Entrepreneurship
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Lecture 22
Technological Innovation and Entrepreneurship Part 2

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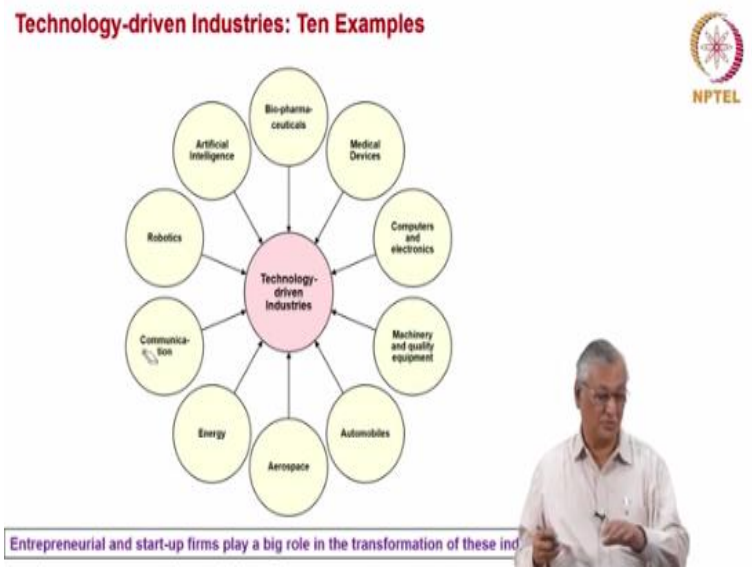

Now let us look at a few examples of technology driven industries. It is not that industries are limited by only these descriptors. There are several other industries which are driven by technology, but just as an example. Bio-pharmaceuticals is one industry which is going to be driven by technology because once upon a time it was chemical based small molecule later on it is cell based biological molecule.

Now we have got genetics which is driving bio-pharmaceutical development. Medical devices the way the pharmaceutical product and also the injection or the syringes united or the way multiple drugs can be infused into a human body with lot of self-correction through an infusion pump or the way the internals of a human being can be captured by a medically operated camera.

The way these robotic surgery can be done by a surgeon these all point out to the enormous potential of medical devices being new way of diagnosing the person. Then we have computers and electronics the strong hold for new technology, machinery and quality equipment because as sensor capabilities as testing capabilities improve there will be much better methods of doing materials.

Much better ways of doing components which we will also consider in some of the other areas. Then automobiles is one area, aerospace is another area, energy with renewable energy that is going to be another area where technology is going to driven the changes, communication and robot and all this is going to be covered, driven primed by artificial intelligence.

When we talk about artificial intelligence, a fact which is referred to in the first slide on global unicorns also. Artificial intelligence tries to replace human intelligence, but it also tries to do certain things far better than a human intelligence can do, no bias ability to work on logic, ability to work on patterns, ability to suggest several alternatives available from a vast pool of choices.

All this is going to work in a significant way in technology driven industries and the industries could also combine with each other to make sure that the final technological output is far greater than what a single industry can offer. Now entrepreneur and startups firms have a great role to play in all these 10 industries and industries which could be considered outside of this pool.

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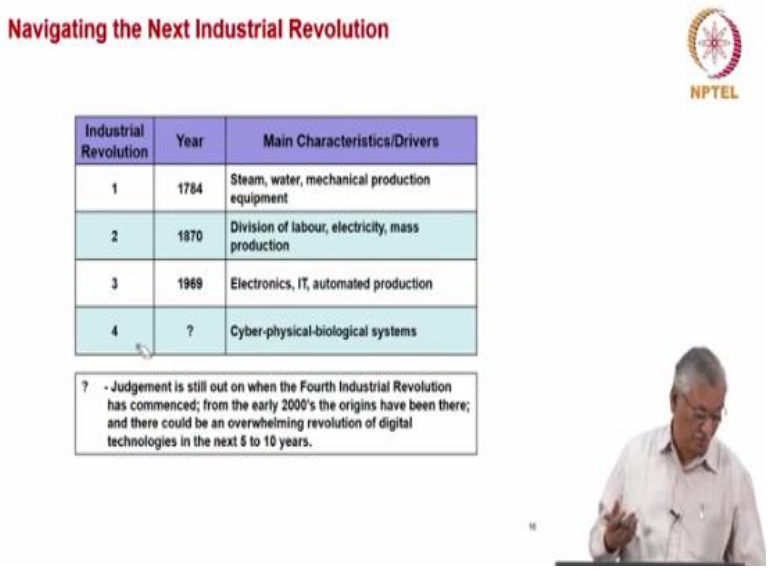

Now let us look at the overall perspective, around 1784 the first industrial revolution started. It was based on steam, water, mechanical production equipment about 100 years later that is in 1870 the second industrial revolution started which was based on division of labour electricity, mass production. The typical examples were automated car assembly division of labour then Taylors principles management.

These are the kinds of thing which ensure that the productivity enhanced in the industrial system. In 1969, we had electronics IT automated production. Now if you look at the first, second and third industrial revolution it took about a century in each case to fundamentally transform the nature of industrial change that has been occurring.

But if you look at the cyber-physical biological system integration that is the essence of the new fourth industrial revolution, we can say that it has started early 2000s or the late 1900s and it has just taken less than 50 years or less than 40 years to have the next generation of fourth industrial revolution and there could be an overwhelming change how this is going to be done.

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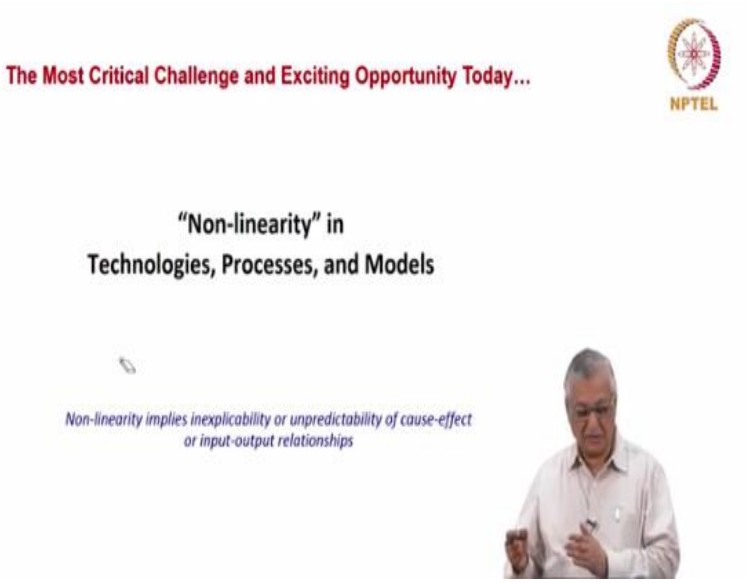

Therefore, the most critical challenge and exciting opportunity today is not only in terms of the fourth industrial revolution the integration of physical biological and cyber systems within a particular product or service, the more exciting thing is the non-linearity. When we say linear, we say that if times proceeds in this manner, technology proceeds in this manner there is a linear relationship.

If you put in more resources probably you will get better output that is the linearity, but the current milieu is one of non-linearity in technologies processes and models. Non linearity implies inexplicability or unpredictability of cause-effect or input output relationships.

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Industry	Past/Current	Future
Pharmaceuticals	Chemical molecule based	Biological cell based
Automobiles	IC engine driven	Electric power-pack driven
Internet	Connecting people	Connecting people and devices
Banking	Conventional ledgers, password protected	Distributed ledgers, blockchains
Analytics and Services	Human intelligence	Artificial intelligence
Space	Disposable spacecraft	Reusable spacecraft
Diagnostics	Laboratory sampling	Wearable devices
Energy	Fossil fuels	Solar, and other renewables
Crop Protection	Chemical fertilisers and pesticides	Bio-fertilisers and bio-pesticides

Let us look at a few examples. We have here in this table industry past current state and the future. When you look at pharmaceuticals it is moving from chemical molecule based biological cell based. Automobiles IC engine driven to electric power pack driven. Internet it just connected people and today it is connecting people as well as devices. In fact, the entire city would be connected with internet that is how this concept of smart city comes up.

Then banking, we used to have conventional ledgers and then they got improved to password protection, but today we have distributed ledgers, we have block chains. If you look at analytics and services, they are depended on human intelligence which coded the programs, which establish the heuristics and which analyse the results, but we are moving into artificial intelligence.

Then when we look at space, we always felt that the spacecraft cannot be reused, it has to burn itself when it comes back to the earth, but today we are thinking of reusable spacecraft and this spacecraft in the past were only to reach other celestial bodies, but today we are thinking of spacecraft to reach other parts of the planet. Diagnostic we always needed a laboratory to analyse our samples.

But today we have wearable devices which could analyse our biological movements of the body, the condition of the skin, the tears, the sweat if you find out how we are performing as a human system. Then energy are based on fossil fuels until now and tomorrow we are going to be solar and other renewables. Crop protection typically was with chemical fertilizers and pesticides and it caused its own damage to the soil quality.

And the potential carcinogenic effects on the plants and agricultural produce and we are moving to bio-fertilizers and bio-pesticides. So, this is the kind of innovative technological development that is happening and that is reshaping the industries.

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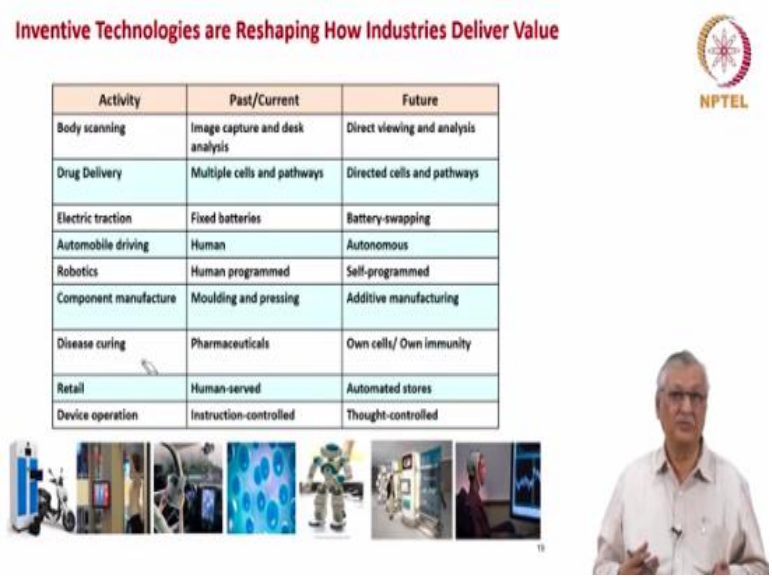

Not only that the way the technologies are working in the products and in the business processes to develop these service or the product functionality that itself is undergoing change. Like you look at body scanning, the way it has been done it is to capture image then print it out either through an x-ray or through a CD then send it to the doctor and then he analyzes after a few hours.

But today it is possible to directly view the human system through the professional body scanning systems and then come to some judgment. Then drug delivery we used to look at multiple cells and pathways and we are moving into a situation of personal medicines where we go to the directed cells and pathways.

When we look at electric traction even within the electrical vehicle systems, we used to think of a single battery charging the automobile up to a particular range and then getting recharged, but today we are thinking of battery swapping. So, the way of delivery of this mobility through electric traction is undergoing change. Similarly, from human driving we are moving into autonomous driving. Human programmed or robos are being replaced by self-programmed robos.

What does self-programmed robot means? It is also programmed at one stage by human being. But then when it sees suppose it does a weld and then robo also has got the ability to see how much of weld metal has been deposited, what is the strength of the weld metal, it goes in a self-correction mode okay, I did this particular cycle of welding in this manner therefore the weld metal got this, got put into the metals in this fashion so I must correct myself.

And then this is called the self-programming system which may be called machine learning. The machine is learning by itself. Similarly, component manufacture we used to do metal cutting, metal molding, metal pressing, but today we are moving into powders being joined together as additive manufacturing. Disease curing was essentially through pharmaceuticals now we are programming our own cells our own immunity to cure the diseases.

Retail was essentially by human service and today we have automated stores. And the device operation itself is instructional controlled, it could be thought controlled in the future.

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Now when we say thought controlled in the future, thought could influence how our eyes will move and how our eyes will move could dictate how the device response to you. I mean the linkages between any part of the body and the device would come to different functionalities like the bones themselves could be conductors of certain signals and those signals could imply that the device should function in a different manner.

Then the business models themselves we talked about the technologies of products, we talked about the technologies of delivering the product now we are talking about the business models they themselves are getting changed because of the technological changes. The key customers used to be homogenous segmented that is high paying customers, mid paying customers, low paying customers or high quality based customers, luxury customers then developing markets customers or middle income customers and the low income customers.

But today it is completely heterogeneous, it is layered, no longer you can say that if somebody wants a low quality product, he will be willing to pay low price. No, he maybe wanting low price, but he may still want high quality. So, it is much more interconnected layering which is happening in the market place.

Secondly earlier the new entrants could have only a particular definition you should come with 100 crore investment, you should setup your project in this particular fashion, you should have your product lines, you should have your market coverage, but today multiple startups are likely to take space. If you think of two wheelers, we have at least 5 to 10 electric two wheelers makers, who are trying to come into the two wheeler manufacturing space.

Similarly, people are trying to enter the three wheeler manufacturing space. Tomorrow people could come into the bus manufacturing space as well. Therefore, the traditional rules of industrial development that you should have certain scale and scope to be able to enter a new industry based or new technology they are being rewritten that business model is going to go out of window.

Then the operating systems as we discussed it in a brief, from coded operational systems we are looking at deep learning, artificial intelligence based operating systems. Then the financing, it is an extremely important determinant of business model depending on the money which we had in the banking system we thought that industry could progress in a particular fashion, but today our own liquidity is dependent on the global liquidity.

So, the global liquidity is a strong economic force which is going to determine how our business models will progress. Competition, earlier it was industrial and national if even within the MNC system, if MNC enters the competition essentially took place within the national parameters, but today even if no MNC enters India or if no Indian company moves into another economic market the trade wars determine how the industrial business model will work.

For example, if Brexit happens, Tata Motors as a company has its own up and down mainly because the company has chosen to enter the global market through its JLR acquisition. Similarly if our steel demand does not go up or if our steel industry has a slowdown it is mainly because of the trade wars which are determining how fast or how slow China would move or how the steel industry would function in different markets or how the tariff would determine the overall demand levels in each market.

So key suppliers earlier component makers were considered to be the key suppliers, but today natural and rare materials they are the key suppliers, but what does it mean for startup, why are we discussing for example this particular line? Why natural and rare material, what can startup do?

Startup cannot obviously produce more natural and rare materials than available in the planet, but if you really look at this situation little more deeply startups can do two things, one or three things. One, they can have better methods of discovering where the natural and rare materials are there. Two, they can have better methods of bringing those natural and rare materials out into the open and then bring them out with the kind of purity which is required.

Third, the natural rare materials which are used in the devices can be recovered when those devices are not used anymore. So, the recovery of natural and rare materials could itself be a huge technological opportunity and a business opportunity and an industry disruptive opportunity for startups. Therefore, any line here you take you will find that there is a scope and role for startups to come up with newer technology.

Newer ways of delivering the technologies or newer business models. So, coming back to our discussion. Substitute products were typically improvers that is if you had a pen which had a particular form factor if you had a superior grip better way of flow of ink it was an improvement, but today we are having disruptors and transformers probably an ink which will last for several days.

And probably an ink which will never dry even if it is not used for 6 months or so, so that could be a new kind of substitute product or a pen which does not only the writing, but based on the grip assess the mood of the person or mood of the body that is quite possible. Then the key macro unlimited growth, every industry, every service sector had to grow linearly 5 to 10 percent depending upon the economy for the industry to sustain itself.

But today we realized that we cannot afford to put every year 10 percent more cost on the roads, simply there is no road space available. Similarly, we cannot keep on having more plastic bottles being made and used for let us say drinking water purposes and there is a limit on that. We cannot keep on encouraging certain industrial sectors beyond a point we got to do more with less and that is driven by the need for protecting our climate.

So key macro the climate protection is going to be another great area for startups to enter and contribute industrial strategy previously it was all business driven but increasingly it is going to be government driven. When we say government driven it is not in the terms of licensing a company or determining the capacities, but it is more in terms of determining the direction which the industry should take in terms of protecting the environment.

Improving the quality of life or improving the diagnostics of people things like that. So, some of these illustrations, images here try to explain these things.

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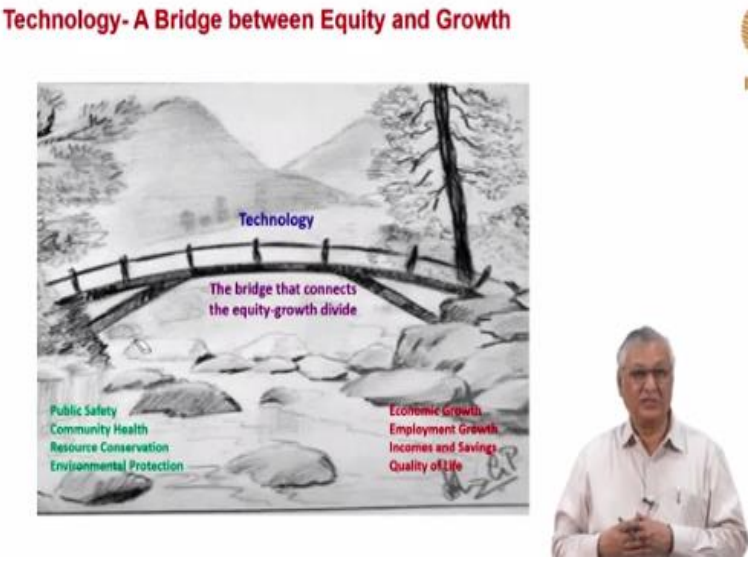

Now when we talk about technology it is a bridge basically between the consumer and the product that is how we have described, but technology is a bridge between equity and growth, but there is even more important philosophical connotation. When we do more products, when we expand our industries there would be growth and that growth is economic growth, industrial growth which leads to employment growth.

More purchasing power, more consumer power therefore more demand for goods and services. It was considered for long as a virtue of cycle that is you produce more, you earn

more, you want more products and services therefore you produce more therefore there is more employment, more GDP, more better per capita income that is the kind of virtuous of economic cycle which we all loved and which the government wanted to do.

But then there is other portion which is public safety, what is the amount of emission we can afford to put on the roads, what is the impact on the community health, what kind of materials we should use in our detergents, in our pharmaceuticals in our talcum powders, what is the kind of resource conservation we must do so that the planet is safe for not only us for our grandchildren, for the successive generations, how do we protect the environment., how do we ensure that there is no melting of glaciers, how do we do that?

So, when public policy says that public safety, community health, resource conservation, environment protection are important and another limb of the government says that we should have more economic growth, more industrial growth, greater employment generation how do we merge these two, how do we bridge these two? Technology is the bridge that connects the equity growth divide because technology can probably help us do more with less.

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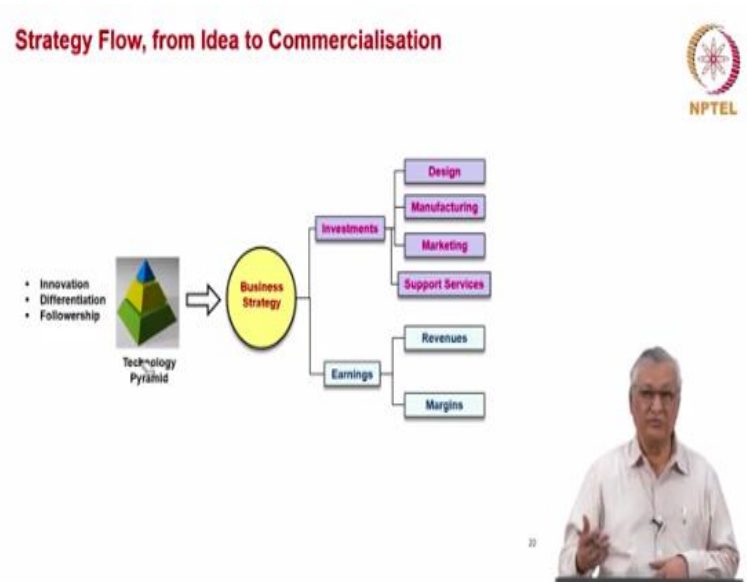

And when we say technology it is the startup which can play big role. We discussed earlier that technology is basically in terms of three slots. One is innovation, second is disruption, third is followership. The way the innovative differentiated following technologies work determines the way we structure the business strategy in a company and the business strategy leads to the investments, the investments themselves function in design that is the R and D.

They function in manufacturing, they function in marketing, they function in support services like quality, regulatory affairs and various other aspects. These investments, these strategic direction, the product and the services manufacture, the market play that is satisfied lead to earnings and the earnings are basically in terms of revenues and margins.

Now, when we look at this strategy flow from the idea to commercialization which is in a way same for an established company or for a startup. The question that is arisen for any startup or for any established company which is more important scale or sustainability. Do we embark on our strategy of startup for scalability or for sustainability?

So, when we go through the unicorns when we think of companies having highest number of footfalls in these shortest possible time therefore enjoying highest revenues we think that scalability is extremely important. But when we de-layer the performance and we would see that for a 1000 crore turnover the company has been making 600 crore loss and that loss is being funded by the premium placed in that company by the investors we wonder whether that is the right model.

So, it is not sustainability more important because the money available for investments particularly in an emerging country like India is rather limited. So how much of the money can be put in to funding losses discounts for growing revenues and when should really the startups business model, commercial model beyond prudential line, what is the balance between risk and reward, what is the balance between commercial aggressiveness and business prudence. So, these are the aspects which we need to really consider in depth.

Before we say that a particular business strategy must be adopted by the startup, but if the technology is competitive, if the technology is smart, if it is deployed in a very smart manner, it is quite possible that without commercial props, without excessive investments, we will be in a position to achieve prudential norms even while driving aggressive growth to a startup mechanism.

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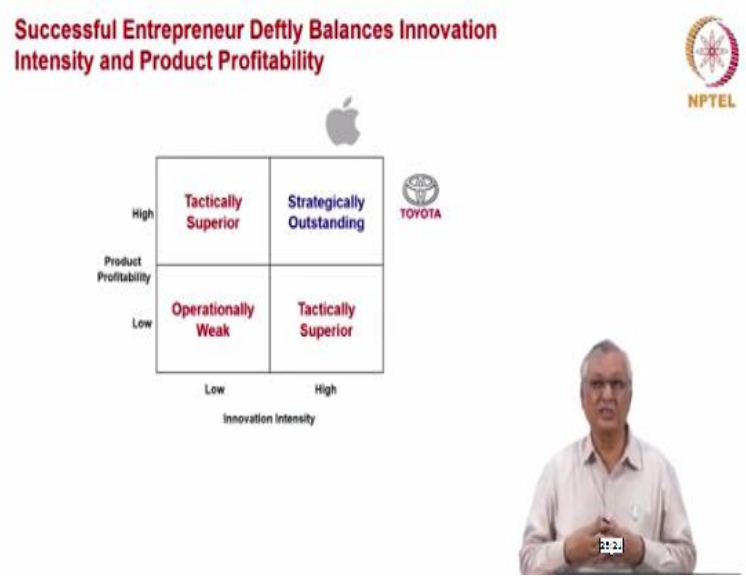

We have so far looked at the role of technological innovation, we also looked at how technology has been developing, we also looked at how technology has changed the markets and the types of technological innovation which is sustainable and disruptive innovation and sustainable innovation being of 2 types evolutionary and revolutionary and also the ways in which a particular innovation achieves the market dominance.

We also looked at how the nature of innovation determines the business strategy, the business strategy determines the earnings as well as the investments and we also looked at how startups need to have a holistic business strategy depending upon the product market space they would like to operate. Now the successful entrepreneur definitely need some kind of balancing act to be done.

He needs to balance the innovation intensity and product profitability. It is not sufficient that the product is innovation rich, innovation in every aspect of the product, every component of the product ideal, but not necessarily a profitable approach to developing a product. Therefore, the balance between innovation intensity and product profitability that is extremely important.

Now if you look at on a 2-dimensional matrix innovation intensity and product profitability looking at the established companies you will find that those companies which are low on innovation and low on product profitability they are operationally weak companies, they will have a marginal existence in an industry.

But if you look at companies which are high on innovation intensity and low on product profitability or companies which are high on product profitability, but low on innovation intensity they tend to be tactically superior companies and they continue to exist and could probably form the bulk of the industry company space that is because they adopt a mix of followership strategies, a mix of differentiator strategies to be able to achieve those particular positions.

A company which probably adopts lots of followership strategies will be high on product profitability, but probably low on innovation. On the other hand, a differentiating company would be high on innovation but probably low on product profitability, but a company which achieves high innovation intensity as well as high product profitability we may term it as a strategically outstanding company.

And every company must aspire to be in that quadrant of having high level of product innovation as well as high level of product profitability. If you look at the space of various industrial firms you will find that a company such as Apple, a company such as Toyota they are strategically outstanding because they are very innovative and they are very profitable as well.

So, when we look at as a startup starting his or her entrepreneur journey the balance he or she creates in her mind and in her business strategies in terms of balancing the innovation intensity and the product profitability is very important. Now although we are looking at startups, we are looking at several examples from the established industrial space because that helps us to analyse the underlying equations, the underlying philosophies and the underlying constructs for startup to construct his or her business as he or she moves forward.

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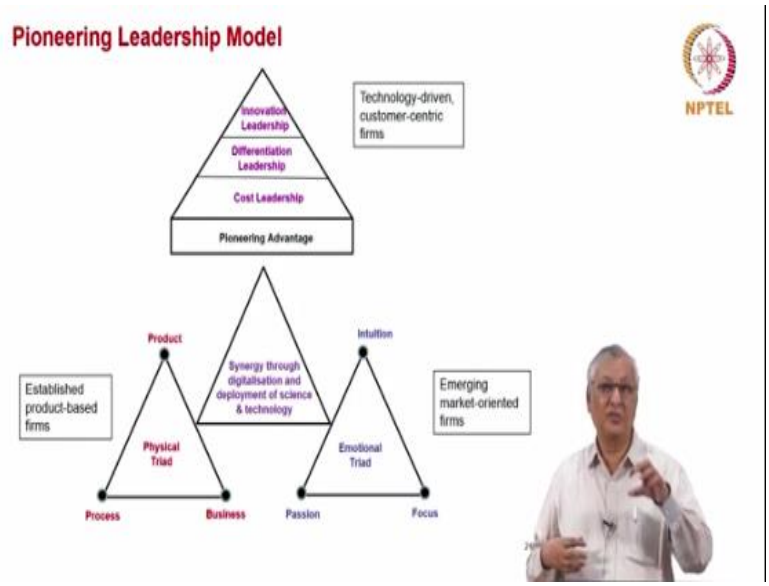

Now, a startup typically is a pioneer which means that the company should be leader in innovation. The company should at least be a leader in differentiation and if the company is following followership model it should be a leader in cost competitiveness. This provides the pioneering advantage. It is a cluster of technology driven, customer centric firms that constitutes the pioneering leadership cluster.

But if you look at the established product based firms, they have a got a triad of a product, a process, a business is very well established. The business model has certain products and markets which are produced and offered through certain processes and that leads to a particular business result that is if established product based companies then that several companies which appeal to the senses.

Which appeal to the consumer preferences like an online fragrance is a marketing company or a company which says that I will give nutrition products for yoga regime. So, they are based on emotional parameters certainly they are products in that cluster of companies they are certainly technologies, but the way they are entering the market is essentially through emotional aspects or someone who is developing raw cold fresh juices.

Which are appealing to certain segments of population who would like to have the highest level of health consciousness in beverage drinking and they are based on certain emotional factors, they have passion for doing something which is quite different, they are very focused on a very narrow market space and they are intuitive about it they feel that the market is going in particular way.

And then I would be in a position to enter this market with this product. Now the established product driven companies, the emerging market sensing companies and the pioneering startup system they all have a synergy that synergy works through digitization, through deployment of science and technology, but the startup movement is something which can energize the established product based firms in a particular manner.

Which can provide certain structure, system and also technology to the market sensing group of entrepreneurs and by itself the pioneering leadership can create new markets completely new markets.

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Now when we look at the technological value chain, we can look at technological competence in different aspects of the value chain. Now fundamentally when you start the startup journey we have to define the value chain of the company and value chain has 2 parts the business value chain which is very well known like R and D to manufacturing, to customers delivery supported by various other functions that is a business value chain.

But there is a technological value chain which starts from the basic materials to the components, to the conversion process, to the assembly processes, through the packaging processes and the distributional logistics process there is a technological value chain. Now we need to see when we define the startup journey where do I integrate the technologies and startups can integrate the technology in only one segment and be successful.

So, when we have number of startup firms which have come in the logistic space they are looking at either the first mile delivery or the last mile delivery, digitization of top movement or tracking of movements under emergency conditions things like that. They are looking at one part of the overall transportation business value chain, the overall transportation technological value chain they are looking at one aspect providing technological solutions there and they are becoming successful startups.

But the point is that when the startups tend to focus more on technology rather than on business value chain it is also possible that the power of technology as it flows from design to delivery gets diluted a bit. So, it is important for startups to look at both business value chain as well as the technological value chain.

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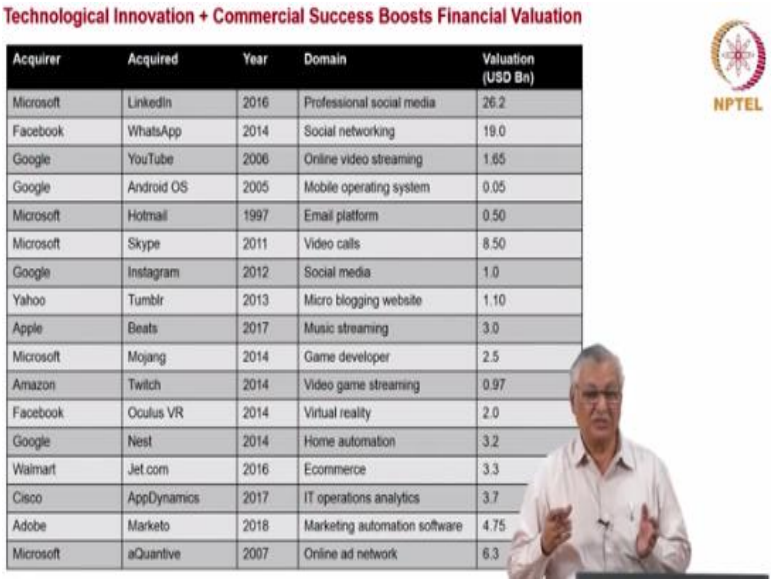

Acquirer	Acquired	Year	Domain	Valuation (USD Bn)
Microsoft	LinkedIn	2016	Professional social media	26.2
Facebook	WhatsApp	2014	Social networking	19.0
Google	YouTube	2006	Online video streaming	1.65
Google	Android OS	2005	Mobile operating system	0.05
Microsoft	Hotmail	1997	Email platform	0.50
Microsoft	Skype	2011	Video calls	8.50
Google	Instagram	2012	Social media	1.0
Yahoo	Tumblr	2013	Micro blogging website	1.10
Apple	Beats	2017	Music streaming	3.0
Microsoft	Mojang	2014	Game developer	2.5
Amazon	Twitch	2014	Video game streaming	0.97
Facebook	Oculus VR	2014	Virtual reality	2.0
Google	Nest	2014	Home automation	3.2
Walmart	Jet.com	2016	Ecommerce	3.3
Cisco	AppDynamics	2017	IT operations analytics	3.7
Adobe	Marketo	2018	Marketing automation software	4.75
Microsoft	aQuantive	2007	Online ad network	6.3

Now when technological value chain results in complete realization of technological innovation it leads to commercial success and when technological innovation and commercial success combine it leads to financial valuation. So, I have listed here a number of acquisitions that have happened in the tech space. You will find that Microsoft has acquired Linkedin. Linkedin was a startup which started as a professional networking business. And it was acquired by Microsoft which is a leading software company for valuation of 26.2 billion dollars.

We have Facebook which has acquired WhatsApp which is a social networking site for 19 billion dollars. Google has acquired YouTube in 2006 to get online video streaming into its

business for a valuation of just 1.65 billion dollars, but today YouTube is one of the most profound areas of business for growth.

Same with android OS, the mobile operating system was acquired for a very marginal 500000, the next example is Google which has acquired android operating system which is the mobile operating system which was under development for 0.05 billion and today android operating system is probably the largest mobile operating system. This also points out to how the technological evolution of startup leading to commercialization could provide such value which could really find a proper home in a larger organization.

So when Microsoft required its office productivity tools, its business productivity tools, its personal computing tools to have a greater impact it fell that it should really touch the lives of the business professional in a more direct way other than just doing the business related professional work so which was the logic for acquiring Linkedin.

Similarly, when Google felt that it should be beyond search, it should be a way of connecting the various citizens in terms of their activities, accomplishments and also contemporary development it acquired video streaming platform. It foresaw the need for a very critical aspect of smart phone devices which is the operating system and acquired android, but for these acquisitions the basic potential of the startup technologies would not have found the kind of success that has been received to date.

So which also means that in several cases even though the startups are small and they have only a limited scale of business, but in terms of the overall global business potential for those startup technologies sky could be the limit and therefore the startups must be cognizant of the for reaching dimensions of the technological developments they are doing with their startup activities.