Technology Forecasting for Strategic Decision Making - An Introduction
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System Operator

Professor. Dmitry Kucharavy: So, hello, welcome back to our course technology forecasting for strategic decision making. And now we are going to learn about system operator and why it is useful and what can we, what is the usability of system operator for technology forecasting.

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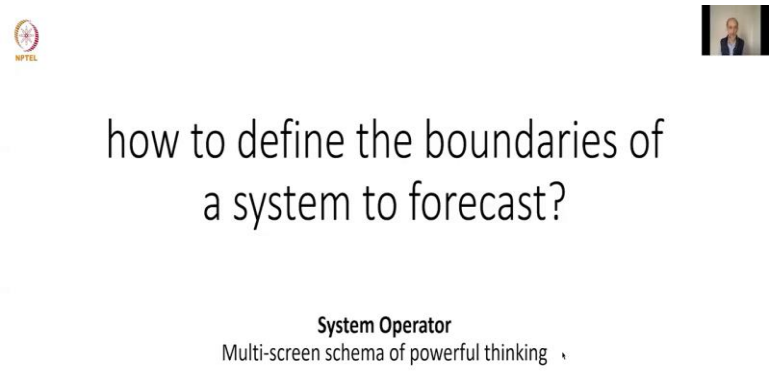

In fact, in border of process of technology forecasting, we need to define boundaries of our system to forecast and this is not easy task because, if you are talking about kind of making cleaner, you can see this compartment, this is a physical boundaries, but if you are talking about public transportation system in your city, it is not so easy to define boundaries of this system. So, in order to deal with this question how to define the boundaries of system to forecast, we can purposefully use a system operator and the system operator, this is a technique which has another name in English literature multi-screen schema of powerful thinking.

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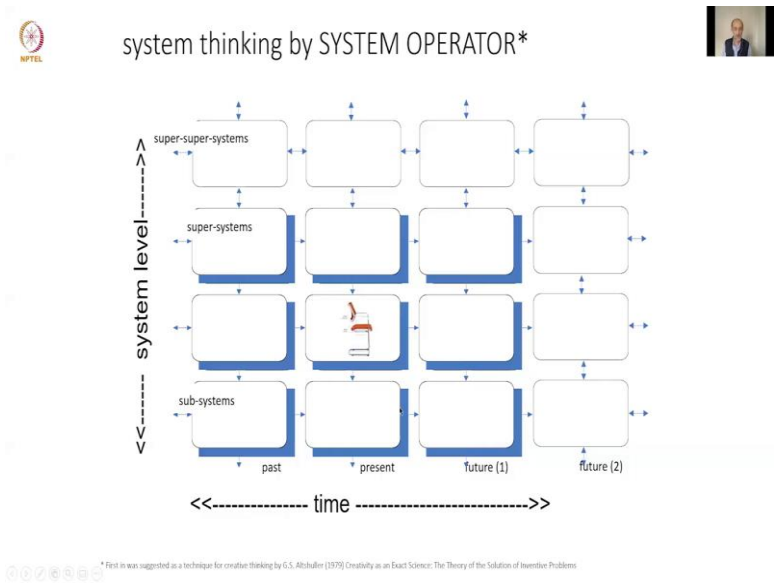

The first time this technique was suggested for creative thinking by Mr. Genrich Altshuller, father of Theory of Inventive Problem-Solving in his book, creativity is exact science the serious solution of inventive problem which was published first time in Russian language in 1979. What does it mean and what are the dimensions of this system operator?

In fact, these system operators suggest you to describe your system using kind of virtual screens and the central screen, we put our system and we try to define what are the components of our system and how they interact among each other, but the upper screen, which is super system level, we put the systems which need our system as a part. The system that cannot provide its functionality without our system.

So, we have a at least two levels, the system level, and time level because it is asked not only to represent what is the system, system which needs our system to function and what are the components, but it is also asked to describe the past of our system. And using knowledge about past, present, we can project some tendencies, which will be in the future of our system. So as a minimum, those kinds of this system operator include at least 9 screens, but for different purposes and number of screens can be increased.

For instance, if you are studying social impact of our technology, we need to go much more in the super system to the society in order to see how our system serves the society needs or if we are making long term technology forecast, we go several dimensions in the future. If we are making study about history of evolution of technological system, we can go in and past. So, the system operator is not limited by these 9 screens. And you can see behind the of each

screen something that looks like Shadow, and it is not known for the beauty. The idea is that the system operator is a multi-dimensional schema.

Let me show you an example, in order to make it clear how you can use this way of thinking in practice, and how it helps us to define the boundaries of our system. On the central screen, we put our subject that we are interested to study. For instance, if you would like to make a study about the chair in a classroom, we put our chair or office chair on the central screen. Of course, this chair has a seat, it has a back, it has a structure. Those are the components. It is quite straightforward and you are used to describe your system like that. But what is also important to describe what are the system which needs your chair.

For instance, whatever office you have with a desk, it does not work if you have no chairs, if you use a computer, you need a chair in order to sit comfortably and stay in front of your screens. So, we need to describe the system which includes. Those description helps us to envelope and define our system not only through each function but also through the components.

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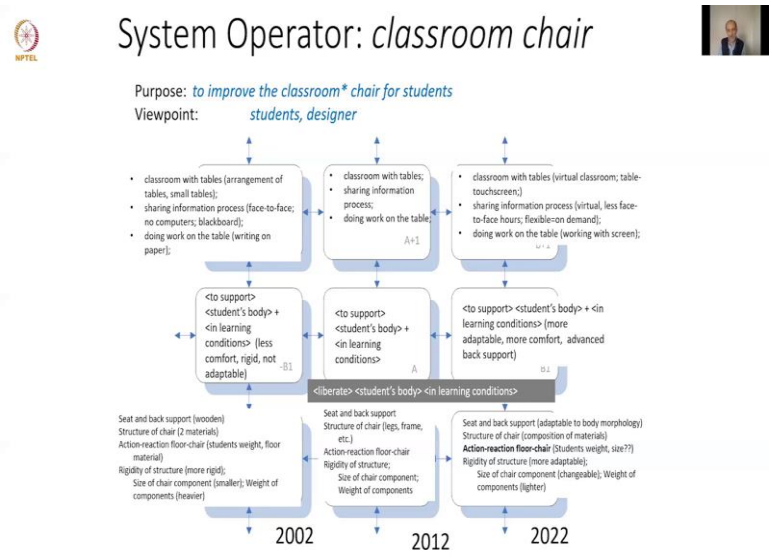

Let us see one of the examples about classroom chairs. How system operator can be fulfilled for the classroom chair? First of all, we have to define the purpose of running system operator and the viewpoint because depending on the purpose and depending on the viewpoint, the content of each screen can be very different.

In our case, the purpose was to improve the classroom chair for students, not for professors, but the classroom chair which are used by students and the viewpoint were the students

which are clients of this classroom chair and the designer who designed this classroom chair. The function of classroom chair was defined to support student's body in running condition and this is what we put on the central screen. We also put the inverse function because whichever system we took, there, we always have a direct function and inverse function this is something which comes from systems theory and the inverse function or opposite function is to liberate student's body in learning condition.

So, we have to support student's body and we have to liberate student body at the same time depending on the changes of the condition. The structure, seat and back support, structure of the chair, action-reaction flow chair this is something which is very essential, without this we cannot support students' body and rigidity of the structure which is described through his visual size of chair components weight of and those are they have certain values. So, what are the nearest supersystem, what are the nearest system which need our function to support student's body and without this function, they cannot perform their functionality?

The classroom with tables, they share an information process when we need to take certain place in space within certain amount of time and doing work on the table when we are doing something on the table, we need to have a chair in order to support our students back. If you put for instance the present for 2012, we take life cycle of the chair is about 10 years. So, we step back into the past for 10 years, which is one once again it is not random number, it is number which corresponds to the life cycle of chair in the classroom.

And we see how it was different. The main idea is to disclose what was different in the past and we can see that in the past the classroom chairs for students were less comfortable, more rigid, and not adoptable. So, they did not change their behaviour. So, and sit and back support was mostly from the wood, as structure of chair was just two materials. And we had a student's weight flow material was not absolutely the same that we have today.

Today we have more new materials for the floors and the size of the component was a bit smaller and the weight of components was a bit heavier. And we see that in the past and this is very important to capture in order to define our system. But in the past, on the level of the super system, we also had some differences. The classroom with tables, the arrangement of tables was different. We had a small table they were differently arranged.

We had a sharing information process mostly it was a face to face without computers using Blackboard. When today it is less face-to-face in a condition of pandemic, we have most distant interaction and doing work on the table. Writing on the paper, this was the main

activity and today, even for 2012, it was doing boths and doing something with your computer devices and writing on the paper. So, all those changes, we capture them and we try to see how those trends from past to the present will continue to the future.

And we can see that in the future the classroom will be more virtual classroom, the table little by little will be transformed to the touchscreen table, the process of sharing information will be more distant, less face to face hours and we will be more flexible, more flexible on-demand that means our students can participate face to face session or they can participate a synchronous distance session or synchronous distance session this is what does it mean on demand. And doing work on the table, we will work most of the time with screens and very little bits of paper.

So, those changes since the supersystem inevitably will lead us to the changes on of our classroom chair for the students and we will be classroom if it will be distant classroom, the chair for the students will be different, and when we depict our system this way, we define not only function of the system but we envelope our system because we clearly define what is the input, what is the output for our system, and we can predict how this function will change in the future, what will be the technology, what will be the system that will answer all those requirements.

Of course, we will have some requirements from the subsystem but still that they are more easy to figure out I do not spend so much attention with them. Whenever we take care about how student's weight is going to change, how size of our device is going to change.

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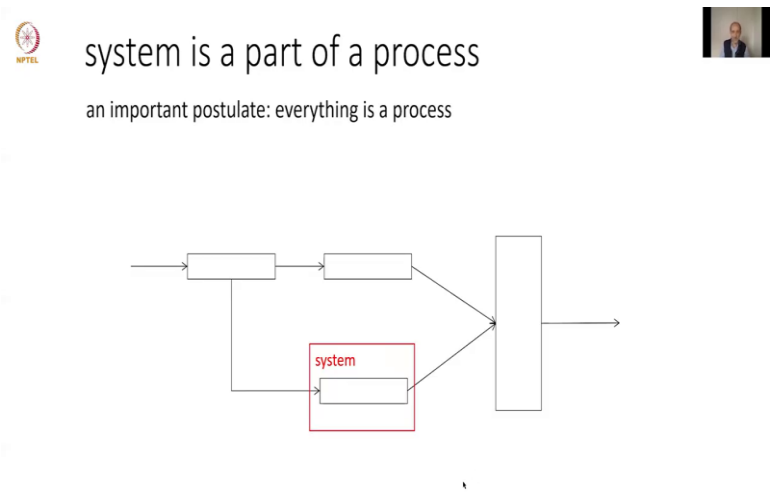

And so, we always have to take accountable, when we run our system operator another very important thing to keep in mind that system, that we tried to define system to forecast is a part of a process. And this is a very important postulate that everything is a process. Whatever we define, we have to define it not only in space or instruction, we have always defined it in a term. So, that is why system operators describe a system with past and future dimension.

What does it mean? That system is a part of the process. Whatever system we analyze, we have to keep in mind that we have the super system, this is a process which needs our system is apart, if you just remove this part, this process cannot be performed, this part can be but this one no. So, this two boxes can be considered as a neighbour system. They do not depend so much from our system functionality when this box in the process is entirely super system which need our system as a part.

So, very important to keep in mind when we define the system that we have to define what are the input for our system, what are the output and what is the transformation which happens, this is exactly what we already discussed when we discussed about function of the system. The function of the system that is one of the key features of our system, remember we put it in the central screen of our system operator in order to start description of our system without specific terms.

Up to now if no questions, I can go further. If any questions, we can answer them within our webinar, or we can discuss it right now.

Professor. Bala Ramadurai: I have one quick question.

Professor. Dmitry Kucharavy: Please.

Professor. Bala Ramadurai: I noticed that changes in future supersystem you have from supersystem of present to the future. Does it necessarily reflect on the future system as well? Is it necessary?

Professor. Dmitry Kucharavy: Yeah, in fact,…

Professor. Bala Ramadurai: That the relationship between…

Professor. Dmitry Kucharavy: This future system, you can see the errors they are in the blue side. In fact, how the future system will look like entirely defined by changes on the super system levels. In fact, what will be the future state of the system depends not on

possibility what we can do that very often we can do very interesting, very amazing things, but if as soon as they are not required from the super system, they will never take place.

This is one of the explanations why so many inventions do not appear as innovations, do remember our distinction between invention, which is feasible, which can improve ratio of performance through expenses. But innovation, this is when we start running the production and when we have a market, because in fact, what will be there, classroom chair for the student depends entirely on the changes on the super system level. So, that is why we have to describe nearest super system changes as much as we can. Did I answer your question?

Professor. Bala Ramadurai: Yes, you did. Yes, you did. Thank you.

Professor. Dmitry Kucharavy: Thank you, and using the postulate that everything is a process, it becomes even more clear that our system is an embedded part of the process. And we always have to see all the changes on the process.

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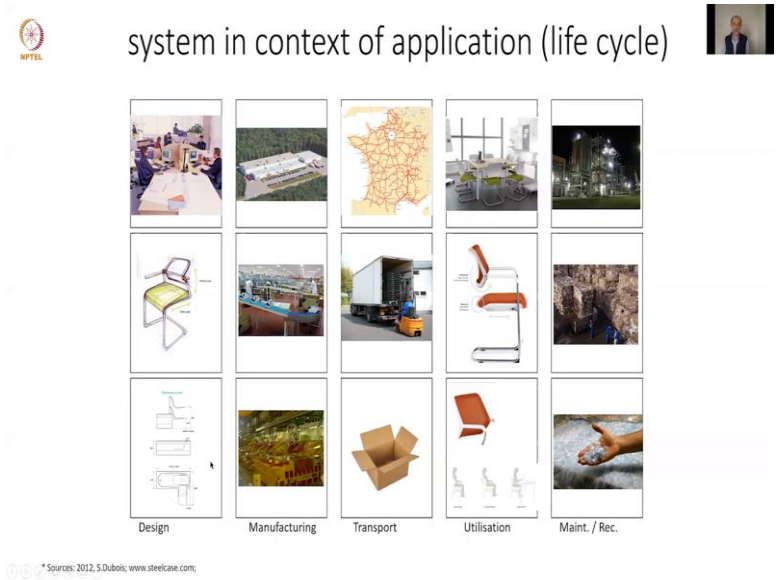

But let us see one more dimension because before we saw just how to use our classroom chair, but the very first slide about system operator is, I told you that there are many dimensions in our system operator. Because if you look at the dimension of life cycle, we can see that the beginning of the life cycle when we designing your chair, this super system, this is a, you know designer and the team of designers who supposed to develop the new design and new kind of components.

When we start manufacturing, the super system is changing, the super system this is a factory, and the process to produce different components, those are the subsystems. When we

deliver our system, we have warehouse, we have a transportation network, and our system is once again, changing, and we have a subsystem like packaging, like components of the chair, and so on.

When a time of virtualization, this is exactly what you have seen in the previous slide description, how do we use our classroom chair or our office chair, and we have different components and here and the utilisation, I would like just to recall to our definition of the technology to remember, it is not enough to have an artifact, we have to have knowledge how to use it and we have to have regulation how to use it. I mean, rules how to use it, and this is exactly the issue not only within utilization, this is an issue in each stage because we have to have knowledge to design, we have to have knowledge to manufacture, and we have to satisfy certain regulation at each step and the transportation and under-delivery also.

But one more dimension, which we can build once again more than 9 screens, this is a maintenance and recycling, because everything that begins everything will end sooner or later. So, when we design our chair, we have to also take into account how are we going to make maintenance and recycling of this one. And once again, the super system for recycling our chairs is not the same as a super system when we use it and the subsystems are not the same as here.

So, in fact, if I just look you have 1,2,3,4,5, 5-dimensions and this is, if I just go back to the general schema of system operator, this is a 5 dimension that we can extend in a deep, in a deep, in the third dimension of our system operator. For the purpose of technology forecasting. First, we use the 1 or 2 dimensions in order just to define our system like it is explained on the example on this slide.

The main idea is to define our system boundaries, in order to predict future without being driven by biases and preconceived ideas based on its function and based on the transformation and supersystem and abilities to produce necessary components and organize necessary interaction. This is mostly all that they would like to share with you today about the system imperator.

Of course, it is interesting to practice it and I believe for some of you who are interested about technology forecasting an advanced course about technology forecasting for strategic decision. When developing your project, you will have a good chance to develop system operator for your technical system. Thank you very much for your attention.