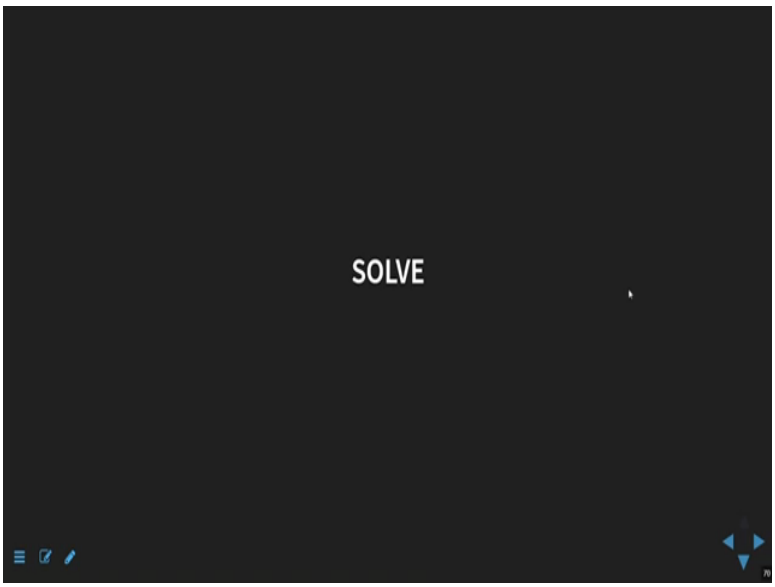
Design Thinking A Primer
Professor Dr. Bala Ramadurai
Solve - Lecture 01

Hello and welcome back to the design thinking course that we have, it has been a fantastic last few weeks with you. Now we are going into a very very important part of design thinking, a very exciting portion of design thinking, we have looked at two stages so far first was we got into the shoes of the customer or the user who are you are trying to help that was the empathize, you got to know them personally, you got to interview them, you got to know what they were going through that you can help out with.

The second was analysis, analyze where we found out with two techniques that we went through with 5 why the multi why or the why why technique you keep asking series of why and we found out what is going on at a root cause level, at different levels what is going on with the customer, why is it that they are going to such a problem, why is it they are in that state where they need help from people like us?

So the next was to see okay now that I have found out what is it that is causing that, how can I think about it as a conflict between two parties, two things, a thing a human and a thing or a between two humans. So what is that person A wants something and person B wants something else, how do we look at this it from this perspective from this stand points from how do we understand both these stand points?

(Refer Slide Time: 2:07)



Still we are helping out one person but we need to understand the other person's perspective also. So this was what we did so far, so great we found out what is going on, but we need to solve it. So this is the third phase of design thinking and we are going to embark on a solution and this has to address the conflict so whenever you come up with an idea, you generate an idea, discussing with your friends, discussing with your colleagues, looking at reading up some material or you sitting under tree and waiting for the apple to fall and an idea pops into your head, so be it grab that idea, the best piece of advice I have for you at this stage is to write it out, to externalize too.

So that the part of the brain that is working on the idea is a super-fast genius who takes things so quickly and rapidly and can help you out with that, that is the guy inside your visual part of the brain and for that person to get triggered you need to write things down, write it on a piece of paper, you do not have to be high-tech, you do not have to take the latest gadget and write it on, you can write it on a piece of paper even that is great. So write it down, write down the ideas that is the main take away from this method this state in design thinking.

(Refer Slide Time: 3:37)

So solve is where we are at, so I am going to take you to a place far away in time and far away you probably have viewing there, I do not know where you are viewing this video from, but we place that we are going to talk about a story is set in this place on your screen right now, can you take a guess where this could be? Quite easy actually given the way the people are dressed in the photo and the way the snow is all around then there are forest, there are all sorts of like a thick dense forest, yeah that is right you guessed it right, it is Siberia in Russia.

And the time period around which this photograph was taken was in the 40's so that is where my story begins and I would like you to take another guess, now that you have come with me so far you guessed so well where this place is, I would like you to guess one more thing, what kind of a place are we looking at? Is this a bus stop, is this a railway station, is this a port, is this a frozen lake, what is this?

Take a moment to think about what kind of place are we looking at? Any guesses? No, not quite, this is a prison this is a prison, it does not look like it, no high walls, no you know machine gun barring down people, soldiers around, none of them, this is a very unconventional or let me say this was a very unconventional kind of prison, this was the Gulag prison very infamous in the good old days for the fact that it was extremely torturous place to be in.

In fact the fact that you do not see walls my guess is that there is nothing for 100's and 100's of miles around this place so even if someone would were to escape probably the warmest place that is there and for 100's of miles is the prison, so you are better off in the prison than

out there somewhere trying to just survive in this bitter cold I do not know minus 40, minus 50 degree Celsius is not a pleasant condition, so you better off back in the prison.

So my story starts here (())(5:44) 40's 1940's a young inventor by name Altshuller was in prison in this prison, okay so let us go to (())(5:55) times I mean better times this is a sombre place. So about roll the clock few years and young Altshuller was known to be a great inventor, he had filed his first invention way back when he was in the steins, so any problem anything that he saw, he felt the need to go and invent something and that is how (())(6:23) he was and particularly when there were resource constraints and things could not be solved, so he is always a very different kind of person.

So he started working at a patent office, patent is a government protection of an idea similar to a real state where you can draw an outline and say this belongs to me or a group of people, same way this is for the intellectual property intellectual state so to speak, you can actually say this is my idea and the government says yes yes he told me first, he told us first so this guy gets the patent of that particular ideas.

So our inventor actually started working in the patent office, he was very excited at this proposition because he surrounded by people's inventions, people's greatest ideas presented in all its detail. So he actually went through 1000's and 1000's of paper documents paper documents were the patents to written as so he would go through them page by page as if you are reading a fiction novel, he would read through patents and he would really love the whole idea of being there.

So he was totally excited by this proposition and slowly and steadily he started realizing that there was something strange going on that he actually found out certain patterns across this patents, so this was crazy because the patents that he was looking at reading where from different domains aerospace and electronics or whatever was invoke at the time I do not know if electronics is around in the 40's but whatever was invoked at the time he saw they were all commonalities between all these, he noted that there was certain types of problems that were fixed or solved in a certain type of in a certain way, he notice these patents all along.

And now he was also bothered by the fact prior to this is that all the other sciences seem to have a certain formula, a certain way to do it except when it came to problem solving people relied on intuition and a background and experience and the people who they hang out with whatever or their own persona, etc etc. So nothing about a formula that anybody could learn

up and actually solve like you have in mathematics or chemistry for example these two are rely on formulae to get you going.

The same way if I knew a formula to invent, to solve a particular problem I could actually teach anybody and they could actually get faster with this get better at problem solving as well. So he was really (())(9:20) so that suddenly popped up and I said wait a second this sounds like a formula, this sounds like a way to solve it very systematic way to solve it and he slowly started categorizing the problems and the solutions accordingly.

So he did that very methodically with 1000's and 1000's of these patents and finally figured out a way an algorithm or a formula to actually solve the problem and he was happy about it and he said this is great this is extremely excited about this idea and he said the whole nation has to know about this, all the schools have to know about this they have to start doing this, they have to start embarking on this method.

And what he did was he wrote a big long letter to the then President of or the story goes from the internet I am borrowing this from a story on the internet that he actually wrote a letter to Joseph Stalin the President or the head of state for the USSR at that time and he said this is what we can do to you know take our motherland to greater heights so he wrote all that and he did not hear back from Joseph Stalin of course he is the head of the state, he is a busy guy, he does not reply to every mail that comes to him.

So a year later he did Altshuller did get his reply and I am guessing it was in the middle of the night somebody knocking at the door is this Altshuller? And this guy sleepily opening the door and Altshuller said yes this is me and they say you are under arrest, what? Why am I under arrest? And they say well you wrote this long letter, yes then you are under arrest. So it turns out that he not only wrote about how to transform the motherland into greater heights by using this method but in the way he had also sort of put down the way things were run in the state at that time and that probably did not go very well with Joseph Stalin and that is why he ended up in the place that you see on the screen, Siberia Gulag prison.

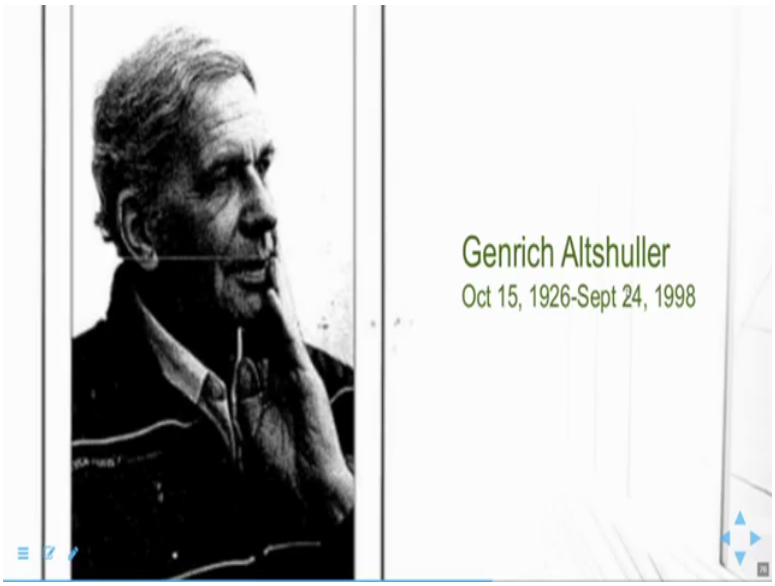
So Altshuller should have been totally crestfallen his mom did not think he would come back at all because people who went there never returned. So this was pretty sad state at that time but Altshuller was extremely motivated, he said wow this is a great place for me to think about this you know there is hard days labour and he has to do all that those things that they

do in the prison but he still had time to think, his brain was free to think about stuff, about invention, about problem solving.

And then he felt the need for going and checking with people as to how to how does this fair in other domains like mathematics and biology and chemistry and all this he wanted to check with other people and this is a prison I mean how could he find such people, but he was wrong, there were other people who were biologist, chemist all these guys were there in prison because of some political something that they had done, so they were all there and he would go and check with them that is this really working out very well, is this theory does this make sense for your domain? And he got a few suggestions, he perfected the theory.

So he worked on this in the spare time in the prison and 5 years later the prison's period was 5 years about 5 years and at the end of 5 years Joseph Stalin passed away and they started releasing political prisoners from the Joseph Stalin regime and Altshuller was one of them. So he was released, he was happy to come be out in the free world. So now he was totally motivated to go and check out how his theory will stand, so he started running case study upto case study.

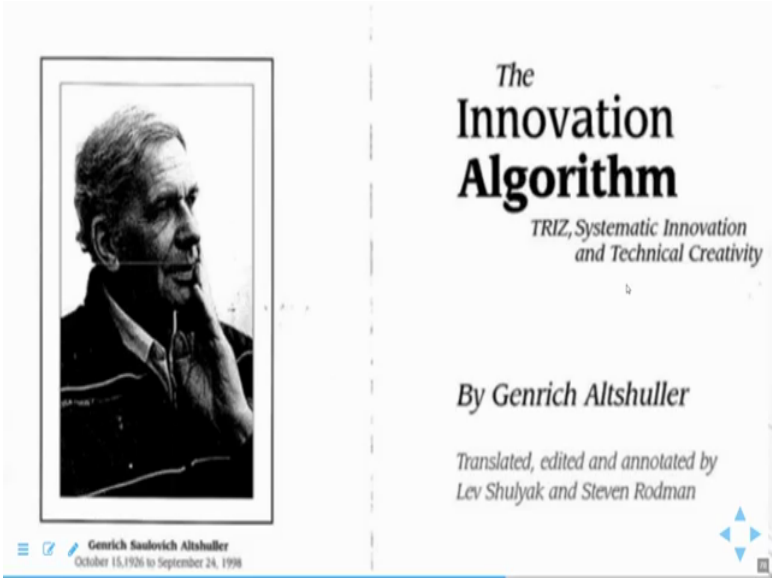
(Refer Slide Time: 13:33)



So this is his picture this is Genrich Altshuller, he came up with the idea that problem solving can actually be a formula and he applied it and started applying for different case studies in real life, he developed an algorithm of problem solving he called it ARIZ is the Russian acronym for algorithm of inventive problem solving and he slowly started releasing version after version he tried it several case, he would take painstakingly take so many years to make small changes to his algorithm.

So he in his own words he says that this algorithm is great on its own, it works on its own because he tried it on so many case studies but he said this can be a great aid to invent us, it can be like a ladder guiding them okay if you should not go too far away from this but you can actually go towards certain path. So that was what he set out to do.

(Refer Slide Time: 14:36)



So this is in Russian, the Russian pronunciation if I get it right it is (теория решения изобретательских задач) Teoriya Resheniya Izobretatelskikh Zadatch and the acronym for that is TRIZ is this is the theory that he pulled out of the algorithm after trying it so many times, he actually generated I mean he build the whole theory around this and even sort to find out how the human mind works, how the whole creative skill works? And it is now popularly known as TRIZ the Russian acronym still stays in between some people did try to call it tips as theory of inventive problem solving TIPS, but for a powerful method like for inventive problem solving TIPS sound it more like pocket change than a powerful theory.

So TRIZ still sticks you can find lots of literature in this method, in this theory all across the internet I have given you a few references as well in the reference list. So this is the theory that Altshuller came and this generated and now lots of people across the globe including Altshuller students have taken the message all across and have really made a difference in many many industries, made inventors jobs a little easier and generated a lot of ideas using TRIZ as a method.

So why am I telling you this? Because this is an efficient way of solving a problem, you do not have to try out all sorts of variants before generating the method that works. So this is why I am introducing you to this method, to continue and finish up the story Altshuller wrote many many books in Russian, few of them were translated to English one of my favourite is this book called Innovation Algorithm and theory gives a lot of examples on how to innovate invent particularly doing it systematically and this is in technical field because Altshuller himself was a mechanical engineer, the terms that were used were all to do with mechanical

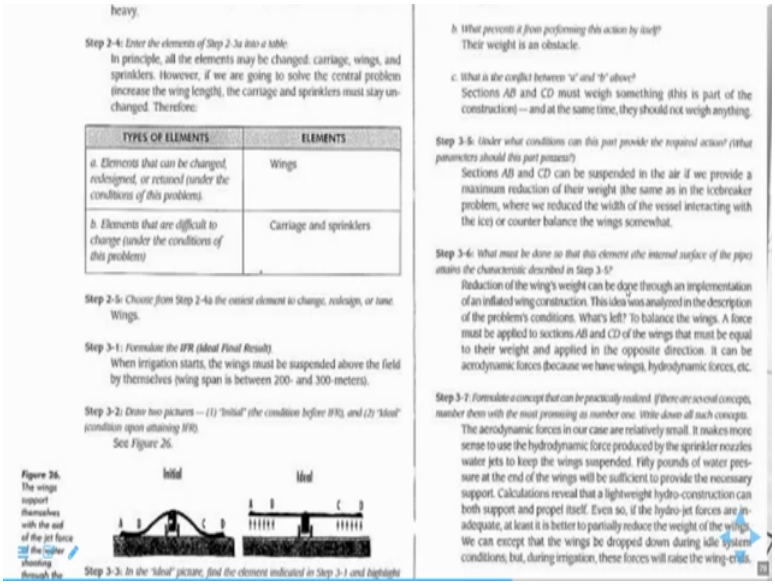
engineering but this applies after so many years we found that this applies all across disciplines, okay.

One of the methods that he suggested and a very powerful one at that is one of the components is after you do your conflict analysis which we did last time, you can actually use one of the methods called inventive principles, what it says is like I was talking to you about certain methods or certain types of solutions these where crystallized they was were put in to heuristics of saying I will give you some examples of these things are worded and you can actually apply it back to your problem and generate ideas so that your conflict is resolved, so that you know between two humans or between a human and a thing (())(17:47) is all the conflict.

So this is what Altshuller had said, one of the algorithm looks like this so many steps and you know it asks you certain questions, it is almost like a form filled out but you need to keep doing the thinking, the thinking is not replaced by the method the thinking is still done by the human. So often times I get this question from students, so should I tone down my thinking and just follow this and I should be okay? No, you shall have to do the thinking, you still have to do the finding, it still the inventors job to solve the problem, this guides you in your thinking.

So worry not I am not straight jacketing you an saying this is the only way to think, this is the only way to go if you are stuck, if you cannot move what is equivalent of a writer's block for an author, for an writer is an inventor's block if you have reached that then this method will help you that is what I am telling you.

(Refer Slide Time: 18:52)



heavy.

Step 2-4: *Enter the elements of Step 2-3a into a table.*
In principle, all the elements may be changed: carriage, wings, and sprinklers. However, if we are going to solve the central problem (increase the wing length), the carriage and sprinklers must stay unchanged. Therefore:

TYPES OF ELEMENTS	ELEMENTS
a. Elements that can be changed, redesigned, or retuned (under the conditions of this problem).	Wings
b. Elements that are difficult to change (under the conditions of this problem)	Carriage and sprinklers

Step 2-5: *Choose from* Step 2-4a *the easiest element to change, redesign, or tune.*
Wings.

Step 3-1: *Formulate the* **IFR (Ideal Final Result)**
When irrigation starts, the wings must be suspended above the field by themselves (wing span is between 200- and 300-meters).

Step 3-2: *Draw two pictures — (1) "Initial" (the condition before IFR), and (2) "Ideal" (condition upon attaining IFR).*
See Figure 26.

Figure 26. The wings support themselves with the aid of the jet force of the water shooting through the

Initial

Ideal

Step 3-3: *In the "ideal" picture, find the element indicated in Step 3-1 and highlight*

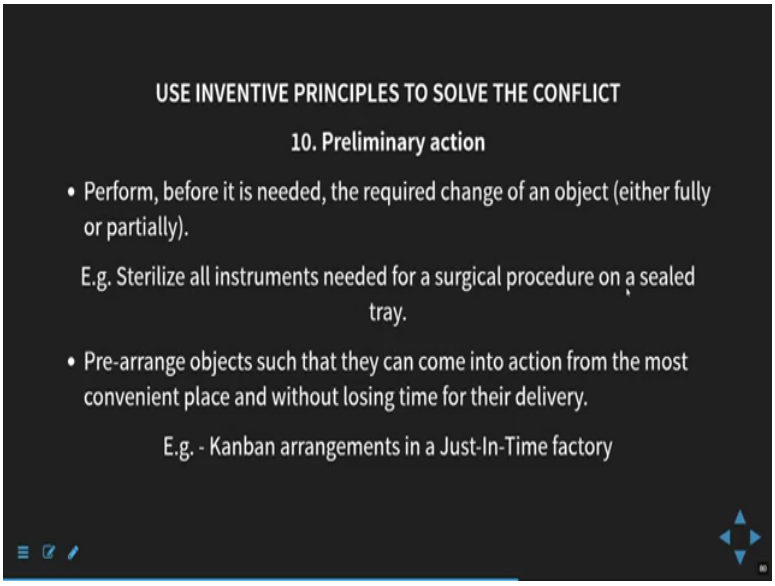
b. What prevents it from performing this action by itself?
Their weight is an obstacle.

c. What is the conflict between "a" and "b" above?
Sections *AB* and *CD* must weigh something (this is part of the construction) — and at the same time, they should not weigh anything.

Step 3-5: *Under what conditions can this part provide the required action? (What parameters should this part possess?)*
Sections *AB* and *CD* can be suspended in the air if we provide a maximum reduction of their weight (the same as in the icebreaker problem, where we reduced the width of the vessel interacting with the ice) or counter balance the wings somewhat.

Step 3-6: *What must be done so that this element (the internal surface of the pipe) attains the characteristic described in* Step 3-5?
Reduction of the wing's weight can be done through an implementation of an inflated wing construction. This idea was analyzed in the description of the problem's conditions. What's left? To balance the wings. A force must be applied to sections *AB* and *CD* of the wings that must be equal to their weight and applied in the opposite direction. It can be aerodynamic forces (because we have wings), hydrodynamic forces, etc.

Step 3-7: *Formulate a concept that can be practically realized. If there are several concepts, number them with the most promising as number one. Write down all such concepts.*
The aerodynamic forces in our case are relatively small. It makes more sense to use the hydrodynamic force produced by the sprinkler nozzles water jets to keep the wings suspended. Fifty pounds of water pressure at the end of the wings will be sufficient to provide the necessary support. Calculations reveal that a lightweight hydro-construction can both support and propel itself. Even so, if the hydro-jet forces are inadequate, at least it is better to partially reduce the weight of the wings. We can except that the wings be dropped down during idle system conditions, but, during irrigation, these forces will raise the wing-ends.



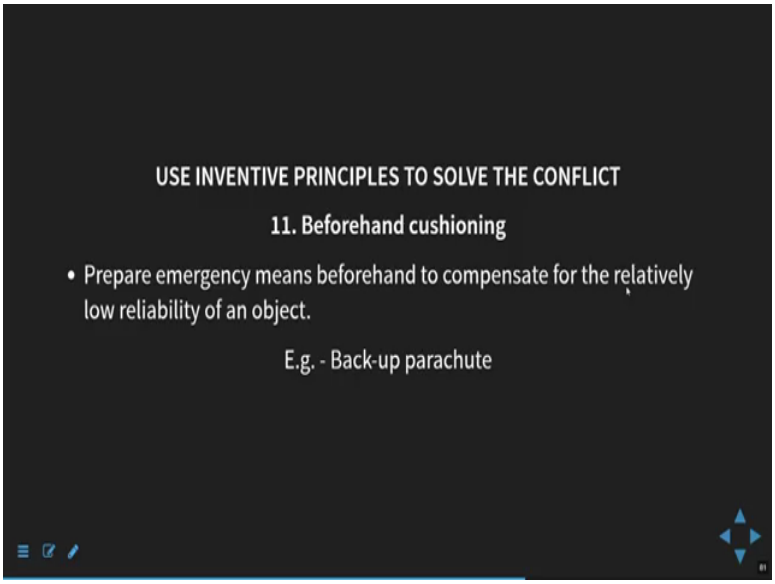
So this is a snapshot from the book, I promised to give you examples of inventive principles this is one of the inventive principles called preliminary action. So what it says is that perform, before it is needed, the required change of an object either fully or partially. An example is given for you it is to sterilize all instruments needed for a surgical procedure on a sealed tray.

So before the surgery is performed all of this the instruments needed are all sterilized and kept on a sealed tray so that it is ready when the surgery has to be performed in the state that the surgeon wants it to be. So the another example or another way to do preliminary action is pre-arrange objects such that they can come into action from the most convenient place and without losing time for their delivery this is popularly known as just in time in some factories

have this implemented, so there is no need for a warehouse the components come on time just in time and get delivered when it is needed, not before, not after but just in time. So this is one of the manifestations of preliminary action.

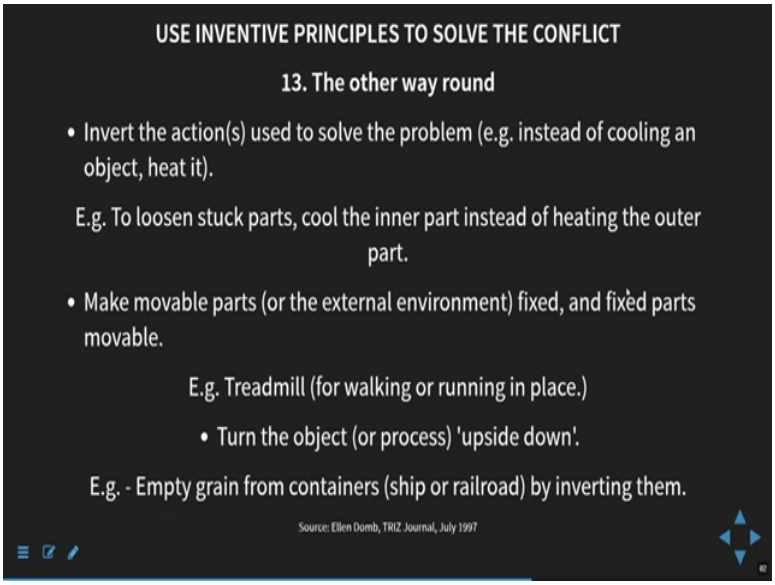
So this is the number 10 in this signifies that this is the number 10 principle, there are 40 principles that Altshuller thought about saw this in the patents, he also generated 76 standard solutions that also became popular but 40 is easier to work with easier to imagine, 76 requires a little bit of training for you to think about it, how do you apply it and if you have it nailed down the problem nailed down then 76 standard solutions help you. In this course we are not going to go deeper into this I am going to give you two more examples and then we will move on to the solve part of it.

(Refer Slide Time: 20:43)



So in here the next principle is beforehand cushioning the example is a backup parachute, so you need something to compensate for the relatively low reliability of an object then you do this.

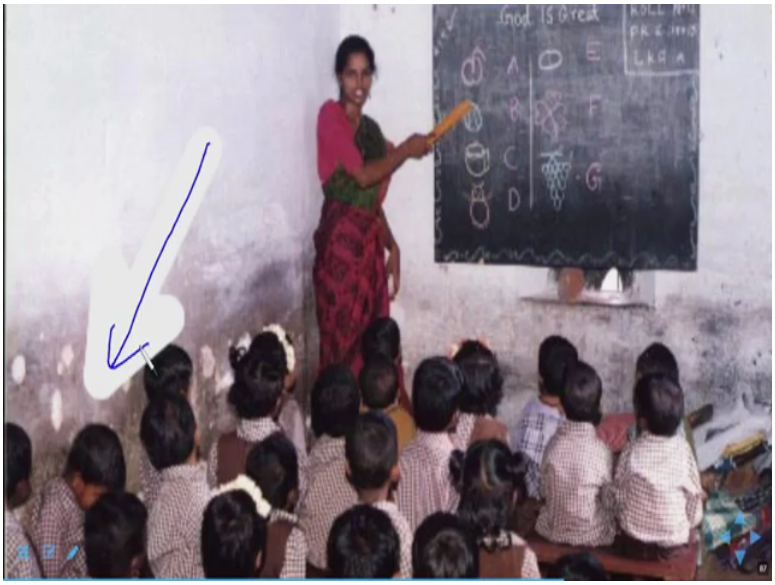
(Refer Slide Time: 20:56)



So this one is my favourite, one of my favourites of the principle, principle number 13 the other way round and here we do the opposite to solve a problem. So if you have a stuck part rather than cooling the inner part we heap the outer part to loosen it out. So this is an other way round a treadmill is an excellent example of making movable parts fixed and fixed part movable. So the jogger is in place while the path is moving, typically a jogger moves and the path remains stationary, in a treadmill it is the opposite so these are several ways to do this.

So other way round is a principle name of a principle, now that they have identified the conflict, can I flip the actors around, can I flip whatever is moving stationary and can I change the other one around? So these are questions you should be asking to generate ideas, okay.

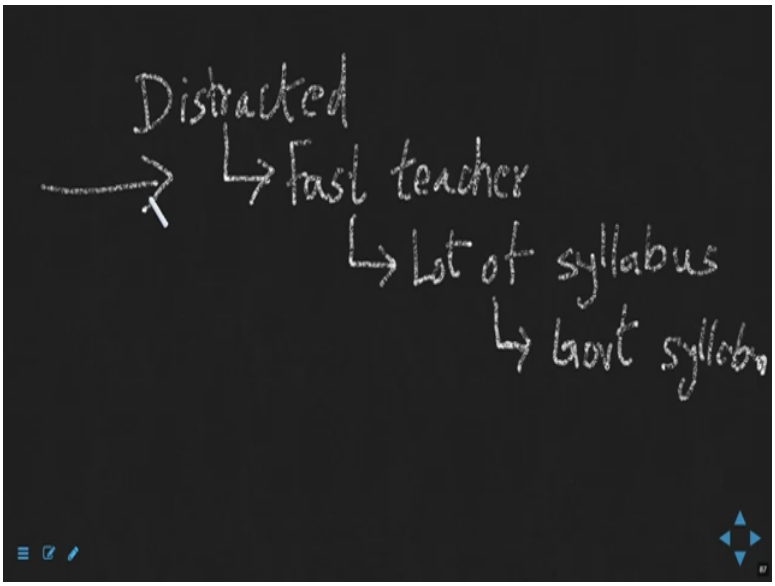
(Refer Slide Time: 21:53)

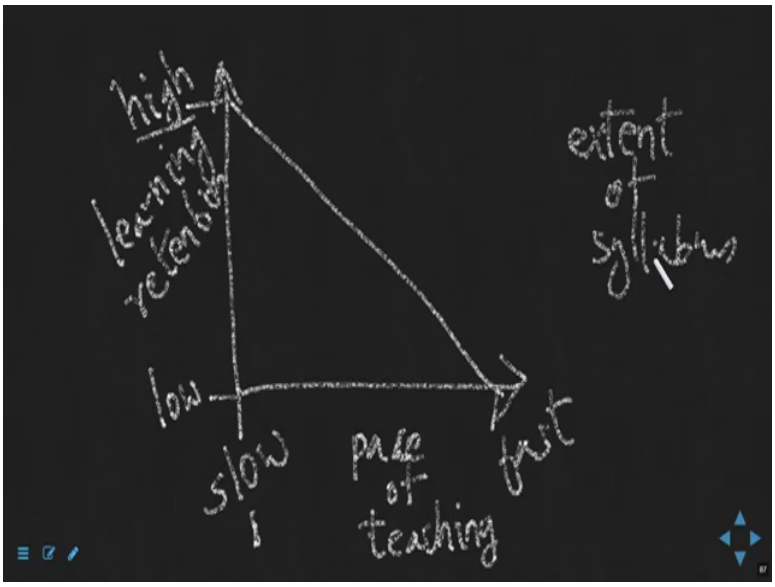


So let us look at some of the examples we looked at last time, this is my first problem that I proposed to you, I said you should be thinking about this. So if you remember I will reiterate the problem right here we are looking at is this distracted child I mean he is not just one of them, there are probably many of them but this guy clearly is distracted he is looking at something else and he is not paying attention towards the teacher is saying but I am sure the class is filled with people who have different learning rates so that is the problem that I posed to you.

So now what you had to do was to analyze using 5 why and the conflict of interest, once you have that then we can jump into the solved stage.

(Refer Slide Time: 22:48)





So I am going to help you out with that, I am going to give some of the answers here. Let us go to the blackboard, so the teacher is teaching and this guy is not paying attention so let us say why is he distracted? So why is he distracted? Well he is learning at a slow pace that the teacher has already gone pass, he is not able to keep in pace with what the teacher is saying so this is the reason is she is teaching very fast, the teacher in our picture is teaching very fast, we had a fast teacher fast teaching teacher, why is she going fast, why is the teacher in our picture going very fast?

Well she has lot of syllabus to cover, lot of syllabus to cover, okay. So let us say a large portion of syllabus still remains and she is not able to cover that is why she is going fast and since the kid cannot keep up the kid is distracted, why does she have a lot of syllabus to cover? Well she is being assigned that this is what the tat of the government is, so let us say she is following a government syllabus so that is fixed.

So we have reached the place where unless you work for the government and you can make a difference you should probably look at this level for simplicity sake I am going to look at this level which is distracted versus fast teacher and why does the teacher teach very fast? It is a lot of things to cover, I am saying lot of syllabus but it is lot of portion to cover in the syllabus.

So if we look at it one more time in terms of a plot if you remember from my last time we had plots for plotting the 5 why analysis, so how do we track the performance of the child? Let us call it learning retention learning retention so how much does the child actually retain, okay. So high point and the low point, so the high point is high learning retention so if the

child is able to recall or able to retain a lot of information in lot of what the teacher is saying in this class say it is a beginner class we will keep that as high and low is the opposite which is the kid is not able to catch up with class, what is going on. And the variable that we have with us is the pace of teaching pace of teaching (sorry this is pace), okay.

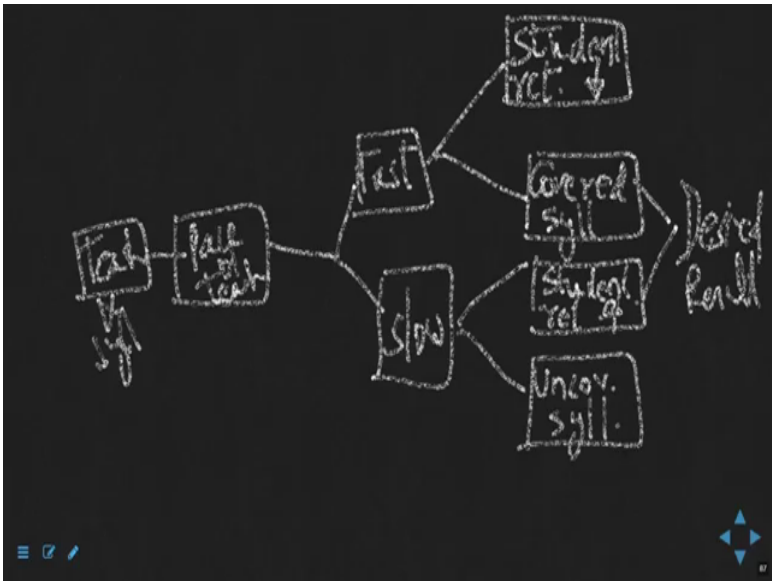
So now if we look at this plot we have a high learning retention and the pace of teaching is what we are tracking, so we have a low pace of teaching which means she is going very slow let us say slow and she is going very fast so that is the variable the teacher has from a teachers point of view it was one thing that she can vary to keep the child interested and keep motivated and make him or her retain in our case it is him I guess the student, we will make him retain, we need to track that so that is our variable that we are tracking.

If you remember from last class we actually had a plot like this a straight line just to keep things simple, if I go fast if I am the teacher and I go very fast I sort of miss out on the retention this kid is probably not retaining a whole lot and hence he is distracted, but if I choose to go slow I will have a high retention however what I am losing out on is here is the conflict is that I will not be able to cover my syllabus if I am the teacher, okay.

So this is what the teacher can control whether I can go fast, or whether I can go slow, what is the parameter that we are losing out on if we go very slow is the extent of syllabus let us say the extent of syllabus coverage, okay. So the extent of syllabus is what we will miss out on. So if we actually go slow in teaching we are going to miss out on the extent of syllabus it is going to be remain uncovered, if we go fast syllabus is covered great but I lose out on my primary customer who is my student.

Now that I have presented in this way it started to sound like a conflict, right so remember the conflict of interest. Now the conflict is between the teacher and the student so that is what we are looking at from on this x and y.

(Refer Slide Time: 27:28)



So now we will look at the conflict itself so here is the teacher and the syllabus let us put it that way and sorry about the bad handwriting here I drew a small box and that was the problem, here we have is what can I vary it is the pace of teaching, okay so it is pace of teaching I can chose to go fast, I can chose to go very fast or fast and I can chose to go slow, okay. So these are the two states so to speak between slow and fast and then what happens as a result of going slow and fast.

So represented like what we had last time is when I go fast I lose out on retention from the students so student retention is low let me abbreviate it retention is low so I put down arrow so that I indicates it is slow, whereas what I am gaining out of going very fast is covered syllabus, I have actually done a good job in the administration's eyes I have actually covered it on time.

If I go slow yeah for the student, student actually loves me because I am matching pace with his learning speed so student retention is definitely there it is a high and what I am losing out on is uncovered syllabus I have not finished what I have signed up for, I have a lot of stuff that I have not covered. So as design thinkers what we generally need are these two which is the covered syllabus and student retention to be very high, so this is my desired result, okay.

So I will post it in a better way this is how I am writing on my blackboard here so this is what is going on with respect to the analysis of the teacher student problem, okay. So this is the conflict of interest between the student and the teacher. Now how do I solve this problem? I want to be fast so that I can cover my syllabus but I have to be slow so that the student retains

it and if you remember one of the principles I said was going the other way round, I will give you a moment to think about what can you do other way round opposite of of course you can come out with your own ideas but I am just trying to help you over here we are using what we just learnt a few minutes ago is how do I help my student retain and how do I help my teacher teach at a fast rate or teach so that she covers her syllabus?

So this is the conflict of interest we had and I am asking you to apply the other way round idea to see how you can solve this? A moment here you can pause the video if you want any ideas? Okay, yeah so the most common idea that normally I hear from my students is let us make the students a teacher and the teacher reverses the role. So she cuts up the portion of the syllabus and gives it to the students this is a common practice in some subjects some brave teachers do this and says you guys prepare and tell me what you have learnt and you will have to present and teach the other people in the class.

So this way there is a role reversal and actually the students end up retaining a lot lot more then what the teacher could have possibly imagine and you can be selective saying this guy can do this job and that guy can do that job, so you can actually do that. So this is the reversal idea of course there are several other ideas that can be keep coming up like for example the preparative atleast or prior action you can actually ask them to prepare in advance and come here to clear their doubts in hand or you could do a video recording and make them play at home like you see in popular platforms like, even like this you can actually slow down go reverse and see what I have spoken few minutes ago, this is also an example of reversal.

I come to your home through a medium rather than you coming to my class and listening to me at whatever pace I have to teach. So this is the reversal as well. So several ways to solve this problem this is just to trigger to get you thinking about how to apply these methods that I talked about.

(Refer Slide Time: 32:25)

The same way you can do the analysis of this aircraft landing a lot of smoke so the conflict really is between the tyre and the runway and the lot of puff of smoke that you can see and that is because there is a tyre ware at the moment the tyre actually hits the surface and you can actually solve this by applying a reverse once you have figured out what the problem is, the problem is that it is too fast at that particular time that is the conflict you want the wheels to be slow so that it does not wear the tyres and it has to be fast so that can land you know there is a case of error dynamics stalls if it goes too slow these conventional aircrafts including this (())(33:14).

So you need to be fast so that it can land, you need to be slow so that there is tyre ware and the way to reverse you can reverse it some of my students think of ideas like oh well I will make a conveyer belt that is at the same speed as the aircraft, I will dump a lot of tyres spent tyres already at the place where the runways or rubberize the place where the runway is, one often time I have read the solution that I have seen for this is the other way round solution is to rotate the tyre at the same speed as the aircraft so the relative speed between the ground and the wheels are zero, so it is as if it is landing stationary, so it does not actually start from zero to 200 kilometre or whatever speed it is going at, at that moment but it is already at a rotating speed so the tyre ware is minimum. So this is one solution from the other way round principle.

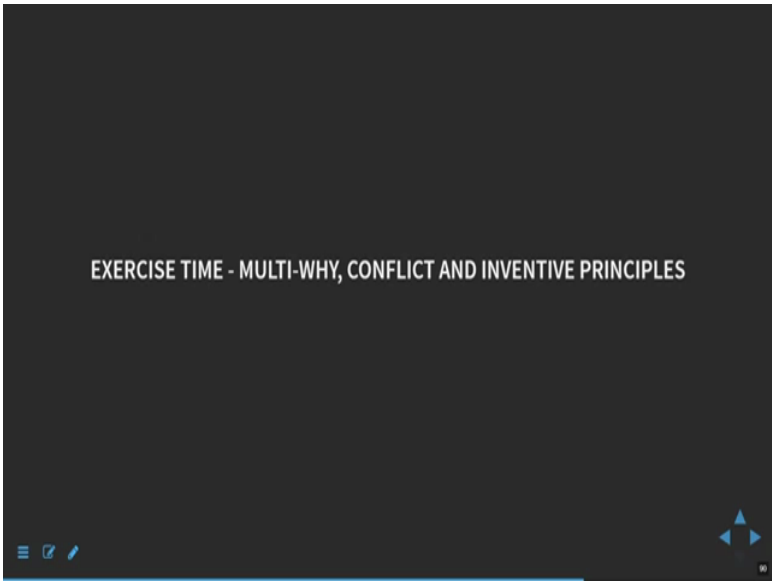
(Refer Slide Time: 34:19)

The third problem that we looked at last time again you can do the analysis similar to that is the chocolates are melting when you take it to a hot place and that was the main problem, so you need the chocolates to be in solid shape with the customer with somebody is opening it and you want it to be transported in hot places. So the conflict is between the environment and the chocolate.

So the other way round solution can be applied here and can I instead of heating the environment which is what the air-conditioning will do, can you think of lower cost ways to do it? Well we will cool the chocolate before it shipped to ultra-low temperatures and then ship it with vacuum around it that you can probably pull out the air and send it across so set a cooler environment all through its shipping and at the end you get is the cool chocolates, so you have done the other way round not allowing it to heat up but to cool it so this is a prior action sorry previously you do this and so you solve the problem.

There are many ways to solve this of course we have not submitted these ideas to (())(35:37) if you want to probably Harsh is already figured out how to do this, so again like I said last time this was an open innovation problem that we found.

(Refer Slide Time: 35:50)



So you can take up more problems that you see all around you, apply the multi why, apply conflict of interest and take one of these principles and see if how it works just to get practice on that before you can embark on serious problems. So that is it for now this module of solve, so I would like you to go out in the world and try these methods with the examples that we have suggested in this part of this course so that you can actually get more practice, this is about just like driving, swimming or new skills that you have learnt, this is about trying at many many times and then you get a become you attain mastery with these methods, okay so happy luck you know good luck trying these methods, bye bye.