Entrepreneurship
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Lecture 21
Technological Innovation and Entrepreneurship
Part 1

Hi friends. Welcome to this module on Technological Innovation and Entrepreneurship. In the previous sessions, we covered number of topics including what does entrepreneurship mean, how does one undertake the entrepreneurial journey, how does one discover whether one is entrepreneurially inclined or not, what are the various key steps in entrepreneurship which we listed as ideation, prototyping testing, validation, commercialization and so on.

We also discussed how several Indian and global entrepreneurial companies went through these steps and carved out niche for themselves in the entrepreneur space. So, in this discussion we also looked at various pros and cons of different methodologies, different strategies adopted by entrepreneurial firms, entrepreneurs themselves and also what could be the success factors.

In this session and also in the next, session we will focus exclusively on technology. We know that technology is the key aspect of modern living, the several products we see the several services we have are all primed by technology, but looking at from a different perspective technology has always been there. Like when somebody innovated on printing machine or when the automobile came.

When the machine tool produce certain parts, obviously technology was there and when factories were built using some of these machine tools, testing equipment, technology was there. So, what is new about technology now? Why technology is such a strong buzz word today? Almost, assuming the universal predominant omnipresent kind of factor driving all kinds of industrial growth.

Why does it happen that way? Why does it get interpreted that way? The reason is when technology was there in the earlier years that is in the previous industrial revolutions technology was in a machine and the machine operated on certain technology, but actually it was operated by man-machine interface, the machine tool ran on power which itself was technologically generated through power generating systems.

And then transmitted through distribution systems, but the machine itself was operated by the person, the output of the machine which could be a camshaft or a crankshaft was measured with an instrument, but the judgment on whether the dimensions were correct or whether the tolerances were appropriate was being made by the human being. But today we have a situation where several of these processes are technology driven.

It does not mean automation, it only means that wherever there was need for hazardous activity or judgmental activity, automation has taken place and machine has extended its purview of operations and then technology therefore has become little more universal than it was before. Secondly, all the business processes were manual even after the advent of computerization, man-machine interface in business process was pretty high.

But today we have a situation where many of the business processes are rendered machine led which means that technology has replaced the way we conduct business processes. So, we say that technology is today more omnipresent that it was ever before. And when technology is more omnipresent than ever before to that extent it gives several opportunities for new companies to emerge, new ways of doing businesses to emerge and new products and services to emerge.

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So, in this module we will discuss the role of technological innovation and entrepreneurship, but before we go there, we will look at the entrepreneurial black box. The activities which an entrepreneur does or what the entrepreneurial organization does could be seen as a black box.

On one side we have a product on the other side we have a customer. The product is made by the entrepreneur in a particular way and then delivered to the customer.

But underlying the product is technology and overwhelming the customer is the valuation of the company. So, we have on the left side the product and the underlying technology on the right side we have got customer or the market place and the overarching market valuation for the company. So, what goes on within this box of conversion called entrepreneurship is indeed a black box which is very specific to each entrepreneur, specific to each context.

But the goal of every entrepreneur is not only to solve a problem, not only to produce a product in an innovative way, but also achieve a claim and also achieve market valuation. We have discussed in the previous sessions the concept of unicorn. Unicorn is an entrepreneurial firm or a startup which has achieved market valuation of US dollar 1 billion or above. It is a kind of benchmark that has come to stay.

So, when we look at global unicorns, we can look at a few of these companies by their logos and emblems. As I said when we present the logos, we do recognize that these logos are being used for pictorial representation of the companies and for visual impact and obviously the ownership and the copyrights of the logos stay with the respective companies so Ant Financial is a global unicorn which is into Fintech.

ByteDance is another company, DiDi is Uber kind of company in China, Airbnb is a hospitality company, Stripe is a payments company, Spacex is Elon Musk's space exploration company, LU.com is an internet commerce company.

So whichever field you look at you have a global unicorn not that all unicorns are beyond controversy, we have JUUL which has achieved unicorn status through the E-Cigarette product innovation. But opinion is divided whether that has been a good thing or not so good thing.

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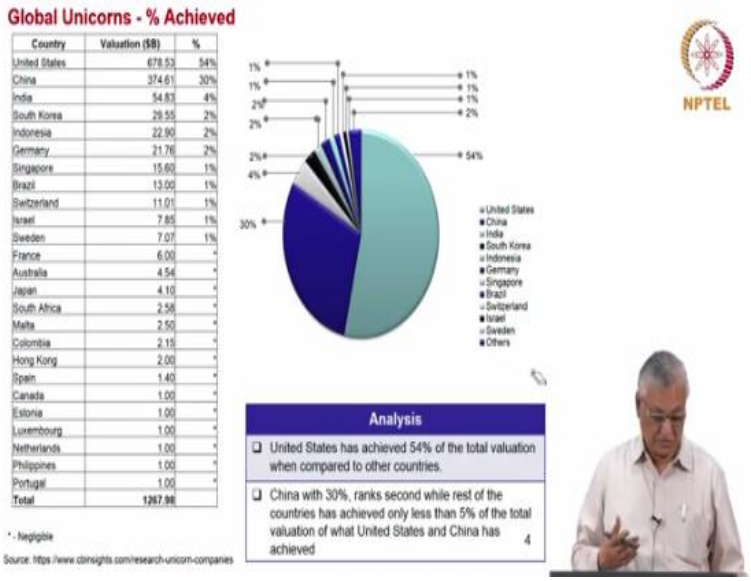

So, when we look at global unicorns country wise, we have looked at based on CB insights data several developed and emerging economies and you will find that US naturally leads the global unicorn list with valuation of 678 billion dollars and China aggregates to 374.61 billion dollars.

While India has been the third largest global unicorn club it is also evident that the distance between the first and second and the third which is India is significantly high, so there is lot to be bridged. But when we also have several developed countries such as South Korea, Germany, Singapore, Switzerland, Sweden, France, Australia, Japan in the mid-range that is significantly below India and some of them are almost near 2 billion dollar nominal valuation amount.

This is one aspect of the global unicorn. In terms of the percentage, 54 percent of the global unicorn club is held by the United States based startups. 30 percent by the China based startups and 4 percent by India based startups. Companies in South Korea, Indonesia and Germany contribute 2 percent each and companies in Singapore, Brazil, Switzerland, Israel and Sweden contribute 1 percentage.

While several other companies in other countries do contribute to the global unicorn club, the share is so marginal that they do not get shown in our excel ranking.

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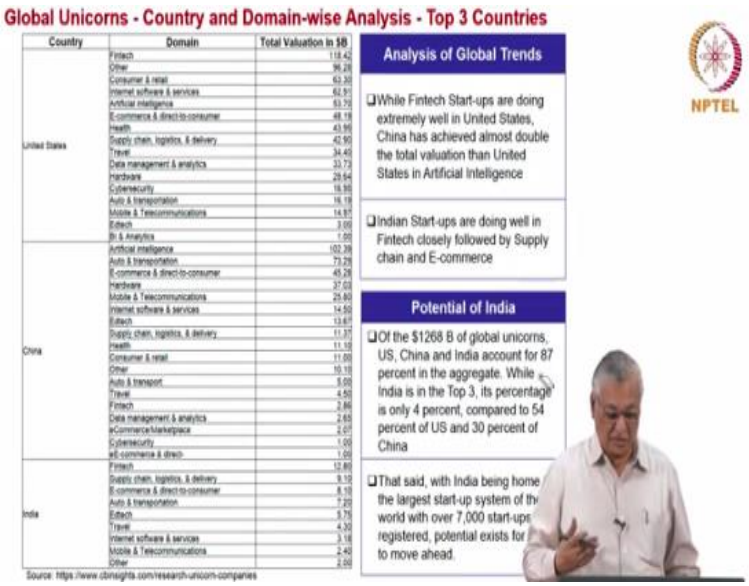

But more importantly let us look at what is the kind of domain distribution in various global rankings? In the United States, Fintech, E-commerce, internet software and services they lead the pack. In China however artificial intelligences leads the pack, it is very interesting and India is more mimicking the Western model with Fintech supply chain, E-commerce, auto and transportation leading the unicorn club.

Now that is a fundamental ship therefore how China is trying to develop itself in the new industrial path while China may have lacked in the data processing and also in the computerization and software domains in the past. Now I think China is making a very determined effort to get into the artificial intelligence, machine learning, deep learning space and also achieved global leadership.

And essentially that is being done through a variety of startup initiatives. That said India is also starting to realize the importance of artificial intelligence and I do hope that given the distance between the first and second and the third and also given the fact that India is considered to be one of the largest ecosystems, startup ecosystems in the world numbering 7000 to 10000 startups depending upon how you look at the count.

I think there is significant potential for Indian startups to help India achieve leadership in artificial intelligence.

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Similarly, when you look at other countries you will find that even countries which are as developed as South Korea and Japan are not in the global unicorn club to the extent India has been. That does not mean that technology and innovation are not existing in those countries and that India is superior to those countries in those aspects. Quite probably, flipping this number into another type of qualitative analysis.

I would think that the companies in those countries are themselves undertaking significant technological innovation in their large corporate labs, in their large industrial labs so much so the need for startups to be independent and grow those technologies is probably comparatively less or many of these startups which are there and which are promising in terms of the new technologies are being observed by the bigger companies in those industrially developed areas before they achieve unicorn status.

So, the numbers, the valuations, the spread are very indicative, but not necessarily fully conclusive. The fact that even developed industrial countries such as South Korea, Germany, Singapore, Japan and Sweden trial behind India in global unicorn club does not mean that modern technologies or futuristic technologies not being pursued by startups in those countries.

Rather it could mean that the big companies, big industrial labs, big corporate labs in those countries are in the forefront of developing those kinds of technologies that is one possibility. The other possibility is that startups are indeed functioning in those area and developing those

futuristic technologies, but before this startup's attain the unicorn status they are being observed by the bigger industrial companies in those countries.

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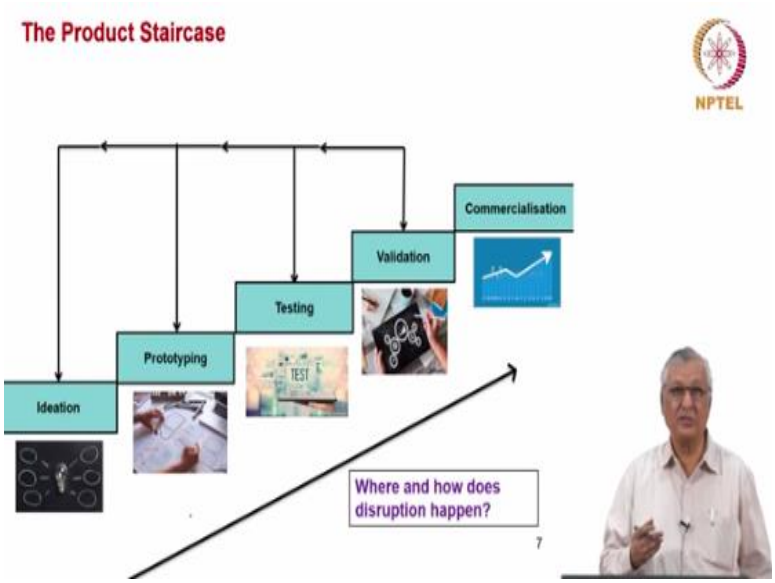

So, we move on to our familiar product staircase. We said that there are 5 important steps in the startup journey. The first is ideation, the second is prototyping, the third is testing, validation and commercialization. As I said in the previous sessions, we keep coming back to this very important product staircase, but the important aspect when we look at technology is where and how does disruption happens that is one question.

Does the disruption happens in terms of the ideation, in terms of the prototyping, testing, validation or in terms of commercialization or is just a linear flow that is one question which we have.

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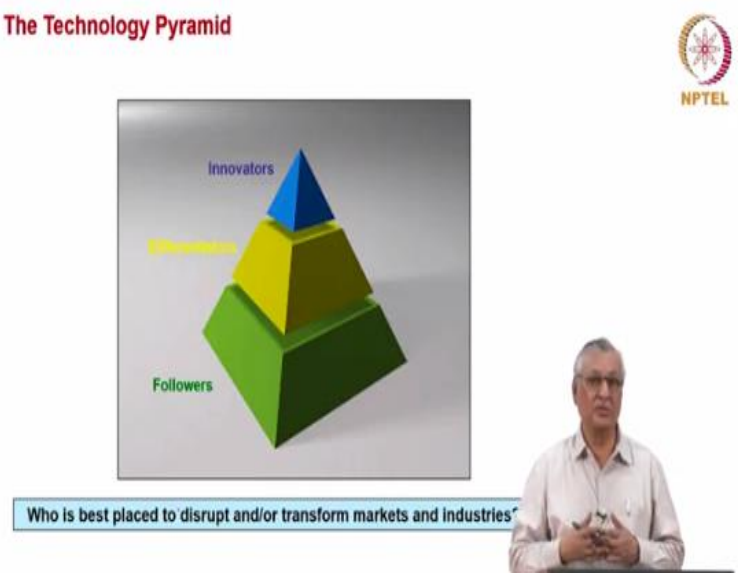

The second question is who is to best placed to disrupt and transform markets and industries, is it innovator? Is it the differentiator? Or is the follower? And to make ourselves very clear on the terminology, Innovator is a company or an entrepreneur who innovates on a technology, innovates on a product probably for the first time and creates a market around that product. He discovers a new solution for a latent problem and offers it to the market.

Differentiator is also a type of innovator, but he follows the overall approach, but differentiates himself or herself with a product that is distinctly different and probably he is also superior to the innovator's products. Follower is someone who mimics the innovator product or the differentiator product, but comes up with a new way of presenting the product to the customer.

Comes up with a more cost effective way of manufacturing and delivering the product or service to the customer. We have also gone through in the previous session that both innovators and differentiators has 2 classes and followers has one large class are extremely important for the society to benefit from the innovation in a larger framework.

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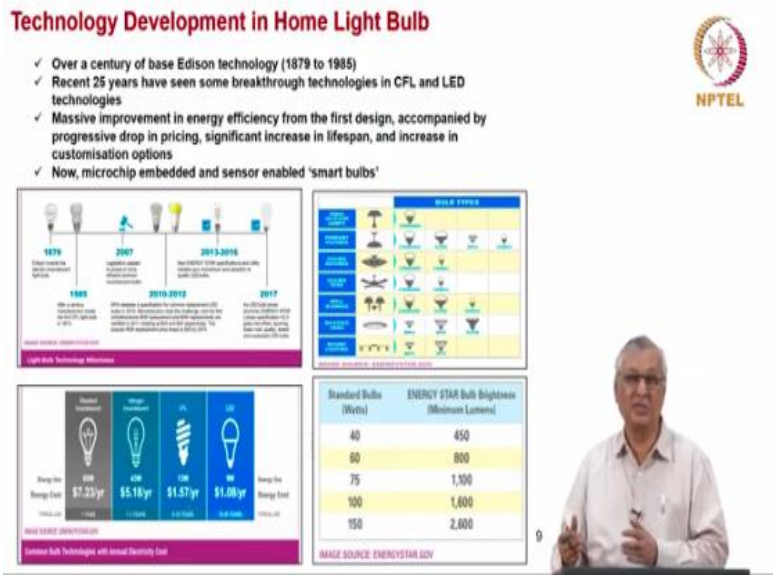

Now when we talk about technology let us look at how technology moves. Technology has been moving rather slowly in the first and second even in the third industrial evolution, but in the fourth industrial evolution which is where we are present should a technology has been growing pretty rapidly.

Now let us take the example of home light bulb and based on the information provided by American energy star organization. As we know the light bulb has been invented by Edison. Over a century between 1879 to 1985, the light bulb remained largely what Edison discovered as a light bulb. However, over the last 25 years there have been more breakthrough technologies in light bulb than there have been ever.

Compact fluorescent lamp and LED light emitting diode bulb technologies are two of the most important examples. So there has been massive improvement in energy efficiency from the first design accompanied by progressive drop in pricing, significant increase in lifespan and increase in customization options.

So if the energy cost was 7.23 dollars with a typical life of one year in the standard incandescent bulb it came down to 5.18 dollars per year and 1 to 3 years of life in halogen incandescent came down further to 1.57 dollars per year in the compact fluorescent lamp with a increased lifespan of 6 to 10 years.

And now in the LED stage it is just 1 dollar that means the drop has been as high as 1\7th of the original incandescent lamp and the wattage which has been used by the lamp has come

from 60 watts to 9 watts and lifespan has increased by 15 to 20 times. Not only that the types of bulbs which are used themselves have varied substantially with retaining the same kind of holding system the options available for different kinds of bulbs to meet different room conditions, different lighting requirements and different ambient conditions has substantially gone up.

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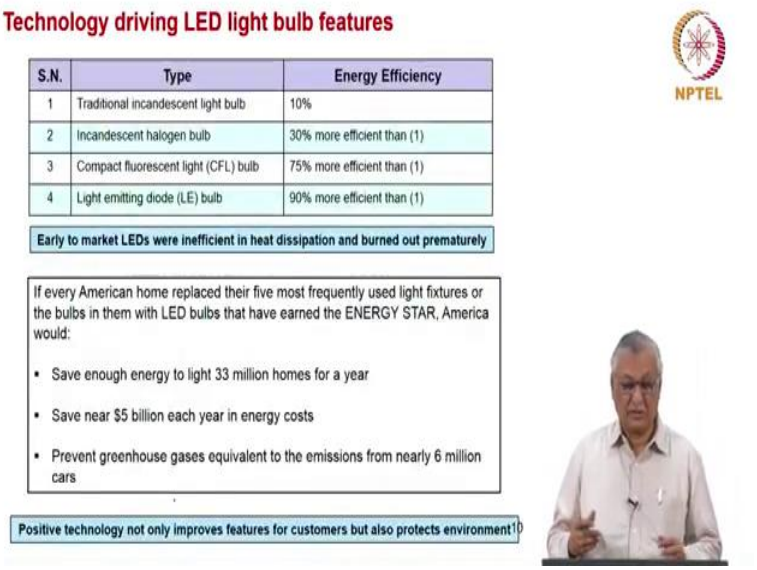

So there is greater energy efficiency and it has been estimated that if every American home replace their 5 most frequently used light fixtures or the bulbs in them with LED bulbs that have earned the energy star rating America would save enough energy to light 33 million homes for a year, save nearly 5 billion dollars each year in energy cost, prevent greenhouse gas is equivalent to the emissions from nearly 6 million cars.

So, all this points out to the fact that positive technology not only improves the features the lifestyle for the customers but also protects the environment and improves the quality of life itself. So, technology is an extremely important driver of how we progress. We progress not only through growth and use of more products, we also progress by preserving our environments in a very sensitive way so that is where technology plays a new role.

And as we go through this important aspect of technology we will not necessarily focus only on startups and technology we will also focus on technology as a broader concept and how technology could permeate different walks of life from basic needs to the sophisticated needs and how there could be opportunities in all such technological value chains for startups to come and deliver some specific value.

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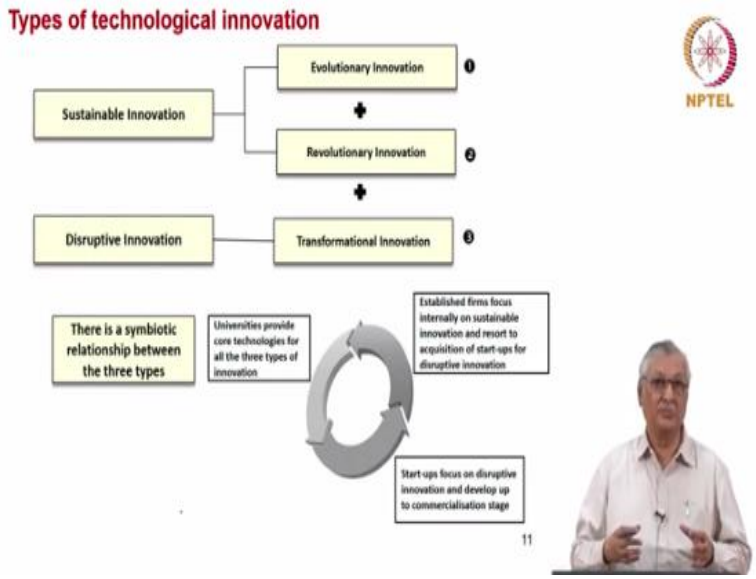

So now let us look at technological innovation. I would say that there are 2 types of innovation one is a sustainable innovation second is a disruptive innovation. What is the difference between a sustainable innovation and disruptive innovation? We all know that generally there is a product market situation or scenario, certain products fit certain markets and certain markets require certain products.

This is the product market configuration that happens like automobiles requiring automobile users, coal requiring thermal power plants. So, there is a product there is a market. Now sustainable innovation is that kind of innovation which does not disrupt this market situation that is the customers remains as they are, the products by enlarge remains they are, but the product themselves have been substantially improved to lead to a different kind of state of the art for the market as well as for the product.

The example which we went through previously that is the light bulb, the movement from CFL to let us say LED is a sustainable innovation, the product market configuration remained the same, but the way the industry developed itself and the way the consumer started using the bulbs has substantially changed and why this is an innovation because if somebody does not follow this technological path and chooses to be in the previous generation of products that company would go away.

The industry would not go away, but the company would go away. Therefore, it is important for all companies to pursue innovation. So, within sustainable innovation we have 2 types of innovation, one is the evolutionary innovation where the changes are incremental and the

second is revolutionary innovation. If the CFL bulb is improved to better coating through better strength of the light holding area it is an evolutionary innovation.

When LED has replaced the CFL is a revolutionary innovation but again comeback to the point neither the evolutionary innovation nor the revolutionary innovation does not alter the fundamentals of product market configuration. We have the second type of innovation which is disruptive innovation which is a transformation innovation which it completely changes, how the industry does its activities.

So, when we talk about let us say electric vehicle completely replacing the IC engine vehicle then it is a disruptive innovation. Why is it a disruptive innovation? Because the way automobile will look, the way automobile will run will change not only that the entire component industry will change, the fuel supply industry will change, the battery charging industry will come in, the profile of automobile itself will change.

Therefore, the industry itself will go through a significant transformation therefore it is a disruptive innovation. Now where do the sources of innovation lie? The sources of innovation lie in 3 places. One, the universities, universities typically provide the inputs for all the 3 types of innovation although advanced countries have advanced research labs which provide more disruptive innovative inputs for startups or established forms.

So when universities provide inputs for innovation typically startups take on those innovations and build their startups around those innovations which is one of the reasons why increasingly students when they are undergoing their advanced engineering courses or advanced science courses or taking up some of their innovative activities in the universities or colleges as their own startups along with the professors.

There is a trend which has worked very well in the United States and likely to work very well in the Indian situation also. Over and above that universities themselves mostly the advanced universities have their own intellectual property generation and protection systems and they have the ability to generate technologies, preserve them and license them to startups as well as to other companies.

Now when universities provide the technological inputs the fundamental technological inputs and when startups focus on disruptive aspects of innovation and develop them to commercialization stage. We have established firms which take on those startups and then

work with them and then absorb the startups or the technologies developed by them for commercialization status.

In relation to that established firms could take up directly from the universities incremental innovation, the sustainable innovation and then they also could develop their innovative developments in the sustainable space, but if you look at the overall macro picture there is a symbiotic relationship between these 3 types of innovation.

The sustainable evolutionary innovation, the sustainable revolutionary innovation and the disruptive transformational innovations and there is also the symbiotic relationship between the 3 organizational systems which work on these innovative aspects.

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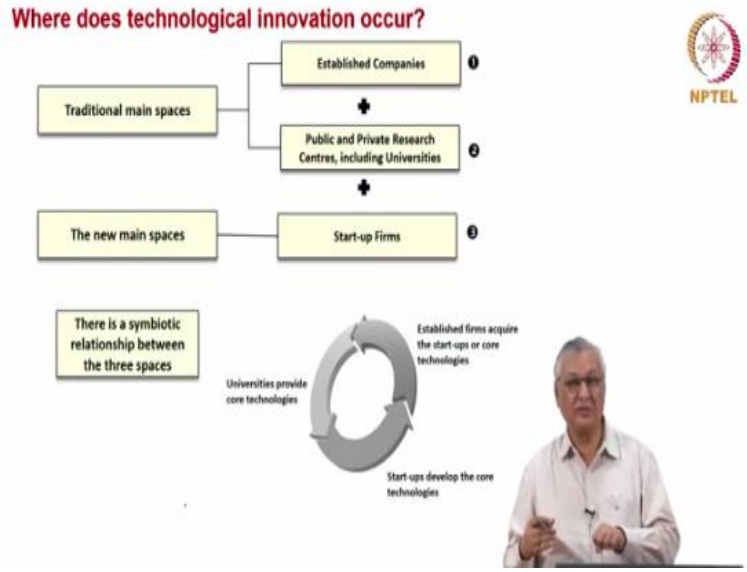

Now alluding to this further we have to focus on where does technological innovation occur? There are this traditional main spaces, traditional main spaces are the companies the labs like CSIR labs the university labs and then publically funded, privately funded research labs, but then we are having these new main spaces which is the startup space which is our focus as we go through this course.

And again, there is a symbiotic relationship between all these 3 spaces, the traditional main spaces as well as the new main spaces and universities provide the core technologies, startup develop the core technologies to a commercialization stage and established the firms acquire the startups or their core stages.

Now it is very important therefore for startups to know how they are going to acquire the technologies. How they are going to develop the technologies and what kind of symbiotic relationships they should have with the universities on one hand and with the established companies on the other.

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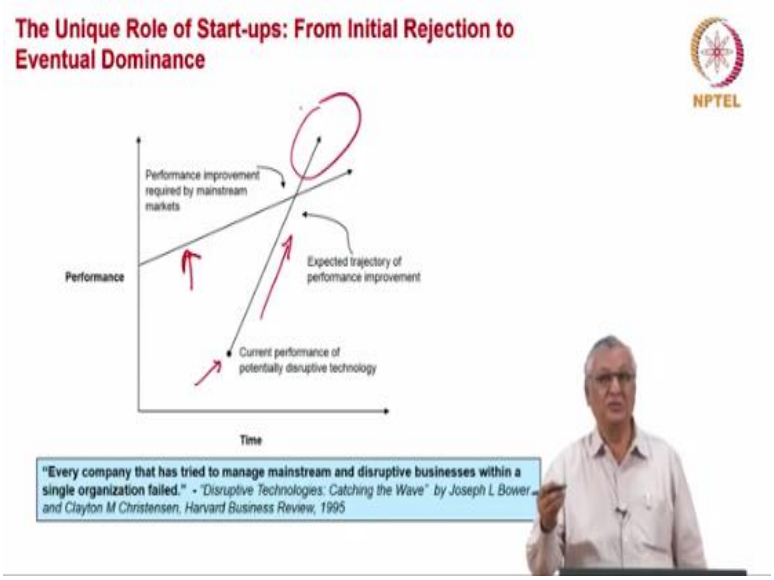

Now the unique role of startups can be described in 2 ways. One initial rejection and second eventual dominance. When the power of technology is so high that the market or the user at first does not understand the full impact, the full power of technology and therefore there is a kind of if not rejection there is at least skepticism whether this is the kind of technology that is going to deliver the goods or services for them.

But when the power of technology is understood, the technology is accepted so widely that there is a dominance. So, this graph plots with x-axis being time and y-axis being performance, how the mainstream technology and how the emerging technology work together. The graph which is on the right, on the top which is the graph which is moving up that is the mainstream technology performance which has got its own set linear performance activity.

As time progresses its performance gets incremented, but then there is this potentially disruptive technology which comes in at a point which apparently is a bit below the established main space technology, but very soon the path is so fast and rapid that it crosses the technological efficiency provided by the mainstream technology and once this happens the emerging disruptive technology occupies the entire space.

And it is not easy to accommodate the mainstream technology and also at the same time encourage a disruptive technology. Clayton Christensen who has done extensive research and hypothesization in the disruptive technology area has opined that every company that has tried to manage mainstream and disruptive businesses within a single organization failed.

Why? That is because the culture, the ecosystem and the passion that are required to support a disruptive technology are significantly different from those required for a mainstream technology. In the case of mainstream technology things almost happen automatically although there are requirements of budgets, there are requirements of planning, there are requirements of diligence commitment.

The kind of passion and the hard work, the smart work which is required for disruptive technologies probably gets replaced by a sense of incremental automatic development that happens with the mainstream technologies. So that is a principle reason why it is so. So, if you look at for example the fixed landlines and the cellular telephones you will find that when the cellular telephones first came they were very bulky probably they were as large as let us say 6 inches by 12 inches kind of boxy appearance.

Therefore, you can say that although it was a potentially disruptive technology it looked almost in terms of the volumetric size as big as the landline. Therefore, it did not immediately disrupt, but the moment the form factor improved, the moment the functionality is improved and when the phone could be operated within the hand obviously it overtook the landline usage.

It overtook the fascination for landlines and changed into infatuation for the new cellular telephone systems. Therefore, that is how this works.

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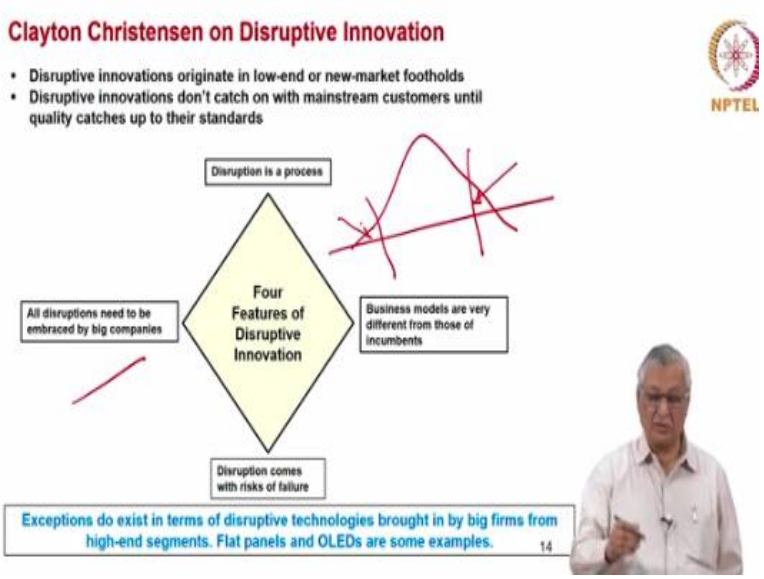

And taking on for further hypothesization of Clayton Christensen, there are 4 features of disruption, disruptive innovation. One disruption is a process it is not a onetime occurrence, it is a process that occurs every now and then and also in a very systematic fashion. Second, the business models of disruptive companies are significantly different from business models of sustainable innovation.

Then disruption typically comes with risk of failure because we are working on something which has not been tried out any time ever. But eventually all disruptions need to be embraced by big companies. Typically, as per the hypothesis in disruptive innovations originate in low end or new market foothold.

That is if you say that the market has a normal distribution curve and if the high end is this portion and if the low end is this portion disruptions occur here or here. Christensen says that disruption typically start in the low end market and then move up the value chain and occupy the entire market space.

But it is also possible for disruptions to occur in the high end market and then takeover. For example you look at the flat panel TVs or you look at the OLED based smart phone, smart devices they typically occurred in the high end and then they moved on to capture the overall market. Therefore, if the disruptive innovation has been mastered at the very first go it is quite possible that there will be there throughout the market space completely.

It is not necessary that they should start at the low end or at the high end. So, when a startup looks at the disruptive innovation it is trying to develop, it is very important to see what kind of market I am addressing, I am addressing the top end market the middle end market or the low end but broader market.