System Design for Sustainability
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Week – 12
Lecture – 02
Design for Sustainability - Engineering Design Criteria and Guidelines

Hello Everyone. So, today we will continue with our Engineering Design Criteria and Guidelines by using the ICS Toolkit.

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So, if you have not already download this particular toolkit that I mentioned in the previous class, please download this toolkit right now. We will try to work on the tool kit together. So, the address that is given over here when you log on to that particular address you will be asked to create a username and password in order to be able to download the file. So, please create the same and download the file and then continue with the video.

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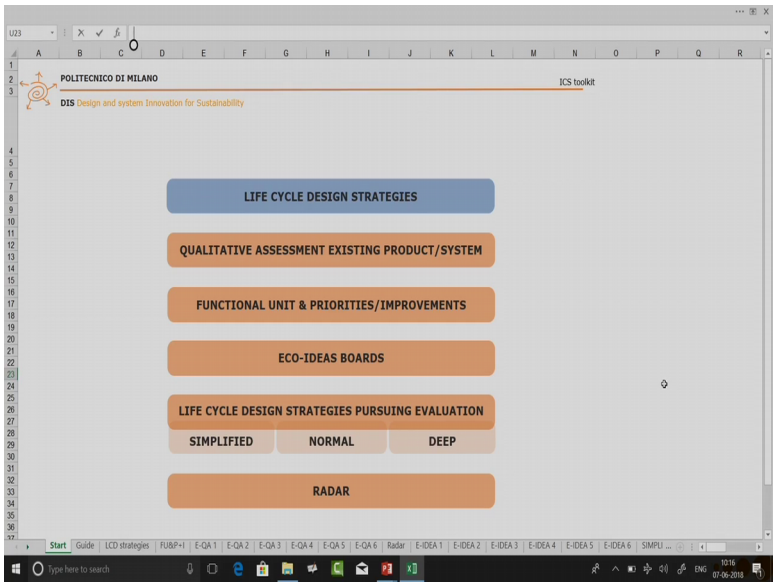

So, let us see how this toolkit is supposed to be used, it is called as the ICS toolkit. So, in this tool kit you can start from the start sheet, so you can see there are multiple number of sheets over here start, guide, LCD strategies, and so on.

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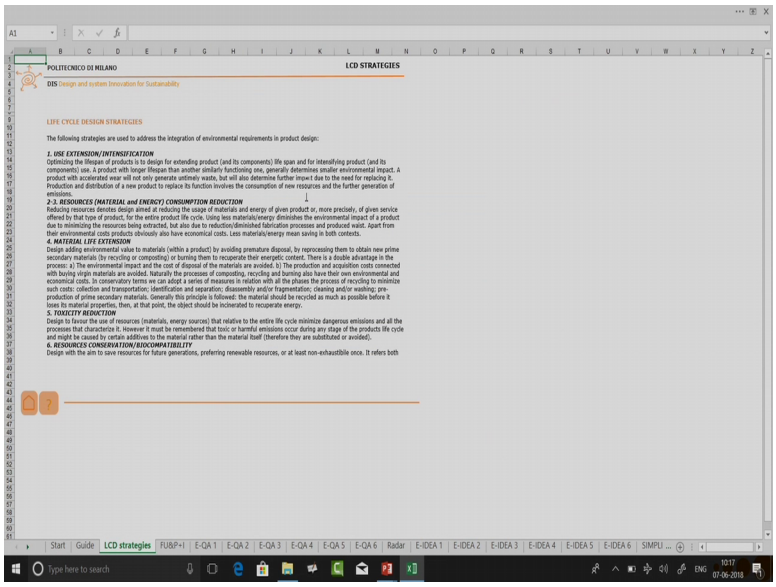

On this start sheet if you click on life cycle design strategies, then you will directly go to that particular page. If you click over here you will come back to this start page.

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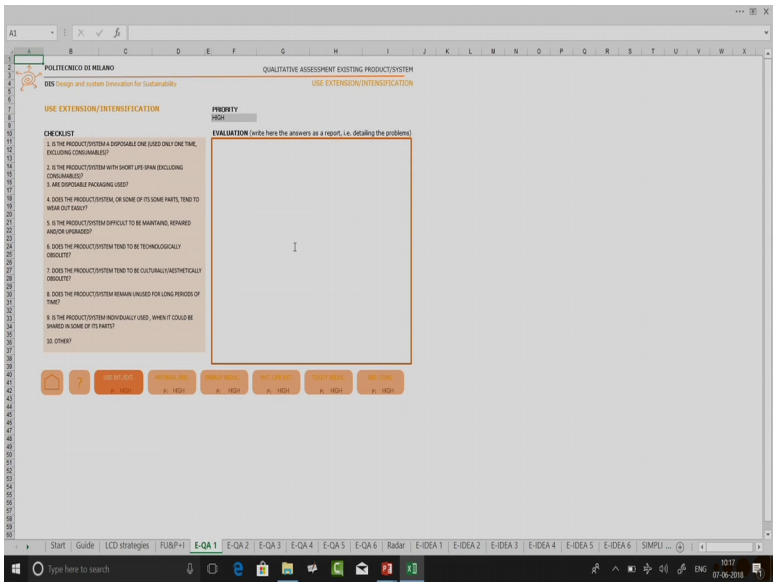

Say I go to qualitative assessment of existing product or system, I directly go to that particular page. If you press the question mark it will download a particular file for you which will help you in how to use this particular tool.

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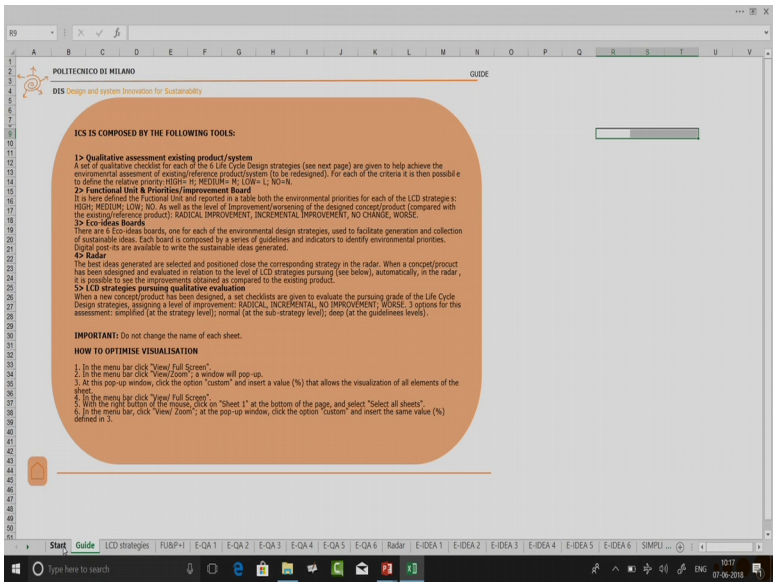

You can also go to this second tab which is called as the guide tab to understand what this particular tool is. So, what all we can use this tool to do is I can go and read about the life cycle design strategies. I can also do a qualitative assessment of existing product,

or system. Then I will set the functional unit and the priorities or improvements, then I have a eco ideas board, then I will do life cycle design strategies evaluation.

The evaluation can be either done by using the simplified in evaluation, normal evaluation or deep evaluation. You can do all the three; you can also select one of them depending on your requirement as well as the time available to you. And finally is the write data diagram which will display you visually the priorities and the improvements achieved. So, let us go to the guide.

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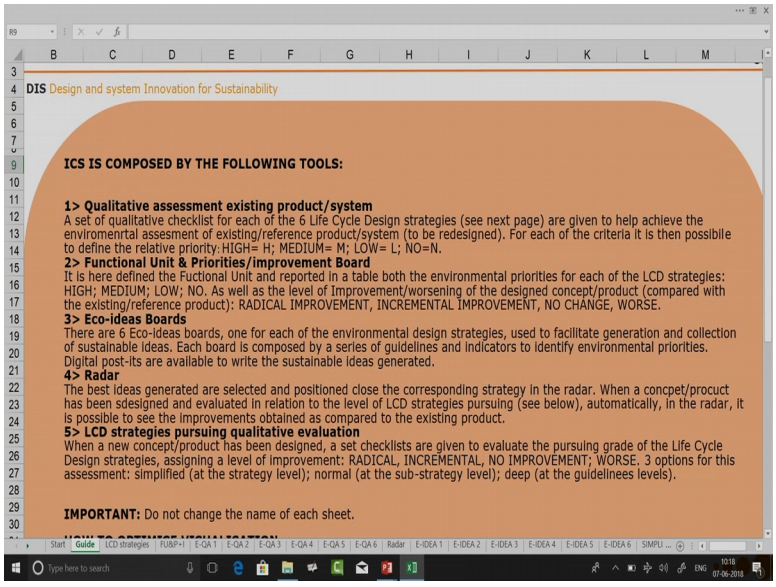

So, if we enlarge this particular guy you will see that it talks about ICS is composed by the following tools. Qualitative assessment of existing product or system, it is a set of qualitative checklist for each of these 6 life cycle design strategies and a given to help achieve the environmental assessment of existing or reference product, or system. The ICS tool kit is only meant for the environmental dimension, as you had already seen in the previous lecture when we are talking about the engineering design and guidelines, we were talking only on the environmental aspects.

So, for each of the criteria it is then possible to define the relative priority I can give a high priority and it stands for H, medium priority M, low priority L and no priority N. Then we will define the functional unit and priorities or improvements board. So, it is here the functional unit will be put on and we will use a report we will use a table to say whether there is a radical improvement, incremental improvement, no change or the idea

has gone worse. Then you have an eco ideas board which presents before you all those criterion, guidelines and by using those criterion guidelines you can ideate on that particular board.

Finally you go to the radar diagram where you select the best ideas generator and you do a analysis of the same. Finally, there is a LCD strategies perusing qualitative evaluation where you do evaluation by saying whether it is a radical improvement, incremental improvement, no improvement, or it is going worse. Again it can be done at the level of simplified assessment which is at the strategy level, normal which is at the sub strategy level deep at the guidelines level. So, when we go into more depth you will know each of this mean.

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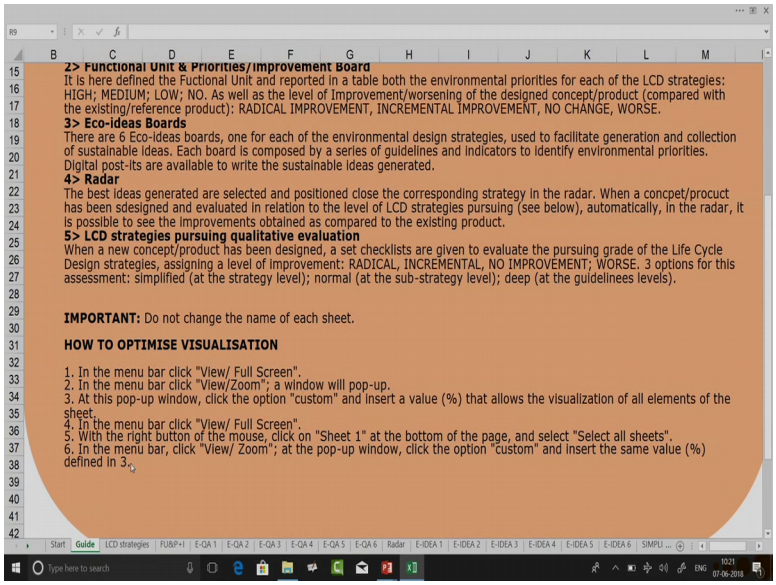

Important do not change the name of each sheets, because the sheets are connected to each other using certain formula. So, if you change the name of the sheet, there might be problems it might come. How to optimize the visualization? It is also very important this is an excel based sheet and you use it in excel only.

Say for example, you can also open an excel file using few other softwares, but the functionalities offered by this particular sheet might all those functionalities might not be available when you open this file in all those platforms. I have not checked it how it behaves when I open it on a mobile platform, but maybe some of the functionalities do

not work. So, it is always better that you open this excel sheet in Microsoft excel on your computer.

So, how to optimize visualization? In the menu bar click view or full screen, in the menu bar click view or zoom a window will pop up, at this popup window click the option custom and insert a value that allows the visualization of all elements of the sheet. Then you can also click view or full screen with the right button of the mouse click on sheet 1 and the bottom of the page and select all sheets. So, these are certain navigations on how to navigate through this particular excel sheet, so this is the full view. So, let us go back to the home page again and let us start with the first step which is life cycle design strategies.

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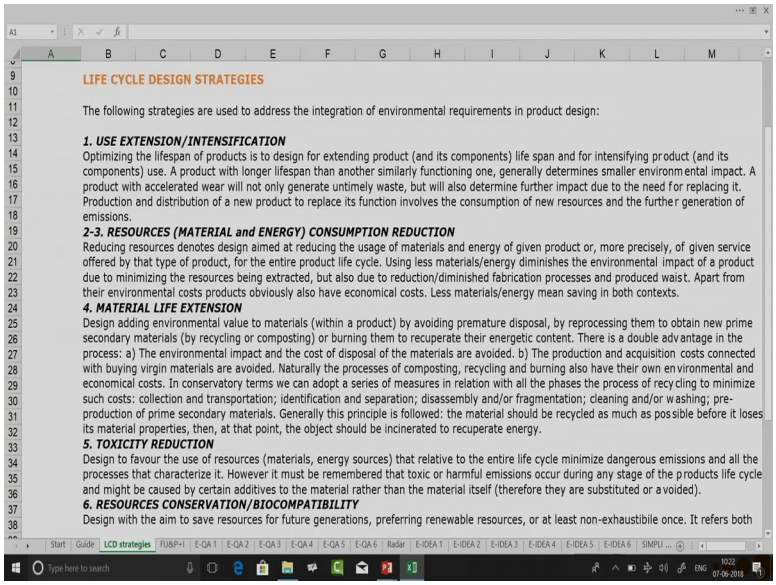

So, yesterday we discussed 7 strategies for the same.

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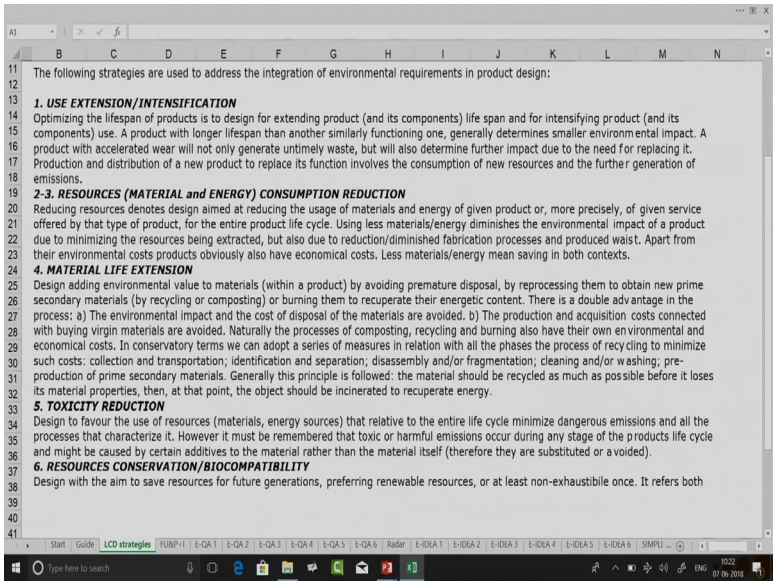

Here they have been grouped into 6, because I have combined in this material and energy consumption reduction together. Whereas, in my slides presented in the last lecture they were separate groups and elaborated in that.

So, my first strategy is used extension or intensification; optimizing the lifespan of products is to design for extending product and it is components lifespan and for intensifying product and it is components used. A product with longer life span than another similarly functioning one, generally determined smaller environmental impact. A product with accelerated wear will not only generate ultimately waste, but will also determined further impact due to the need for replacing it.

Production and distribution of a new product to replace it is functions involves the consumption of new resources and further generation of emissions. Hence we should target use extension, or intensification. When I say extension I mean, extending the period of time over which it can be used or intensification means over say a period 10 years when the products good life span I do more usage of it. So, per day usage can be increased something like that.

Then the next one is resource that is both material and energy consumption reduction. So, reducing resources denotes design in that reducing the usage of materials and energy of given product, or more precisely of given service offered by that type of product for the entire product life cycle. So, you have to consider the entire product life cycle from

pre production to you have to also consider the design and development phase of the product.

So, the next one is material life extension. So, design adding environmental value to materials within a product by avoiding premature disposal, by reprocessing them to obtain new prime secondary materials by cycling or composting or burning them to recuperate their energetic content. Then comes toxicity reduction, where again you are talking about toxicity reduction both in terms of material and energy sources, then the last one is resource conservation or biocompatibility.

So, design with the aim to save resources for future generations preferring renewable resources or at least non exhaustible ones. So, once you have read through this, you can keep on coming back to this particular slide depending on your requirement. Let us go back to home again. Now, I will go to the next step which is qualitative assessment of existing product or system.

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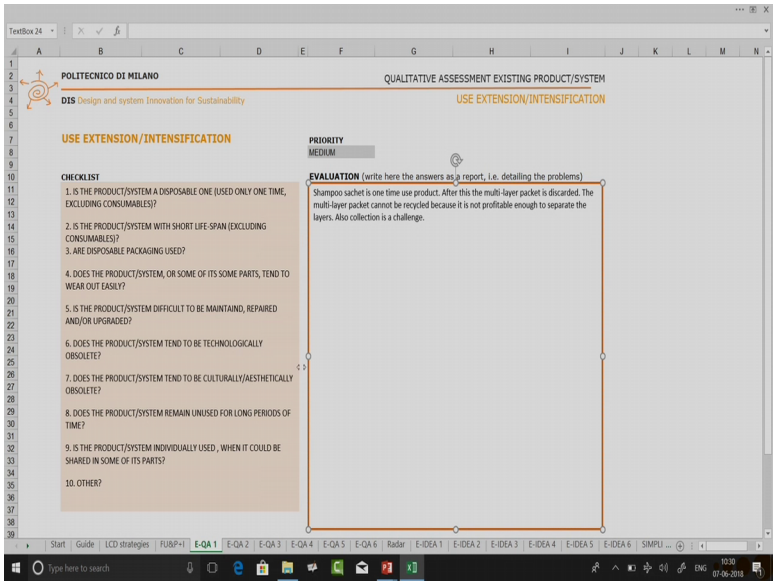

So, if I see this particular board it says use extension or intensification, first I will have to set a priority. So, when you click here there is a drop down menu you select one of these priority levels, not necessarily you have to select the priority first and then you do the evaluation you might also type the evaluation and then you can select the priority level.

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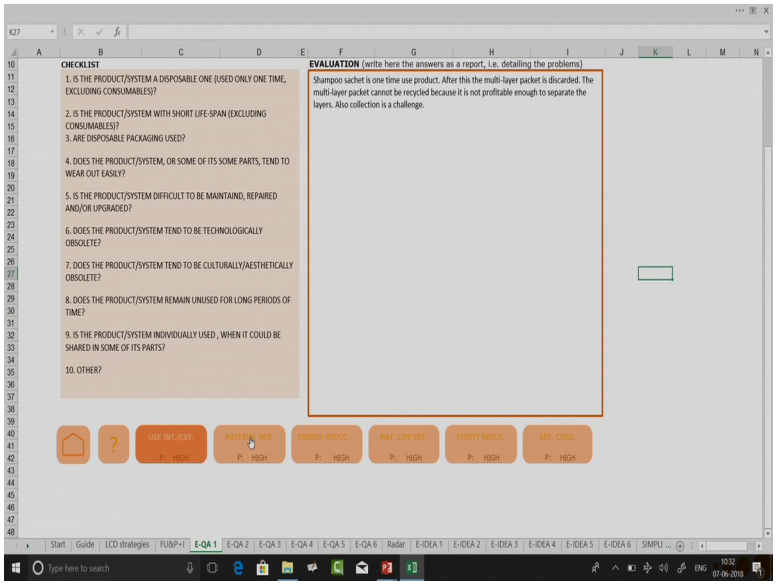

When you select the priority level, so when I selected low you can see in this particular box it automatically got selected. Say I am selecting medium the priority change, you are not supposed to change anything over here this will change automatically. This is my first sheet in which I am trying to do a qualitative assessment of existing product or system.

When I want to go to the next sheet this is the next sheet, I will have to click over this and I go to the next sheet, I can click over here again and I can be back to the sheet. So, this is how you can navigate between the 6 checklist, 6 criteria items to do this qualitative assessment of existing product or system. Now here at the checklist questions which helps you to do an evaluation of the existing system or number.

So, say the first question is; is the product or system a disposable one used only one time excluding consumables? Say for example, injection syringes that is a onetime use product, it is a disposable product; say shampoo sachet, the sachet is a onetime use product. So, after that one time use you throw it away which means it has very low amount of usage, so you answer these questions. So, in case I am doing it for a shampoo sachet I can say that shampoo sachet is one time use product, after this the multilayer packet is discarded.

You can also add extra information say for example; the multiplayer packet cannot be recycled, because it is not profitable enough to separate the layers. Also collection is a challenge.

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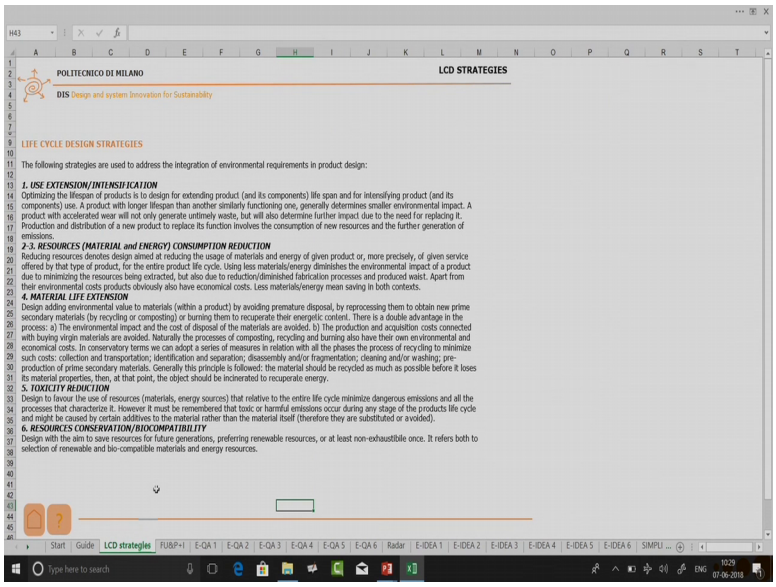

When I go to the other criteria for qualitative assessment so let us see this LCD designs. So, you see we have used extension intensification I have resource of material and energy consumption. I have material life extension toxicity reduction and resource conservation of biocompatibility.

So, there might be situations in which I can put some of these statements in those pointers also, but when you start writing down it is advisable that you start writing down all the problems that you see. May be on next question level where you can answer something similar, you will again put it down no harm in doing that. So, I answered my first question then I have my second question is the product or system with short lifespan excluding consumables?

So, the difference between the first one is here I am disposing off here, is it with the short lifespan. So, the product is made in a manner that it has is very short lifespan say for example, I have a mobile phone, it is designed in a manner with certain kind of components which have very short lifespan. So that can be a particular answer to this question if you are doing this analysis for that kind of a system, Then are disposable packaging used?

So, again you can see if I was doing the same for shampoo sachets. So, question 1 and question 3 are related. Does the product or system or sum of it is parts tend to wear out easily? So, you can see these questions are related to all those criteria that we were discussing in our previous lecture on the what can make a engineering design criterion guidelines list. You also have something called as others because these are just guidelines and it might not suit for all your purposes.

Say for example, I am talking about agricultural machinery. Now, in that particular context everything is about the product or the system, but say what about the result that particular machine is producing. If you do not find that any of these questions are trying to target the results produced by the machine then you can and those questions in the others. But those question should be related to use extension and intensification. Once I have completed my evaluation over here I will give it a priority level. So, I realize that the priority level over here is very high. So, I change the priority level.

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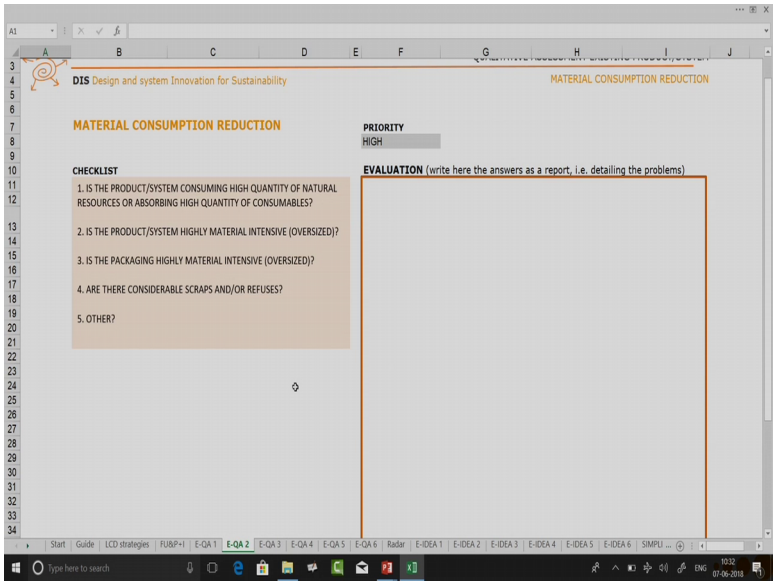

Now, let us go to the next one which is material consumption reduction. Again it follows similar kind of hierarchy by default all of these priorities are set at high.

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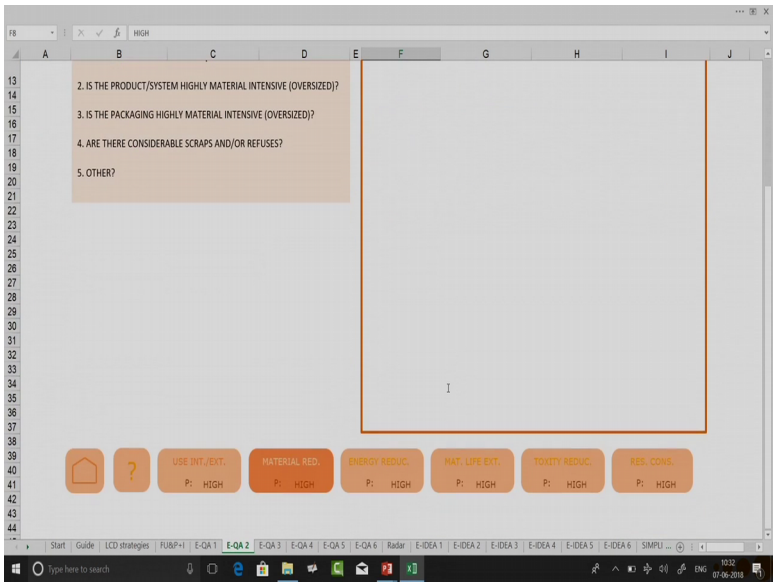

So, you have to go everywhere and change the priority after you have done your evaluation. All of them follow the same structure they have certain checklist questions and you have a question others. You can also open up the presentation that contained all the engineering design guidelines and criteria. Some of those questions; some of those trigger points can help you also in identify more questions in the others category. So, after I have done for material consumption I will go to energy reduction board, similar strategy once energy consumption and reduction is done then you can go to.

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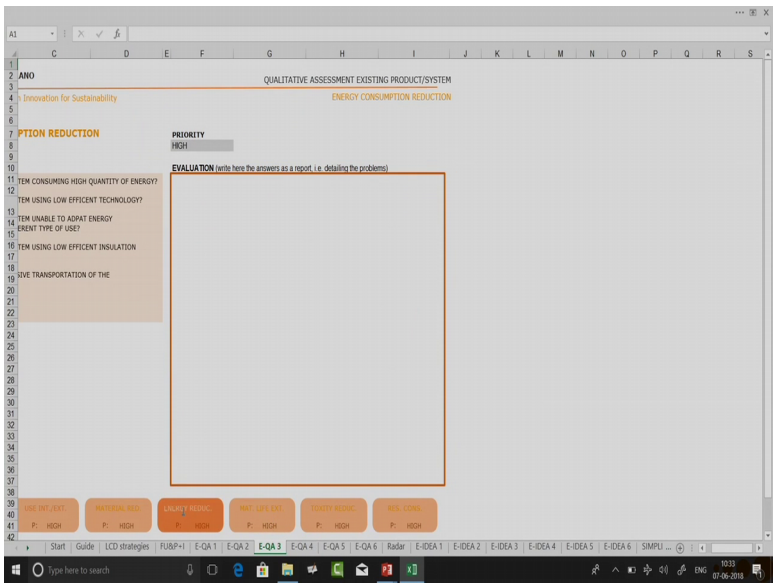

So, you can see because I am on this energy reduction phase this one is highlighted in a different color as compared to this one. Then I go to material life extension, then I go to toxicity reduction. Let us set a different criteria level different priority level over here let us say I give a priority level of low, and here I give a priority level of in resource conservation of biocompatibility none.

So, now you can see I have a high, high, high and a low and a none. Let us also change the criteria over here let us keep it a medium. So, after I am done with this whole thing. So, say I am I have reached over here then what I can do is again click on the home button. Once I click on the home button I will be directed to go to this third step.

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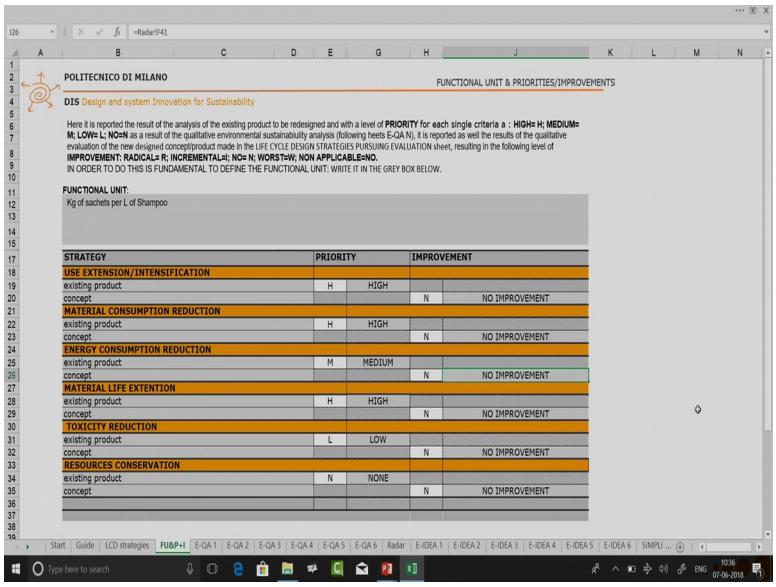

So, in the third step it is a setting up your functional unit and the priorities improvement. So, what is the functional unit? So, it is the unit on which you are going to do your measurement. So, like we had already discussed in our life cycle design strategies how to set a functional unit. You can set a functional unit you can also set declared unit. So, you can go back to the lectures to understand a function unit, or a declared unit. So, let us say kg of sachets per liter of shampoo. So, I declare that that is my functional unit.

Now, you can see that I had said this priorities they have already been populated over here. Because they are already populated over here you should not make any changes to this particular place, you should not also these are all formulas set over here. So, do not make any changes. Also this should not be a change because it is not here that you make

the changes, you have to go to the appropriate slides where you make the changes after doing analysis. So, as we discussed we have eco, we have a life cycle design strategy evaluation step, so the when I do an evaluation over here.

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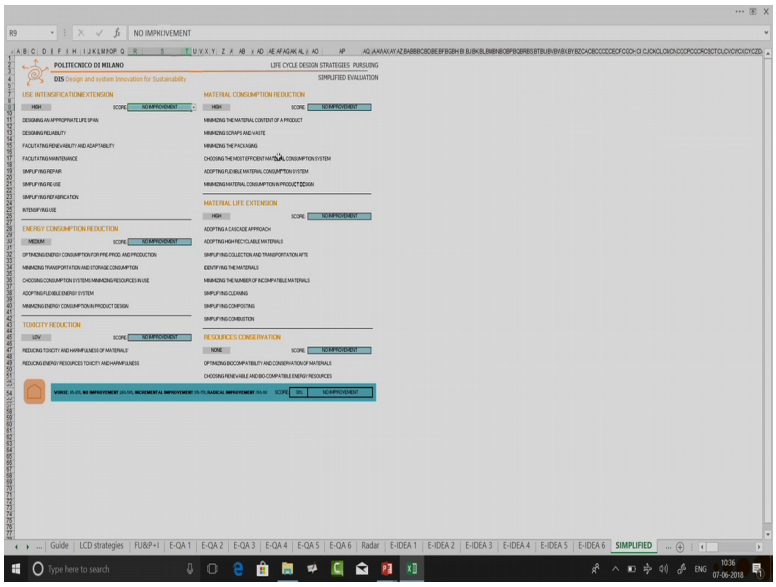

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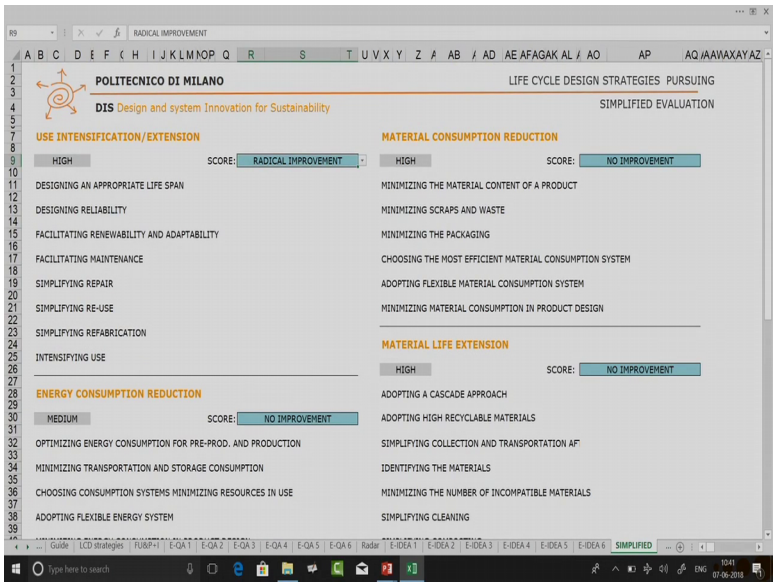

So say I want to do a simplified evaluation. So, when I change this criteria say I change this criteria to radical improvement. Now, let us go back to the functional unit and priorities.

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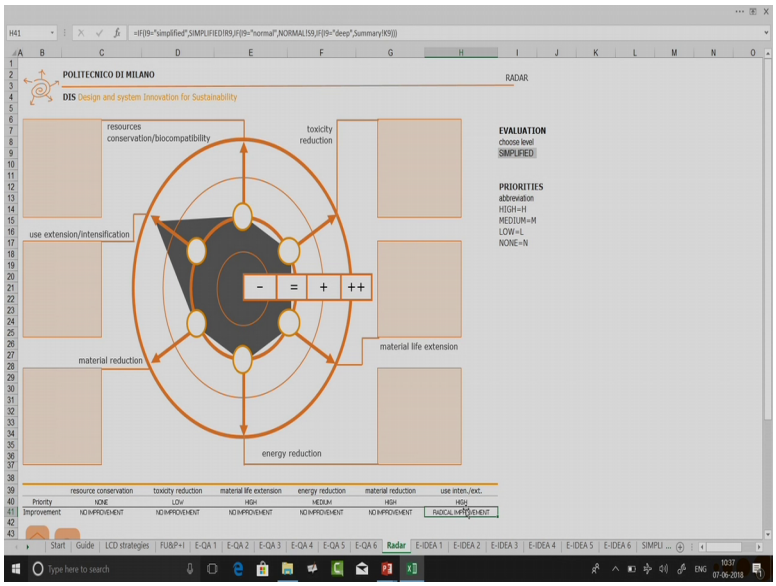

So, when I go to this particular radar diagram I can select the evaluation level, because I change my data on the simplified level. So, when I select the level over here as simplified I get my data for use extension and intensification which I had said that I have got a good level of improvement. So, you can see this has been populated already a radical improvement in use intensification.

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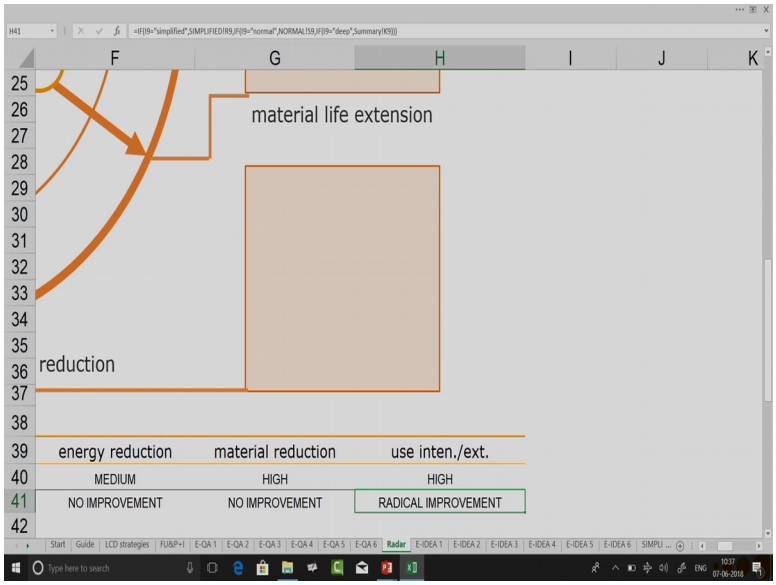

So, let us go to the eco ideas board.

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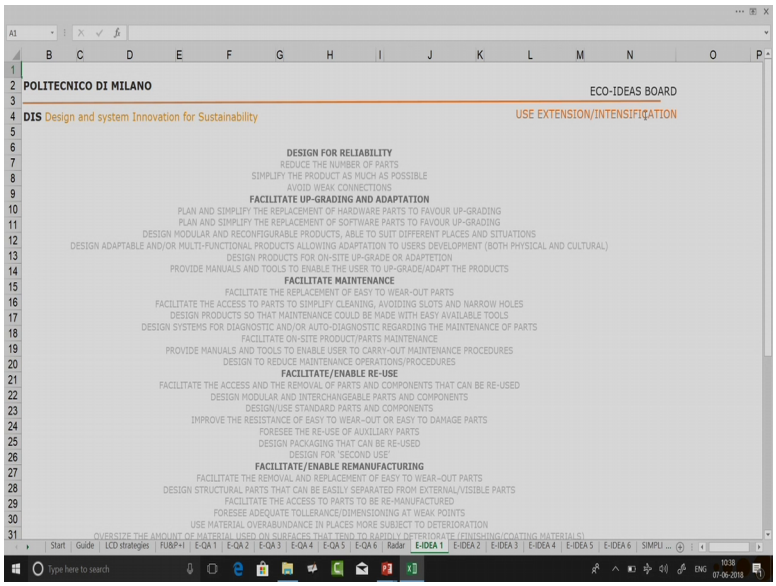

In the eco ideas board you have 6 different eco ideas board. Each eco idea board is for one of the criteria that is used extension or intensification.

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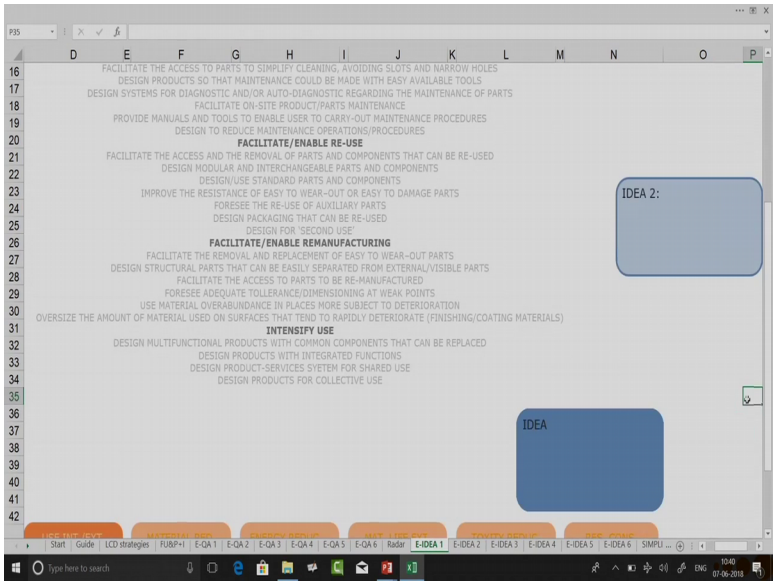

Again the same strategy is followed over here I am highlighted by this. I can go to the next board which is from material consumption and reduction. So, all your criteria you can also navigate through this board when you become more comfortable you will know which one to click.

So, you can see all the criteria that we discussed in the engineering design criteria. They are criterion guidelines, they are all listed over here and here you have a box for idea you can create more boxes for ideas that does not affect the program in any particular manner. This is just an idea board it does not transfer any information any data to any other sheet. What this sheet helps you is at a glance see to use intensification and extension I had given a high priority. So, I will have to have lots of ideas in a manner of criterion which I have high priority I should have more radical improvement.

Let us say I want to while I am trying to do generate ideas. I want to go back to my slide, this slide where I had done evaluation against that criteria you can always do that by using this particular channel. Unfortunately over here there is no way to go back to that particular in a board, so you have to do this. So, you can come here read here evaluation and again go back to this particular board and do this activity back and forth.

Also there is no relationship there is no sequential relationship that you have to do this EQ A 1 first and then EQ A 2, you can do it any sequence you can also do EQ A1 first and then you can go to the e idea one generation and start doing idea generation. So, it is not required to be sequential. So, here you can double click and try type your ideas, I can also copy paste this and I can have my idea 2 for this particular criteria.

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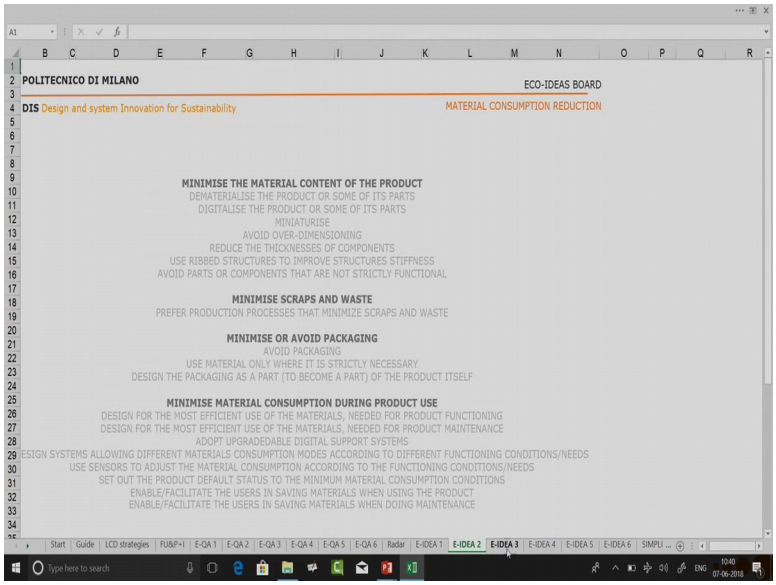

Once done you will go to E idea 2, E idea 3.

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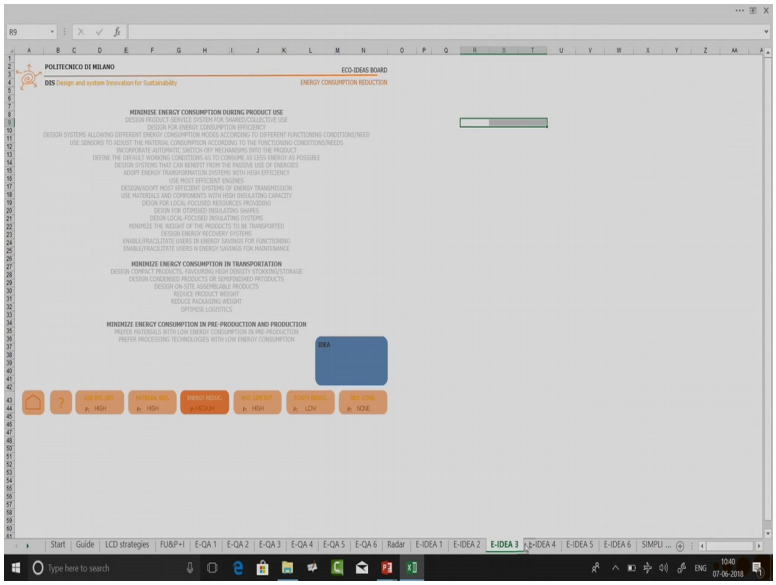

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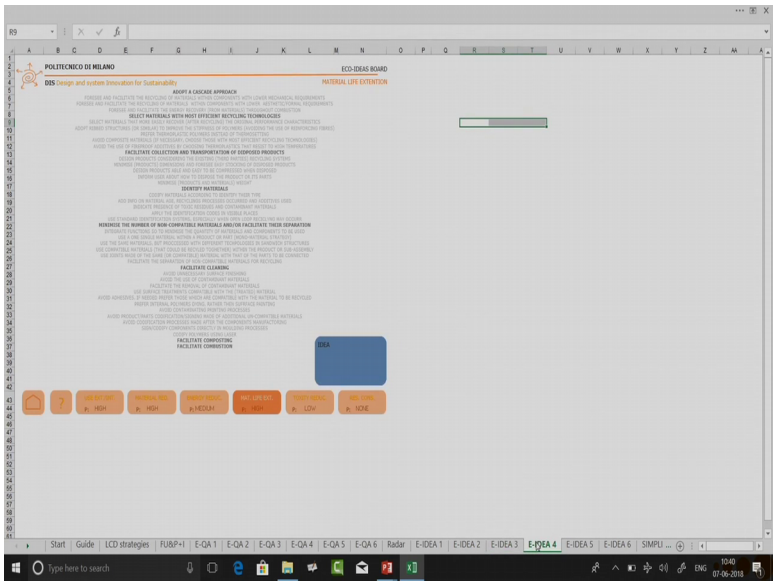

And repeat this particular process.

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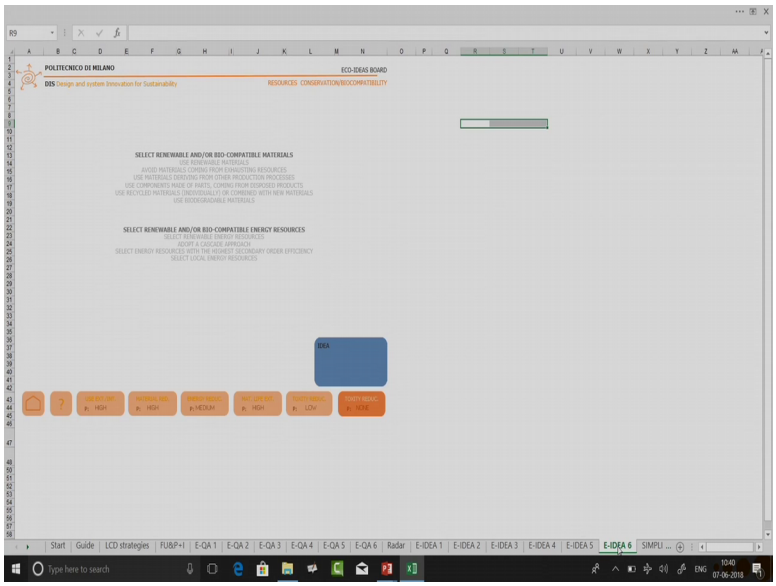

Once you have generated all the ideas I can go back to home again then I will have my I can do this evaluation on simplified normal or deep. Let us see what simplified is? So, if you see this particular chart, here it has automatically populated what priority I had set for each of those criteria. So, I have high, high, high, medium, low and none.

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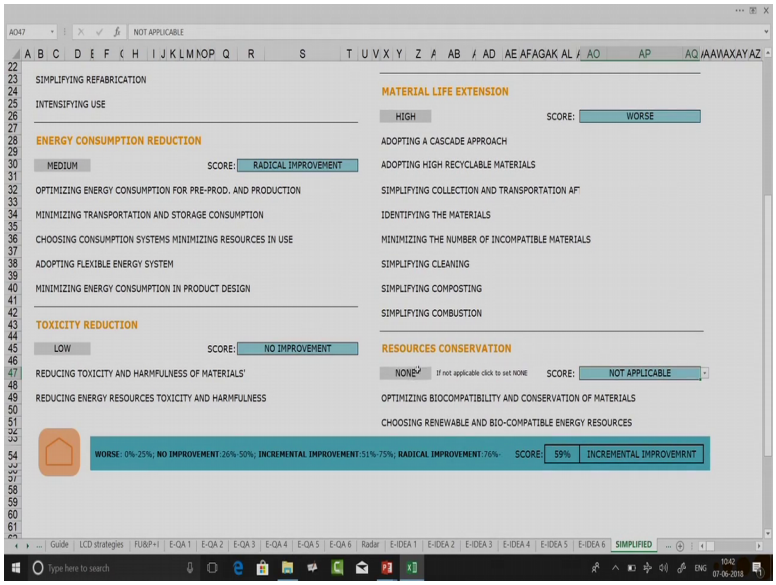

Now, what I can do is I can say what kind of improvement I have brought in.

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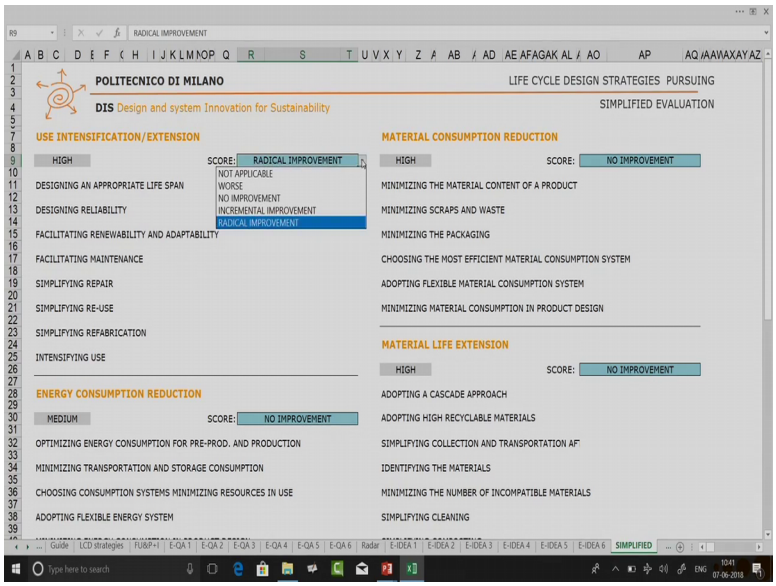

You really do not need to populate anything for these things. So, you are doing a very simple analysis, you have doing an overview analysis. This one is a very qualitative analysis, and very overview level, you just do not think too much into depth of each and every component, you are also not getting anything in terms of numbers.

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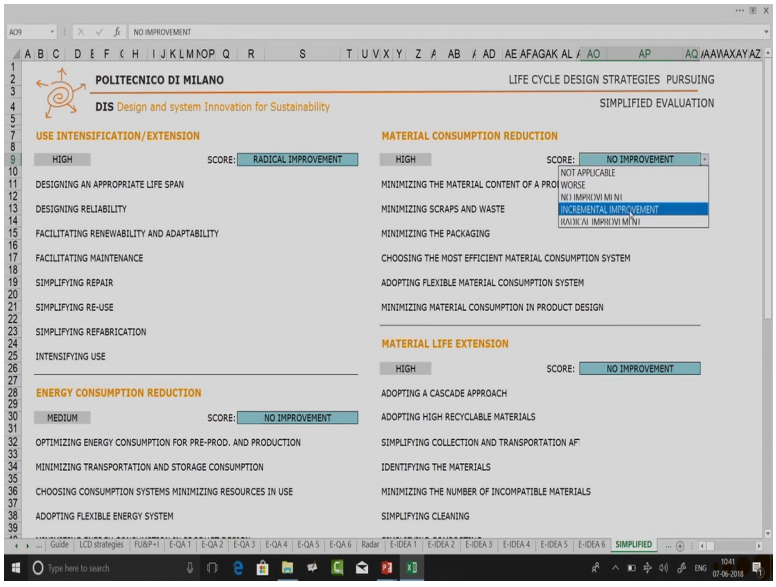

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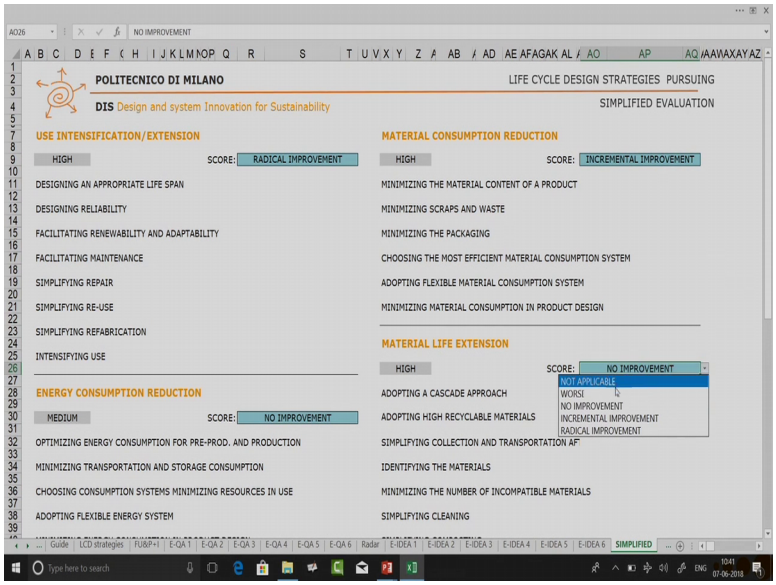

So, let me say I got radical improvement over there; I got incremental improvement here, I got worse over here which is not very a good situation where you have given high priority. Then I say this was radical improvement then I say I brought in no improvement in this particular case you can say not applicable. So, not applicable can be used only when you have none over here. In case if you have put anything other than none over here, you should not say not applicable. Then I will again go back to home and I will go click on my radar diagram.

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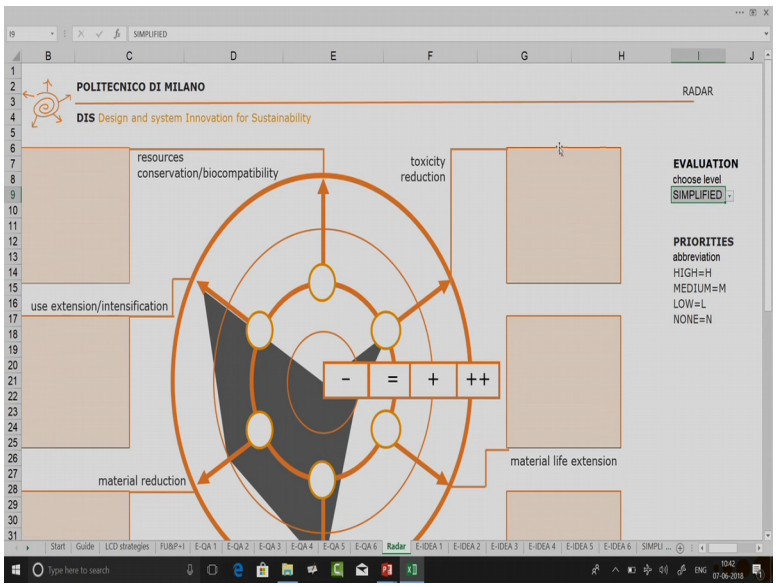

Here at that level, so here at level you select simplified because I have done my simplified evaluation. So, if against each of them you can see if there was a priority high. So, this outside circle is meant for priority high, the inside circle is meant for priority medium, here I have low priority, and here I have low prior ok. Sorry I made a mistake.

So, these circles are meant to show what is the improvement level which has been brought in. So, the outside circle tells about in a very radical improvement, the next layer of circle tells you incremental improvement, this one tells that there has been no improvement, and this one is for getting things worse.

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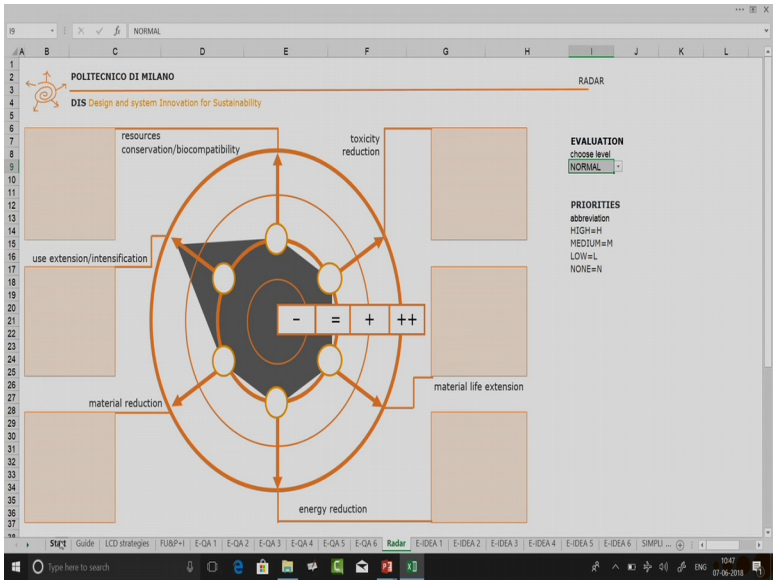

So, you can see that, so if you see here for use intensification you had given high priority and you have got radical improvement. So, if I go to use extension I had a given high priority, and on that I have got a radical improvement. So, my radar diagram is somewhere over here. In case of material reduction I had high and incremental improvement so my radar diagram is at this particular point. Say for example, for the resource conservation which is over here, I had said it is applicable and I had given low priority also.

So, as a result this radar diagram pointer is at the center because it is not applicable, so you get a very visual picture for showing the qualitative comparison, if we go back to home again. Because now we want to do now we want to do a life cycle design evaluation on this normal.

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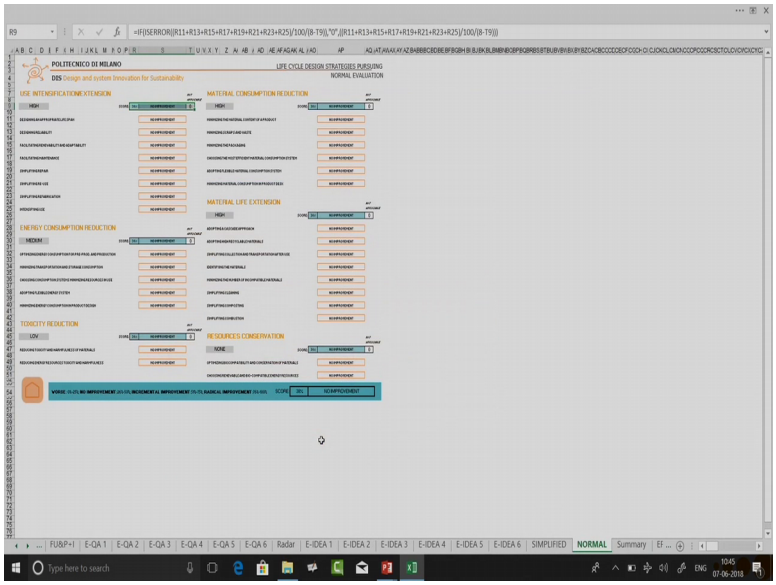

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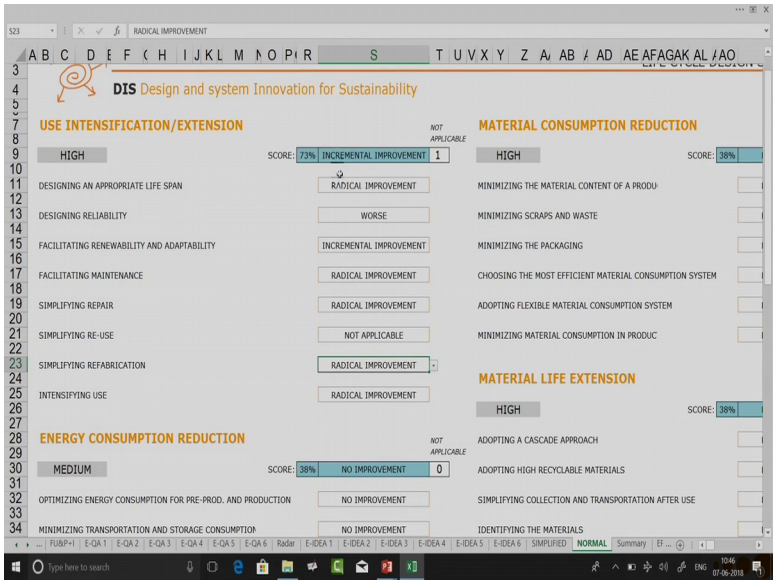

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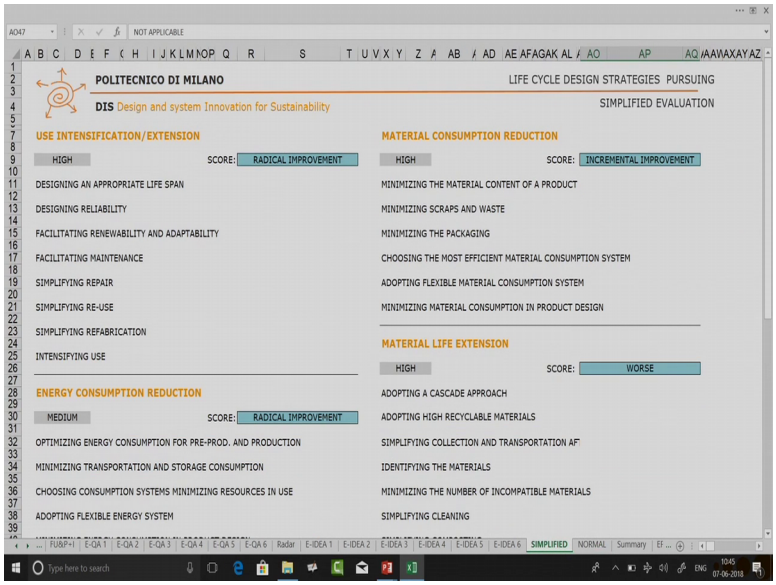

So, in case of simplified what you saw? You had the criteria, so I have my criteria I have all my guidelines and I am not scoring against each guidelines. I am scoring at and an overall basis. In normal what you try to do is you try to score each and every sub criteria also. So, say I got radical improvement here, I got worse over here, I became incremental improvement, I have radical improvement, I have got again radical improvement, I got not applicable in this context, worse, and no improvement. So, here you can see you have got 55 percent, say if I made it radical improvement, radical improvement it already increase to 73 percent.

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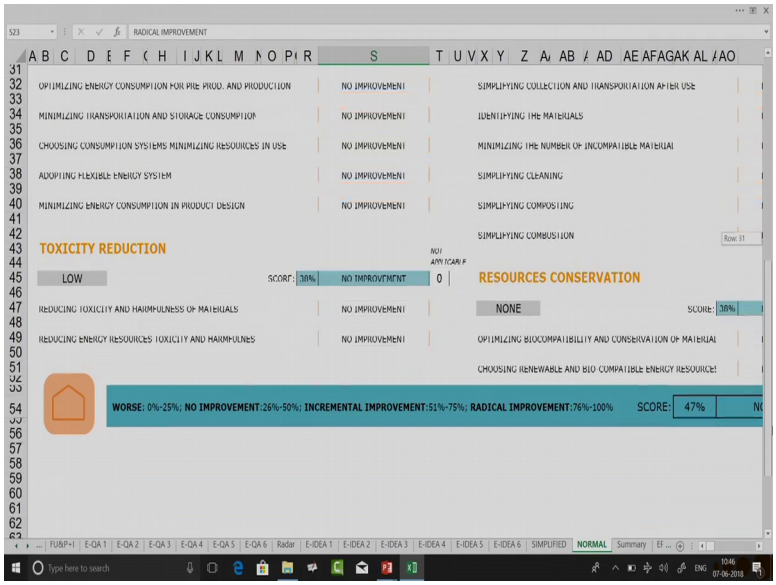

Now, how do you qualify that one? So, here there is a score chart it says if your score is between 76 to 100 percent, you can put it as radical improvement. So, here you can see my score is 73 percent, so it is a incremental improvement, say I change it to radical improvement. So, automatically because it became 75 percent here, score over here overall score got to radical improve. So, in normal mode you are doing at the sub strategy level as well.

So, you repeat the process for each and every criterion, then when I go back to home let us go back to the radar I will select over here normal. So, I will get a different kind of radar be careful because in this particular context, you can see that by default all of them are filled with no improvement. So, that is why no improvement, so by default values are already filled. So, even when you go to this radar for normal you will always see that if you have not filled something it is at this particular level. So do not get confused because it will happen, so because it is automatically filled with no improvement everywhere. Then let us see the deep evaluation.

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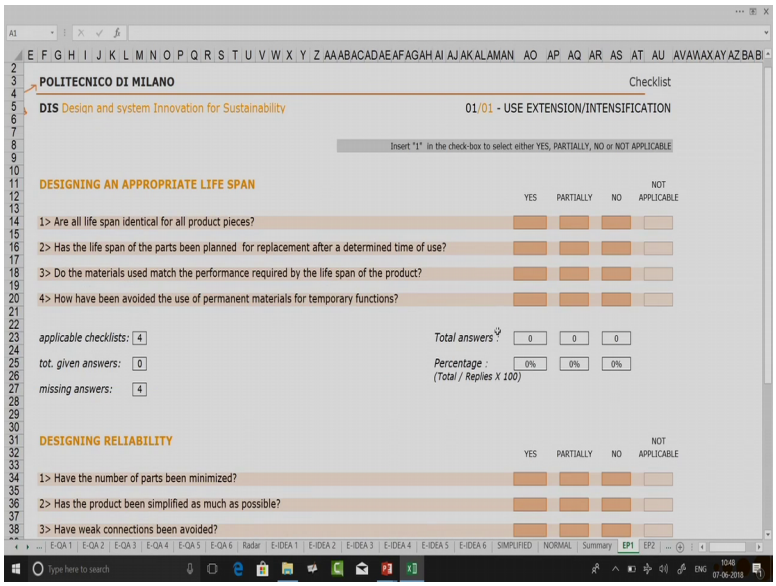

So, the deep evaluation as the name suggests is really in depth evaluation. So, for use intensification you have one chart. So, you have 6 different charts for this one chart for each criterion, so then I have my sub criteria, designing an appropriate lifespan, designing reliability. So, all my sub criteria's are mentioned then my questions are mentioned. So are all life one identical for all products? So, I can say yes, I can say

partially, I can say no. So, if you insert one in the checkbox to select yes then it means you are saying you are giving score to 1 yes, so I said 1 over here. So, you can see that total answers and the percentage of yes is 25 percent.

Let us say this one was completed partially only this was completed at the done yes and here I have a no. So, now you have total answers. So, you can say applicable checklist is 4, total given answers is 4, so this should tally once they tally you know that you have not made any error. You cannot have yes and partially yes in case you do something of that you have this missing answers 1 minus 1. So, your number of questions and total given answer should match. Now I know that I have got 50 percent on yes, partially on 25 percent and no 25 percent.

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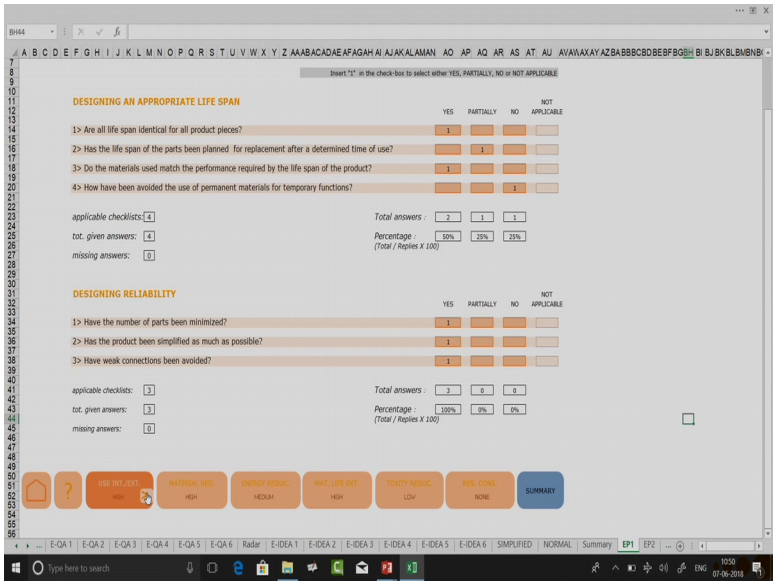

Again let us fill up this one. So, once this whole chart is filled up, we can go to the next chart.

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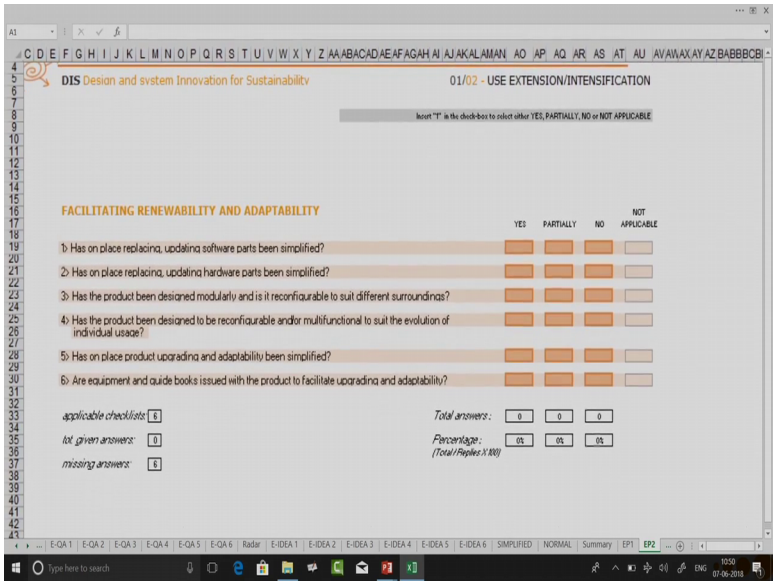

So, you can see there is an arrow over here. It takes you to the, because there are lots of sub criterion each one of them needs to be met.

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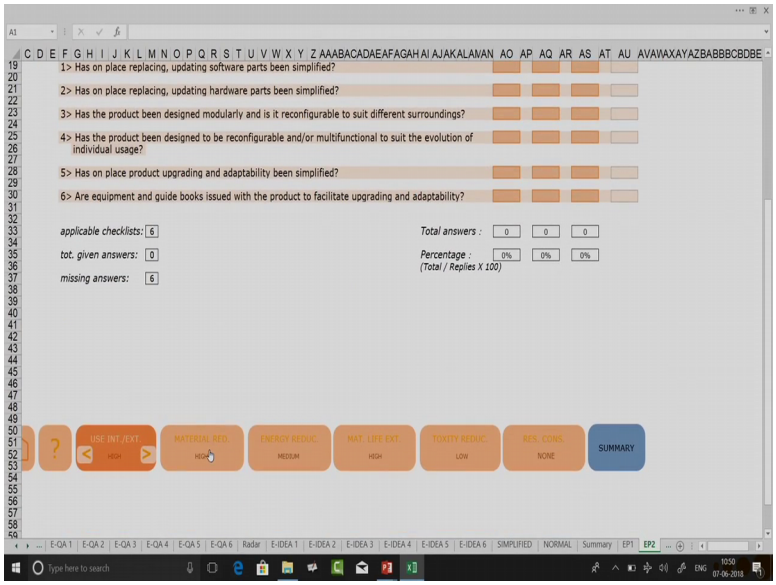

So, in this particular case rather than going to this board, if you got is this board you will go to the next criteria you will not be going to the next sub criteria. So, you should click on these arrows, this showing me that there is one sheet or maybe more sheets over here. This shows that I have more sheets on this direction.

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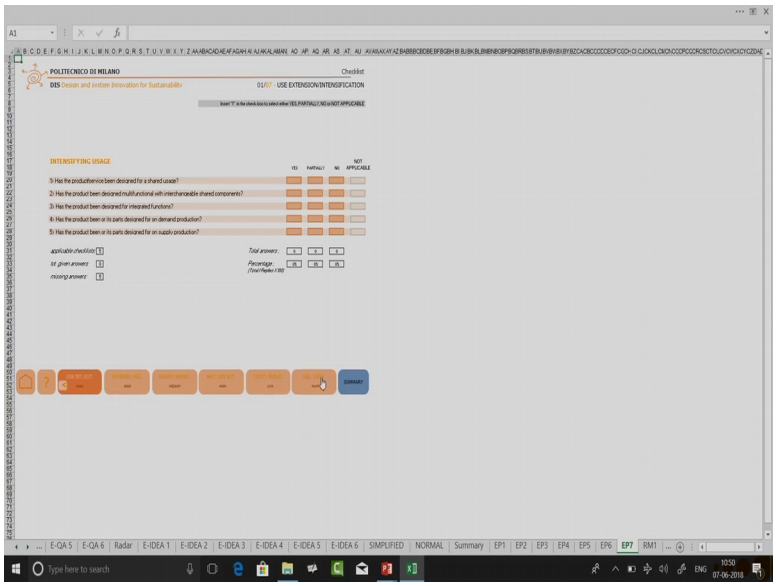

So, when all my sheets are completed, you do not have anything over here. Then you can go to the next one and similar strategy will be followed.

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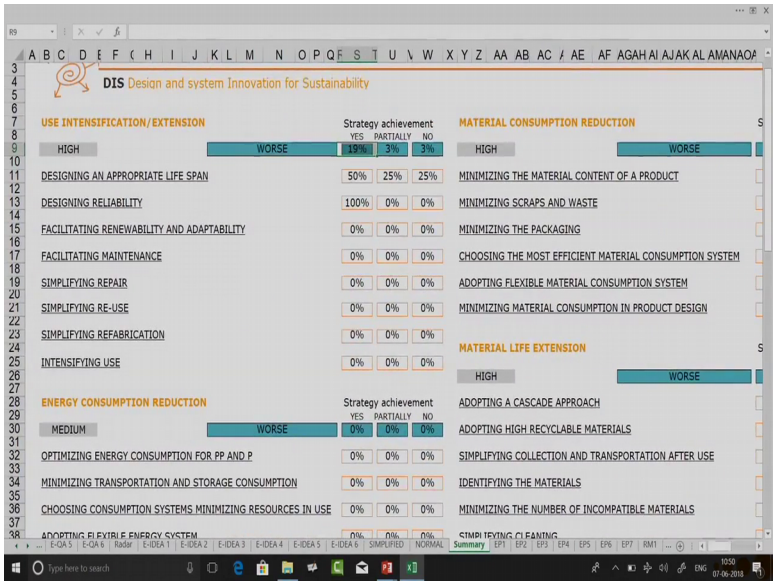

Once you have completed everything you can go to the summary sheet. So, here the data is automatically populated, so you can see because I filled up something over these places. So, automatically it is saying because there is 19 percent yes, partially is 3 percent and no is 3 percent. It is giving a judgment that it is worsening of the situation. Again you repeat the same process.

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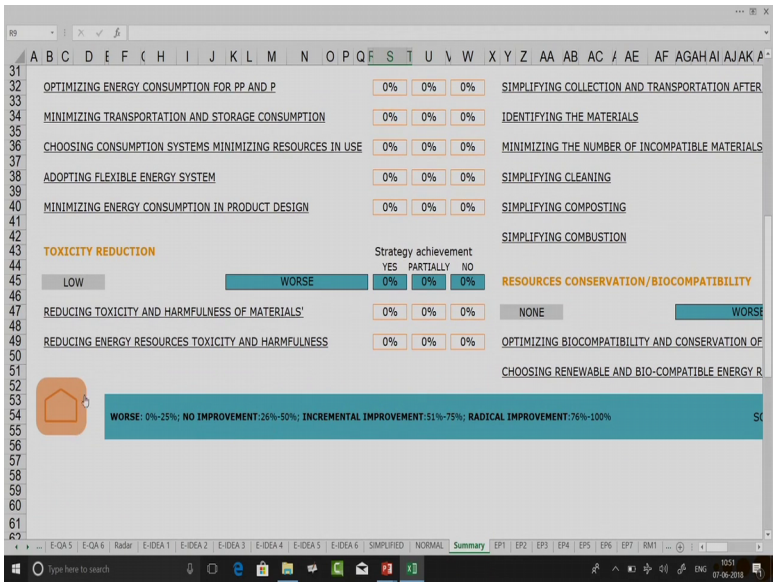

So, once this whole chart is complete, you go to the radar diagram, here you can select deep and you can do the analysis. In this particular context everything is set to 0 0 percent by default which means worse.

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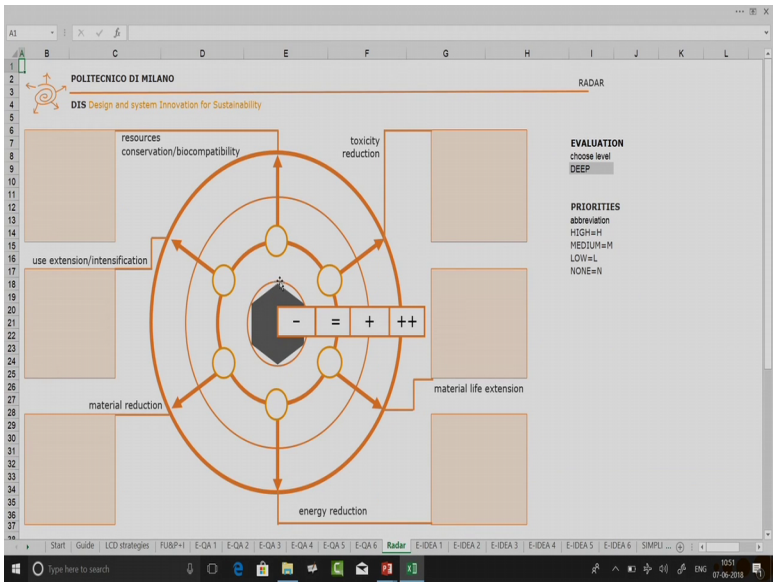

As a result you can see that this kind of a diamond, this kind of a hexagon will be visible to you on the radar diagram. If you have not done any modifications to it, so this completes how to use this particular toolkit. And I hope you can you some of these aspects and see how you can bring in environmental improvement to your product or

system design. Please remember that this tool kit is only meant for environmental aspects. So, it is a life cycle design strategy so, it is in connection with are in our lectures that we did for life cycle design strategy. The other lectures that we did were quantitative analysis.

So, quantitative analysis has its own advantages, but it does not help you to design at that point of time. Whereas this one helps you to design because it gives you so many checklists, so as a result it becomes a very important tool to be able to design. If there is no escape from the quantitative calculations after you have completed your design, you should always go back and do a quantitative analysis.

Another thing which I missed on towards this in this radar diagram you can again see these boxes. So, you can write down in this boxes also like what was your main design features or main design interventions that you did in order to get the toxicity reduction. In case you do that then this page can be very easily printed. So, this page is already set with printable area, if you remain within that printable area you can very easily print this page and put it into your report.

So, now we have already come to an end of our course. So, in our last lecture we will do a summary of all that we have learned till now. And we will also try to see all the connections which we can now more appreciate because we have learned a lot more about sustainability and design for sustainability.

Thank you.