Technology Forecasting for Strategic Decision Making
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Technological Roadmaps

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Professor Dmitry Kucharavy: Welcome back to our course, Technology Forecasting for Strategic Decision Making. And today we are going to discuss a question about technological roadmap. What are the technological roadmaps? And how we can use them to support strategic decision making? And what is the connection between technological forecasting and technological problems.

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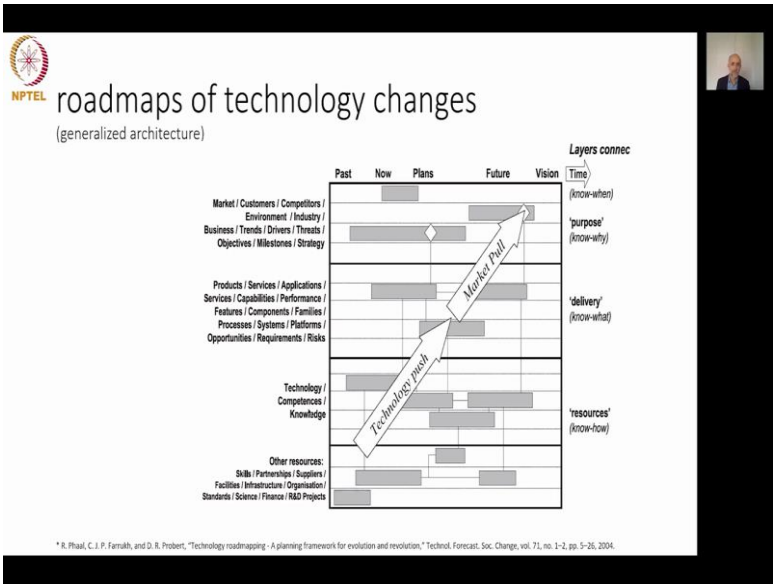

If you look to the very generic architecture of roadmap usually, they allow us to interconnect the planning on the level of technologies and competencies with a level of skills, partnerships, suppliers, production organization, with a level of products that we sell to our customers that we provide service; with a level of marketing, customers, competitors and industry.

In fact, the roadmap usually this is a representation within a time from past through the present to the future of several layers which allow us to establish the long-term plans when level of technology describe level of resources or level of know-how. The level of products or level of delivery described know what the level of market and customers describe know, when and know why, the purpose.

Then one of the most interesting result of road mapping that we can connect our strategy of technology push and market pull in border of one planning roadmap. The roadmap, they became very popular in the 70s, at the beginning of 70s. And one of the pioneering company about road mapping was Motorola.

Even if you look through the literature review, you can see that within a space ages error, at the beginning of space ages error. We can see the very first roadmap suggested by NASA and other institutions and research centers who developed the space technology. Why road mapping so interesting to use because they allow us to coordinate the old levels. Not just try to push technology without considering the market response but to connect also the technology with suppliers, with finance, with a scientific advancement and other advancement.

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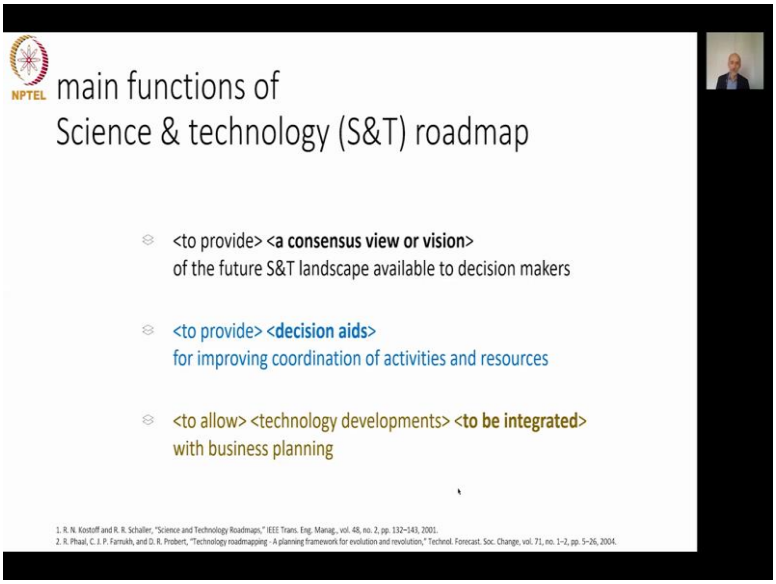

What are the main functions of Science and Technology roadmaps? One of the main functions is to provide a consensus view or vision of the future Science and Technology landscape available to decision makers. The consensus view or vision among different levels: among scientists, industry, market and financial institution.

In this case, when we have a consensus view, we are more harmonized in our activities and we are more efficient and effective. Another main function of Science and Technology roadmap is to provide decision support for improving coordination of activities and resources. In order to arrange resources, exact in time and in order to perform activities according how it was planned.

And the third one, it is not the last one but third out of most important the Scientific and Technological roadmap allow us to integrate technology development with business planning which is very important from point of view of running our technologies and have a profit out of the technologies. So, if you are interested to look more detail always on the bottom side of our slides you can find the source of literature where you can go more in detail about science and technology roadmap.

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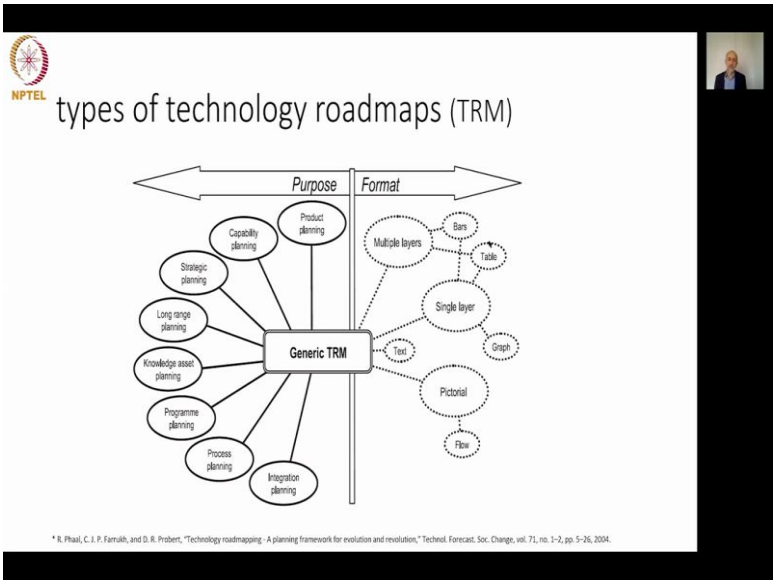

But we are going to see what kind of different roadmap we can see and we can use. And if we looked at the taxonomy of technology roadmaps, mostly they are divided by roadmaps according to the purpose of building and according to the format. For the same purpose the format can be different.

But at least there are several generic purposes of building technology roadmaps. The product planning, the capability planning, strategic planning, which is most interesting for us, long range planning, very close to strategic one, knowledge asset planning, program planning, process planning and integration planning, when several companies, several businesses try to integrate.

And those roadmaps they can be presented a different way. The first slide I show you about multiple layered roadmaps but it can be also as a text, as a single layer, as the pictures. Let us see a few examples in order to understand what are the different purposes and what are the different format of presentation of roadmap.

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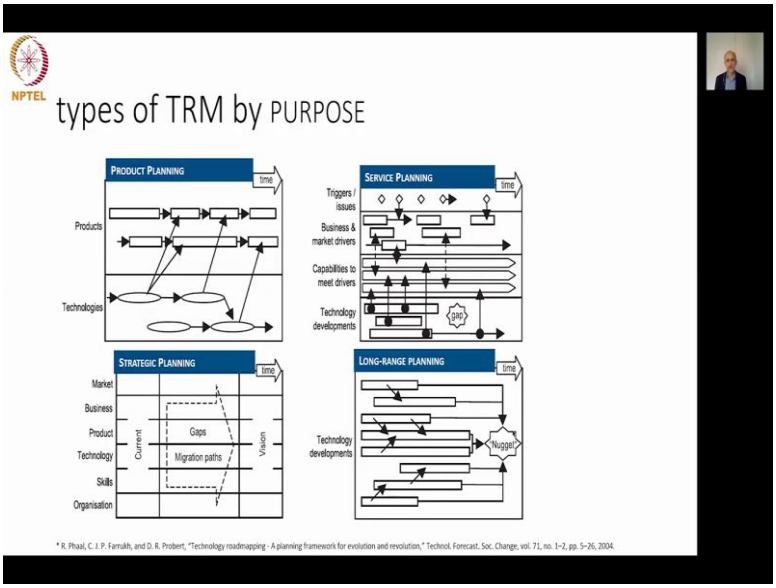

If you look to the purposes for instance, a product planning roadmap usually describes the layout of product and technologies used in order to perform these products according to the timing. So, we see how technologies and then a level of maturity can support or not support the advancement of the product.

The service planning connects level of technology development with the capabilities to meet those technologies and with business and market drivers who need to use those technologies. Or strategic planning connects organization skills, technology, product, business and market in one timeline and describe what are the present situation, what are the situation in the future and how the gap will be closed.

And from a point of view of our courses, strategic planning roadmap, they are most most interesting kind of roadmap. Long range planning, so just as technology development, how different technologies can be integrated in order to arrive to the result that we are interested to get. For instance, when we try to launch the new airplane, for instance, what kind of technologies we have to aggregate in order to have for instance electric airplane, electric driven airplane.

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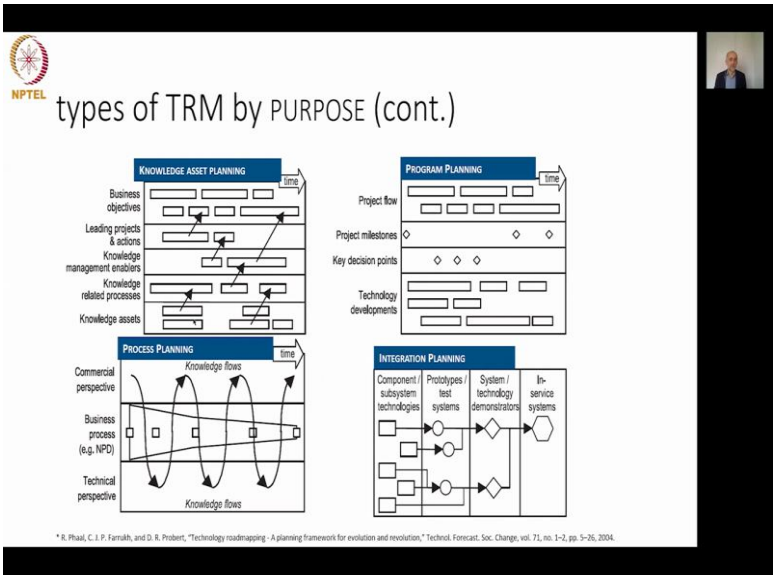

The second slide continues about the technology roadmap by purpose. We can build the knowledge asset planning roadmap when we connect level of knowledge asset, knowledge related projects, knowledge management enablers and leading project and action. It can be program planning when we see the project flow and how these project flow is connected with technology development with milestones, milestones for project and milestones for decisions.

Or process planning when we connect within a one knowledge flow, how technical perspective business processes and commercial perspective will be interconnected in order to arrive to strategic goal. Integration planning when we see how within a time, we will arrive use the components and subsystems and technologies on solution on the level of prototypes, system integration in order to arrive at the final goal. It is not a full list but some examples just to show you how do we differentiate technology roadmaps by purpose.

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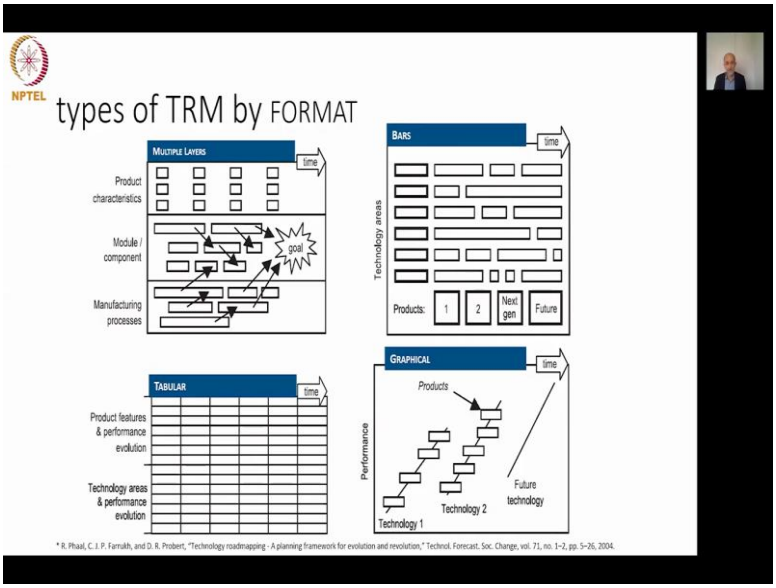

If you look to the format, how it can be represented. Okay it can be represented very classical, the multiple layers when in the horizontal dimension we have time and we connect several different layers. It can be represented just like in bars. When we have the different kinds of products and different kinds of technology area and we just described them with the bars without being so specific on the interconnection.

It can be done as a spreadsheet, when we have a product features and performance evaluation with the technology area performance and the horizontal dimension always a time. Or it can be done graphically when we see how performance of certain technology should be changed within a time in order to arrive to the future technology.

Different way of but what is the main feature of technological roadmap? It has to describe the connection between the timing and how we will go how we will close the gap between present state and our strategic goal.

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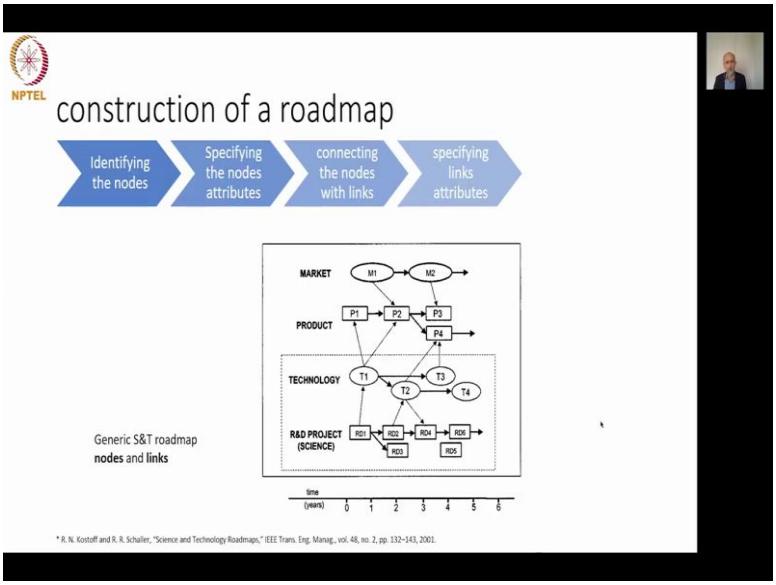

If we just look very brief at the process of construction of roadmap, we always start from identification of the nodes. This is the first. After that we specify the nodes attributes. It means those nodes how they are described through their features. We try to connect nodes with links and we specify the links attribute within a time because there are some for instance in a research and development project, there are some activities which are dependent and there are some activities which are independent.

They can be done in parallel in order to arrive to another activity. So, we always have to identify nodes at identifying links with the attributes within a time. This is this is how we in very general we are thinking build our roadmap. But of course, we have to have some idea about nodes. And we have to be consistent when we plan resources when we plan the resources and time resources.

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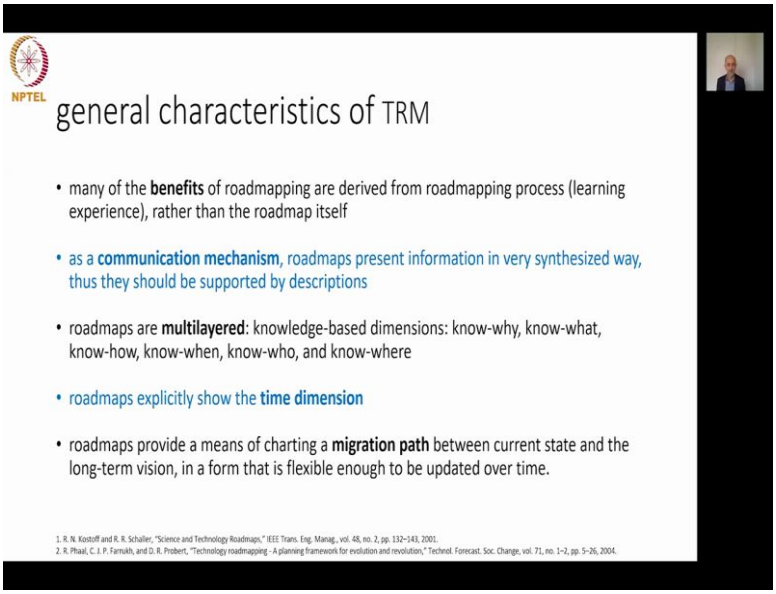

So, what are the general characteristic of technology roadmaps? Many of the benefits of road mapping in fact they are derived not from roadmap by themselves but from their road mapping process. This is very important to understand that the road mapping process, this is a process to find the consensus. Many different people with different expertise involved and it allows us to arrive to this consensus.

Road mapping, this is a communication mechanism. Roadmaps just present the fix the results of those communication in a very synthesized way. And in the future those road maps can be used in order not to be lost on the way by different participants of the process. Usually, roadmaps are a multilayer. They have knowledge-based dimension like know-why, know-what, know-how, know-when, know-who and know-where. So, the roadmap they represent more than knowledge than just information. Roadmaps explicitly show the time dimension.

This is very important because this is a planning. The roadmap, this is a way of strategic planning. This is not a operational planning. It is not a branch diagram; not at all. But this is a way to plan and through monitor how do we progress according to our plans. Roadmaps provide a means of describing migration paths between current state and our long-term vision or long term forecast in a form that is flexible enough to be updated over the time.

It means if we shift within a time some activities, then all-other links will be shifted and we will arrive to the clear vision what will be the delay or what will be their advancement in these

activities. It can be done that something will happen before it was planned at the very beginning.

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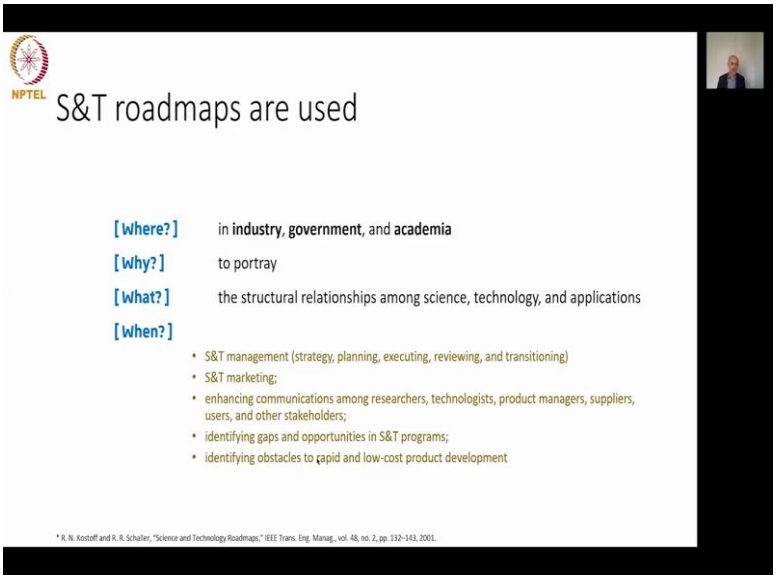

Where do we use roadmaps? We use them in industry, in government, in academia for the long-term planning for strategic planning. Why? In order to portray, in order to clearly describe the structural relationship among science, technology and its application from business perspective, from the market perspective. When? When do we need roadmap?

We need science technology roadmap and when we perform the management, not only for strategic planning but for the executing, reviewing, transitioning and the most of all validating. Did we arrive to what was planned or not? We need them also for science and technology marketing when we try to promote our projects and try to find financing to run our science, technology and research and development projects.

We use them within enhancing when we need to enhance communication among researchers in order to make clear who is doing what technologists, product managers, suppliers, and other stakeholders and participants of the process. We use their when we need to identify the gap and opportunities in certain programs. And we use them when we need to identify obstacles for faster and low-cost development of what we would like to develop is it is product or is it is service.

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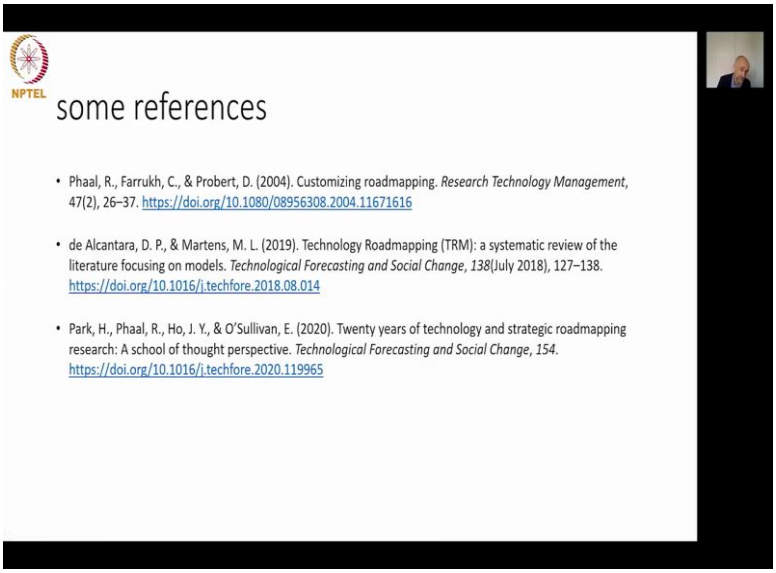

Yeah, this is mostly all that I would like to say about roadmap. If you are interested about latest publication for road mapping, I would like to invite you to look through these 3 selected papers. The "Customizing Roadmapping", "The review of literature" and description of the history of 20 years of technology and strategic roadmapping research when we can see some very interesting facts from history which are not can be find in other sources.

Well, thank you very much for your attention about roadmapping. Can we have any questions Bala to discuss? Do we?

Professor Bala Ramadurai: Sorry. Thank you so much, Dimitri. It is very revealing for me in many ways than one. One question I have is, again, this is also a frequently asked question is there are different types of these planning activities and broad mapping that you mentioned. Are there some specific types of people who are suited for a certain role?

Or in summary, who is best suited for which activity? How do we decide because there is lots of lots of activities in this planning. Is there somebody who need we need with a certain skill set? Or what would you recommend? How would you do that? Yeah, in these.

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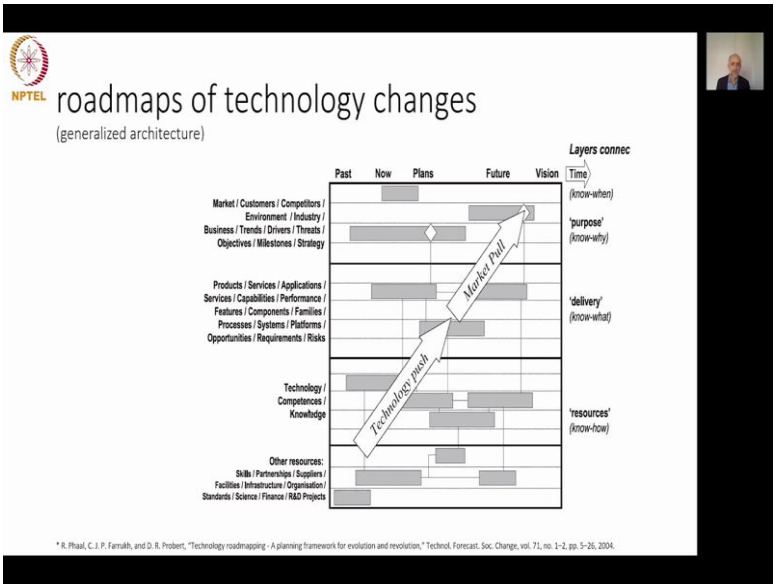

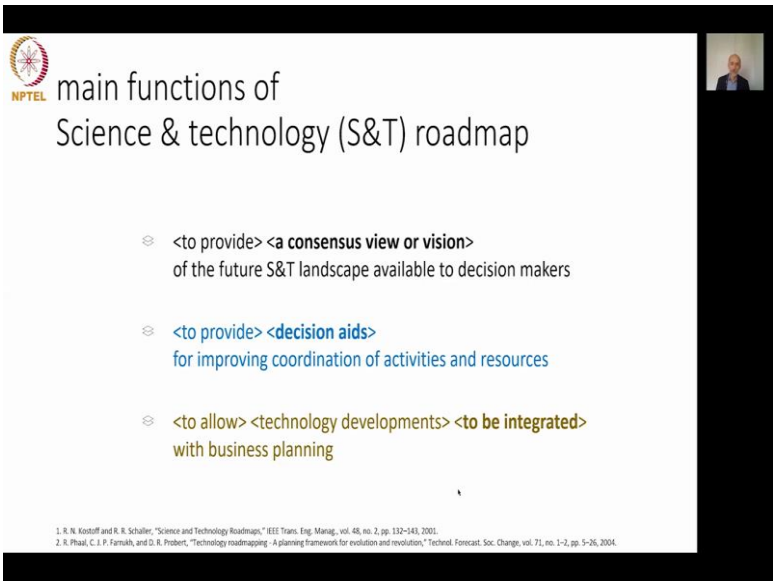

Professor Dmitry Kucharavy: In fact, when we build the roadmap, we need to allocate the necessary skills, the necessary suppliers, the necessary infrastructure and organizations. In fact, on this level, we identify the required skills and expertise. Out of this, out of this, we can draw the conclusion, what kind of specialists they have to be hired or educated or invited in order to satisfy what was planned according to the technology roadmap.

But building the technology Roadmap by itself, it is not activity of one particular working team. In fact, we are building a technology roadmap, we communicate through all layers of the company. We can start for instance, from market layer. What are the demands of the customers and go to the technology what technology can provide us as an answer? And go to the product.

So that is why but the process by itself of technology roadmapping this is a very (how to say this) this is very useful process in order to find consensus; in order to find consensus and to share the vision. Not only vision of what was decided on the top management level but the everybody in the company, every division or every person, they arrive to the clear understanding what he or she need to do in order to progress towards this vision. Did I answer your question?

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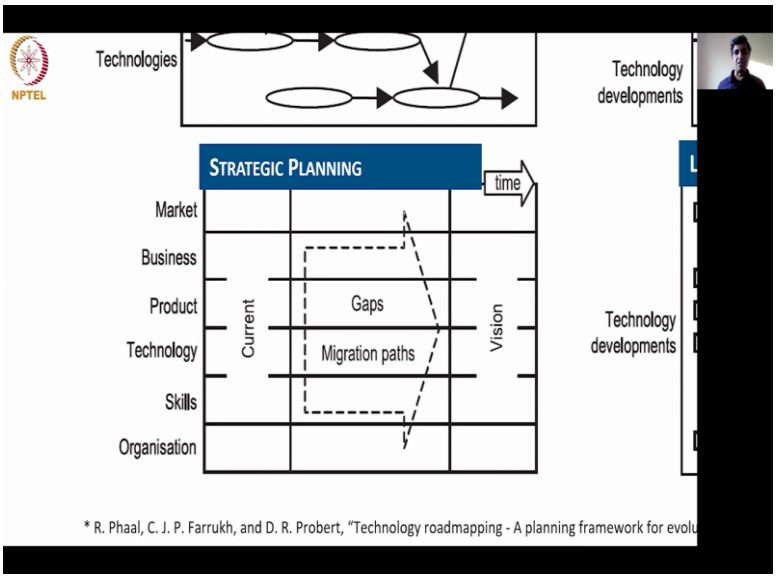

Professor Bala Ramadurai: Yes, most certainly you did. Thank you so much. Now I got it. I always think that a multidisciplinary team and particularly specifics like what you describe really come together, and they will give their perspectives and then putting it all together is, is a tricky activity but a useful one all the same. Like you rightly said that is for me the biggest takeaway is that roadmapping as an exercise itself can, you know, be very beneficial for the teams rather than the roadmap or what it says but the road mapping exercise.

That is for me a definite takeaway. A very, very basic question, Dmitri, and I know we have discussed this in the past but what is the difference between knowledge, information and data? This is a; lots of my students interchangeably use all these three. So it is, it is I have been through it so many times. But I would like to hear your opinion, your view on how do students' learners actually do this: knowledge, information, and data.

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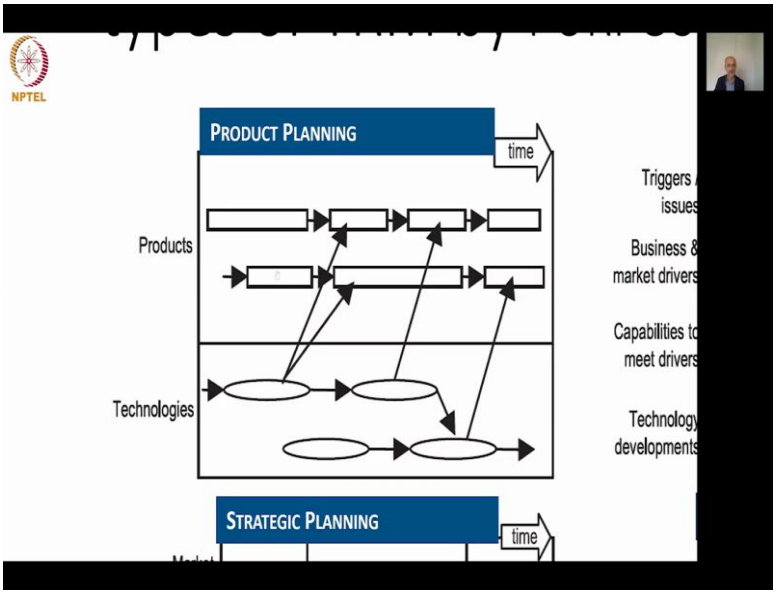

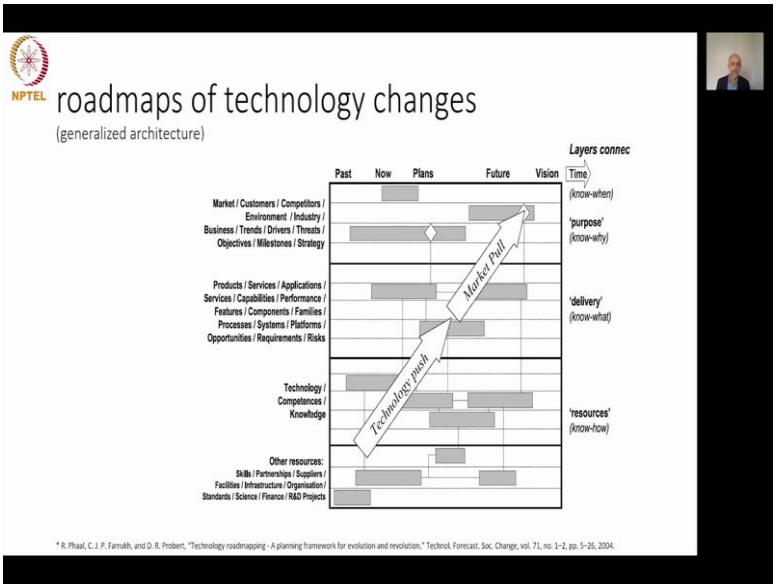

Professor Dmitry Kucharavy: So, thank you Bala for this question. And use let us use what we are discussing about the roadmap. The roadmap by itself this is an information, when it is represented this way or another way. This is an information which consists a lot of data in order to be constructed. But what we can do with our roadmaps and our capacity to build these roadmaps. This is a knowledge.

In fact, if you look to the question of resources, we need to have a knowledge. Knowledge, this is a capacity to do something. Unfortunately, just having information, we cannot act. We use information in order to learn how to act properly, how to build something. And the data, this is

what we can consider before information. Because information, this is a subtle way to observe certain data.

Let me make clear what I am talking about. If I can say there is a 1 million population of certain city. Is it big city? And the data; we have a data, 1 million population of the city. But the information the city is big or the city is small, this is according to certain point of view. From certain perspective, for instance, in most of the European countries like France and Germany, 1 million population cities, it is a big one.

Because most of the city in Europe, they are less than 1 million population. But from the point of view of many cities in Asia, those are the normal cities. They are not so big; just 1 million population. You see the information is different even the data is the same. The relation between data and information depends on the point of view.

When knowledge, this is something that you cannot put onto the video, you cannot put onto the text, on to the sound. Everything that we can store on the certain; everything that we can store on our computers, inside of our computers, those are informational in nature when knowledge, this is a capacity to do something to produce something. Did I clarify the question?

Professor Bala Ramadurai: Oh, that is a powerful one. Thank you so much. This is definitely a new point of view that I have learned. Thank you so much.

Professor Dmitry Kucharavy: Today, just I forgot to add that today computers arrive to be capable to do something. And this is this is what is named, you know, artificial intelligence. When computers are capable to produce something, not only just reproduce information once copy, paste and so you can send. Sorry.

Professor Bala Ramadurai: Okay, thank you so much, one last question about the technology roadmap itself. Are there any serious limitations of technology roadmap that you have come across in your experience?

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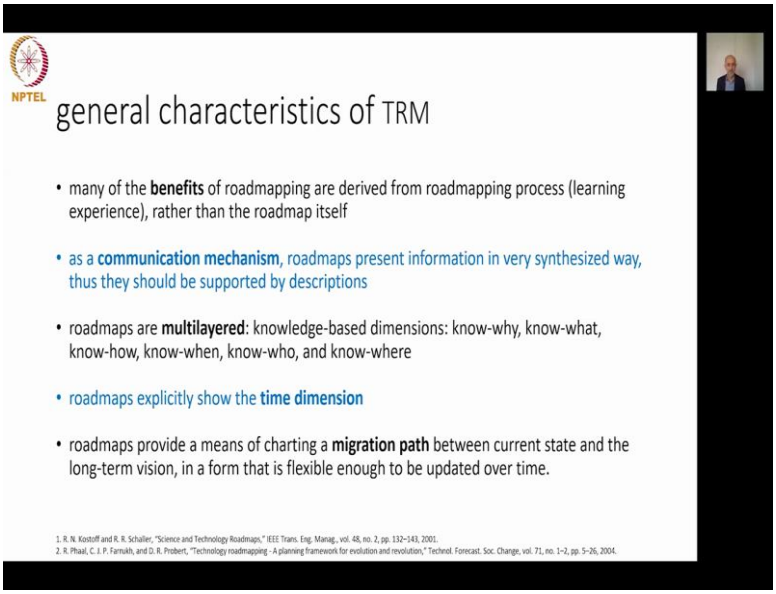

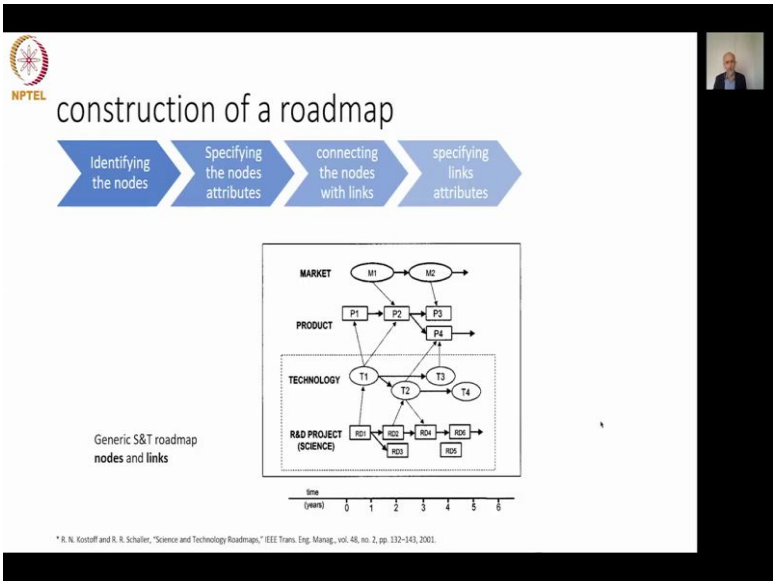

Professor Dmitry Kucharavy: Yeah, there is. We can say this is a limitation and for it depends how do we how do we act in a certain situation, because when we already have the roadmap, we need to communicate it properly because by itself, it is a just a map and it depends where we need to go we can use a different way.

And another limitation which lay more on the process of construction of roadmap that in fact, it is not always evident, how to organize communication among different parts of the companies in order to build the common vision, this is this is also limitation. And one of the good examples of road mapping which show us its power to have a roadmap - The famous law of Moore's Law in microelectronics which stated that the computational power is doubled every 18 months. In fact, this was the result of roadmapping in industry, in microelectronics.

It was time and those roadmapping was performed. Not in more of one company but by companies even they were competitors. But it takes a lot of how to say this energy and power in order to put actors and stakeholders around the same table. This is this is kind of limitation on the level of process, on the level of having the roadmap, the limitation is how to communicate, how to communicate the road map.

Professor Bala Ramadurai: Certainly. Thank you so much. This is very useful for me. Thank you so much for that.

Professor Dmitry Kucharavy: Yeah. Thank you.