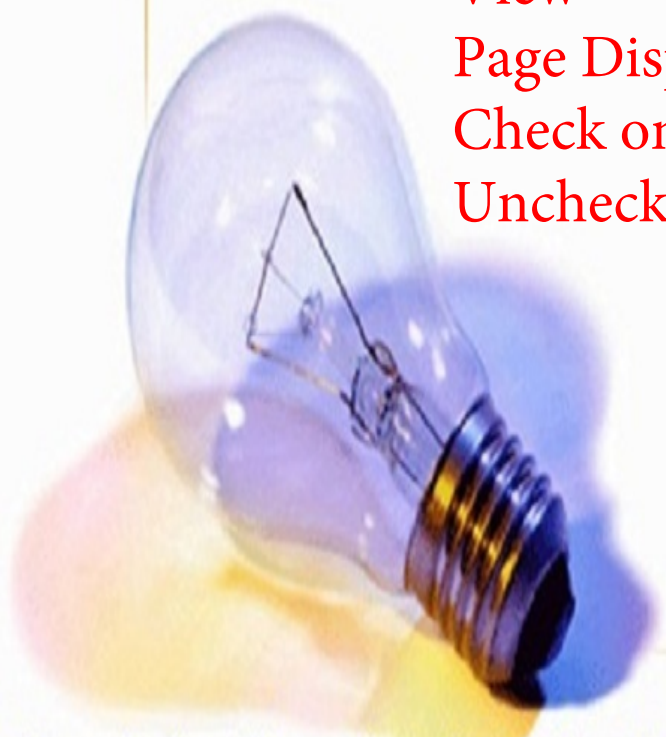
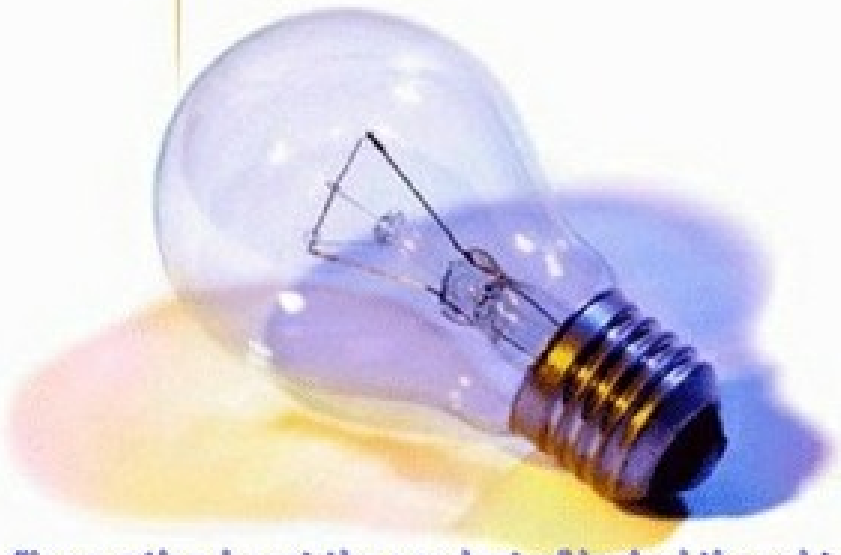
Overview of TRIZ

VIEWING INSTRUCTIONS:
View
Page Display
Check only "ENABLE SCROLLING"
Uncheck "Show Gaps Between Pages"



"Innovation is not the product of logical thought, although the result is tied to logical structure." - Albert Einstein

Overview of TRIZ



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Agenda

- Objective
- Background
- Levels of inventions
- Inventive problem
- Patterns of invention

- Inventive problem
- Patterns of invention
- Laws in the theory of TRIZ
- TRIZ Tools
- Interaction with Six Sigma
- Appendix

Objective

Provide an overview to

- TRIZ
- Enrich innovation skills
- Solving problems encountered during the innovation process

- Enrich innovation skills
- Solving problems encountered during the innovation process
- (I)TRIZ approach & methodology

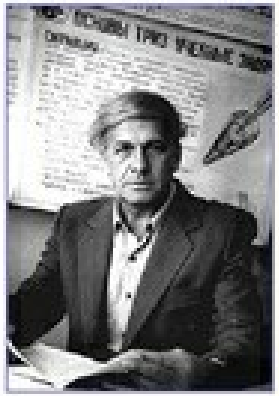
Background

- TRIZ, (*pronounced as treez*) - "Theoria Resheneyva Isobretatelskehuh Zadach," or "Theory of Solving Problems Inventively." is a Russian acronym for the theory of inventive problem solving

- Problem solving method based on technology rather than

- **Problem solving method based on technology rather than psychology**

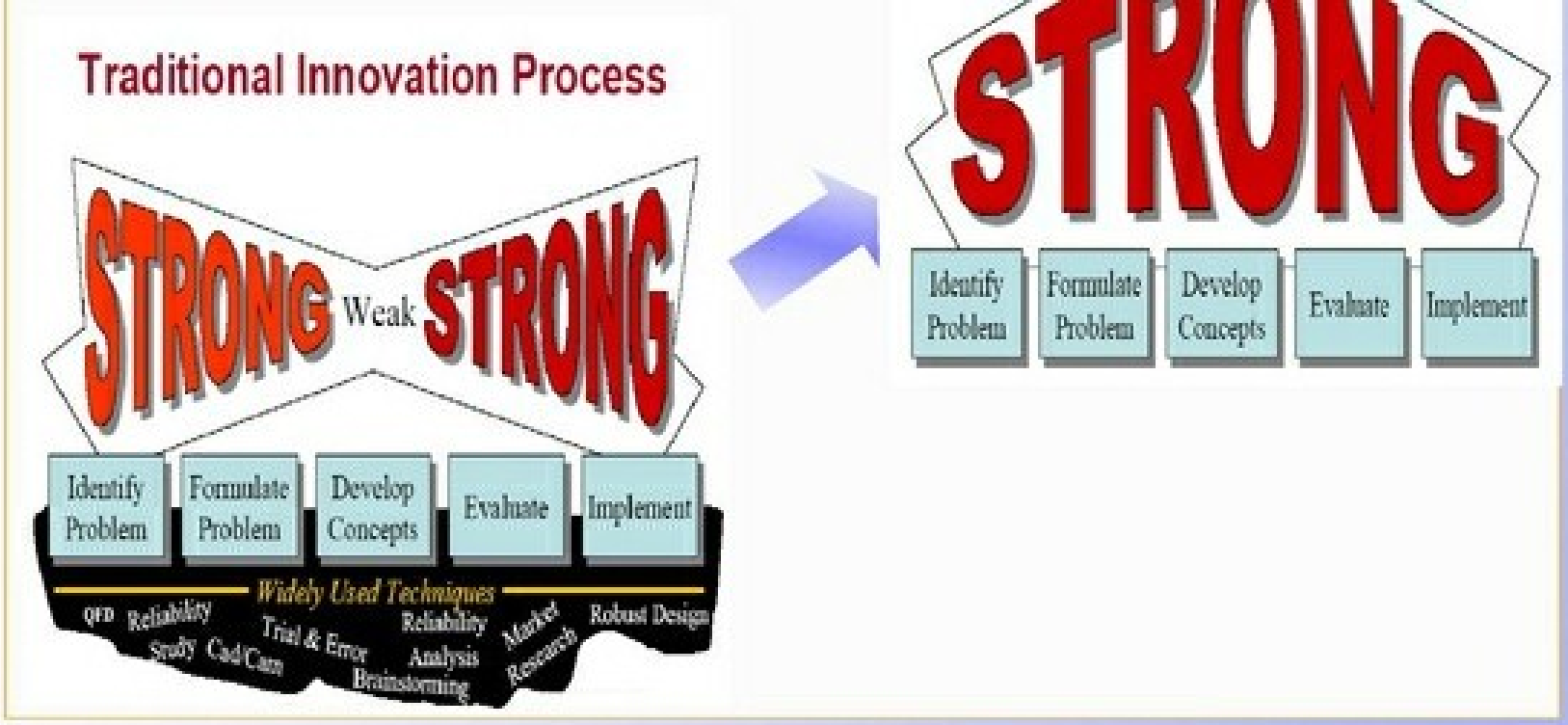
- **Invented by Genrich Altshuller, Russian inventor, in 1946**
  - Worked in the patent department of the Soviet navy.
  - Primary responsibility was to assist inventors in filing patents
- **Ideation – TRIZ (ITRIZ)**
- **Successfully tested over the past 60 years**



Background

Traditional Innovation Process

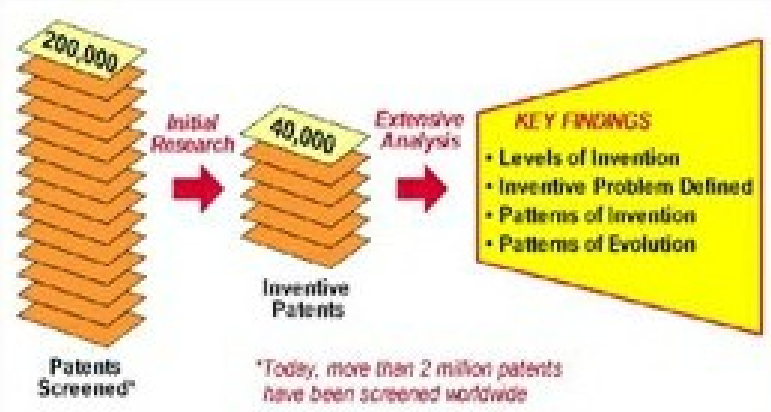
The Added Value of TRIZ


Traditional Innovation Process
STRONG
Weak
STRONG
Identify Problem
Formulate Problem
Develop Concepts
Evaluate
Implement
Widely Used Techniques
QFD
Reliability
Study
Cad/Cam
Trial & Error
Brainstorming
Reliability
Analysis
Market
Research
Robust Design
STRONG
Identify Problem
Formulate Problem
Develop Concepts
Evaluate
Implement

Background

- **Screened approximately 200,000 patent abstracts, fewer than 40,000 of these patents represented inventive solutions and four key findings resulted out of that.**
  - Levels of Invention
  - Inventive problem defined

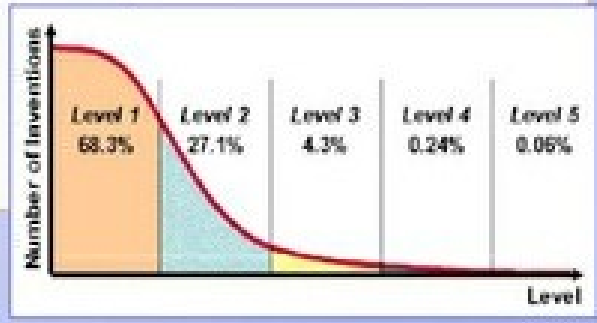
- Levels of Invention
- Inventive problem defined
- Patterns of invention
- Patterns of Evolution



Levels of Invention

- **I-TRIZ, inventions are categorized into five levels**
  - **Level 1 -** Routine design problems solved by methods well known within the specialty. Usually no invention needed.
  - **Level 2 -** Minor improvements to an existing system using methods known within the industry.

- **Level 2 -** Minor improvements to an existing system using methods known within the industry.
- **Level 3 -** Fundamental improvement to an existing system using methods known outside the industry.
- **Level 4 -** A new generation of a system that entails a new principle for performing the system's primary functions. Solutions are found more often in science than technology.
- **Level 5 -** A rare scientific discovery or pioneering invention of an essentially a new system.



Inventive problem

- **There are two groups of problems people face:**
  a) Those with generally known solutions, it can be usually solved by information found in books, technical journals, or with subject matter experts
  b) Those with unknown solutions, also called as **inventive problem**
- **An inventive problem is a problem that:**

b) Those with unknown solutions, also called as **inventive problem**

- **An inventive problem is a problem that:**
  - Suggests no known means for solution
  - Especially prone to **psychological inertia**
  - Involves one or more **contradictions**.

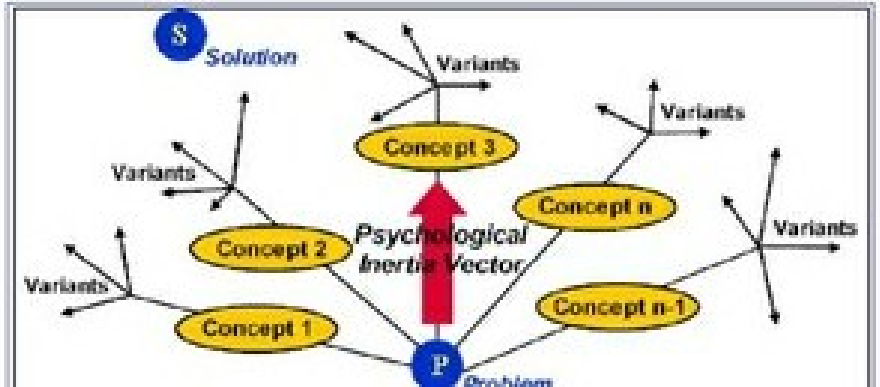
New Knowledge	New knowledge applied to known problems. Example: New plastics provide strong, lightweight products.	New knowledge applied to new problems. Example: Various uses for lasers (surgery, etc).
Existing Knowledge	Existing knowledge applied to known problems. Example: All tasks with generally known solutions.	Existing knowledge does not provide satisfactory solution. We are dealing with an **inventive problem**
	Known Problem	**New Problem**

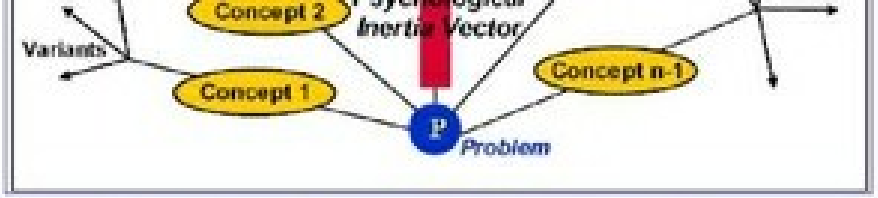
Inventive problem

- Psychological Inertia

P = problem.

S = solution





The table below explains why inventive problems are especially difficult to solve.

Levels	Degree of inventiveness	% of solutions	Source of knowledge	Approximate # of trials
1	Apparent solution	68.3%	Personal knowledge	10
2	Minor improvement	27.1%	Knowledge within the company	100
3	Major improvement	4.3%	Knowledge within the industry	1000
4	New paradigm	0.24%	Knowledge outside the industry	100,000
5	Discovery	0.06%	All that is knowable	1,000,000

Inventive problem

- **Contradictions**

  The situation where an attempt to improve one feature of a system causes another feature to degrade is called a contradiction.

  Examples

  - When the strength of a mechanical object is increased, its weight increases as well

Examples

- When the strength of a mechanical object is increased, its weight increases as well.
- Increased acceleration in an automobile also increases fuel consumption.

How to resolve contradiction ?

- Compromise
- Trade-off

Patterns of invention

- Analogical Thinking
- Directions

- **Analogical Thinking**

  It is a form of inductive logic that emerges early in life and is gradually refine during the years between infancy and adulthood

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- **Using I-TRIZ method**
  - **Step 1** : Read the operator's recommendation and accompanying illustration relate it with the system you are working with
  - **Step 2** : Mentally map the relationship between the system and recommendation unless you get the required image
  - **Step 3** : Write down any and all ideas (crazy & valuable) that result

Patterns of invention

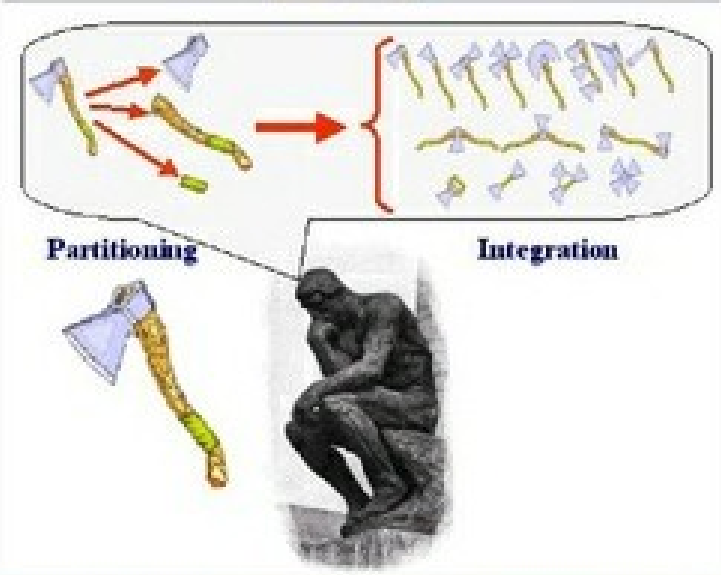
- **Analogical Thinking**

Example: Figure 1 shown describes the process of applying the operator partitioning followed by integration to the problem of improving the design of an axe

1

partitioning followed by integration to the problem of improving the design of an axe

1



Patterns of invention

- Directions

Patterns of invention (operators) are grouped into Directions for changing the system

Example of Direction - Inversion: "Think the opposite." Invert

changing the system.

Example of Direction - Inversion: "Think the opposite." Invert something in the system by applying the operators listed below.

- Make movable parts immobile
- Apply an opposite action
- Replace a sequence of operations
- Inside-out or upside-down
- Replace external action with internal
- Instead of heating use cooling_

Laws in the theory of TRIZ

Laws in the theory of TRIZ

Laws in theory of TRIZ

Some of these laws briefly described:

- **Law of Ideality. Systems evolve toward increasing *Ideality*.**
  - An *Ideal* system being a system that requires no energy to operate, costs nothing to produce and occupies no space. It performs *function* without *form*.

costs nothing to produce and occupies no space. It performs *function* without *form*.

- **Law of Transitioning to Microlevel using Energy Fields**
  - Systems will become smaller, replacing mechanical systems with alternative energy fields performing the required function.
- **Law of Dynamization**
  - In the course of its evolution, systems develop from rigid structures into a flexible ones.

Law of increasing Ideality

- **Law of increasing Ideality**
  - Technical systems evolve toward increasing degrees of ideality, where ideality is defined as the quotient of the sum of the system's useful effects, ***Ui***, divided by the sum of its harmful effects, ***Hj***
  - Useful effects (***Ui***) - valuable results of the system's functioning,
  - Harmful effects (***Hj***) - undesired inputs such as cost, footprint, energy

useful effects, ***Ui***, divided by the sum of its harmful effects, ***Hj***

- Useful effects (***Ui***) - valuable results of the system's functioning,
- Harmful effects (***Hj***) - undesired inputs such as cost, footprint, energy consumed, pollution, danger, etc
- The ideal state is one where there are only benefits and no harmful effects.

$$Ideality = \frac{\sum U_i}{\sum H_j}$$

TRIZ approach to problem solving

- **Step by step process**
  - Step 1: Identify my problem
  - Step 2: Formulate the problem: the Prism of TRIZ
  - Step 3: Search for previously well-solved problem
  - Step 4: Look for Analogous Solutions and adapt to my solution

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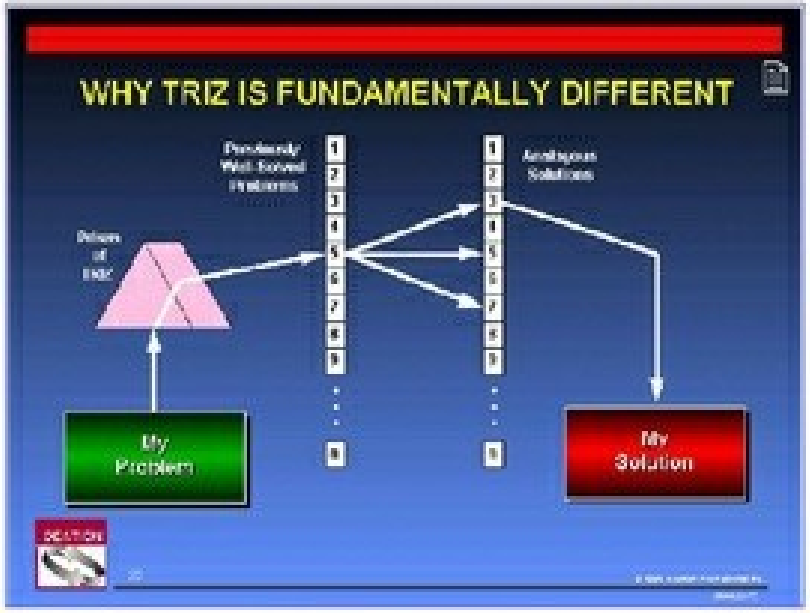
- Step 4: Look for Analogous Solutions and adapt to my solution



TRIZ Tools

TRIZ Tools

TRIZ tools

Directed Evolution
Systematic procedure for strategically evolving future generations of technological systems

Failure Analysis
Systematic procedure for identifying the root causes of a failure or other undesired

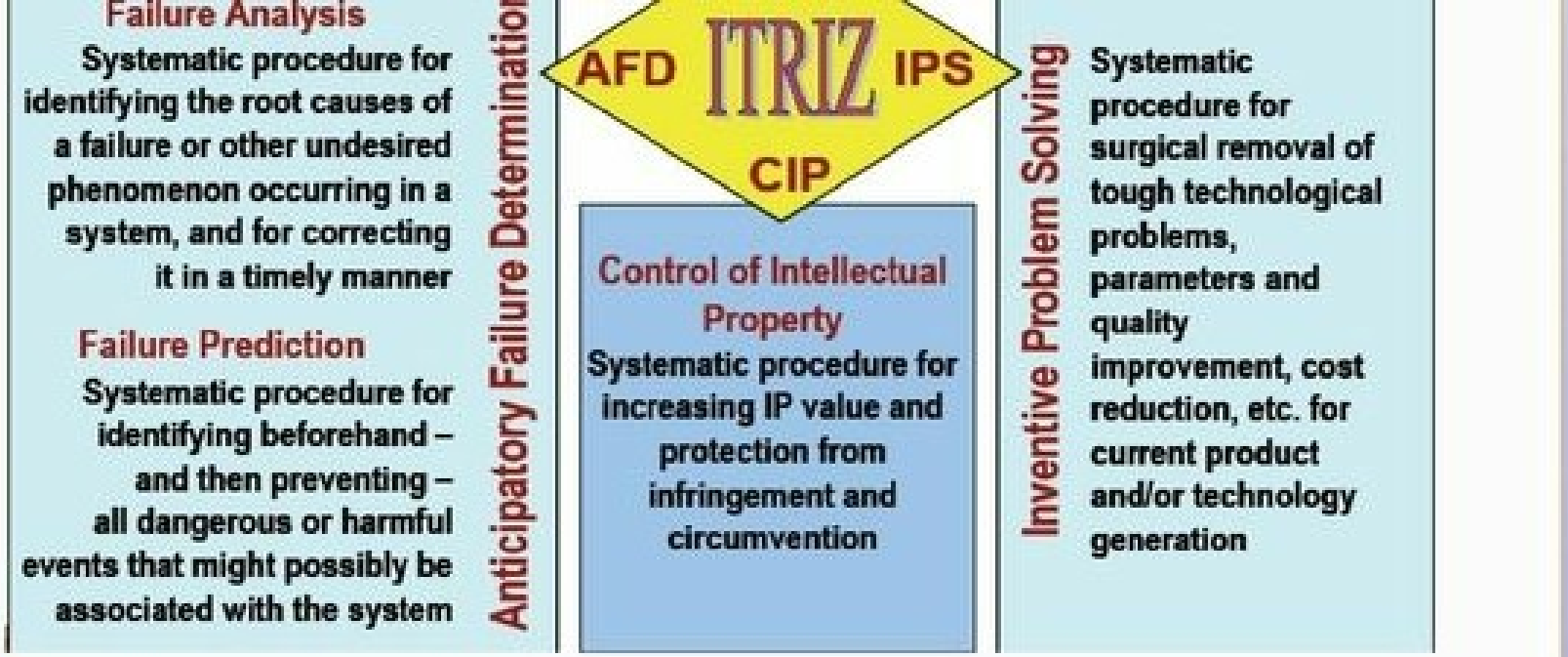
mination

DE

AFD ITRIZ IPS

olving

Systematic procedure for



* *Inventive Problem solving (IPS), Anticipatory Failure Determination (AFD), Directed Evolution (DE) are trademarks of Ideation International Inc*

TRIZ tools

- **ARIZ (Algorithm for Inventive Problem Solving)**
  - A systematic procedure for identifying solutions without apparent contradictions.
  - Depending on the nature of the problem, anywhere from five to sixty steps may be involved. From an unclear technical problem, the

- Depending on the nature of the problem, anywhere from five to sixty steps may be involved. From an unclear technical problem, the underlying technical problem can be revealed.
- Basic steps include
  - Formulate the problem.
  - Transform the problem into a model.
  - Analyze the model.
  - Resolve physical contradictions.
  - Formulate ideal solution.

Interaction with Six Sigma

- I-TRIZ Is an advanced, productive enhancement to Six Sigma

- Advanced I-TRIZ methods and tools can be used for enhancing Six Sigma methodology (DMAIC and DMADV or DFSS) especially when

- Advanced I-TRIZ methods and tools can be used for enhancing Six Sigma methodology (DMAIC and DMADV or DFSS) especially when Six Sigma methods and tools have proven to be inefficient and/or insufficient.

- Integration of I-TRIZ tools with the Six Sigma methodology significantly improves the overall potential of Six Sigma

TRIZ Tools in Six Sigma Process Optimization (MAIC)

Six Sigma	TRIZ Tools
A. Recognize	Functional Analysis, Ideal Final Result
B. Define	Same as A
C. Measure	Measurement methods, instrumentation

B. Define	Same as A
C. Measure	Measurement methods, instrumentation
D. Analyze	Understand interactions (FA, Su-F)
E. Improve	Create new product, process, & service concepts. The full Basic TRIZ tool set.
F. Control	Same as C
G. Standardize	“Reverse” TRIZ
H. Integrate	Same as E

TRIZ Tools and DFSS

DFSS Phase	TRIZ Tool
Multi-Generational Plan	Technology Forecasting, Guided Evolution, Functional Analysis
Voice of Customer	Conflict Resolution for planning visits
	Ideal Final Result

Voice of Customer	Conflict Resolution for planning visits Ideal Final Result
Concept	All
Design	All
Optimize	Conflict Resolution, Trimming, Problem Solving
Validate/Implement	Same

ITRIZ Implementation

Automotive Industry		
GM	Navistar	Dana Corporation
Ford	Peugiot	Rockwell Automotive
Chrysler	Visteon	Dura Automotive
Valeo	Ecostar	TRW
Chemical Industry		
Amoco	DuPont	Henkel (German)
Conoco	Solutia	Rohm and Haas
Cabot	S.C.Johnson	Techoominco
Oil Industry		
Amoco	Armco	British Petroleum
Medical Industry		

Conoco	Solutia	Rohm and Haas
Cabot	S.C.Johnson	Techcominco
Oil Industry		
Amoco	Armco	British Petroleum
Medical Industry		
LaRoche	Cardiovascular	Johnson & Johnson
Consumer Products		
Bissel	Whirpul	Helen of Troy
General Mills	Concept Solution	Henkel (US)

Aviation Industry		
Boeing	Pratt & Whitney	McDonnel Douglas
Allied Signal	Techspace Aero	Rockwell International
BF Goodrich	NASA	Hughes Aircraft
Litton	US government	Loral
Electronics/Electrical/Software Industry		
Honeywell	Motorola	Philips Electronics
Xerox	Solarex	Northern Telecon
LG Electronics	Rayovac	Rockwell Automation
GE	Cybertek	National Semiconductor
United Technology	Concept Solution	Tyco
Others		
Parsons	Knuf	Arthur Anderson
Mercury Marine	Pico	Toeda
Servend	Unisis	Mayfran
Aero product	Cardil	Helix

Determinants

- **Resistance that comes from**
  - The *Not Invented Here* syndrome
  - Lack of management support
  - Poor presentation of ideas
  - Prejudice and hostility

- Poor presentation of ideas
- Prejudice and hostility
- Lack of salesmanship from the inventor

Take away

- **Identify inventive problem**
- **Approach to solve inventive problem**
- **Interaction with other Quality Frameworks/models**
  - Six Sigma
- **Where do I implement them – Projects, personal life?**

- **Interaction with other Quality Frameworks/models**
  - Six Sigma
- **Where do I implement them – Projects, personal life?**
  - Where ever new problem exists

Q&A

Thank You

Thank You

Appendix

Appendix

FEMA and AFD

Comparative Criteria	Traditional (Failure Mode and Effects Analysis)	Anticipatory Failure Determination
Purpose of the technique	• Identify potential failure modes and to rate the severity of their effects • Identify Critical and Significant Characteristics • Rank order potential design and process deficiencies	• Analyze previous failures and be able to understand how to "invent" such failures • Identify an exhaustive list of potential failure scenarios as well as any negative, harmful or undesired effects or phenomenon • Transform the process of problem analysis from asking why a failure occurred to how

	• Identify Critical and Significant Characteristics • Rank order potential design and process deficiencies • Help focus on elimination of product and process deficiencies.	failure scenarios as well as any negative, harmful or undesired effects or phenomenon • Transform the process of problem analysis from asking why a failure occurred to how can a failure be produced • To incorporate the full complement of TRIZ operators to develop innovative solutions
Scope of applicability	• System design, product design, process design	• System design, product design, process design
Analytical tools	• Previous FMEAs, subject matter expertise, internal engineering and warranty data, logic of the FMEA process	• Same as FMEA plus rigorous problem formulation and inventive analogs utilizing: Inventive Principles, Standard Solutions, incorporation of System and Environmental Resources

FEMA and AFD contd…

Comparative Criteria	Traditional (Failure Mode and Effects Analysis)	Anticipatory Failure Determination
Analytical tools	• Previous FMEAs, subject matter expertise, internal engineering and warranty data, logic of the FMEA process	• Same as FMEA plus rigorous problem formulation and inventive analogs utilizing: Inventive Principles, Standard Solutions, incorporation of System and Environmental Resources

	logic of the FMEA process	Inventive Principles, Standard Solutions, incorporation of System and Environmental Resources
Process for completion	• Generally linear following design intent	• Iterative and "inverted" or subversive by probing how failures can be deliberately created.
Thoroughness of the analysis	• Fair to good, depending on the rigor of application and the knowledge level of the team/individual	• Good to excellent because of the access to the AFD knowledge base, the TRIZ Inventive Principles, Problem Formulation and analysis of all resources

TRIZ Software

Software Name	Purpose
Improver	Improve existing designs Improve manufacturing process Improve system performance Improve system quality Improve manufacturing cost Improve patent applications

	■ Improve manufacturing cost ■ Improve patent applications ■ Improve product features
■ Ideator	■ ARIZ helps you to create abstract models of a system, including the formulation of contradictions and envisioning of the ideal situation. ■ Idealization is a process used to bring your system as close to ideal as possible. ■ Innovation Mini-Guide contains approximately 100 technical applications of physical, chemical and geometrical effects.

TRIZ Software

Software Name	Purpose
Eliminator (Appetizer)	The Ideation Appetizer is designed to help you find truly elegant and innovative problem solutions without any drawbacks or trade-offs.
Innovation	-

	drawbacks of trade-offs.
Innovation Workbench TM (IWB)	-

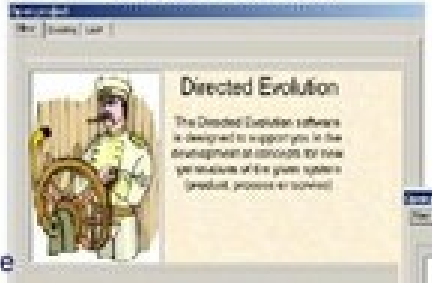
TRIZ Software

Innovation workbench

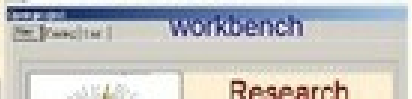
Ideation Failure Analysis

Ideation Failure

Directed Evolution



Research




Ideation Failure Analysis
Ideation Failure Prediction
Research
Workbench
Research WorkBench
The essence of research is knowledge creation and thus typically involves obtaining creative solutions to numerous scientific tasks
Knowledge wizard
Intellectual Property Validation & Enrichment Software

Consolidated offerings of ITRIZ

- **Five Key findings**
  - Definition of inventive problem
  - Levels of invention
  - Patterns of invention
  - Patterns and lines of evolution
  - Exhaustive set of solutions

- **Eight Knowledge-Based tools**
  - Pattern/Lines of Evolution
  - 40 Innovation principles & contradiction Table
  - Separation principles
  - 76 Standard solutions
  - Effects

- Patterns and lines of evolution
- Exhaustive set of solutions

- **Three main premises**
  - Ideality and resources
  - Contradictions
  - System Approach
- **Four Analytical tools**
  - Innovation Situation Questionnaire (ISQ)
  - Problem Formulator
  - Algorithm for Inventive Problem Solving (IPS)
  - Substance Field Analysis (Su-Field)

- Separation principles
- 76 Standard solutions
- Effects
- Selected Innovation Examples
- System of operators
- System of Lines

- **Four main applications**
  - Inventive Problem Solving (IPS)
  - Anticipatory Failure Determination (AFD)
  - Directed Evolution (DE)
  - IP Enhancement