New Product Development: New concept generation and the use of TRIZ

Raffaella Manzini, Valentina Lazzarotti, Gloria Puliga
FASE 0: Planning or declaration of intent

FASE 1: Concept design

FASE 2: System level design (pre-design)

FASE 3: Detailed design

FASE 4: Test and improvement

FASE 5: Production

FASE 6: Marketing and Commercialization

Development process
Identification of clients’ needs

Definition of the specifications

Product concept generation

Evaluation and selection of the concepts

Test of the concepts

Definition of the final specifications

Project plan
CONCEPT development

- Customer needs identification
- Target product specification
- Benchmarking
- Concept generation, evaluation, selection  TRIZ
- Final target product specification
Techniques for supporting new concept generation

- Quality function deployment
- Lead users analysis
- Benchmarking
- Brainstorming
- Lateral thinking
- Serendipity
- ....
- ....
- **TRIZ: theory of inventive problem solving**
TRIZ: theory of inventive problem solving

теория решения изобретательских задач

• A theory developed by Genrich Altshuller in Russia in the late ’40s, based upon the following assumptions:
  – Inventors use patterns without awareness to develop new technology;
  – Technology evolution is a systematic process;
  – Innovation can be organised in a systematic way;
  – 98% of inventions use already known solution principles
TRIZ INVENTION MODEL:
GENERAL FRAMEWORK

GENERAL PROBLEM

SPECIFIC PROBLEM

PSYCHOLOGICAL INERTIA

GENERAL SOLUTION

SPECIFIC SOLUTION

$ax^2 + bx + c = 0$

$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$3x^2 + 5x + 2 = 0$

$x_{1,2} = -1, -2/3$
The problem of invention: psychological inertia

THINK TO A BALL...
The problem of invention: psychological inertia

WHICH ARE THE MINIMUM DIMENSIONS OF A CD READER?
The problem of invention: psychological inertia

WHICH ARE THE MINIMUM DIMENSIONS OF A PIZZA CARTON?
Invention vs. optimisation

EXAMPLE: COMPACT PRINTER

AS-IS solution

Optimization

Invention

Optimization → works on technical parameters
Every qualified engineer might solve the technical problem

Invention → it is a change in the perspective: I am not working on technical parameters but on something completely new. I have to think «out of the box» → TRIZ
Implementing TRIZ
a proposed framework

UNDERSTAND THE «HEARTH» OF THE PROBLEM
• PHYSICAL / TECHNICAL CONTRADICTIONS

PROBLEM ABSTRACTION
(building a model)
• SU-FIELD ANALYSIS

HOW «MATURE» IS MY SYSTEM?
• Distance from IFR
• ITEMS

HOW DOES MY SYSTEM WORK?
• Describe your system/products in the most objective way as possible (“film maker”)
• Describe functions, value proposition, tangible and intangible features (product specifications)

FINDING A SOLUTION
• 40 PRINCIPLES
• SEPARATION PRINCIPLE

APPLYING THE SOLUTION TO THE SPECIFIC PROBLEM
• PATENT ANALYSIS
• Understanding evolutionary trends

RAFFAELLA MANZINI
Specific Problem

HOW «MATURE» IS MY SYSTEM?
• Distance from IFR
• ITEMS

HOW DOES MY SYSTEM WORK?
• Describe your system/products in the most objective way as possible ("film maker")
• Describe functions, value proposition, tangible and intangible features (product specifications)
Film Maker

- The film maker aims to describe the main phases of the life of a product
- Provide general information about the system, describing them using the active form
- Describe the actual structure
- Description of how the system work, by detailing the phases of the life of the product ad the environment in which it acts
- Interactions of the product with other systems, close systems, “higher system” and environment
- Identification of the available resources (substances, fields, functional resources, information, time and space)
# Product Needs

<table>
<thead>
<tr>
<th>No.</th>
<th>The suspension</th>
<th>Need</th>
<th>Imp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The suspension</td>
<td>reduces vibration to the hands.</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>The suspension</td>
<td>allows easy traversal of slow, difficult terrain.</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>The suspension</td>
<td>enables high-speed descents on bumpy trails.</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>The suspension</td>
<td>allows sensitivity adjustment.</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>The suspension</td>
<td>preserves the steering characteristics of the bike.</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>The suspension</td>
<td>remains rigid during hard cornering.</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>The suspension</td>
<td>is lightweight.</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>The suspension</td>
<td>provides stiff mounting points for the brakes.</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>The suspension</td>
<td>fits a wide variety of bikes, wheels, and tires.</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>The suspension</td>
<td>is easy to install.</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>The suspension</td>
<td>works with fenders.</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>The suspension</td>
<td>instills pride.</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>The suspension</td>
<td>is affordable for an amateur enthusiast.</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>The suspension</td>
<td>is not contaminated by water.</td>
<td>5</td>
</tr>
<tr>
<td>15</td>
<td>The suspension</td>
<td>is not contaminated by grunge.</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>The suspension</td>
<td>can be easily accessed for maintenance.</td>
<td>3</td>
</tr>
<tr>
<td>17</td>
<td>The suspension</td>
<td>allows easy replacement of worn parts.</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>The suspension</td>
<td>can be maintained with readily available tools.</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>The suspension</td>
<td>lasts a long time.</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>The suspension</td>
<td>is safe in a crash.</td>
<td>5</td>
</tr>
</tbody>
</table>
## Product needs and specifications

<table>
<thead>
<tr>
<th>Product Needs</th>
<th>Technical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Trolley (Case) should have a low weight</td>
<td>Weight of the case below 2 kg</td>
</tr>
<tr>
<td>The Trolley (Case) should be waterproof</td>
<td>Build with a waterproof material</td>
</tr>
<tr>
<td>The Trolley (Case) should be as small (in terms of volume) as needed</td>
<td>The dimensions should be $x<em>y</em>z$</td>
</tr>
</tbody>
</table>
The Ideal Final Result (IFR)

• The way towards the Ideal Final Result (IFR) requires reduction (ideally, elimination) of ITEMS:
  – I → INFORMATION
  – T → TIME
  – E → ENERGY
  – M → MATERIAL
  – S → SPACE
Ideality

**Ideal:**

\[
\text{Ideal} = \frac{\text{Useful Functions}}{\text{Harmful Functions} + \text{Cost}}
\]

**Ideality Approach**

- The ideal system performs a required function without actually existing.
- The function is often performed using existing resources.
- ALL systems evolve in this direction over time by resolving contradictions.
- Defining Ideality breaks psychological inertia.
Ideality: example

Vibratory feed move pills around an internal spiral to top of vibratory bowl where the pills are discharged and slide down an incline plane onto a conveyor. As the pills go by, the inspectors identify and remove the damaged pills.
Ideality: example

IDEALITY:
Defective pills are removed by their self

bad  good

Change the escapement for the vibratory bowl so that the pills are ejected standing on their edge. Move the conveyor 3 inches. Pills that are round will roll at a velocity that allows them to jump to the conveyor. The pills that are chipped will slide or will roll at a lower velocity and fall into the trash.
The Ideal Final Result (IFR)

- The way towards the Ideal Final Result (IFR) requires reduction (ideally, elimination) of ITEMS:
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Problem generalisation

PROBLEM ABSTRACTION
(building a model)
• SU-FIELD ANALYSIS

UNDERSTAND THE «HEARTH»
OF THE PROBLEM
• PHYSICAL / TECHNICAL
CONTRADICTIONS
Su-field analysis

The minimum SF model includes:

• an "article" \((S_1)\) representing an object that is changed or influenced in some way

• a tool \((S_2)\) representing the means by which \(S_1\) is changed or influenced

• energy \((F)\) representing the interaction between \(S_1\) and \(S_2\)

• A vacuum cleaner cleaning a carpet
  \(S_1\) - carpet (article)
  \(S_2\) - vacuum cleaner (tool)
  \(F\) - cleaning (mechanical field)
Su-field analysis - language

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Desired action or effect</td>
</tr>
<tr>
<td></td>
<td>Insufficient (inefficient) desired action or effect</td>
</tr>
<tr>
<td></td>
<td>Harmful action or effect</td>
</tr>
<tr>
<td></td>
<td>Transition to a solution</td>
</tr>
</tbody>
</table>

Fields can be:

- **Me** - mechanical
- **Th** - thermal
- **Ch** - chemical
- **E** - electrical
- **M** - magnetic
Applying su-field analysis

• Identify the elements of a system.

• Identify The fields.

• Construct the model.

• After completing these steps, stop to evaluate the completeness and effectiveness of the system. Bring into evidence if some element is missing, some effect is harmful, or not necessary, try to identify what it is.
Su-field analysis example: the airbag
From the general problem to the general solution

Undesired effects, inefficient effects are often generated by CONTRADICTIONS (conflicts in a system); they represent the general problem

Solving contradictions means moving towards a general solution for the general problem