AQS 200
ROOT CAUSE INVESTIGATION

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LECTURE 11
TOOLS FOR
ROOT CAUSE ELIMINATION

- Six Thinking Hats

- Theory of Inventive Problem Solving (TRIZ)

- Systematic Inventive Thinking (SIT)

PROBLEM

? ? ? ? ?

ROOT CAUSE

Problem/Issue Identified → Understand the Problem
Chapter 3

Investigate Potential Causes
Chapter 4

Data Collection
Chapter 5

Data Analysis
Chapter 6

Identify Root Cause
Chapter 7

Eliminate Problem
Chapter 8

Implement Solution

Six Thinking Hats

Process

Feelings

Cautions

Benefits

Facts

Creativity
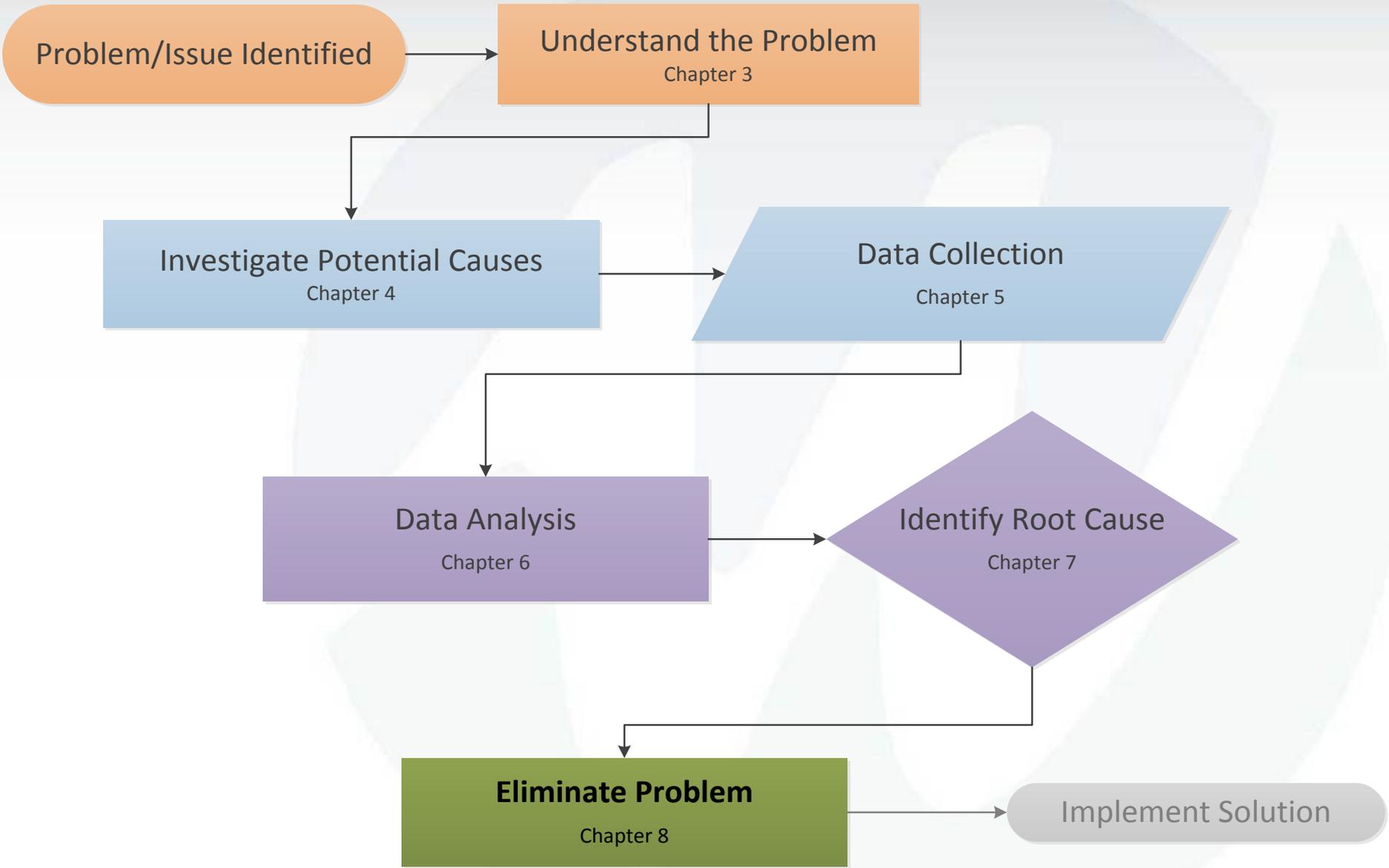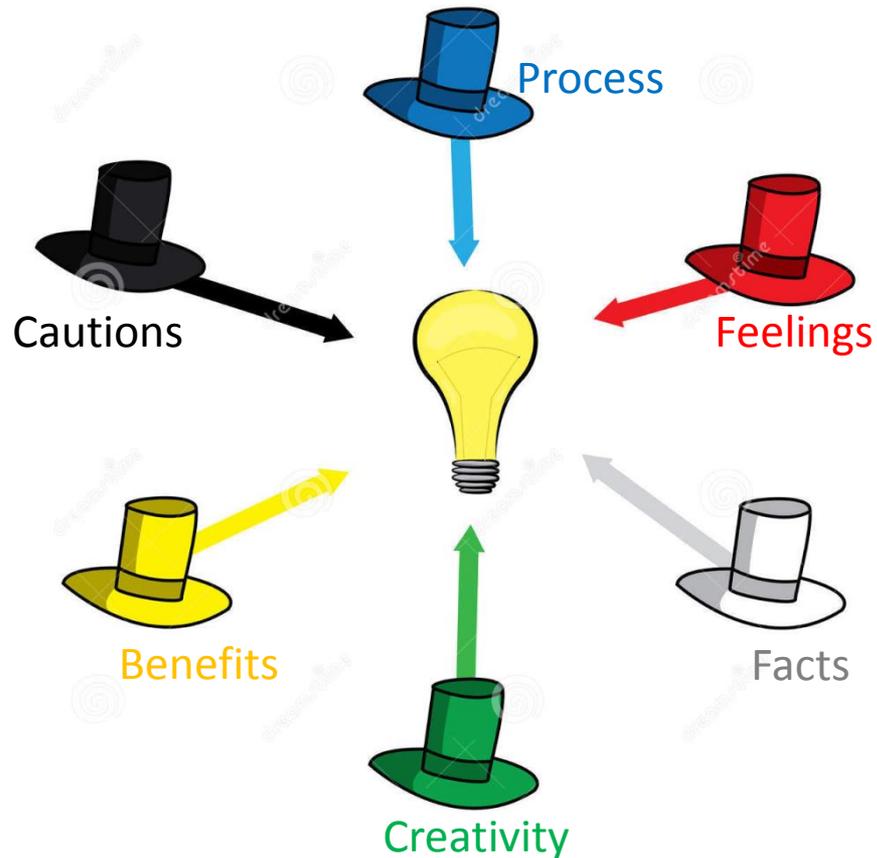
Created by Edward DeBono

Six Thinking Hats

- Encourages recognition of
  - Type of thinking being used
  - Apply different types of thinking to subject

- Purpose: actively encourage viewing a problem and solutions from several different perspectives
  - Solutions are subjected to scrutiny prior to decision

Playing devil's advocate allows for
debate regarding feasibility and potential flaws

Six Thinking Hats

- "Six Thinking Hats" given colors and respective roles:

  ➢ *"White"* hat - Facts

  ➢ **Red hat - Feelings**

  ➢ **Black hat - Caution**

  ➢ **Yellow hat - Benefits**

  ➢ **Green hat - Creativity**

  ➢ **Blue hat - Process**

https://www.youtube.com/watch?v=rVfx3j8QaM8#t=12

Six Thinking Hats

Facts

"*White*" hat: Cold, neutral and objective

- *Team* member(s) assigned this hat should be:
  - systematic and careful in looking at the facts and figures
  - What do I know? What do I need to find out"? How will I get the information?

Six Thinking Hats

Feelings

Red hat: represents anger

- *Team* member(s) assigned this hat should:
  - Follow intuition / gut feeling, their own emotions
  - Immediate reaction to solution under discussion

Six Thinking Hats

Caution

Black hat: represents pessimism

- *Team* member(s) assigned this hat should:
    - Focus on why solution will fail
    - Difficulties, weaknesses, dangers
    - Logical reasons provided
    - Spot the risks

Six Thinking Hats

Benefits

Yellow hat: represents benefits, optimism

- *Team* member(s) assigned this hat should:
  - Focus on why solution will succeed
  - Positives, plus points, why idea is useful
  - Logical reasons provided

Six Thinking Hats

Creativity

Green hat: represents creativity, growth

- *Team* member(s) assigned this hat should:
  - Present ideas, alternatives
  - Provide solutions to black hat problems ("fails")

Six Thinking Hats

Process

Blue hat: seeing things from higher perspective

- *Team* member(s) assigned this hat should:
  - Organize the solutions/thinking
  - Plan for actions
  - Focus on stepping back and seeing "big picture"

Six Thinking Hats

- Encourages recognition of
  - Type of thinking being used
  - Apply different types of thinking to subject

- Purpose: actively encourage viewing a problem and solutions from several different perspectives
  - Solutions are subjected to scrutiny prior to decision

- Some may be viewed as negative, but designed for thoughtful discussion / debate

Six Thinking Hats

EXAMPLE

Six Thinking Hats – HOW TO

1. Assign hats to people on the discussion team
   a) preferably one color per person
   b) when speaking during the session, they must clearly identify with the color of their hat

2. Engage in a creative discussion about the problem
   a) "white" hat presents problem facts
   b) "green" hat presents possible solutions

3. Potential solutions are discussed
   a) "yellow" hat focusses on benefits
   b) "black" hat focusses on risks/drawbacks
   c) "red" hat works to elicit team member reactions

   NOTE: All team members can contribute in each phase

Six Thinking Hats – HOW TO

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4. Following discussion, "blue" hat summarizes, organizes next steps and closes meeting

Six Thinking Hats

EXERCISE

TRIZ

- *Theory of Inventive Problem Solving*

TRIZ

- *Theory of Inventive Problem Solving*
  - Developed by Genrich S. Altshuller for solving problems
  - Finding solutions for "inventive problems" requiring combined knowledge of different disciplines
    - go beyond applying known solutions to similar problems

- Purpose: dissect problem into core components and create unique solutions
  - Stimulate creativity of team
  - Typically used for engineering problems/solutions

TRIZ

- Philosophy
  - Systems evolve through elimination of contradictions
    - Problems are represented in terms of contradictions that must be eliminated to come up with breakthrough solutions
  - Evolution of systems is a systematic process
    - A number of regularities exist which govern the technology evolution. The regularities are generic over various domains
  - Previous experience can be studied and re-used
    - By studying previous experience of creative work it is possible to learn how to use this experience in a systematic way to solve new problems
  - New inventive problems are hard to formulate correctly
  - Successful problem solving requires a blend of generic thinking and specific knowledge

TRIZ

- Altshuller discovered - three primary findings
  - Problems / solutions are repeated across industries & sciences
  - Patterns of technical evolution are also repeated across industries & sciences
  - Innovations used scientific effects outside the field in which they were developed

- Model based tool
  - 39 Technical Characteristics
  - 40 Inventive Principles

TRIZ – (39) Technical Characteristics

1.	Weight of moving object	21.	Power
2	Weight of non-moving object	22.	Waste of energy
3.	Length of moving object	23.	Waste of substance
4.	Length of non-moving object	24.	Loss of information
5.	Area of moving object	25.	Waste of time
6.	Area of non-moving object	26.	Amount of substance
7.	Volume of moving object	27.	Reliability
8.	Volume of non-moving object	28.	Accuracy of measurement
9.	Speed	29.	Accuracy of manufacturing
10.	Force	30.	Harmful factors acting on object
11.	Tension, pressure, stress	31.	Harmful side effects
12.	Shape	32.	Manufacturability
13.	Stability of object	33.	Convenience of use
14.	Strength	34.	Repairability
15.	Durability of moving object	35.	Adaptability
16.	Durability of non-moving object	36.	Complexity of device
17.	Temperature	37.	Complexity of control
18.	Brightness	38.	Level of automation
19.	Energy spent by moving object	39.	Productivity
20.	Energy spent by non-moving object		

TRIZ – (40) Inventive Principles

Altshuller's 40 Principles 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 films

Tools for Root Cause Elimination
TRIZ - Example

Cycle Time Reduction

- Disconnecting electric motors and moving them to a shop area to repair or replace motor brake drums was an expensive and time consuming process at a power facility. Using the principle of ***equipotentiality*** from TRIZ, maintenance staff determined they could conduct on-site repairs using a portable induction heater, brake drum puller and portable floor crane.

- This shortened the maintenance cycle time, reduced maintenance man-hours, avoided potential problems associated with hoisting and moving large electric motors, and improved the operational availability of high speed motors, saving $90,000 per year.

TRIZ – How To

1. Identify the problem
    a) operating environment
    b) resource requirements
    c) primary useful function
    d) harmful effects and ideal result

2. Formulate the problem more precisely
    a) Focus on physical contradictions (39 technical considerations)
    b) first finding the principle that need to be changed then the principle that is an undesirable secondary effect.

Creating a matrix

TRIZ – How To

1. Identify the problem
    a) operating environment
    b) resource requirements
    c) primary useful function
    d) harmful effects and ideal result

2. Formulate the problem more precisely
    a) Focus on physical contradictions (39 technical considerations)
    b) first finding the principle that need to be changed then the principle that is an undesirable secondary effect.

3. Use "40 Inventive Principles" to look for analogous solutions and adapt them to problem
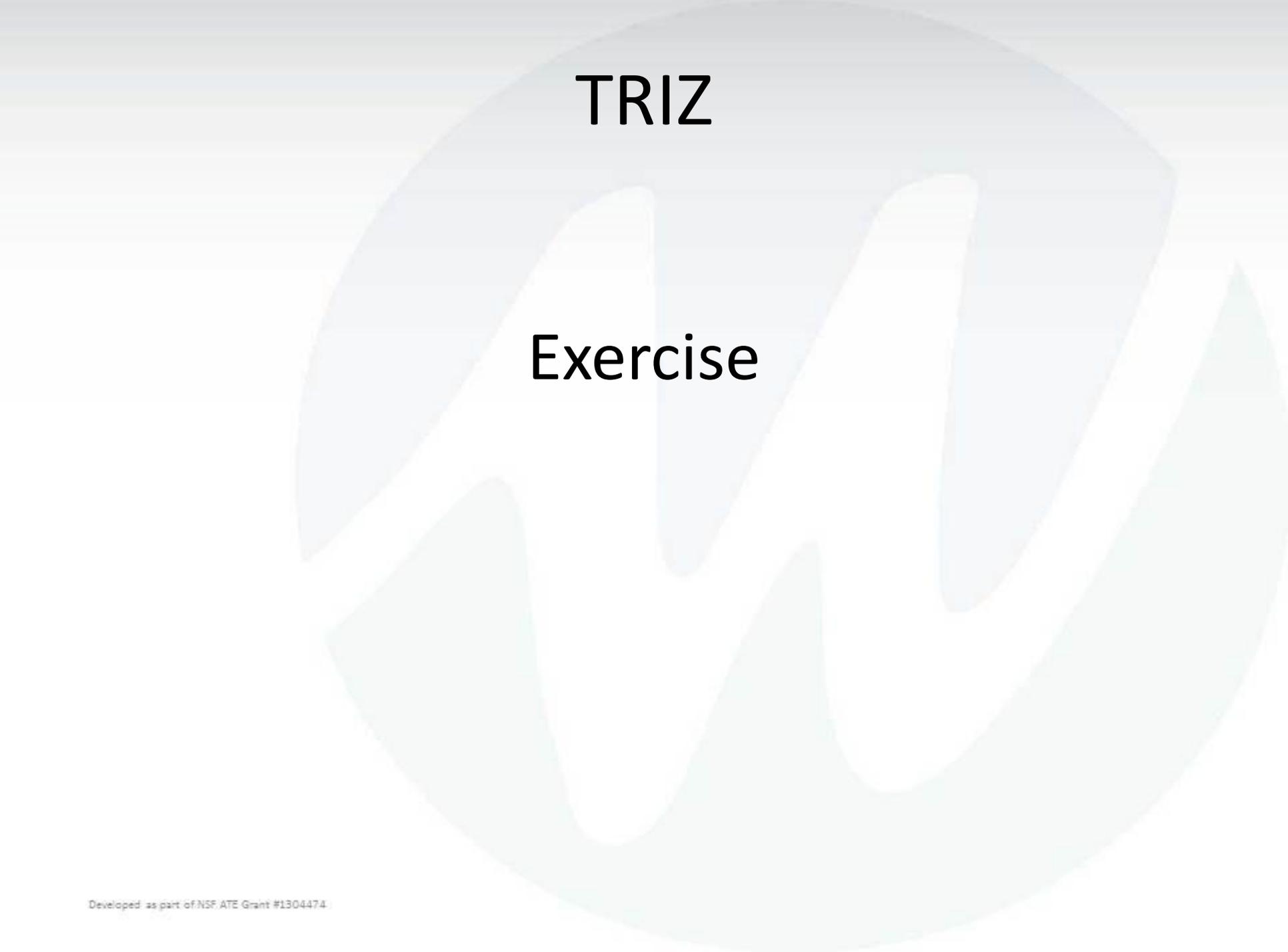
TRIZ

Exercise

SIT

- *Systematic Inventive Thinking*

SIT

- *Systematic Inventive Thinking*
  - *Develop mid-1990's ; derived from TRIZ*
  - Practical approach to creativity, innovation, problem solving
    - Inventive solutions share common patterns
  - Typically used for new product development
  - Root Cause Analysis
    - Find creative solutions
    - Ensure solutions are workable within the environment for easier implementation

SIT

- Operates on idea of "closed world'
  - Utilize only elements already existing in the product/problem
  - Forces reliance on resources already available rather than adding new ones

- Inventive solutions share common patterns
  - Attribute dependency
  - Component Control
  - Replacement
  - Displacement
  - Division

SIT – Main Principles

1. Attribute Dependency
   - Works with variables rather than components (ie. color, size, material)
   - considers changing a key variable of a product

   Example:

   Why couldn't wet diapers generate a strong but pleasant scent – instead of the usual one – to let parents know that the baby needs changing?

SIT – Main Principles

1. Attribute Dependency
   - Works with variables rather than components (ie. color, size)
   - considers changing a key variable of a product

2. **Component Control**

   - Looks at the way a product is linked with its environment

   Example:

   Post-It-Notes - How can memo writer link their notes to the place where they want them to be seen?"

SIT – Main Principles

1. Attribute Dependency
    - Works with variables rather than components (i.e.. color, size)
    - considers changing a key variable of a product

2. Component Control
    - Looks at the way a product is linked with its environment

3. Replacement
    - Substituting part of a product with something from the product's immediate environment
    - Task unification

    Example:

    Bedouins use camels for different tasks: transport, milk, hides, etc.

SIT – Main Principles

1. Attribute Dependency
   - considers changing a key variable of a product
2. Component Control
   - Looks at the way a product is linked with its environment
3. Replacement
   - Substituting part of a product with something from the product's immediate environment
4. Displacement
   - Remove an essential component and find uses for new arrangement of existing (remaining) components

   Example:

   More than 20 years ago, Sony Corporation realized it could squeeze high-quality playback into its early Walkman by removing the recording function.

SIT – Main Principles

1. Attribute Dependency
   - considers changing a key variable of a product
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4. Displacement
   - Remove an essential component and find uses for new arrangement of existing (remaining) components
5. Division
   - Divide product and/or components and rearrange them to form new product
   - Forces different structures

SIT Example

https://www.youtube.com/watch?v=Hg8B6hZBFN8

https://www.youtube.com/watch?v=ZrJ3CN7H6W8

SIT – How To

1. Assemble multidisciplinary team (10-12 people)
2. List all the components of the problem
   a) include components that might seem irrelevant
3. Use five principles in sequence to generate ideas
4. Assess ideas and select "best" for further exploration
5. Continue with most promising ideas
   a) Develop one or more solutions with increased detail

Systematic Inventive Thinking

EXERCISE