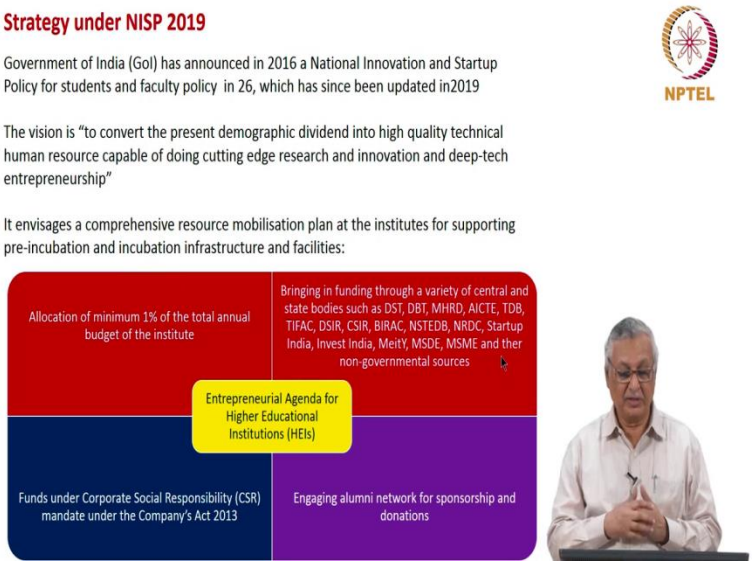

Bodies that can Support Start-ups in Higher Education Institutes

Agency		Agency	
Department of Science & Technology (DST)		Biotechnology Industry Research Assistance Council (BIRAC)	
Direct Benefit Transfer (DBT)		National Science & Technology Entrepreneurship Development Board (NSTEDB)	
Ministry of Human Resource Development (MHRD)		National Research Development Corporation (NRDC)	
All India Council for Technical Education (AICTE)		Startup India	
Technology Development Board (TDB)		Invest India	
Department of Scientific and Industrial Research (DSIR)		Ministry of Electronics and Information Technology (meitY)	
Technology Information, Forecasting and Assessment Council (TIFAC)		Ministry for Skill Development & Entrepreneurship (MSDE)	
Council of Scientific and Industrial Research (CSIR)		Ministry of Micro, Small and Medium Enterprises (MSME)	

The vision is to convert the present demographic dividend into high quality technical human resource capable of doing cutting edge research and innovation and deep-tech entrepreneurship. The policy envisages a comprehensive resource mobilization plan at the institutes, higher educational institutions especially, for supporting pre-incubation and incubation infrastructure and facilities. So, it has certain very good components which and has the entrepreneurial agenda for higher educational institutions.

There are four components; one, allocation of minimum 1 percent of the total annual budget of the institute on programs and policies which are prescribed in NISP; then, two, bringing in funding through a variety of central and state bodies such as DST, DBT, etc. to augment the resources; third, to access or to seek funds under Corporate Social Responsibility, CSR, mandate under the Companies Act, 2013; the fourth one, engaging alumni network for sponsorships and donations.

These four aspects are envisaged under NISP and these are the agencies which are available which can fund various start-up activities. For example, Technology Development Board has got certain investment limits. TIFAC has got certain investment capability and different ministries have got certain investment budgets.

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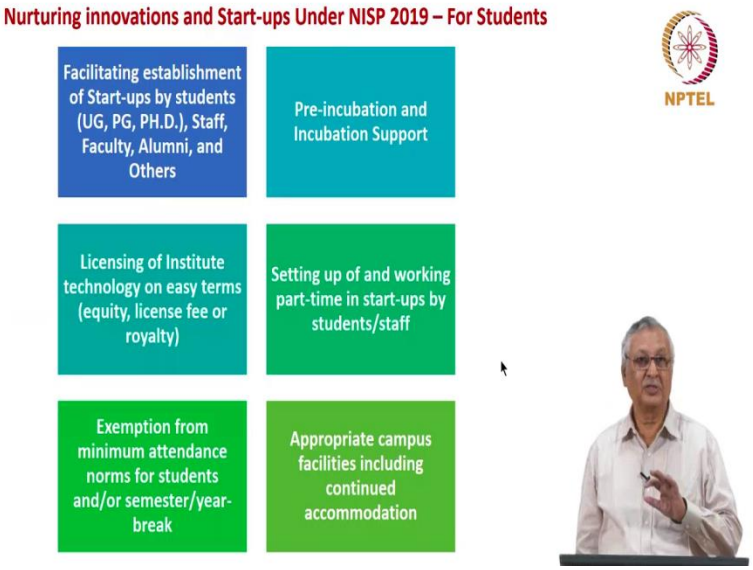

For students, there are six parameters that are available. One, it provides the framework for establishment of start-ups by students, UG, PG, PhD, staff, faculty, alumni and others. It provides pre-incubation and incubation support. It enables licensing of institute technology on easy terms which could be a combination of equity, license fee, or royalty. It enables setting up of and working part time in start-ups by students and staff, exemption from minimum attendance norms for students and/or semester year break, and extension of appropriate campus facilities including continued accommodation as the start-up is established.

This is a big departure from the framework that existed earlier prior to 2016 that the student when he or she is a student should only be looking at studies and examinations and nothing else. This is a big departure from that policy and the transformational mindset change that student while also studying can develop his or her own products through start-ups. Not only that, it can be done under institutional framework.

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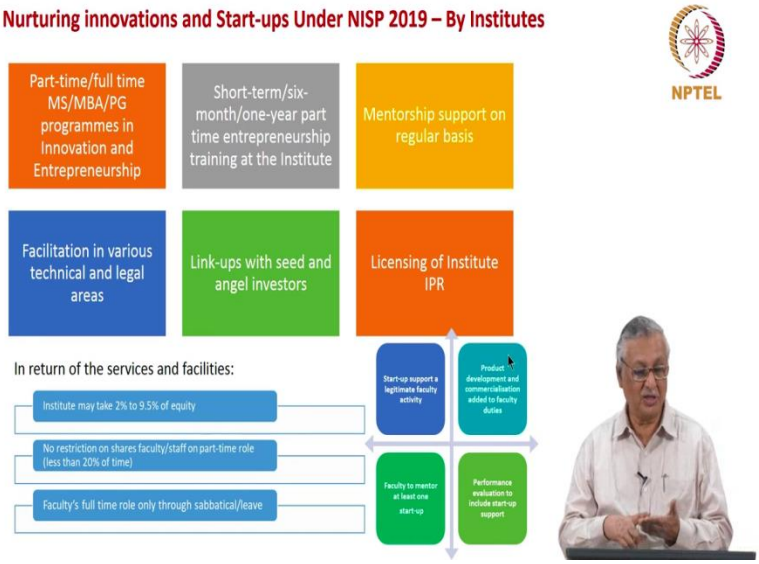

And what should institutes do. Institutes should provide part time full, time MS, MBA, PG programs in innovation and entrepreneurship. The institutes should provide short term, six month, one year part time entrepreneurship training at the institute. They should provide mentorship support on regular basis. They should facilitate in various technical and legal areas. They should enable link-ups with seed and angel investors, and they should help licensing of institute IPR.

So, in return of the services and facilities provided from the start-ups, the institutes are allowed to take up to 9.5 percent of the equity, minimum being 2 percent. There is no restriction on shares, which faculty and staff can take on part time roles as provided in the start-ups provided that not more than 20 percent of the time is impacted by such start-up activity and if faculty want to take full time roles, they could do it by using their leave or going on leave without pay or having a sabbatical.

So, what does this do? It does four great things. One, start-up support is now defined as a legitimate faculty activity. It helps enlarge the faculty's activity spectrum, including product development and commercialization added to faculty duties regularly. That is teaching and research. Faculty is expected to mentor at least one start-up and performance evaluation of start-ups would include these measures which have been highlighted earlier.

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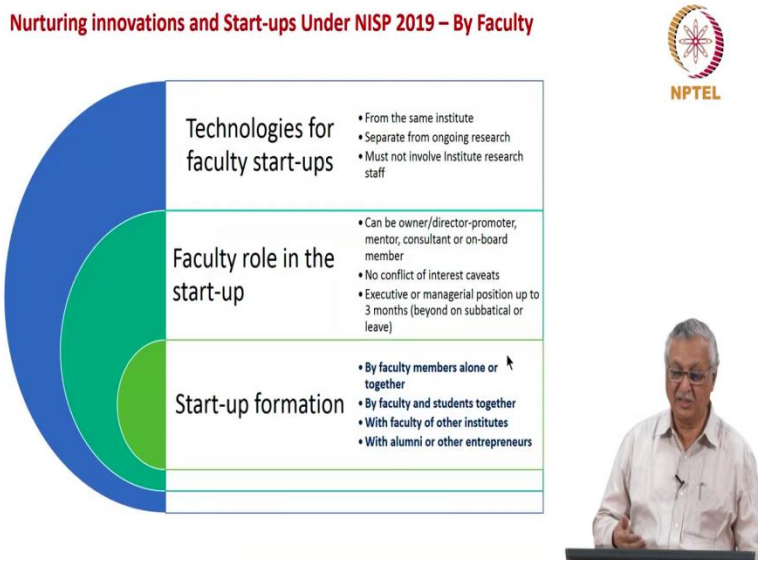

So, what can faculty do? Faculty do their own start-ups. They can utilize the technologies which have been developed in the institute and then they should be able to separate the technology which is embodied in the start-ups from the technology which is ongoing within the institute and they should also not involve the institute research staff, but rather have own start-up staff, so that there is better definition of boundaries of conflicts of interest.

The faculty can be owner, director, promoter, mentor, consultant or on-board member. There should be no conflict caveats and executive or managerial position up to three months to start the venture. Start-up formation can be by faculty members alone or together. It could be by faculty and students together and with faculty of other institutes and it would be with alumni or other entrepreneurs as well. So, there is a whole new era which is opened up for faculty members to participate in the entrepreneurship development.

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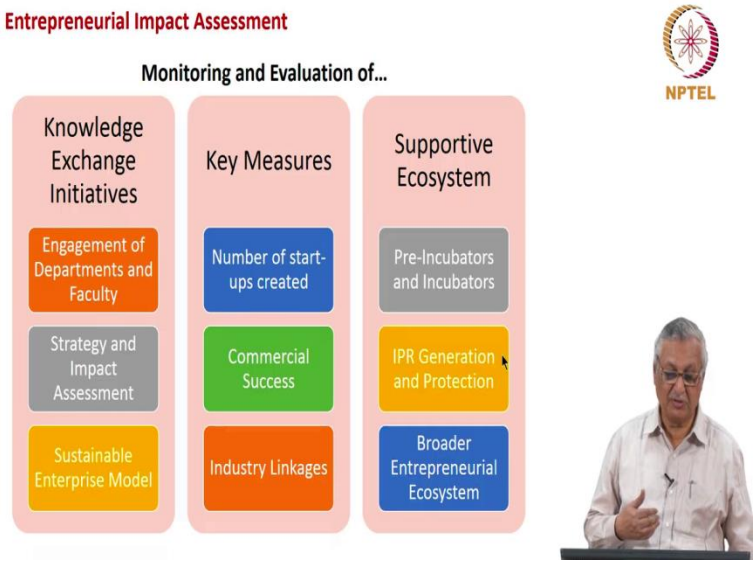

And how do we assess the impact of this development? We need an entrepreneurial impact assessment, which does the following three things. It monitors and evaluates A of knowledge exchange initiatives, that is how engaged departments or faculty in terms of entrepreneurship. What is the strategy adopted by a particular institute regarding start-up support and what is the impact. And how do we have sustainable start-up enterprises coming out of this.

And the key quantitative measures, KPAs, number of start-ups created, the commercial successes start-ups and the industrial linkages that have been established and the supportive ecosystem which the institute has been able to establish, pre-incubators and incubators, IPR generation and protection, and the broader and entrepreneurial ecosystem. So, we have a vision through NISP.

We have a strategy and approach and we also have an entrepreneurial impact assessment. So holistically speaking, we have been able to generate a new mindset in higher educational institutions, both on the part of students as well as on the part of faculty and staff to create new start-ups which are relevant to the institutes as well as to the society.

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When we talk about student entrepreneurial ecosystem, one of the most important examples that comes to mind is the Stanford Entrepreneurship Network. Stanford University, as we know, is the hub of most exciting entrepreneurial developments and spanning several fields from biology to digital technologies. Stanford University has produced some of the basic foundations of the new generations Silicon Valley companies and these are done by networking students into different groups across the domains.

So, we have Graduate School of Business, School of Law, and several multidisciplinary groups working on different aspects. And the images on the right indicate the kind of spread of activities. One group looks at demystifying and nurturing entrepreneurial journey. One looks at the computational law. Another looks at solving world's toughest social and environmental problems. Then we have got another group which looks at communication solutions, intersecting technology and people interfaces. Some groups look at the solving world's energy problems.

Another group looks at improving the well being of people, especially those above 50. And another group looks at environmental and sustainability problems. So, for all the groups which I have listed on the left side, I have also listed on the right side the basic objectives of this group. So many of them also fall under the ages of social entrepreneurship that is solving the planetary problems, solving the earth's problems and solving the problems of the people, not merely providing more products or more services.

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Similarly, they have got good Office of Technology Licensing and they also have got very specific schools for new biomedical technologies and new therapeutics and diagnostics. So, this kind of virtuous entrepreneurship network system has created a kind of fervor within the university campus to consider entrepreneurship development as part of the regular curricular development.

These are spawned by the graduate programs, therefore, there is linkage between knowledge which is generated in the start-ups, also knowledge which is generated in the university laboratories and classrooms. It has created a network of student, faculty and industrial business leader communities. It also helped in bringing several ideas to life on a continuous basis. Some of these aspects, for example, the bio-design aspect, the design thinking aspect, these also have become leaders in the overall start-up ecosphere.

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India has not been lagging far behind, particularly in more recent years. We have got IIT Madras Research Park, which is an outstanding example of a start-up ecosystem that has been created. This has been modeled after MIT and Stanford Research Parks and IIT Madras Research Park, I would say, fulfills even a larger purpose, three with multi-tower complex which has got total 1.6 million square feet offering space of laboratories and offices and with several common support services.

There is also an IITM Incubation Cell which has so far help 200 start-ups come into play funded by, developed by 68 graduates and 103 innovators and 73 start-ups are already in the market. 227 million dollars has been invested in these start-ups by angles, 3,000 plus jobs have created and the valuation of these start-ups is at 6,000 crores which is 845 million dollars and 100 plus patents have been filed.

So this is indicative of an incubation system that can be created by a higher educational institution in the country and the fields where this IIT Madras Incubation Cell has been working are waste management, financial technology, livelihood, water treatment, energy renewables battery, consultancy, agritech, biotech, edtech, skill development, IoT, Internet of Things, health-tech, MI, AI, AR, VR, analytics, enterprise technology, manufacturing, automobiles and robotics.

You can see that there is a huge diversity in the start-ups and also therefore say area of development. IIT Madras Incubation Cell has become India's leading deep-tech start-up hub. It is a non-profit Section 8 company established and also is governed by a Board of Directors.

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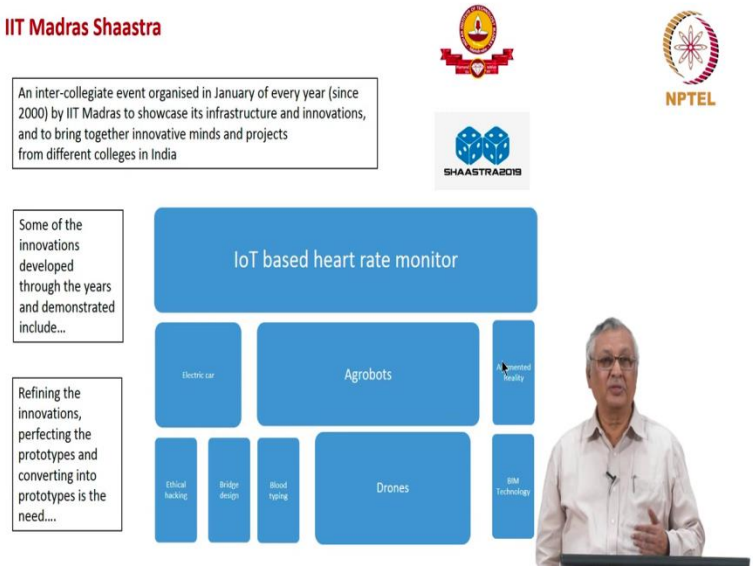

In addition to that, IIT Madras conducts number of events which help not only IIT Madras, but also different colleges come together and showcase their innovations. In IIT Madras, Shaastra is one such event conducted every year in January to showcase such innovative developments. In 2019 edition, certain things such as IoT based heart rate monitor, agrobots, electric car, augmented reality devices, drones, blood typing systems, bridge design things, ethical hacking, BIM technology they have been developed.

So, the challenge is to convert these kinds of ideas which are developed at the prototype stage and at experimentation stage into viable products and take them forward in this start-up journey that is the task which we have. If these ideas are moved by students into the incubation cell and they are provided further support, obviously the impact would be much more.

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Similarly, the Department of Management Studies in IIT Madras focuses on different subjects each year and this year it has focused on entrepreneurship. And the multiple foci of the people who have presented their ideas from different colleges across India has been quite amazing. They have focused on industrial applications, they have focused on consumption, social purpose and services. For example, one start-up focused on having a sensor which can detect failure of tracks ahead of the tracks being actually broken.

So, the noise levels, the thermal measurements, they help the start-up find out the failure propensity of Indian railway system. Similarly, there was start-up which looked at drones which can measure agricultural yield and you can see in the graph that India lags very much behind US and China in terms of agriculture yield both in terms of coarse grains as well as from in terms of wheat yield. So, we have got important aspects of life which are tackled by these kinds of events.

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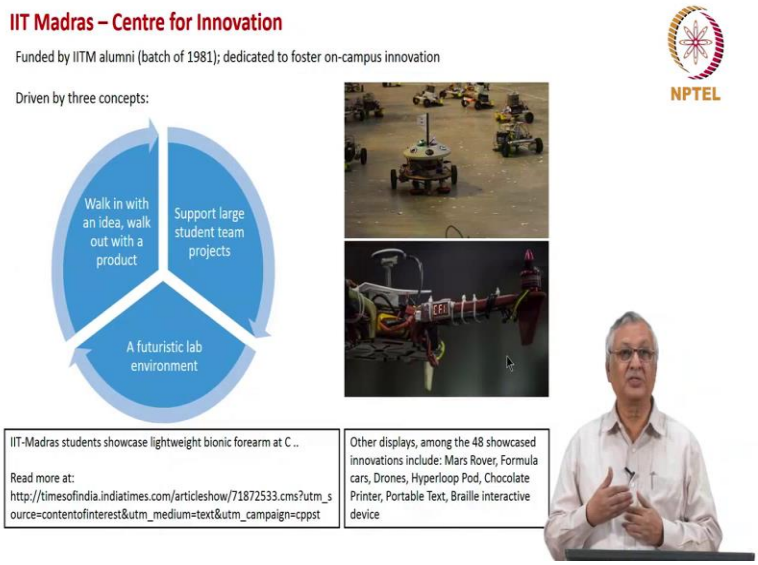

Similarly, we have Centre for Innovation in IIT Madras which brings to fore the developments made by the students over the years and then they are demonstrated in public forum. This year 48 showcased innovations were there and it includes lightweight bionic forearm, which responds to human requirements. Then we also had the products like Mars Rover, Formula cars, drones, Hyperloop Pod, Chocolate Printer, Portable Text, Braille interactive device. So, the concept behind Center for Innovation is, walk in with an idea and walk out with a product, support large student team projects and create a futuristic lab environment.

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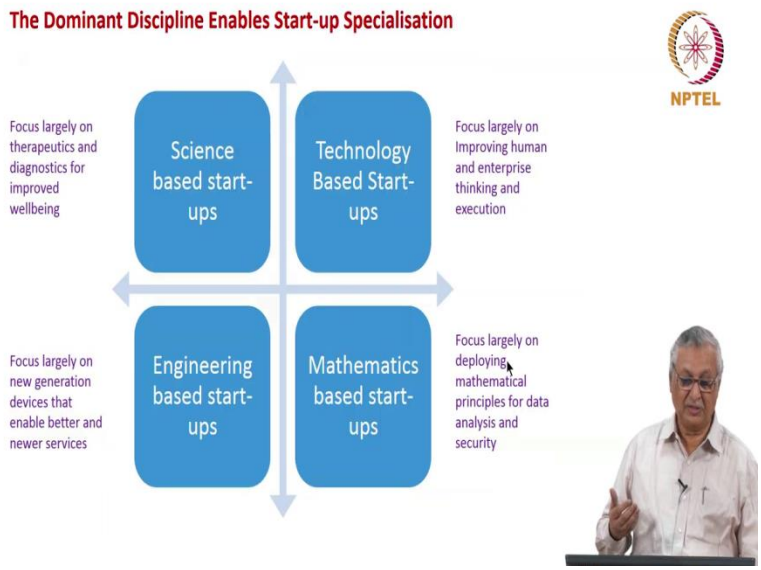

Now these are the activities which are done at IIT Madras and many other institutes similarly do several other innovative activities, events and cross functional cross institute interactions to support development of technology and innovation in the system. So, student entrepreneurship gets a fillip when these kinds of activities are done by the institutes. Again, when we look at student entrepreneurship and when we talk about STEM, science, technology, engineering and mathematics, we recognize that there is a kind of synergy and interdependence as we have seen, but each of these disciplines also creates their own start-ups.

So, if somebody is well versed in science, he or she is well positioned to develop science-based start-ups and they typically focus largely on therapeutics and diagnostics for improving the human well being. If a person is an expert in technology, he can or she can establish a technology-based start-up which will focus largely on improving human and enterprise thinking and execution.

Engineering-based start-ups on the other hand create new devices, new equipment, which will enable better services, newer services. And mathematics-based start-ups typically help analyze huge amounts of data ensured that there is processing of data on both predictive lines as well as prescriptive lines. So, each discipline within the STEM group has got the ability to create certain very specific thematic start-ups. This is of course not to say that they do not have

interrelationships, they do have interrelationships and how the interrelations occur also could be seen in subsequent slides.

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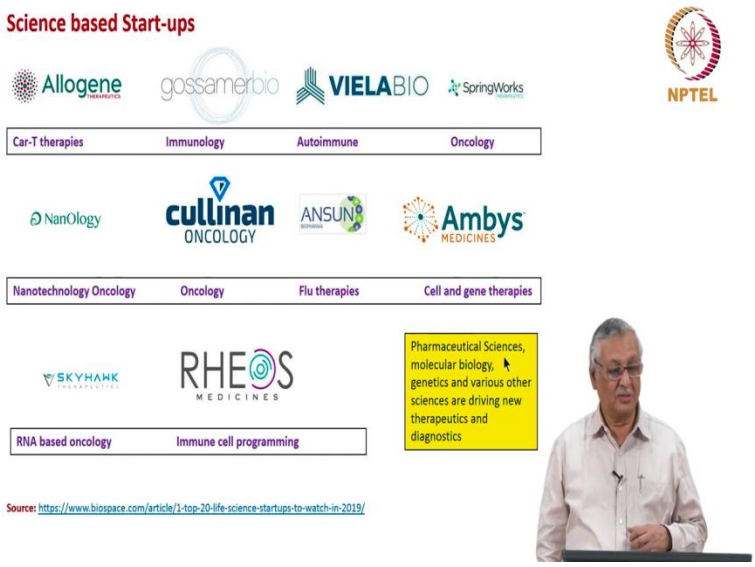

So, these are the top 10 science-based start-ups I have been able to cull from the available literature. We have got Allogene, which focuses on Car-T therapies, very novel ways of dealing with oncology. Then you have Gossamer Bio, which looks at immunology, Viela Bio, which considers autoimmune diseases, improving the autoimmunity of the person, SpringWorks focus on oncology, NanOlogy, looks at providing oncology solutions through nanotechnology.

Some of the known products are being used through nanotechnology to deliver more effective cure. Cullinan Oncology looks at oncology, Ansun looks at flu therapies, Ambys Medicines gives cell and gene therapies, RNA based oncology is provided by Skyhawk and Rheos Medicines does immune cell programming.

In addition, different other medical products are being improved using newer technologies like, as I mentioned, nanotechnology for example, same eye drops are being used to develop to better therapeutic efficacy by application of nanotechnology. So pharmaceutical sciences, molecular biology, genetics and various other streams of science are driving new therapeutics and diagnostics start-ups based purely on science.

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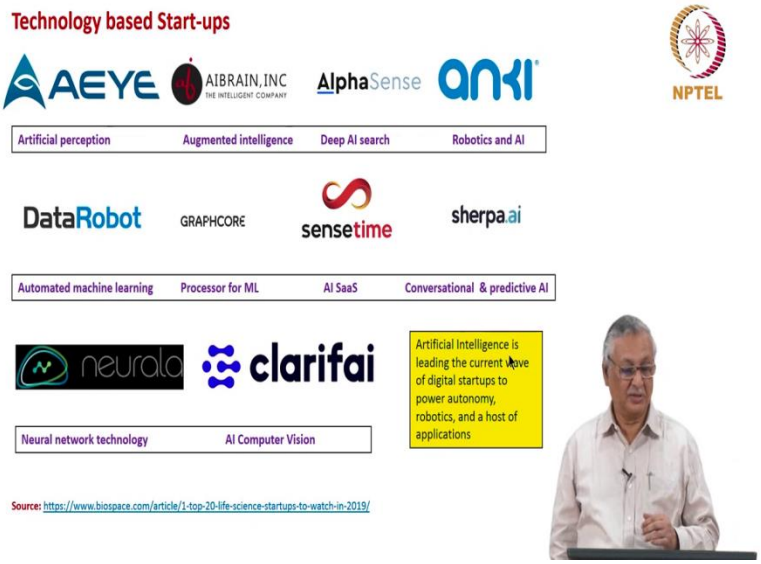

Then we look at technology, artificial perception, augmented intelligence, deep artificial intelligence search, robotics and artificial intelligence, automated machine learning, processor for machine learning, SaaS based on AI, conversational and predictive AI, neural network technology, AI computer vision, these are all some of the technology based start-ups that have come into certain serious reckoning as capable of bringing in new technologies into street.

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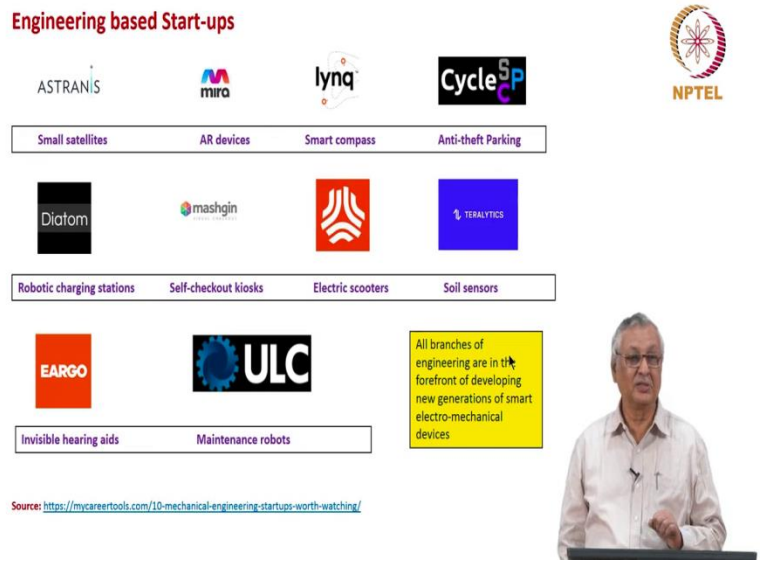

When we talk about engineering, as I said, engineering helps you make newer devices better devices. So small, making of small satellites, making devices for all augmented reality, smart

compass to help people navigate better, anti-theft parking for different kinds of vehicles, robotic charging stations for electric vehicles, self-checkout kiosks, electric scooters, soil sensors, invisible hearing aids, one of the issues with hearing aids says that people would not like the hearing aids to be seen that leads to loss of social esteem.

So, having invisible hearing aid is a improvement and this is a start-up which is working on that. Then maintenance robots, oil and gas utilities, power plants, oil refineries, these are all extremely hazardous areas and they are all 24 by 7, 365 day functioning utilities. You cannot stop any of the activities for maintenance. So, maintenance robots these are all very novel ways of doing. Similarly, when you have solar cell and solar power stations, cleaning of solar power stations is easy, provided they are kept in a different area and then you have facility to clean.

But if they are, let us say, located on oceans or on rivers, how do you ensure the cleaning. So, having a robot which has got the ability to clean without disturbing the solar capture, that is, that can be achieved by robots. So, maintenance robots and preventive, predictive maintenance conducted robots is very effective. So, these are engineering based start-ups. So, people who have got that engineering eye and the ability to create new equipment, they are well suited for creating these kinds of start-ups.

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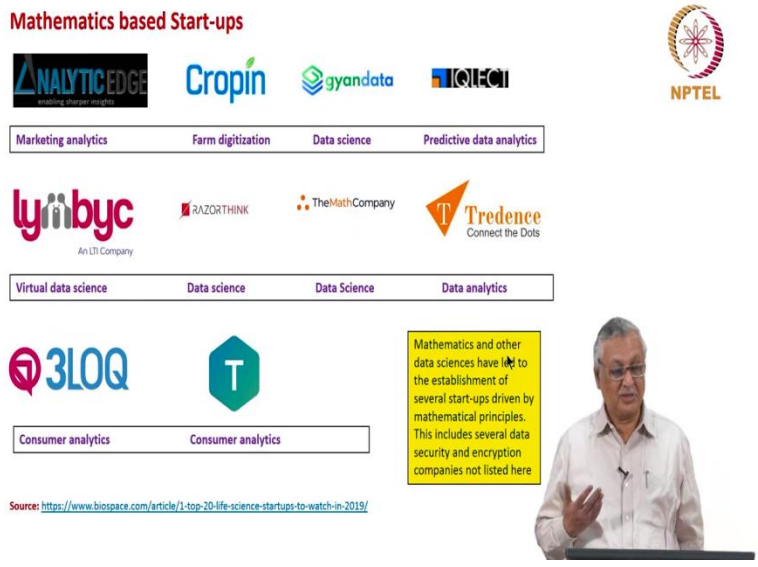

Then what about mathematics based start-ups, while there may not be a pure mathematics based start-up, we can also appreciate that mathematical principles are at the back or behind all data

science applications. Similarly, encryption is supported by mathematics. So, mathematics and other data sciences have led to establishment of several start-ups which are driven by mathematical principles. Data security and encryption companies are also included in this.

So marketing analytics, farm digitization, data science companies, predictive data analytics companies, virtual data science companies, then consumer analytics companies, market analytics companies, these are all have come up by using complex mathematical models and data analytics procedures to analyze the data and help us understand both device performance, system performance as well as human performance much better.

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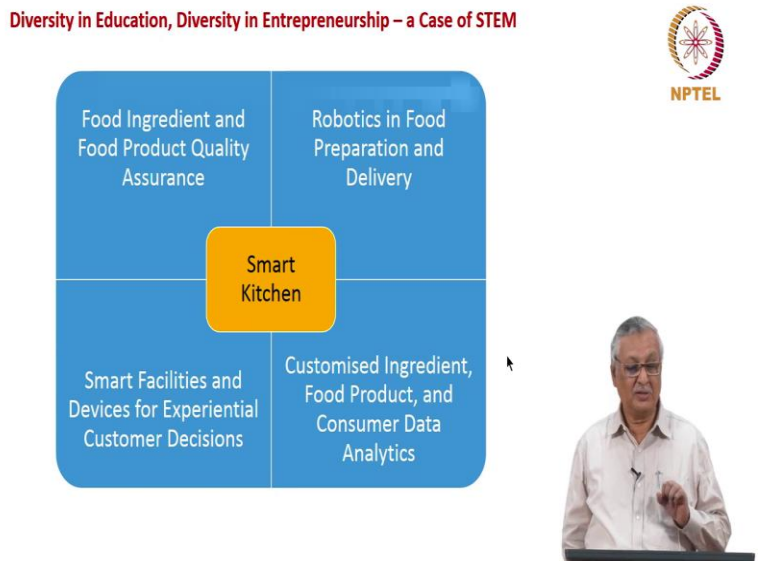

So, how does this happen? When you have diversity in education, there will also be diversity in entrepreneurship. This is a case of STEM and they coexist with each other. Let us have a concept of a smart kitchen. Smart kitchen is one where things are done differently using digital technologies. The actual food preparation does not vary, but the new technologies which we have discussed so far STEM, they make different ways of doing these things. So, when you adopt science, you can analyze, measure food ingredient and food product quality.

You can assume that science has got enough technologies to see whether an ingredient which is coming has salmonella infection, which is one of the biggest problems in food quality or any other infection, whether a product is aged, whether yeast has, whether there is fungus in a

product or not. Right now, these are all done by visual, human visual activities. All these things can be done mechanically, digitally.

The level of dirt, the level of pesticide in a food product, the level of chemicals, residues in a food product, they can all be measured and then the necessary level of quality can be assured. So, science can be used to make a kitchen a smart kitchen in its own way, which is food ingredient and food product quality assurance. Then technology that is creation of robots which can do the food preparation and delivery that is the second way in which the smart kitchen can come about and we talked about this pizza making machine.

Even to look at a traditional South Indian snack Dosa, the kind of thickness it must have, the kind of color it must have, what is the kind of roast level it should have, it could be done in much more precise way through artificial intelligence than with human eye. And human eye can do it, provided there is no distraction. But artificial intelligence powered a robot can do it unerringly continuously of thousands after thousands Dosas. So that is where robotics in food preparation delivery could be there.

Then the third way, area where engineering could work could be through creation of smart facilities and devices for experiential customer decisions. So, each customer varies in respect of his taste levels, in respect of his preferences. Similarly, each product, each food product varies in terms of what it offers, in terms of its nutrition, in terms of taste. How do you have smart facilities and devices which integrate these two? Then we have got data analytics, which supports all of these things through customized ingredient, food product and consumer data analytics.

So when you think of smart kitchen as an idea in the realm of the future, you can see how STEM, science, technology, engineering and mathematics are contributing in terms of their own start-up efforts to make smart kitchen a reality and there is space for each of these start-ups to exist, there is also potential for each of these start-ups to work together and develop really smart kitchen for the future. So, this is a conceptual example, but this is an example to suggest to us that the knowledge which we learn through our scientific, technological engineering and mathematical education can be of great importance to create a new start-up movement.

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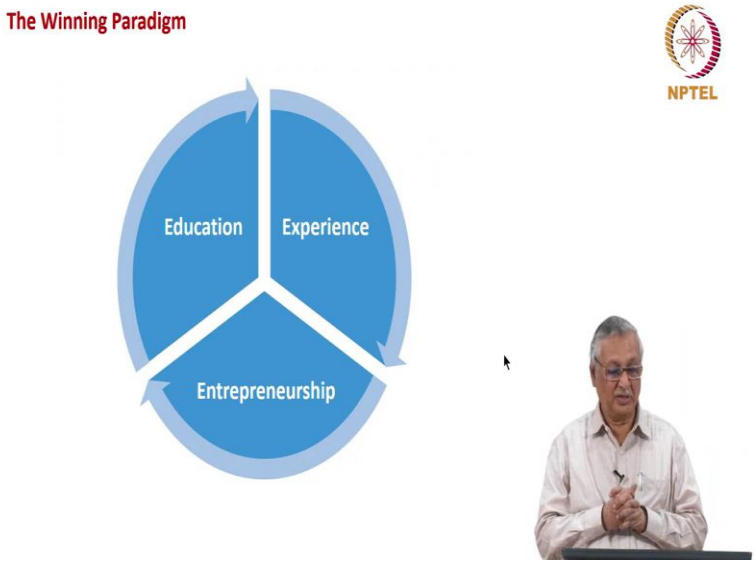

So, what is the winning paradigm we have? The winning paradigm we have is that we should have education, we should have experience, and we should have entrepreneurship and all these three work together. And they, when they work together, they provide a great fillip for the start-up system and inculcating entrepreneurship all through the education phase is one of the vital ingredients to ensure that India has a winning paradigm in this race.

And obviously as experience comes in, this paradigm will only get improved and the experience comes through not only students doing their own projects and products and services, but also through faculty participating in these start-up endeavors and providing their mentoring support, their technological support, and also when universities provide their technologies to start-ups at concessional terms, then this becomes a winning paradigm even to a greater extent.

So, the higher educational system in India is not only to enable people earn their degrees, not only to put people into the roles we have discussed as engineers, scientists, technologists or managers, but to essentially create that level of capability in a person to create their own start-up ecosystems that is through innovation, through creativity, through enterprise and managerial capability. So many steps are being taken in India to mold the Indian educational system, particularly the higher educational system towards supporting start-up ecosystems and the more this change happens, the more impactful the start-up system would be. Thank you!