Technology Forecasting For Strategic Decision Making
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Professor. Dmitry Kucharavy
Lecture 3
Why do we need technology forecasts?
Innovation vs Invention & Efficiency vs Effectiveness

Hello, welcome back to our course about technology forecasting for strategic decision making. Today we are going to discuss the question, why do we need technology forecasting? Do we really need this activity? Can we survive without?

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And why today the technology forecast becomes more demand than it was in the past? In order to treat this topic, we are going to make clear what is different between invention and innovation, we are also going to discuss what is different between efficiency and effectiveness and as well about limiting resources the concept of limiting resources is quite important in order to be efficient not only for technology forecasting but for development of new technologies as well.

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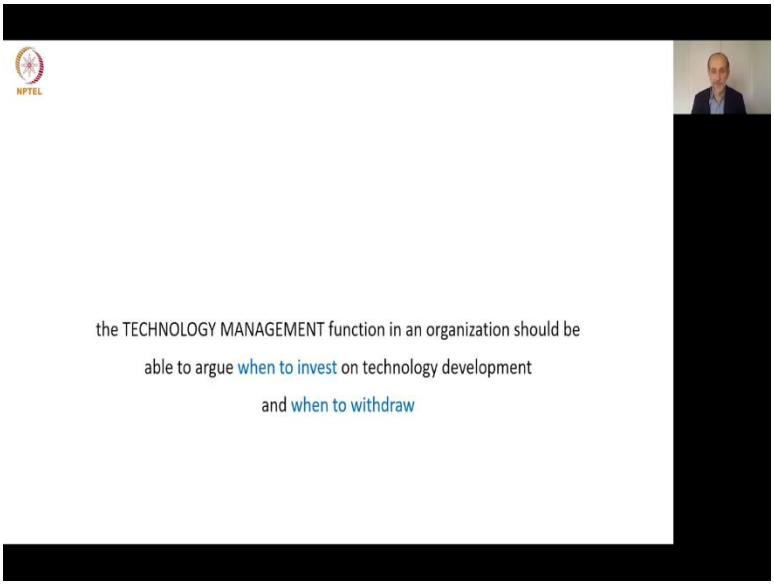

So, if you just take point of view of technology management, the main function of technology management in an organization and should be to argue when to invest on technology development and when to withdraw, and those main function stay on the core of the demand about forecasting.

Because in order to take decision, this decision has to be taken precisely in time for particular market it means in space and about specific technology. But in order to understand how can we treat this decision with the help of forecast, let us first elaborate a bit more on the difference between invention and innovation, today those two words very often are used as a synonym when they are absolutely not synonymous, to our particular point of view.

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If you look through point of view of process, we can see that the invention, this is a new working principle, which is feasible and which show us the performance, which is different from previous working principle. On the left part of this slide, you can see the new kind of transmission for the bicycle, it works, it is tested and this is not something which was in practice before.

On the right side, we can see the example of innovation, here we have a production of new bicycles and what is innovative in these bicycles even from the picture, it is not so evident but this is a airless tires, it means with those tires you will never have a problem that you have a flat tire, because there is no air inside. If you try to measure the difference between invention and innovation, the invention is usually measured in improvement of performance like how many kilometers per kilowatt hour you can run or another kind of performance measurement.

When innovation usually is something that we run production, we sell on the market and we have a return in terms of financial resources. Whenever we are talking about innovation, we are talking about production and profitability, when we are talking about invention we are talking about feasibility and performance.

From point of view of decision making and from point of view of technology forecast, it is important for us that there is a gap, between invention and innovation there is a gap, always a gap and sometimes this gap is really very big, in terms of years to have a feasible concept idea even as a prototype it is not enough in order to be successful on the production and to be

profitable, for different system this time takes different time, if you look just to the history of basic innovation, the basic innovation those are the innovation on which our contemporary technological world is staying.

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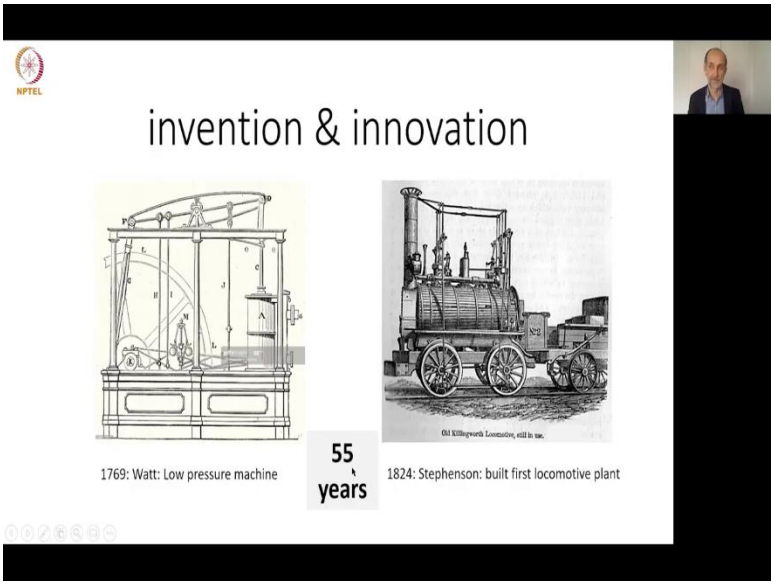

We can see that for instance between invention of low-pressure machine which essentially, this is a core idea of a locomotive, which we used for the transportation of goods for the beginning of industrial revolution, the distance between two things is 55 years. 55 years we needed in order to be capable to build out of this invention which was feasible.

Their innovation the locomotive which used steam engine for transportation of the goods and this is an interesting question why this is so long, because in 55 years if you look this is a at least one generation of engineers, if you invent something by being student and you have this duration between invention to innovation it can takes all entire life in order to see the fruits of your invention. In fact, one of the principal questions of technology forecast is to answer when, how many years it will take and where this invention has a chance to be implemented.

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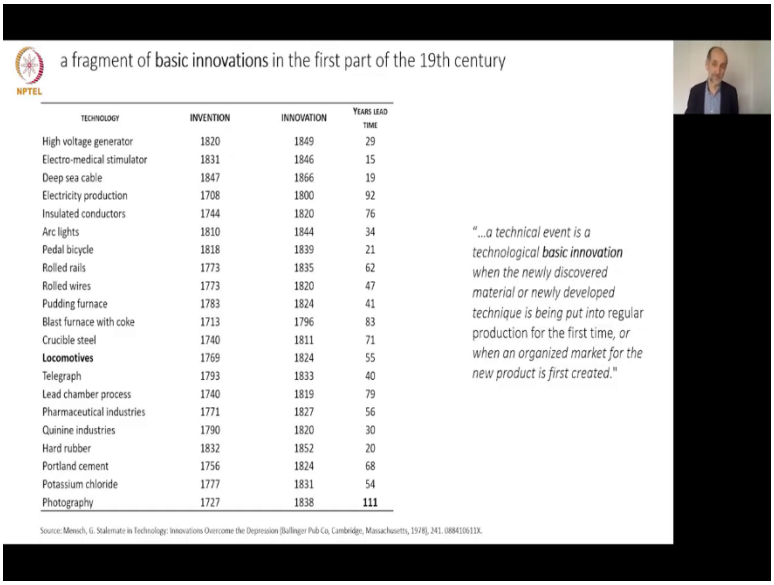

TECHNOLOGY	INVENTION	INNOVATION	YEARS LEAD TIME
High voltage generator	1820	1849	29
Electro-medical stimulator	1831	1846	15
Deep sea cable	1847	1866	19
Electricity production	1708	1800	92
Insulated conductors	1744	1820	76
Arc lights	1810	1844	34
Pedal bicycle	1818	1839	21
Rolled rails	1773	1835	62
Rolled wires	1773	1820	47
Pudding furnace	1783	1824	41
Blast furnace with coke	1713	1796	83
Crucible steel	1740	1811	71
Locomotives	1769	1824	55
Telegraph	1793	1833	40
Lead chamber process	1740	1819	79
Pharmaceutical industries	1771	1827	56
Quinine industries	1790	1820	30
Hard rubber	1832	1852	20
Portland cement	1756	1824	68
Potassium chloride	1777	1831	54
Photography	1727	1838	**111**

If you look to the history of basic innovations, basic innovations like high voltage generator like pedal basic bicycle that probably most of you already have experienced to use and other photography, the production of cement, we can always see that it was a gap between invention when it was feasible possible to do and innovation when it becomes regular production and those gaps sometimes very low, for instance for the photography the gap between possibility to make pictures and commercialization was 111 years.

The forecast, technological forecast has to be capable to clearly depict, how long it will take because do remember the very question which we are interested about is when to invest and when to withdraw.

So, but how do we define basic innovation? Let us assume the definition originally suggested with the book of Mr. Mensch, that a technical event is a technological basic innovation when the newly discovered material on newly developed technique is being put into regular production for the first time, regular production this is very important, regular production it means we have a cycle in which we produce, sell and we earn enough resources in order to continue our production.

What is interesting to see that for most of the invention and I would like to underline that 90 more than 95 percent of inventions, they do not appear as innovation. We have a million of patents and out of them, 95 more than 95 percent never become the innovation. What happens,

why it is like that and from what it depends? It depends on many things, but we will see two or three reasons just few slides later, because this is one of the essential question that our forecast, reliable forecast, technological forecast for strategic decision it has to answer. Shall we put our efforts to the invention or not? Even it looks like feasible and very promising.

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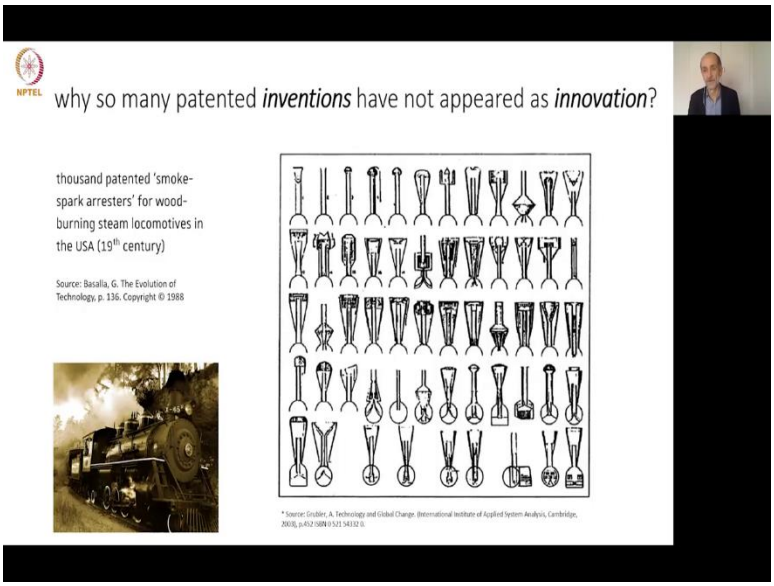

Let me share with you another example of the beginning of industrial era, in order to give you idea how thousands of inventions have not appeared as innovation. At the beginning of era of steam locomotive, we used for the fuel the wood in the 19th century in U.S, we had a very heavy problem because if you use a wood for this kind of locomotive, you have a problem because wood cannot be burnt completely.

So, small particles of very high temperature of wood goes out through the exhausting pipes and cause fires, the wildfire in the forest and in fact all around the roads this was the main danger and main problem at those times.

So, that is why, many inventors they try to resolve this problem. So, thousand patent, patented smoke-spark resistors were suggested, here on this picture you can see just some of them, difference schemer and they were patented it means what does it mean patent, this is something that entrepreneur they have to pay for this document, because this document supposed to protect their intellectual property of the market.

So, it means inventors they believed strongly that there will be some implementation, but I would like to underline once again none of them was implemented, none of them how it could happen? What happened why we did not implement them?

Because when you start to use a coal as a fuel, you have known this problem, the coal can be burnt almost completely at least, you have known this phenomenon when this spark goes out and goes that far around the around the railroad.

You see in fact even you have something feasible in your hand, we need to be capable to predict, will this feasible invention appear as innovation or not and this is a one of the very serious question for the technological forecast. The technological forecast has to answer. Let us see how do we approach today and the question, probably you already heard about so-called Gartner cycle? There is a question. Yeah, please Bala. They have a question.

Professor Bala Ramadurai: Question on, so one of the, this is completely new for me is that, can patent or the knowledge captured in patents be an input for technology forecasting itself, so and where does it go as the methodology itself where would patents as an input for the technology forecasting exercise go, do we start with that or is does it appear somewhere in the middle or how does it go? I do not think, I have ever discussed this with you.

Professor Dmitry Kucharavy: In fact, the patents this is kind of background conformation. Thank you very much for your question. The patents they just show to what people are interested about, because the patents they show the strong intention of people to push their solution to the market. In fact, when we look through the patents there are not so many, not so much knowledge inside, because the main function of patent is to protect intellectual property but not to present.

So, the patent monitoring helps us to understand what is the temperature in a society about those, of those topics, by themselves unfortunately the patents they are not so good indicator to be reliable with forecasting, why because the companies they use different strategies sometimes the companies they build the patent umbrella in order not to disclose in front of their competitors where they are working on.

There are another many different issues that are connected with the patents, the patents it is not source of knowledge, but this is a source of information what people are trying to push on the

market today. So, this is a background, it is not input information not output of forecast, but this is kind of background that we have to keep in mind like when you go outside, you at least interested about what is the weather about outside, did I answer your question.

Professor Bala Ramadurai: Yes, yes, I got it, now i get it.

Professor Dmitry Kucharavy: Thank you thank you for the question. Well, let us try to see what today and we can some of the decision makers they use instead of forecast.

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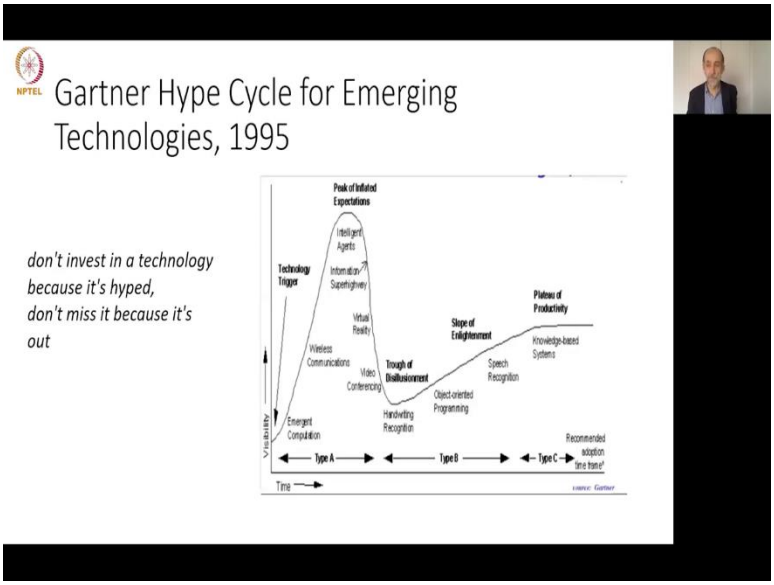

The one of the very famous idea which was suggested years ago by a consulting company Gartner, so-called hype cycle for emerging technologies. Which indicate visibility of the technology it means how many publications or how many patents do we have or how many publications in scientific literature and non-scientific literature we have, and this Gartner hype cycle pretend to explain that any kind of new concept go through the several phases.

The phase 1 when we have a peak of inflated expectations after that the expectations start to decrease, the visibility start to decrease and some inventions they pass through this wave most of them they do not pass, because the real implementation of the market what we say innovation starts somehow at the end of phase b when we have slope of enlightenment and when we have, for instance on this slide I share with you, the one of the very first hype cycle from 1995 and this what we can learn from this.

That in fact, the decision makers they learned that, they do not invest into technology because just it is hyped, because when it is hyped it can soon disappear and they do not miss it, because it is out, it means we have to have something which will help us to put measurement on this time x.

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Unfortunately, even for today we have no any time measurement on the hype cycles suggested for the for the different technology on this slide the emerging technologies for 2019, they put it you can see some name of technologies like Biochip, they are today almost on the top of peak of expectations. Some of technologies like autonomous driving level four, they are less visible but are they going to arrive to this slope of enlightenment and plateau of productivity this is still open question, this is a still open question.

So, we need to when we make technology forecasting we need to clearly distinguish between differences what are our expectations and what are the real capacities of technologies to answer todays needs or tomorrow needs, because the will technology be on the market one day or another one or how many years we need to wait until this technology will be on the market, depends not only on feasibility not only it is possible, but it depends also on other things like does it really solve some problems?

How costly this solution? How long we need to learn in in order to be capable to use this solution? Because the technology this is the synergy of hardware, our knowledge how to design manufacture and use it and the regulations that needed to run this technology and if you look

from this point of view to our evolution of the technology, we can arrive to the idea that in order to be to be reliable with forecasting, we also need to make clear, what is the difference between efficiency and effectiveness, because in new technology usually the new generation provide us always better efficiency.

The engineered system what is the difference between 20 years or 30 years old computer and the computer that you use today? It is much more efficient; it can perform much more tasks with the same power consumption for the same cost or even lower cost. Today's mobile phone for instance they are much more powerful than 30 years and 50 years older super computers. So, but let us make clear what is the difference between efficiency and effectiveness, in order to understand why technology are evolving this way, not just through our expectations.

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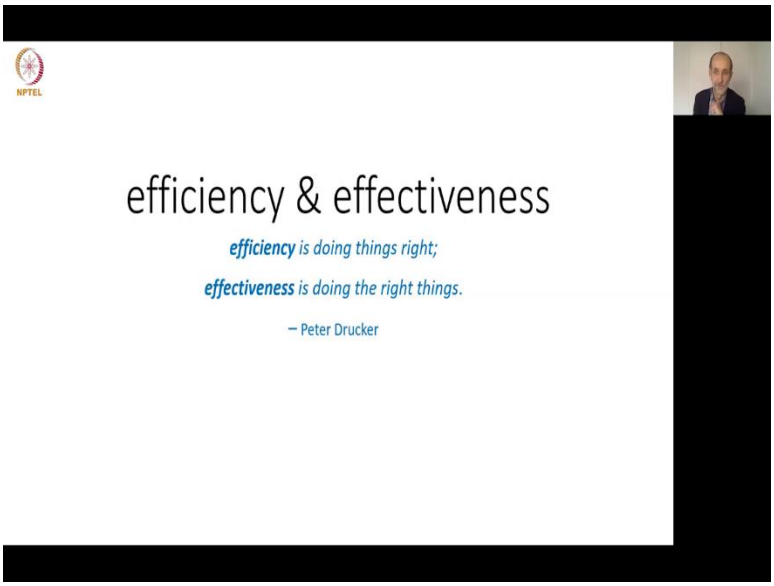

If you took from the management science point of view, I do appreciate the now it is become very classical, the definition that comes from great mind Peter Drucker from management science, he wrote that efficiency is doing things right, when effectiveness is doing the right things, and what is the difference?

The doing right things it is not absolutely not the same as doing things right. We will see the example, but if you look just to the emerging technology most of the emerging technologies, they are struggling, they are always trying to improve efficiency in order to be competitive with

existing technology. So, that is why we often, very often we forget about effectiveness when we are so much concentrated on the efficiency.

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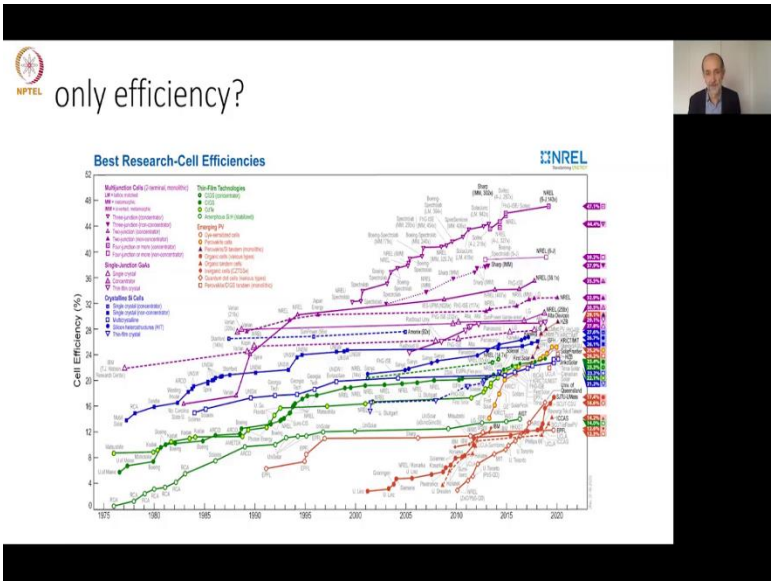

Just to show you how it is serious, let me see for instance the timeline of evolution of photovoltaic solution to generate electricity out of sun, and you can see that on this diagram we see four big families, four big technological families and their evolution within a time starting from 1975 up to now.

According to only one criterion, what is a cell efficiency in a percentage? and you can see how many different solutions they try to compete on the market and it is the highest efficiency for instance which you can see on this line it does not mean the winner, in this competition, but this is what happens usually in engineering world.

I do appreciate, I do like to share this diagram with you also in order to answer the question, that I received from students of mine many times when I showed them that between invention and innovation, we have a many year. Most of my students, they said Dmitry you are right, but it was in the past. Today everything comes much faster, we have a reduced time between invention and innovation because we are doing it right now more efficient, but if you look just for instance for the photovoltaic which is still not main source of electricity on our markets even in very sunny countries, it is still not the main source of electricity.

We can see that their transition from invention to innovation started years before 1975, because from 1975 those are R&D programs, which are invested heavily invested, heavily supported by funding's in order to advance with the products and we can see that we already in this story more than about 40 years, 40 years already done.

So, I unfortunately with introductory course we have no time to discuss the time of from invention to innovation, but what I would like to keep you aware that this time even in modern ages does not shrink, this time is decreasing and increasing and it depends on the cycles in economy, because all technology whichever we take technology, they serve some demand from economy. But now I would like to come back to the difference between efficiency and effectiveness.

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And let us see this picture this diagram, if you like, when on the vertical axis we put efficiency and when on the horizontal axis we put effectiveness. If we are very high with efficiency, if you are doing things right very fast, very low cost, very low energy expenses, in this case we but we are not effective enough we just die quickly.

It is just very fast process that we perform, but if the target is not adequate, we are not surviving. If we are very effective but we are not efficient enough, we are always in a situation of surviving, we do not thrive. In order to be successful in the market we have to be efficient and effective, we need to do the right things and why it is not so easy to do the right things, why we very often we

are doing things that we believe that they are right, but at the end, we do not see so much customers or we do not see so much demand about technology or we do not see so much context.

Before coming back to this subject, I would like to suggest for your attention and the very short video which supposed to help me to convey this idea what is the difference between efficiency and effectiveness.

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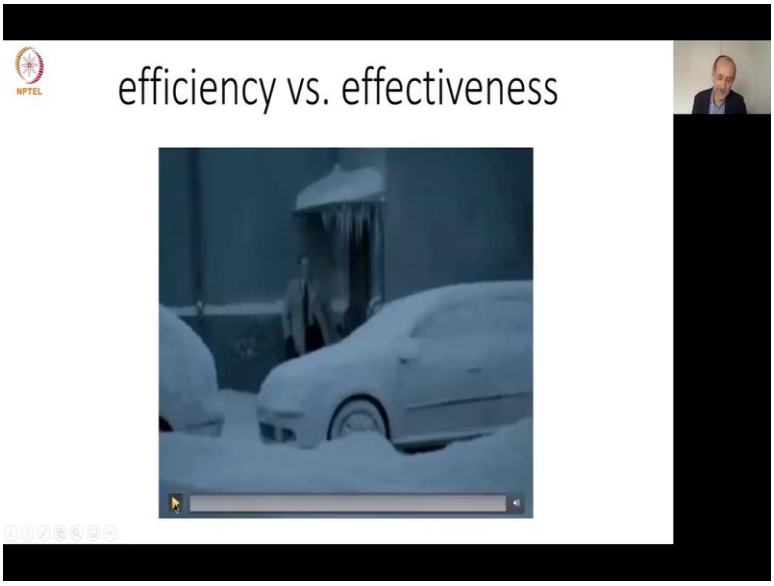

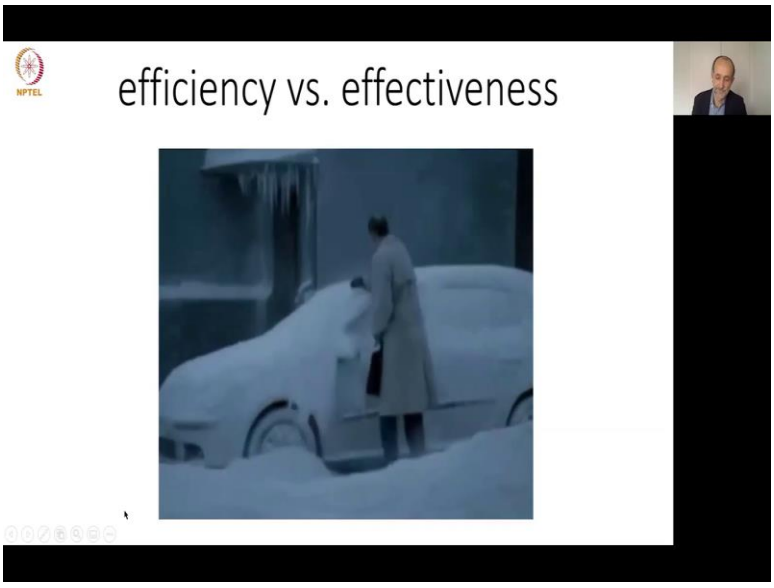

efficiency vs. effectiveness

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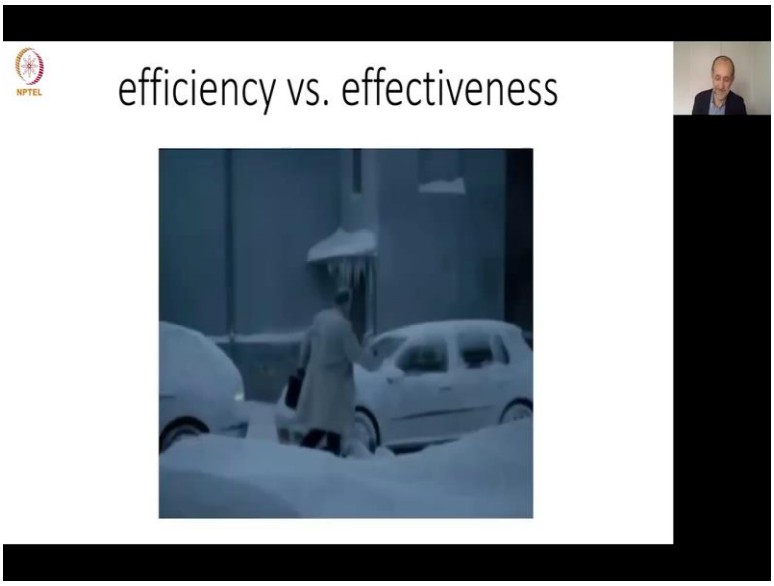

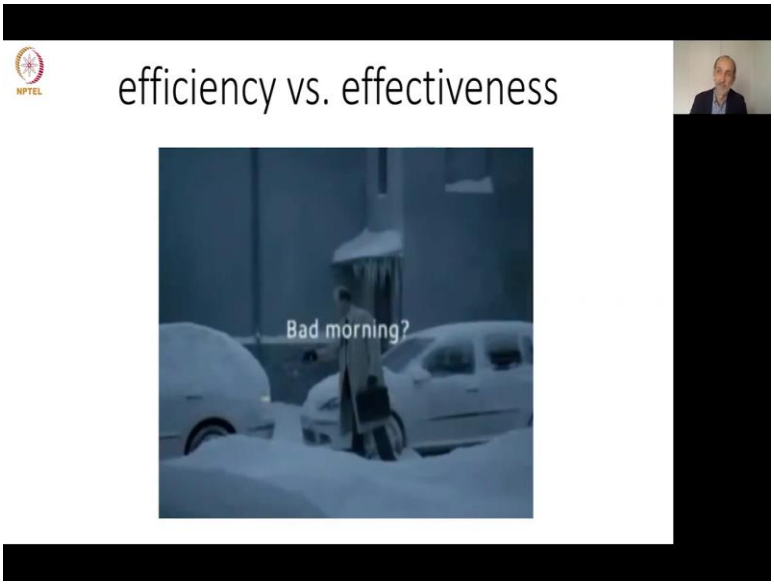

Well, such a situation is quite rare in India, at least in the most part of the country, but we are very familiar with the morning when our cars, especially in winter when our cars are heavily closed by snow, but let us look together what happens.

Yeah, he is working hard and he is doing the best but finally. Yeah, he was very efficient, but not effective at all, we can see a lot of examples of such a situation when we work hard, we do the best to keep our efficiency at the best level, but at the end this is this is not the thing that we have to do. So, in such a situation he was quite efficient but not effective at all.

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Another cartoon that I like a lot to share, in order to emphasize the difference between being efficient and being effective, and this one, the rabbits saying we can go 100 times faster, but the question is not to be faster, if you are not effective, the question is not how fast you are going in this direction, if you are going in the wrong direction it does not matter how we are efficient.

There is a big question which usually we use technology forecast in order to be effective, if we can answer how do we know, what is the right direction in a technological advancement, we can be effective not only efficient. How to be efficient we learned during our education since the beginning but how to be effective depends on your capacity to see the future, what will be the relevant technology to produce, and to suggest from the market in order to meet expectation, in order to satisfy the needs of society. This is a question which helps us to be not only efficient but also effective. Thank you very much for this part of our lectures.