INTRODUCTION TO TRIZ METHODOLOGY OF INVENTIVE PROBLEM SOLVING

TRIZ (Theory of Inventive Problem Solving) is a structured methodology for solving engineering and technical problems creatively by identifying and eliminating contradictions. It was developed by Genrich Altshuller, a Soviet engineer, in the 1940s, after analyzing patents and discovering that inventive solutions often follow certain patterns. The goal of TRIZ is to foster innovation by offering systematic approaches to problem-solving, enabling individuals and organizations to find inventive solutions without relying on luck or random brainstorming.

Key Concepts of TRIZ:

1. **Contradictions:**
    - A contradiction in TRIZ is a situation where two opposing requirements or conditions cannot be satisfied simultaneously. For example, you might want a material to be both lightweight (to save energy) and strong (to withstand stress), but these properties often conflict. TRIZ helps identify these contradictions and provides methods to resolve them.

    TRIZ focuses on two types of contradictions:

    - Technical Contradiction: Occurs when improving one parameter of a system worsens another. For example, increasing the speed of a machine could increase wear and tear, affecting its longevity.
    - Physical Contradiction: Happens when an object or system needs to have two contradictory properties at the same time. For example, a component might need to be both hard and soft simultaneously, which is inherently contradictory.

2. **The 40 Principles of TRIZ:**
    - One of the core components of TRIZ is a set of 40 inventive principles that provide general guidelines for overcoming contradictions. These principles can be applied to problems in a wide variety of fields. For instance:
        - Segmentation (Principle 1): Breaking an object or system into smaller parts to improve functionality.
        - Taking Out (Principle 2): Removing an unnecessary part of a system to simplify the design.
        - The Other Way Round (Principle 13): Reversing the direction of a process or action to solve a problem..

3. **The Contradiction Matrix:**
    - The Contradiction Matrix is a tool used to identify which inventive principle might be applicable to a specific contradiction. The matrix maps technical contradictions (improvements in one parameter leading to worsened values in another) and provides solutions by pointing to one or more of the 40 principles based on which parameters are in conflict.

4. **The 76 Standard Solutions:**
    - TRIZ also contains a set of 76 standard solutions that provide specific strategies to solve common engineering problems. These solutions can be used in a variety of different contexts and have been tested in real-world scenarios.
5. **The Ideal Final Result (IFR):**
    - The Ideal Final Result is a concept in TRIZ that encourages solving problems in such a way that the final system or product requires no further improvements, maintenance, or extra energy. It's essentially a goal for achieving the most efficient solution with the least amount of effort, time, and resources. The idea is to focus on achieving maximum functionality with minimal complexity.
6. **The Evolution of Technical Systems:**
    - TRIZ recognizes that technological systems evolve through predictable stages, and these stages can guide problem solvers in anticipating future solutions. These stages reflect a general trend where technologies evolve from simple mechanisms to more complex, automated, and multifunctional systems. By understanding these evolutionary trends, engineers and inventors can anticipate how a system might develop and improve upon it before it reaches its limits.
7. **Su-Field Analysis (Substance-Field Analysis):**
    - TRIZ includes a method called Su-Field Analysis, which helps identify and optimize interactions between substances (materials or components) and fields (forces, energies, or phenomena) in a system. This analysis is useful for identifying the root cause of contradictions and suggesting improvements to system interactions.

TRIZ Process for Problem-Solving:

1. **Define the Problem:**
    - The first step is clearly identifying the problem and its contradictions. TRIZ encourages you to be specific about what needs to be improved, such as functionality, performance, or cost.
2. **Identify Contradictions:**
    - Next, the problem solver identifies whether the issue involves a technical contradiction (where improving one parameter worsens another) or a physical contradiction (where two opposite properties are needed in the same object).
3. **Apply TRIZ Tools:**
    - Use the Contradiction Matrix and the 40 Inventive Principles to find potential solutions to the contradiction. For instance, if improving speed reduces durability, you could explore principles like dynamic action or intermediate objects to resolve the contradiction.

4. **Implement the Solution:**
    - Once a potential solution is identified, it’s time to implement it, test its effectiveness, and refine it. This is where the creativity and systematic approach of TRIZ combine to improve the solution.
5. **Iterate and Improve:**
    - Finally, based on testing and feedback, further refinement may be necessary. TRIZ advocates an iterative process where solutions are continuously improved to optimize the system.

Example of TRIZ in Practice:

Imagine you're designing a helicopter and you're facing the problem of noise caused by the rotor blades.

- Contradiction: You want to reduce the noise (improve comfort) but reducing rotor speed (to decrease noise) compromises lift and performance.
- TRIZ Solution: Using the Contradiction Matrix, you might discover the principle of "Changing the form or state of an object" or "Using a different material". This could lead to a solution like altering the rotor blade shape or material to reduce noise without sacrificing performance.

Applications of TRIZ:

1. Engineering and Product Design: TRIZ is widely used in industries like automotive, aerospace, and electronics, where there are many technical contradictions and complex design challenges.
2. Business Innovation: TRIZ can also be used in business model innovation and process improvement by identifying contradictions in workflows, customer needs, and market offerings.
3. Research and Development (R&D): TRIZ helps R&D teams to overcome technical challenges and develop innovative solutions more efficiently by using systematic tools rather than relying on trial and error.

Benefits of TRIZ:

- Systematic and Structured: Unlike random brainstorming or trial-and-error, TRIZ provides a logical framework for problem-solving, leading to more reliable and creative solutions.
- Increased Efficiency: It helps to eliminate unnecessary steps or inefficiencies by focusing on resolving contradictions, saving time and resources.
- Fosters Creativity: By using predefined principles and tools, TRIZ encourages engineers and inventors to think outside the box and apply unconventional solutions to problems.

- Universal Application: TRIZ can be applied across industries, from engineering to business, and is adaptable to many types of challenges.