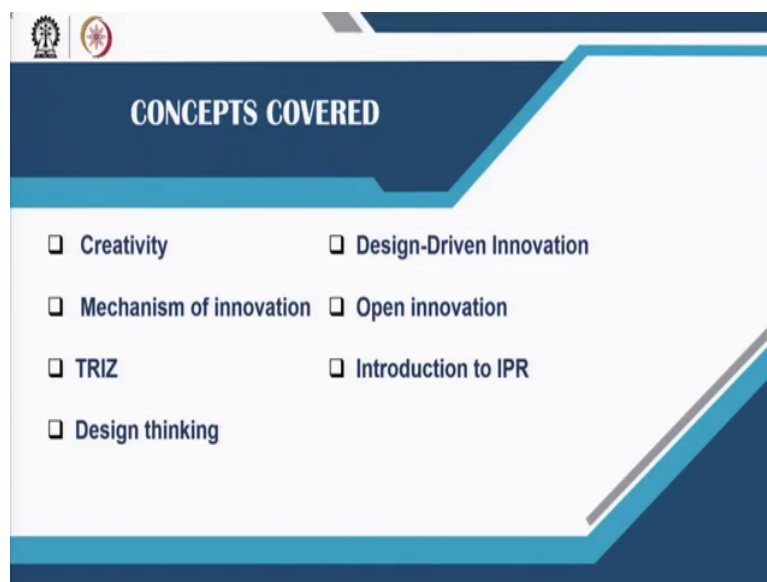


**Entrepreneurship Essentials**  
**Prof. Manoj Kumar Mandal**  
**Rajendra Mishra School of Engineering Entrepreneurship**  
**Indian Institute of Technology, Kharagpur**

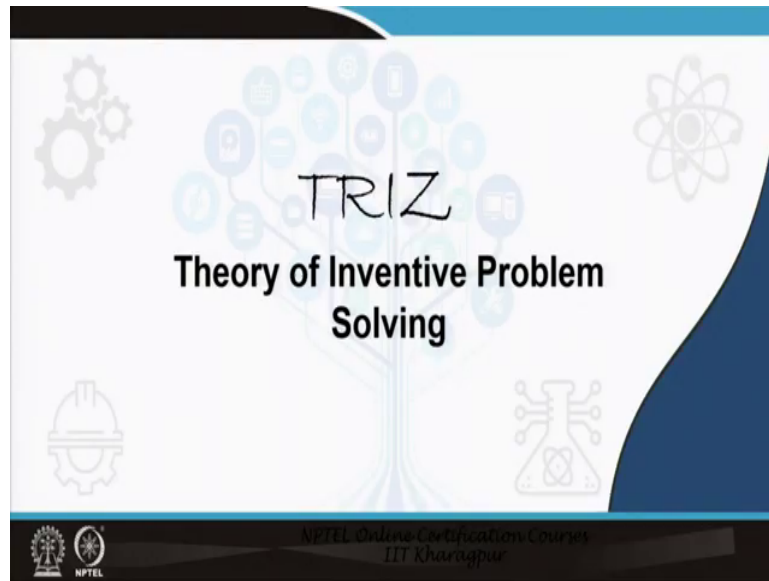
**Module - 06**  
**Lecture – 28**  
**Design and Innovation – III**

Welcome. In this session we are going to discuss about the theory of inventive problem solving, its called TRIZ. Its an acronym from Russian language, but I do not have the Russian name, but its primarily theory of inventive problem solving called TRIZ, TRIZ.

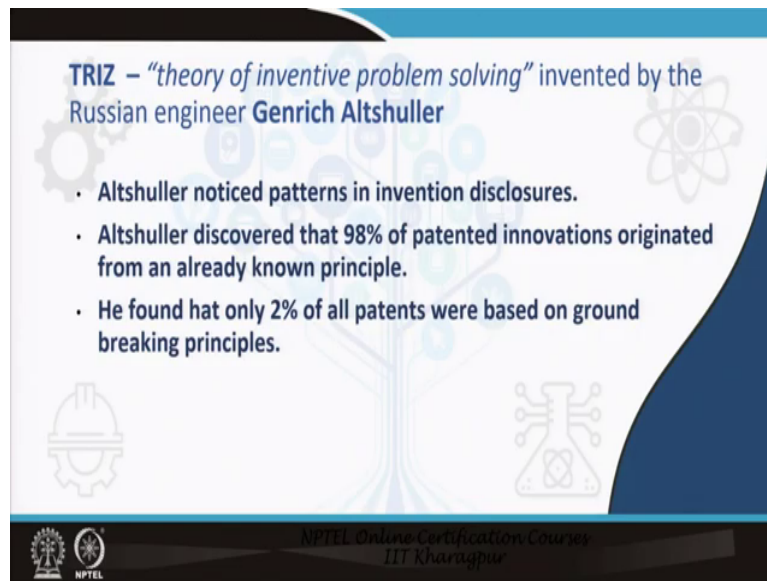
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**TRIZ** – “theory of inventive problem solving” invented by the Russian engineer **Genrich Altshuller**

- Altshuller noticed patterns in invention disclosures.
- Altshuller discovered that 98% of patented innovations originated from an already known principle.
- He found that only 2% of all patents were based on ground breaking principles.

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It is invented by Genrich Altshuller. He was a patent examiner or he was a clerk at patent office. So, used to shift through umpteen number of patent. So, he actually, he was introduce a tip and then he was trying to see what are the are the ground breaking principles that has gone in invention of all these patents, to his surprise he found that about 98 percent of the patented technologies follow a pattern. They are they can be categorized or they can be classified into certain sections or segments or they follow certain, certain principles.

So, how many principles that is that came later, but he found that many of the patents, followed particular pattern. So, they were not ground breaking, he found that about 2 percent of the patented technologies were ground breaking they came up with new principles. Whereas, rest were kind of its not a copy, but it was inspired by some knowledge and it can be explained with those or it can be classified into those.

So, he decided that let me see, what are these principles and then eventually he came up with 40 inventive principles, using which almost anything can be invented. So, eventually he propounded about 39 contradictions. Contradictions meaning, if you want to develop a solution you will find that there are problems, like suppose you want to increase the speed of a car, say the car is speed is say 200 kilometre an hour, you want to put it say 300, 400. You will find that the engine capacity or the fuel consumption will be more and many many other things will be more, so there is a contradiction.

Suppose, you need a big umbrella to cover you from rain, now the big umbrella carrying is difficult. So, when you are not using the umbrella it becomes difficult to carry. So, likewise there is always contradiction. So, you want to improve something, something crops up or something is associated with that which is an undesirable thing, desirable and undesirable make a contradiction.

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So, look at this cartoon, I am sorry that I could not really take permission from the original creator, I am using it from fair use perspective. But, I have attributed the place and the creator the Oxford creativity 2007 is regard is kind of has the copyright.

Now, look at the cartoon carefully and there is a wonderful there are two things that is coming out of the cartoon. Someone invented the wheel for the first time. One person is asking what good it is for whereas, some lady thinks that I can use it for a ground for grinding something, whether its spices or whatever, someone thinks that looks like a toy. Another lady thinks that I can make a kind of a cart or something, to carry something.

Another person think, that I can sit on it and do something nasty or whatever. But then, there are two messages I said from this. One is we think from our experience, we think from our education, from our background. So, if my background is something where I am trying to

carry many many heavy weight from one place to another, I will always think how to find a solution for this. So, looking at a wheel, I will immediately think that, I can use the wheel to make a car or something or a truck.

Whereas, somebody means depending on their background they will be thinking that way, number 1. Number 2, and that is even more important. Is that one technology can be used for many purposes, like your wheel really can be used for as a grinder and a small wheel really can be a toy or a something which can serve another purpose and definitely a wheel can be used as a wheel as well. So, that is precisely the message that TRIZ gives us. TRIZ tells us that, whatever you problem you have the solution already exist almost for everything.

You have to find in what form and where these solution is lying. And then almost like copy paste from there, you get inspiration you get knowledge and then replicate it in this new context and you have a solution. So, you have to actually look both inside as well as outside the domain of your knowledge. Even if you are in the automobile industry, its not necessary that all knowledge in the automobile industry will be useful in automobile. You may find elsewhere the knowledge that you need to be incorporated in next generation automobile.

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TRIZ espouses **5** basic principles for innovation initiatives.

TRIZ uses **40** inventive principles to facilitate innovations.

01 | The ideal end result

- ❖ It is important not to be complacent with some solution.
- ❖ There is always a better solution.
- ❖ Strive to find improvement and aim at an ideal solution.

However, we should remain mindful of the 80:20 rule

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The slide features a background with faint icons of a gear, a lightbulb, and a circuit board. On the right side, there is an image of a dartboard with a dart hitting the bullseye and a small inset photo of a man in a white shirt speaking.

So, these two messages are very prominent this wonderful cartoon, I have the full reference given in another slide. So, you can see there is a wonderful slide share presentation also this is kind of wonderful I could not give lot many ideas that are contained there because of shortage of time, shortage of time means my presentation should be done in half an hour. TRIZ espouses 5 basic principles. And the first principle is that there is always a chance to improve do not settle just with the first solution, second solution or third solution, know for a fact that there is always a better solution.

So, a strived continuously to find a better solution of course, one should remind remember the 80-20 rule. Meaning that you should not spend years on to find the best solution. If you have almost like a 80 percent perfection, that should be with it you should go ahead and go to a market give it to the customer let them start using getting the benefit and then gradually you

add perfection, that is number 1. But then getting that 80 percent is a kind of a debatable issue like whatever you got at the first place you might think that this is 80 percent.

Whereas, perhaps you try some something more perhaps you get a far better form of the same technology.

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The slide is titled "The 5 basic principles of TRIZ for innovation initiatives." and features a list of four bullet points under the heading "02 | Less is more". The background is light blue with faint icons of gears, a person, and a lightbulb. A small inset image of a man in a white shirt is visible on the right side of the slide. The NPTEL logo and "NPTEL Online Certification Courses IIT Kharagpur" are at the bottom.

**The 5 basic principles of TRIZ for innovation initiatives.**

**02 | Less is more**

- ❖ This is related to lean manufacturing ethos.
- ❖ You must try to cut everything that can be eliminated without compromise on the fundamental functionalities.
- ❖ Spend the least possible amount of money.
- ❖ Chances are the objective can be realized with available materials and sometimes the solution is close at hand.

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So, try for betterment of the existing framework, whatever you have. The second is less is more, this is a lean philosophy. Meaning that there is always a possibility that you can cut corners and then cut cost do it faster. So, cut time and then use less people, so cut resources as well.

So, you can do perhaps more with less try to do more with less, a spend the least possible amount of money the least possible amount of time and try to do as fast as possible. Then



your technology will not lose relevance and you will be able to exploit it for full market potential.

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The 5 basic principles of TRIZ for innovation initiatives.

03 | Solutions already exist

- ❖ Almost all problems can be solved using some existing principles.
- ❖ One has to search within and outside the specific knowledge domains in search for solutions.
- ❖ This can reduce time, money, and man-hours and accelerate the innovation process.

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The slide features a blue and white color scheme with various icons representing technology and innovation, such as a gear, a lightbulb, and a network diagram. A small inset image of a man in a white shirt is visible in the bottom right corner of the slide content.

Third and the most important philosophy of TRIZ, is that solution already exists. Whatever problem you have 98 percent chance is that the solution already exists. You have to find it, you have to shift through all the 40 inventive principles that all should hallshawlder propounded and then see the 39 contradictions you will arrive at you will converse on the exact inventive principles that you need to find this solution. This can this can first of all eliminate just casual invention you just keep on inventing something and then to realize that this is not going to work, and then it may take years together to come up with an invention.

Whereas, here it just a matter of, matter of a few minutes of time. Use the software that is available and come up with the succinct inventive principle that is necessary. Then you keep on becoming creative and come up with inventive more inventive ideas.

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The 5 basic principles of TRIZ for innovation initiatives.

04 | Search for fundamental contradictions

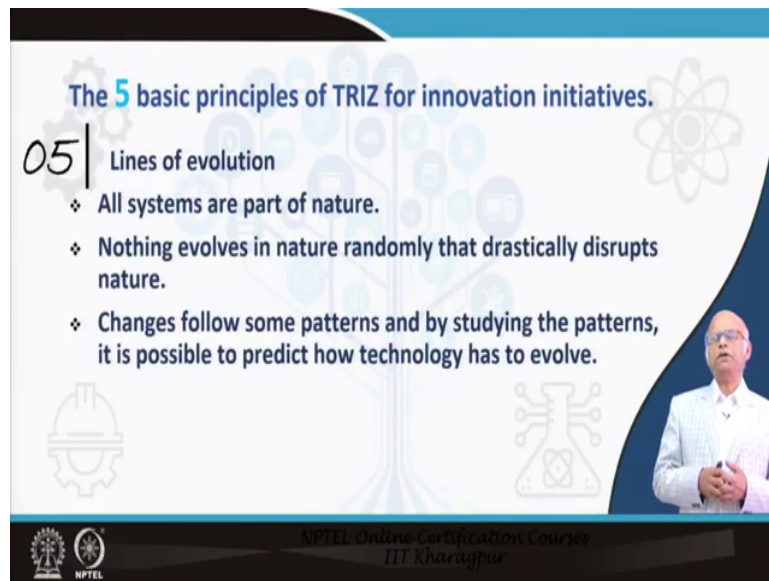
- ❖ Problems can be thought of as contradiction to solutions.
- ❖ Most problem-solution has conflicting requirements.
- ❖ If the contradictions can be accurately identified, solution will emerge. Don't compromise.

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So, then only idea should germinate based on those domains, will come to that very quickly. And the 4 th is search for fundamental contradictions. Meaning that if you designing something you find a solution and you will start building on that rather than doing that you try to find if this is the solution then what is the contradiction. If I am trying to adopt this as a solution, then what is going to crop up as a disadvantage, disadvantage and advantage together gives a contradiction.

Using the contradiction, you are going to find the inventive principles, we are coming to that.

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The 5 basic principles of TRIZ for innovation initiatives.

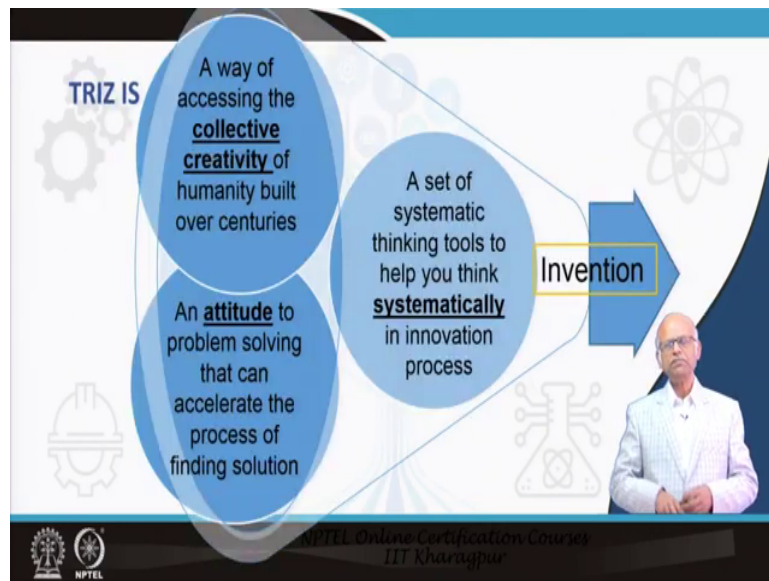
05 | Lines of evolution

- ❖ All systems are part of nature.
- ❖ Nothing evolves in nature randomly that drastically disrupts nature.
- ❖ Changes follow some patterns and by studying the patterns, it is possible to predict how technology has to evolve.

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The last one is, line of evolution. Meaning that everything in nature or we are part of nature, nature is a system we are part of the system. Nothing in the nature come just like that, it evolves. Maybe its a part of the theory of evolution. So, anything that you see evolves through a natural a linear way, is not nothing happens drastically. So, you have to think or think linearly extrapolate from backward and forecast the future has to what is the future technology. You will be able to identify the future technology through this process.

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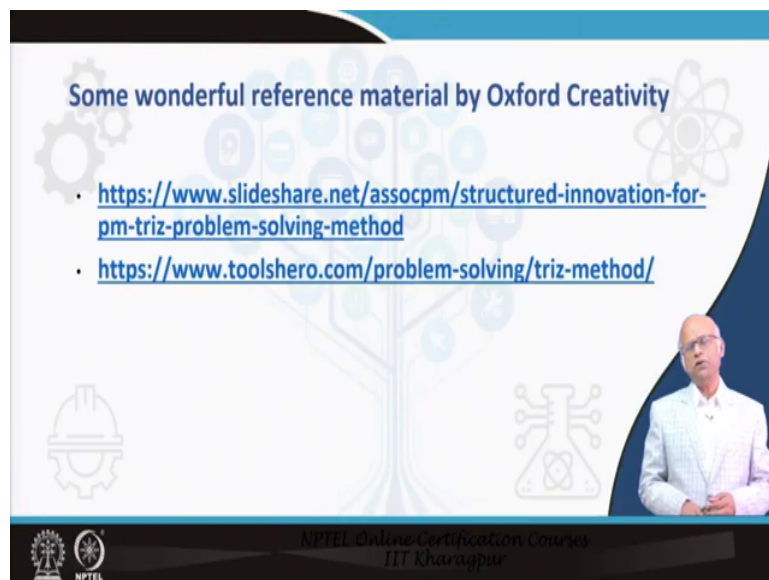


TRIZ therefore, is a collective wisdom. Collective, creative pursuits that human kind has made so, far starting from times time antiquity. So, for whatever they have done everything is documented. So, use that reservoir, reservoir of knowledge to make new invention have the attitude of solving problem like never be satisfied never become plus end that ok, I have got a solution this is the final.

Only then you can accelerate, and then think systematically you have a reservoir of knowledge, how to use or how to identify the nuggets of intelligence or knowledge that you need to solve a particular problem from an ocean of or a reservoir equivalent to an ocean of knowledge.

How to find that think systematically that what TRIZ actually provides and eventually you will be able to innovate that.

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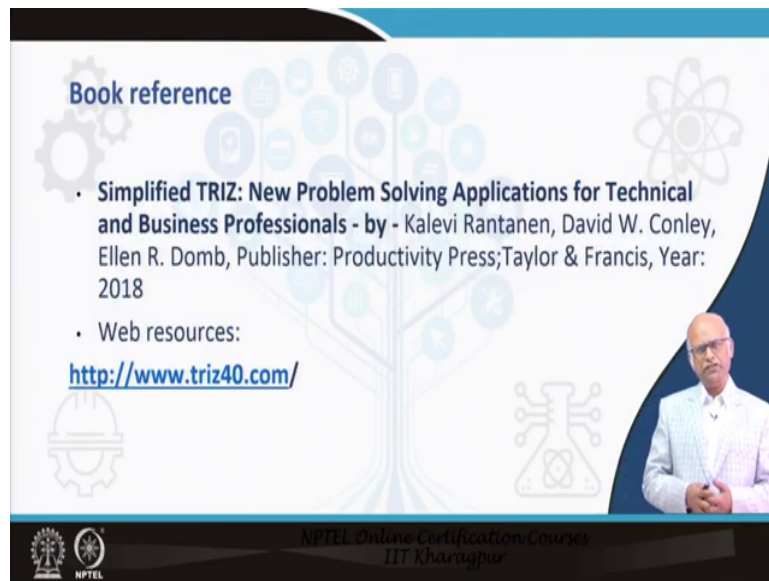
Some wonderful reference material by Oxford Creativity

- <https://www.slideshare.net/assocpm/structured-innovation-for-pm-triz-problem-solving-method>
- <https://www.toolshero.com/problem-solving/triz-method/>

The slide features a background with a stylized tree and various technical icons including gears, a hard hat, and a circuit board. A presenter in a white suit is visible in the bottom right corner.

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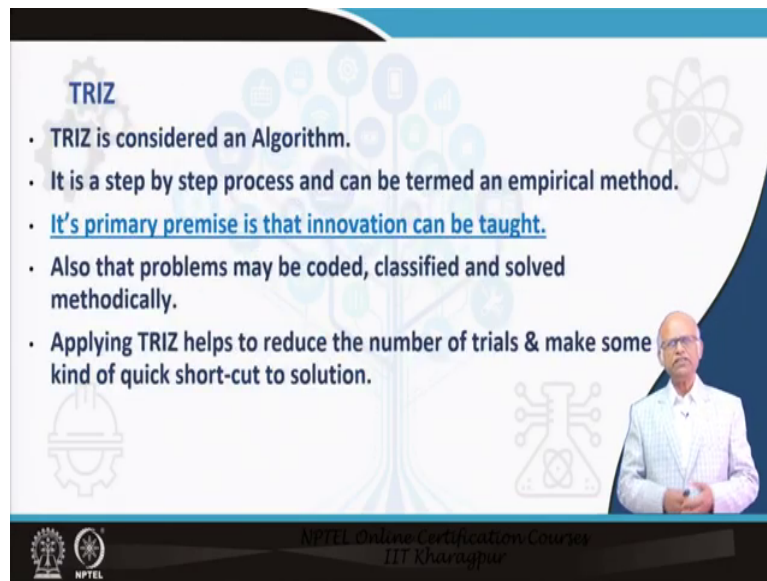
**Book reference**

- **Simplified TRIZ: New Problem Solving Applications for Technical and Business Professionals** - by - Kalevi Rantanen, David W. Conley, Ellen R. Domb, Publisher: Productivity Press; Taylor & Francis, Year: 2018
- Web resources:  
<http://www.triz40.com/>

The slide features a background with a stylized tree of icons representing various technical and business concepts. A small inset image of a man in a white shirt is visible on the right side of the slide. The bottom of the slide contains the NPTEL logo and the text 'NPTEL Online Certification Courses IIT Kharagpur'.

This is the link for the cartoon and for a wonderful presentation, I am really fascinated about that presentation. And then there are other elements if somebody is interested to read more about learn, more about supplement knowledge about this can refer to that.

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**TRIZ**

- TRIZ is considered an Algorithm.
- It is a step by step process and can be termed an empirical method.
- It's primary premise is that innovation can be taught.
- Also that problems may be coded, classified and solved methodically.
- Applying TRIZ helps to reduce the number of trials & make some kind of quick short-cut to solution.

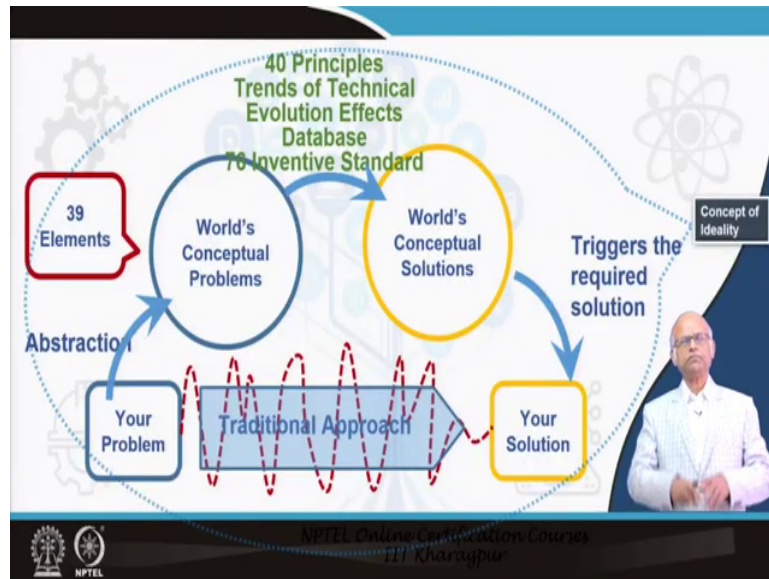
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TRIZ is considered as an algorithm, we will see that TRIZ is a step by step process. That is why it is considered as an algorithm and empirical method. It is a step by step process and can be termed as an empirical method, its primary premises that this is most important, innovation can be taught.

TRIZ eliminates uncertainty, TRIZ restrict or limit the requirement of out of the box thinking for innovation, but it does not eliminate altogether. TRIZ leads us to a certain place where we need to invent, but it eliminates a long path and retains only a small part, where we should use our creativity and come up with ground breaking innovation.

So, because it reduces that long path, it eliminates or it reduces time, it reduces number of trial because walking that distance would lead to many trials, many mistakes, many change of strategy etcetera many surprises.

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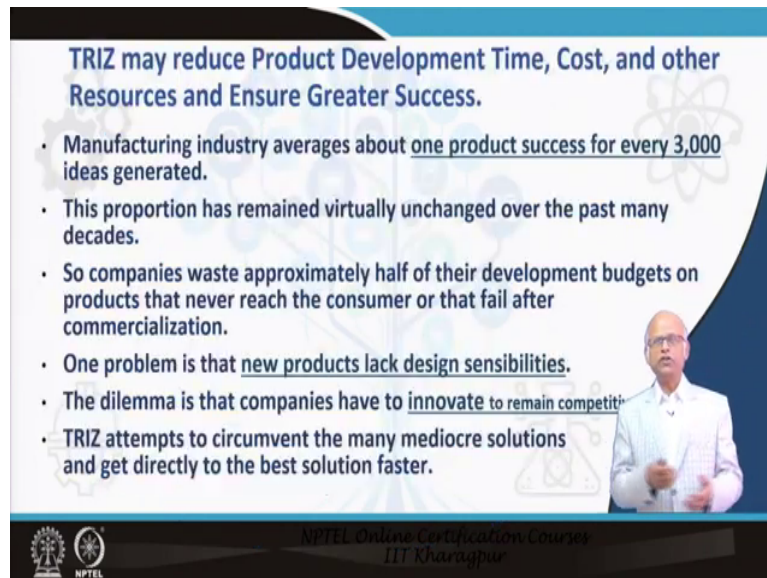
Another thing is that, another means another way of understanding TRIZ is like this, you have a problem. Now the world has a huge reservoir of knowledge, a generalized reservoir of knowledge. You have a very specific problem now this problem you identify out of that reservoir of generalized knowledge as to what can be a specific solution for your problem.

So, you get a specific solution for your specific problem from a generalized reservoir and that is how your solution comes. If you do not apply TRIZ then the path will be tortuous you will



have ups and downs you will have many failures on the way and the time requirement is going to be far along we will show it with two examples.

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**TRIZ may reduce Product Development Time, Cost, and other Resources and Ensure Greater Success.**

- Manufacturing industry averages about one product success for every 3,000 ideas generated.
- This proportion has remained virtually unchanged over the past many decades.
- So companies waste approximately half of their development budgets on products that never reach the consumer or that fail after commercialization.
- One problem is that new products lack design sensibilities.
- The dilemma is that companies have to innovate to remain competitive.
- TRIZ attempts to circumvent the many mediocre solutions and get directly to the best solution faster.

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TRIZ may reduce product development time, cost and other resources, I will not tell much on that. Now the history tells or even data or empirical there are empirical evidences, that one out of 3000 product ideas only becomes successful and goes to market, goes to the customer.

Many actually leads lead to wastage of lot of resources and money, some products do not go after the market, some goals go after the market and fail. So, the huge colossal wastage of money resources time manpower and this is not just a new phenomenon, it has been there for decades. So, it is necessary to eliminate these number of failures. And then come directly to the point as to where the solution lies TRIZ actually takes us to that point that solution is here. Now we will start thinking and try to invent.

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**39 Parameters or contradictions and 40 Inventive Principles**

- Altshuller identified 39 contradictions or parameters and 40 inventive principles.
- In TRIZ process, each innovative initiative can be related to one or more of these principles that would help a solution.
- To arrive at the appropriate inventive principle, one has to be able to identify the right contradiction in a matrix.
- Once the inventive principles are located, the problem solving process can begin.

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Now, the implementation part, TRIZ has or TRIZ recommends 39 parameters or contradictions. There is a matrix, on the horizontal side there are these 37 contradictions, on the vertical side there is this 39 contradiction is a matrix, same contradictions on the horizon on the horizontal side and same on the vertical side.

Now, you have to these parameters or contradiction contradictions meaning that there is one positive, another negative. One advantage, another disadvantage. So, identify an advantage of your solution or of your, right of your solution or proposed solution or desired solution. And then look for the disadvantage side of that.

Suppose, you want to build a furniture say a table or a chair, you need a strength, you need is to be you need this to be strong and you look around anywhere in this world, you will find that strength comes with wet, it becomes heavy. So, if you are looking for a strength is a

desired characteristic, heaviness is an undesired characteristics in some context. So, this is what is contradiction. Now, identify this desired characteristic and then that may be on the vertical side vertical, means horizontal side. Identify its disadvantage part on the vertical side.

Then you wherever they intersect you will find there is a formula hidden there. Using that formula you go to the 40 inventive principles and you will get to know how the solution is to be found out. So, once the inventive principles are located, the problem solving process actually starts.

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**Ideality: A Metric to Measure Progress Towards the Ideal Final Result (IFR)**

The ideal final solution:

- Eliminates the deficiencies of the original system
- Preserves the advantages of the original system
- Does not make the system more complicated
- Does not introduce new disadvantages

$$Ideality = \frac{\sum Benefit}{\sum Cost + \sum Harm}$$

- Improvement is to increase benefit
- Reduce cost
- Reduce harm

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Before we go to the example, there is a wonderful philosophy or say a data or a metric that defines the goodness of a product or product market fit, that is called ideality or what you should necessarily target when you think of developing a new product.

You should target to improve ideality, the formula for ideality is like this the numerator is the sum total of the benefit benefits that you are trying to incorporate in the product or service, the numerator. The denominator is the sum total of the cost and the sum total of the harm that you are causing because you are trying to give this advantages in this product. As we know already that advantages comes advantages come with disadvantages.

So, there is a conflict or contradiction. So, numerator is the sum total of the benefits, denominator is a sum total of the additional cost and additional harm that we are going to incorporate by trying to find incorporate these benefits into this product. So, this is the conflict benefits and cost and harm.

Now our target should be to increase the benefit, then ideality goes up or reduced cost ideality goes up reduce harm ideality goes up. So, improvement is to increase the benefit reduce the cost reduce the harm. So, try not to increase any kind of disadvantage, try to improve on the original system the advantage the ease the efficacy etcetera.

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**The 39 TRIZ Features for technical contradictions or Technical parameters or Problem parameters**

1: Weight of moving object	14: Strength	27: Reliability
2: Weight of stationary object	15: Durability of moving object	28: Measurement accuracy
3: Length of moving object	16: Durability of non moving object	29: Manufacturing precision
4: Length of stationary object	17: Temperature	30: Object-affected harmful
5: Area of moving object	18: Illumination intensity	31: Object-generated harmful
6: Area of stationary object	19: Use of energy by moving object	32: Ease of manufacture
7: Volume of moving object	20: Use of energy by stationary object	33: Ease of operation
8: Volume of stationary object	21: Power	34: Ease of repair
9: Speed of object	22: Loss of Energy	35: Adaptability or versatility
10: Force (Intensity)	23: Loss of substance	36: Device complexity
11: Stress or pressure	24: Loss of Information	37: Difficulty of detecting
12: Shape	25: Loss of Time	38: Extent of automation
13: Stability of the object	26: Quantity of substance	39: Productivity

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Now, this is a list of 39 contradiction. It is not represented like this, it is just to make the lists very difficult to put the list horizontally and vertically. So, these are sometimes referred to as contradictions, sometimes technical parameters, sometime problem parameters.

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**Altshuller's 40 Principles of invention of TRIZ**

1. Segmentation
2. Taking out
3. Local Quality
4. Asymmetry
5. Merging
6. Universality
7. "Nested doll"
8. Anti-weight
9. Preliminary anti-action
10. Preliminary action
11. Beforehand cushioning
12. Equipotentiality
13. The other way around
14. Spheroidality
15. Dynamics
16. Partial or excessive actions
17. Another dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Skipping
22. "Blessing in disguise"
23. Feedback
24. 'Intermediary'
25. Self-service
26. Copying
27. Cheap short-living
28. Mechanics substitution
29. Pneumatics and hydraulics
30. Flexible shells and thin films
31. Porous materials
32. Color changes
33. Homogeneity
34. Discarding and recovering
35. Parameter changes
36. Phase transitions
37. Thermal expansion
38. Strong oxidants
39. Inert atmosphere
40. Composite material film

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And these are the 40 inventive principles. So, we will come to that 40 inventive principles remain like a chart. So, we well come to that.

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This is how the forty inventive principles are shown this has been taken from Wikipedia and its very difficult even to read, so, I have a small close up.

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TRIZ – developed by Genrich Altshuller

39 Parameters and 40 Inventive Principles

[page from https://en.wikipedia.org/wiki/TRIZ](https://en.wikipedia.org/wiki/TRIZ)

A) 40 principles of invention in sketches, rendered into form of vector graphics

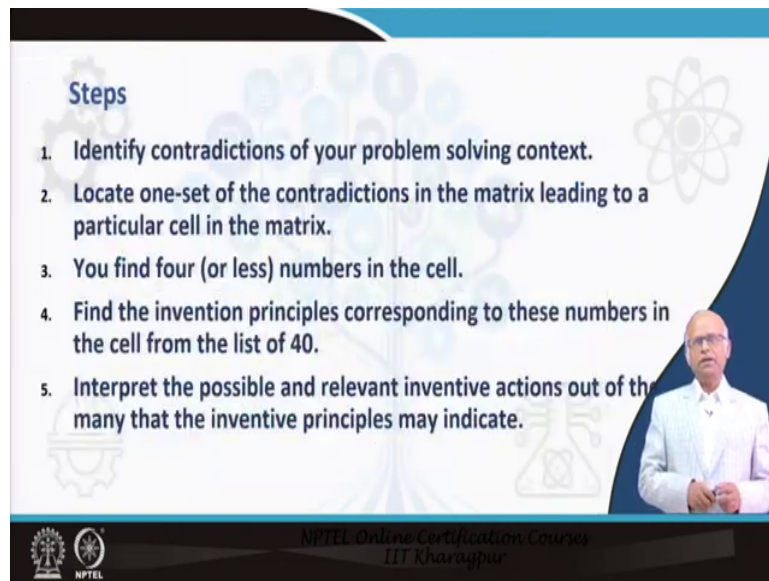
<b>01) DIVISION</b> a) a ship built, made of removable / replaceable bulkheads b) multi-engine aircraft c) multi-piston engine of internal combustion d) a toy made of Lego blocks e) breakable chocolate f) multi-grip fixtures g) a binded file of paper sheets h) multi-blade cartridge razors i) multi-blade aircrews of aircrafts, or wind power-plants	<b>11) BEFOREHAND CUSHIONING</b> a) for instance: a method of "dressing" of the cut tree branches <i>(this action actually forces a tree to beforehand reaction, to gather substances)</i> b) diver's airbag c) masking of the chosen elements, within patches on the object, before its painting d) gathering crops in summer and autumn seasons, while preparing for winter harsh weather conditions
<b>02) TAKING OUT</b> a) taking of notoriously noisy power unit, or compressor out of the main boat b) (engines, turbines, blades) combined with internal duct	<b>12) EQUIPOTENTIALITY</b> a) a sequence of linear movements is replaced by single seamless movement on section of arc usually in sequence of linear movements, is replaced with press deflected on remotely fasten long arm b) a sequence of linear movements c) a press deflected from position

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So, number 1 is division, number 2 is taking out. This these perspective is it not make lot of sense, but if you go inside the way researchers have incorporated several sub headings or several possible solutions, those are very important and those are going to give us clue as to how to innovate or how to take a clue from here to find a solution.



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**Steps**

1. Identify contradictions of your problem solving context.
2. Locate one-set of the contradictions in the matrix leading to a particular cell in the matrix.
3. You find four (or less) numbers in the cell.
4. Find the invention principles corresponding to these numbers in the cell from the list of 40.
5. Interpret the possible and relevant inventive actions out of the many that the inventive principles may indicate.

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Let us see the a steps fast. There will be let me show the contradiction matrix this is the contradiction matrix.

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**Contradiction matrix**

**Making a table that is strong but lightweight**

Worsening Factor->	Weight of Moving Object	Weight of Stationary Object	Length of Moving Object
Improving Factor	1	2	3
1) Weight of Moving Object			15,8,29,34
2) Weight of Stationary Object			
3) Length of Moving Object	8,15,29,34		
4) Length of Stationary Object		35,28,40,29	
5) Area of Moving Object	2,17,29,4		14,15,18,4
6) Area of Stationary Object		30,2,14,18	
7) Volume of Moving Object	2,26,29,40		1,7,4,35
8) Volume of Stationary Object		35,10,19,14	19,14
9) Speed	2,28,13,38		13,14,8
10) Force	8,1,37,18	18,18,1,28	17,19,9,36
11) Stress or Pressure	10,36,37,40	13,25,10,18	35,10,36
12) Shape	8,10,29,40	15,10,26,3	29,34,5,4
13) Stability of object's composition	21,35,2,39	26,38,1,40	13,15,1,28
14) Strength	1,8,40,15	40,26,27,1	1,15,8,35
15) Duration of Action of Moving Object	19,5,34,31		2,19,9
16) Duration of Action of Stationary Object		6,27,19,16	
17) Temperature	36,22,6,38	22,35,32	15,19,9
18) Illumination Intensity	19,1,32	2,35,32	19,32,16
19) Use of Energy by Moving Object	12,18,28,31		12,28
20) Use of Energy by Stationary Object		19,9,6,27	
21) Power	8,36,38,31	19,26,17,27	1,10,35,37
22) Loss of Energy	15,6,19,28	19,5,18,9	7,2,6,13
23) Loss of Substance	35,6,23,40	35,6,22,32	14,29,10,39

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On the left this vertical one to 39 contradictions on the horizontal side of the top there are 39 contradictions, all 39 contradictions both horizontal and vertical. The steps are like this identify contradictions of your problem solving context. So, let us see here suppose you are thinking of building a table that is both strong at the same time it is light. So, what you do is, first of all you maybe you come to the horizontal side, say or vertical side whichever side. Say a strength and number fourteen you have the a strength you need a strength for the table.

So, you go to you travel horizontally, and then you go up at in at a column where you find weight of a stationary object this is in a stationary object and you see weight of a stationary object. Then you see that this two line intersect at a particular point its rounded here. So, there are three items in this, one is number 40, another is number 26, another is number 27 these

are the inventive principles. So, now, with these numbers you have to go to the 40 inventive principles to find a solution.

So, coming back locate one set of contradictions in the matrix like a strength and weight of a stationary object. Matrix leading to particular cell in the matrix find the invention principles corresponding to these numbers in the cell from the list of 40. Interpret the possible and relevant inventive actions out of the many that the inventive principles may indicate. So, if we are thinking of building a chair, building a table, now we have this 40, 26 and 27.

Now, if you if we go to go here you will find that number 40, has something like composite material; that means, composite material is something that is light and strong. So, we do not have to go much we have to see 26 and 27, but from here itself you get a clue that if we need a strength and if we need less weight, composite it is a material we can start with. Then you visit 26 and 27 you will find more features and you will find a solution.

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**Contradiction Matrix of the Airbag problem**  
**Row 15 & Column 31**

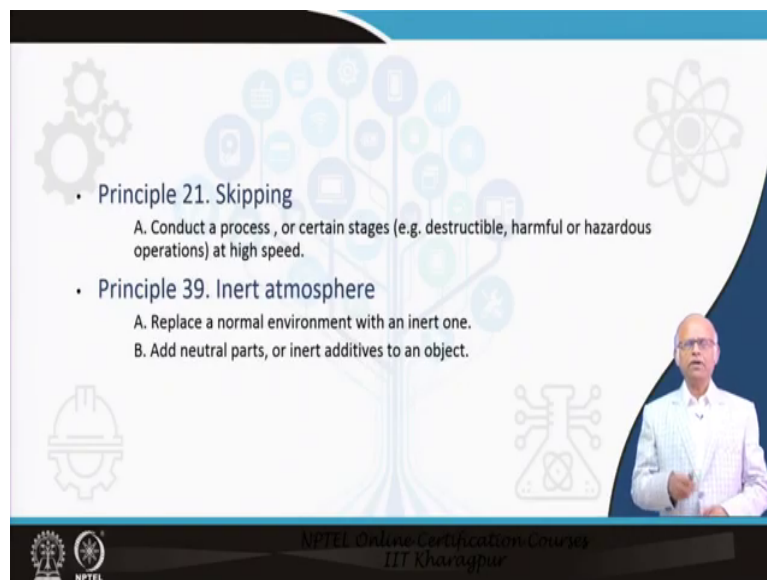
	Worsening Feature →	Volume of moving object	Speed	Force (intensity)	Stress or pressure	Shape	Reliability	Object-generated harmful factors	Ease of operation	Ease of repair	Device complexity	Difficulty of detecting and measuring
		7	9	10	11	12	27	31	33	34	36	37
9	Speed	7, 29, 34	+	13, 28, 15, 19	6, 16, 38, 40	35, 15, 18, 34	11, 55, 27, 28	2, 24, 35, 21	32, 26, 15, 12	34, 2, 28, 27	10, 28, 4, 34	3, 34, 27, 16
10	Force (intensity)	15, 9, 12, 37	13, 28, 15, 12	+	18, 21, 11	10, 35, 40, 34	3, 35, 18, 21	13, 3, 36, 24	1, 28, 5, 25	15, 1, 11	26, 35, 10, 18	36, 37, 10, 19
11	Stress or pressure	6, 35, 10	6, 35, 36, 35, 26	36, 35, 21	+	35, 4, 15, 10	10, 13, 19, 35	2, 33, 27, 18	11	2	19, 1, 35	2, 36, 37
12	Shape	14, 4, 15, 22	35, 15, 34, 18	35, 10, 37, 40	34, 13, 10, 14	+	10, 40, 10	35, 1, 28	32, 15, 20	2, 15, 1	16, 29, 1, 28	15, 13, 89
15	Duration of action of moving object	10, 2, 19, 30	5, 35, 5	19, 2, 16	19, 3, 27	14, 26, 28, 25	11, 2, 13	21, 39, 16, 22	12, 27	29, 10, 27	10, 4, 29, 15	19, 29, 39, 35
33	Ease of operation	1, 16, 35, 15	18, 13, 34	28, 13, 35	2, 32, 12	15, 34, 29, 28	17, 27, 6, 40	+		12, 26, 1, 32	32, 26, 12, 17	

Here is a more complex context say you are thinking of designing a air bag, I have taken it because I personally met with an accident and air bag actually saved my life. So, take this air bag. Now, for air bag in a car when somebody hit the car with an object, then there is going to be a collision and a jerk, and the air bag will inflate that will prevent that person from hitting the dashboard or the steering wheel, and then it is going to save the life.

Now, there are contradiction. One is if the air bag comes very fast. Means is blows very fast and hit on your face, that itself may be that impact itself may be so big that perhaps some people may die of shock. At the same time if the impact is slow meaning that it comes slowly, in that case before the air bag will hit the person, the person will hit the steering wheel. So, there is no saving of life. So, either way you are kind of problem. So, there is a contradiction, if the speed is high then the impact is high. So, it is kind of its a bad thing.

Now, if the speed is low, it does not serve the purpose, so there is another contradiction. Now, look how TRIZ can help us to find this solution. So, on the vertical side, visit number 15. Here it says duration of action of moving object meaning that it should be fast, meaning duration should be less or more whatever it is our in our case duration should be less. So, duration is 15. Then you proceed and see what is the contradictory contradiction object generated, harmful factor meaning it is hitting the body and then you have the problem of meaning if it make cause harm to the body whereas, you want that it should not cause harm.

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The slide features a white background with a blue header and footer. On the left, there are icons of gears and a tree with various symbols. On the right, there is an icon of an atom and a small inset video of a man in a white shirt. The text on the slide is as follows:

- Principle 21. Skipping
  - A. Conduct a process, or certain stages (e.g. destructible, harmful or hazardous operations) at high speed.
- Principle 39. Inert atmosphere
  - A. Replace a normal environment with an inert one.
  - B. Add neutral parts, or inert additives to an object.

At the bottom left, there are logos for IIT Kharagpur and NPTEL. At the bottom right, the text reads "NPTEL Online Certification Courses IIT Kharagpur".

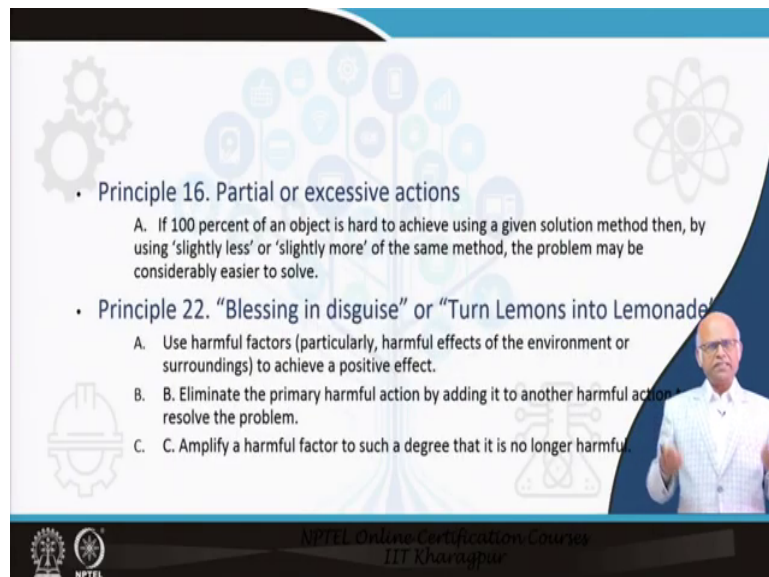
And look at the numbers, 21, 39, 16, 22. Let us see what is there, what are these inventive principles. Principle 21 is a skipping. Meaning the speed, meaning it is in it is suddenly a skip is suddenly coming at a fast-high speed. So, high speed is one thing that is one of the factors, but then we have other factors which together should give us a solution, inert atmosphere. Inert atmosphere is something like if something is causing harm you try to make the

atmosphere in a manner that its harmful effect is neutralized. Meaning add neutral parts or inert additive to an object. So, that harmful effect is neutralized.

Replace a normal environment with an inert meaning if something is causing some harm then try to add something. So, that this harm can be eliminated. What can we do that we what we can do is what or this actually is trying to hit hint on a like this. That this the cloth which makes the air bag can be so soft or can be corrugated or can be there can be multiple bags one coming at a slightly faster speed and where it coming slightly slower speed. So, that or maybe there are layers. So, one will hit and it will blast and body will have some impact, but then there is another

So, gradually your body impacts on layers and it get burst and gradually, gradually the impact is neutralized something like that.

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The slide features a light blue background with various icons: gears, a tree with nodes, an atom, a hard hat, and a balance scale. A presenter in a white shirt is visible on the right side of the slide.

- Principle 16. Partial or excessive actions
  - A. If 100 percent of an object is hard to achieve using a given solution method then, by using 'slightly less' or 'slightly more' of the same method, the problem may be considerably easier to solve.
- Principle 22. "Blessing in disguise" or "Turn Lemons into Lemonade"
  - A. Use harmful factors (particularly, harmful effects of the environment or surroundings) to achieve a positive effect.
  - B. Eliminate the primary harmful action by adding it to another harmful action to resolve the problem.
  - C. Amplify a harmful factor to such a degree that it is no longer harmful.

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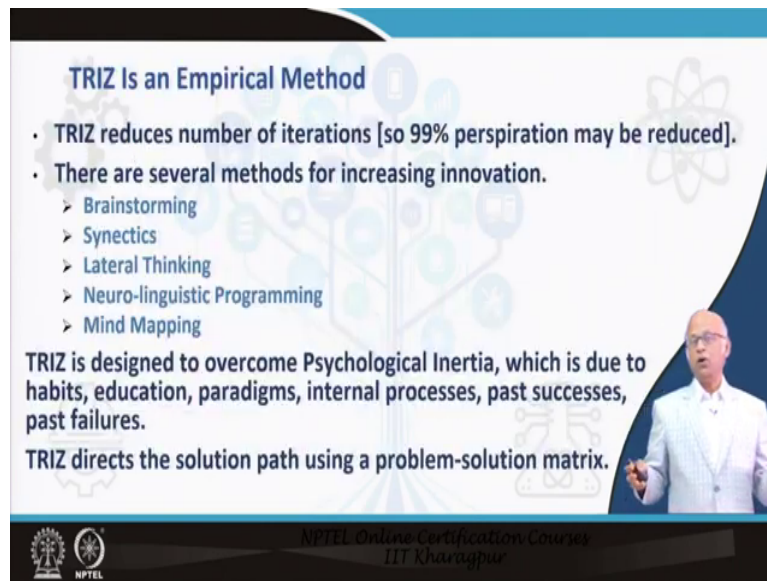
So, it gives. So, many clues this 39. Then 16 is partial or excessive action. Partial means can we think of air bag, that will blow. so, hard so, fast that the body before leaning forward will hit the airbag. So, there will be no impact at all because the moment car will impact there is some inertia. So, before the body actually tries to move forward the air bag comes in. So, the exact collision is less that is called excessive action or maybe partial..

Partial how maybe there may be some several layers, so part impact will be taken care of by layers, blessings in disguise. Sometimes, sometimes negative actions can be used to create some wealth. Like say there is a waste heat you can use it for generating power, here blessing in disguise maybe you can amplify harmful effect to some degree. So, either this impact meaning the impact with which the bill the air bag is coming.

Perhaps by increasing by speed perhaps you can neutralize the effect of the impact. So, we have to really go deeper inside as to what nowadays there are software's, where you just hit the button 22 you will get all possible solutions and you will get hint as to what should be utilized.

Eventually out of this four inventive principles its easy to really come up with or to narrow down your domain of thought. Now you be creative and then find out the solution it becomes easy that is what expert says professionals says consultant says all are saying the same thing.

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**TRIZ Is an Empirical Method**

- TRIZ reduces number of iterations [so 99% perspiration may be reduced].
- There are several methods for increasing innovation.
  - Brainstorming
  - Synectics
  - Lateral Thinking
  - Neuro-linguistic Programming
  - Mind Mapping

TRIZ is designed to overcome Psychological Inertia, which is due to habits, education, paradigms, internal processes, past successes, past failures.

TRIZ directs the solution path using a problem-solution matrix.

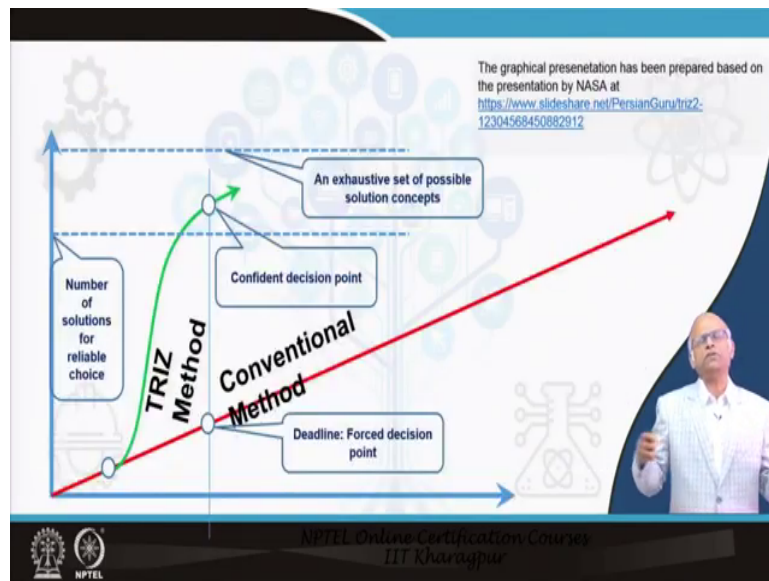
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If TRIZ is not there then you have to go through the linear process normal process like brainstorming like synectic's that we have discussed lateral thinking that is a kind of a orthogonal thinking, not thinking in a straight line or not thinking in a straight line thinking vertically. Then Neuro Linguistic Programming NLP or mind mapping like a graphical representation of mind by of a team or members of the team.

There are other alternatives which are kind of proven to be complex and you come up with. So, many alternatives that it becomes tedious time consuming and costly.



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Therefore, the people suggest that TRIZ method gives you a huge leverage and within short period of time you are reaching at a point where using conventional method you may not reach anytime.

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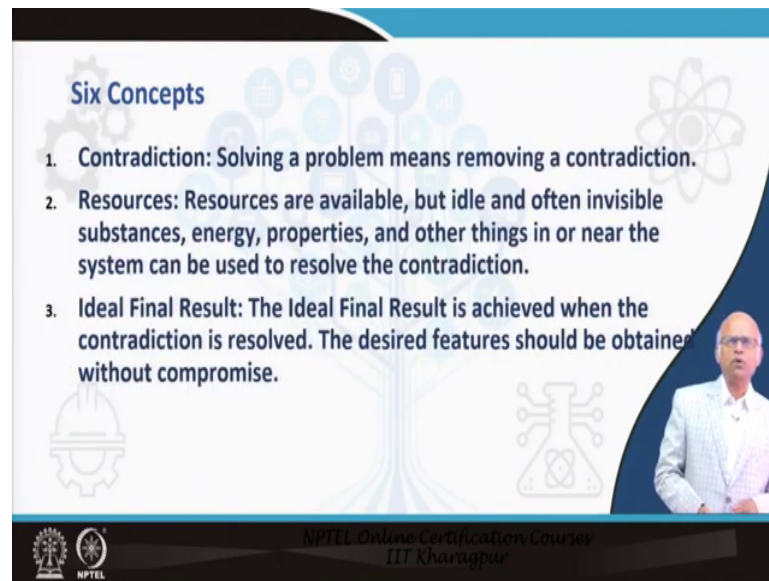
**Six Concepts**

The problem-solving model uses six concepts:

- Contradiction
- Resources
- The ideal final result
- Functional analysis
- The patterns of evolution (called “the increase of interactions.”) and
- Innovative principles.

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**Six Concepts**

1. **Contradiction:** Solving a problem means removing a contradiction.
2. **Resources:** Resources are available, but idle and often invisible substances, energy, properties, and other things in or near the system can be used to resolve the contradiction.
3. **Ideal Final Result:** The Ideal Final Result is achieved when the contradiction is resolved. The desired features should be obtained without compromise.

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Now, there are six more concept its not means its almost like discussed. So, I will just not spend a lot of time on this. Contradiction we have discussed resources meaning that you should look around you resources are everywhere, so do not look far away. Ideal final result meaning that you should not compromise or come be plus complex (Refer Time: 32:36).

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**Six Concepts**

4. **Functional analysis:** Systems exist to create a functional output. Understanding systems functionally provides great insight into how the output is achieved and uncovers problems (contradictions), potential resources and, therefore, opportunities.
5. **Patterns of evolution:** Systems evolve according to certain patterns, not accidentally. The patterns can be used many ways to get new ideas and predict the evolution of the system.
6. **Innovative principles:** These principles give concrete cues for solutions and illustrate what the patterns can mean.

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Then function functionality analysis. Systems exist to create functional output understanding system meaning understanding your environment is very important pattern of evolution like as I said technology has been evolving in a straight line almost like in a straight line its a natural process.

So, we can forecast what should be our next action then there are innovative principles.

Thank you very much.