An In-company Innovation Promotion Activity Utilizing QFD-TRIZ

~ Towards the Base Construction of a "surprise" Tire Product Development and an "innovative" Technical Development Capacity ~

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Tire Technical Center
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Outline of announcement (Contents)

(1) About the company introduction
(2) About the tire technology
(3) About the in-house innovation activity
(4) About promotion device ①
(5) About promotion device ②
(6) About promotion device ③
(7) Conclusion
Centers on parts for the tire and the car, and the global expansion from a domestic technological base
(1-2) Company introduction: About the tire business

- Three branding strategies
  - TOYO TIRES
  - NITTO
  - SILVERSTONE

- Technological concept
  - In the tire, is there a surprise?

- Example of commodity lineup
  - Minivan exclusive use
  - Studless
  - Low fuel cost

- Business form
  - Tires on the market ⇒ BtoC
  - Tires for new cars ⇒ BtoB

Unique conception power and innovation

An approach (innovation) different from the past is necessary to offer "Surprise" to the customer.
The tire is the only point of contact that connects the car to the road, and four large functions are satisfied by making it with air.
(2-2) Tire technology: About a basic component

**Tire structure**

- Tread pattern (ditch)
- Tire structure (bone + meat)
- Air pressure

The rigidity is secured by the code tension

**Tire design element**

- Rubber mixing design
- Fiber material design
- Structural design
- Configuration design
- Pattern design

**Basic configuration**

- Tread
- Belt reinforcement
- Belt
- Belt pad
- Carcass ply
- Inner liner
- Bead filler
- Bead core
- Rim strip
- Side Wall

Meat
- Rubber

Bone
- Steel
- Organic fibre

There are various roles in the tire composition parts, and it carries out four large functions by the optimal combination
(2-3) Tire technology: About the contradiction of technological development

Example of physical contradiction of contradictory performance

Example 1: Low fuel cost tire
Example 2: Studless tire

Coexistence of low fuel cost and braking performance
⇒ want it to roll, but, don’t want it to roll.

Coexistence of ice performance and SNOW performance
⇒ want to reduce the ditch capacity, but, want to increase it

The tire technology development is a battle with many technical contradictions (physical and engineering contradictions)
(2-4) Tire technology: Reverse TRIZ example of an existing technology

Adoption to the rubber for studless tires

Contradiction between ICE character and road influence (obstruction)

Adoption of walnut

Contradiction model

EC−1

It scratches more.
(Yokomizo: Small)

Good

ICE character

Bad

Road

EC−2

Scratch: weak.
(Yokomizo: A lot.)

Good

ICE character

Bad

Road

General parametrization

Improvement characteristic

Deterioration characteristic

10. Power (Strength)

31. Harmful factor that object originates

TRIZ solution

■ Technological contradiction (invention principle)
■ Material-field model (evolution pattern)

Introduction of new material

The TRIZ technique is effective for ⇒ innovation promotion where it can explain the ready-made technology by the TRIZ theory.
(3-1) In-house innovation activity: Promotion details

The mechanism review is necessary for the settling of the in-house innovation activity that uses TRIZ.

- In-house instructor training
- In-house consultant development
- Theme consulting #1 (TRIZ)
- Theme consulting #2 (QFD⇒TRIZ)
- Promotion consulting #3

Amount of creation
(Quality)

TRIZ attention

2012
2013
2014
2015
2016

Trial period
Expansion period
Established period
(review)

Number of inventions by TRIZ (⇒Patent application)

Number of TRIZ application themes

Promotion Review

Is not TRIZ connected directly with commercialization even if effective for the invention creation?

In-house consulting Revival

Promotion consulting #3
(Mechanism that commercialization consideration is done)
It is necessary to devise the former process and the post-processing for making to "TRIZ that can be used" by doing connecting directly commercialization.
(3-3) In-house innovation activity: Problem

- It is process in front of TRIZ.
  - Cannot the problem theme for commercialization be set?
    - The improvement of a main quality property sets (: of a cervine negative performance what).
    - Coexisting of the contradiction quality characteristic sets (Even if it becomes patent).
  - Isn't the foundation cause selection after the cause is analyzed clear?
    - The influence level is indefinite, and the priority is not applied.
  - Is the functional assay insufficient?
    - 「Are there a lot of the extermination type", and is "Wish type" approach a little?
    - ＜･･･A scientific approach of Olympus Corp. is an example.＞

- TRIZ post-processing
  - Cannot? combine effectively and efficiently by the idea,
    - The motivation and time are lack to rely on a technological sense.
  - Is the combination that can be used for the short term for commercialization a little?
    - All quality properties (Q) are Ram though a specializing type and a long-term type can be done.
    - C and D do not satisfy Q even if it satisfies it.

I introduce three promotion device points to the innovation established problem in this lecture.
Low fuel cost tire (Example) \Rightarrow Main quality property: RRC (Rolling resistance coefficient)

<table>
<thead>
<tr>
<th>品質特性</th>
<th>品質企画</th>
</tr>
</thead>
<tbody>
<tr>
<td>質量 (質量化)</td>
<td>質量 (質量化)</td>
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<tr>
<td>RRC (燃焼量)</td>
<td>RRC (燃焼量)</td>
</tr>
<tr>
<td>VET (制動)</td>
<td>VET (制動)</td>
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<tr>
<td>NET (排水)</td>
<td>NET (排水)</td>
</tr>
<tr>
<td>接地性 (動性)</td>
<td>接地性 (動性)</td>
</tr>
<tr>
<td>操車性 (車内)</td>
<td>操車性 (車内)</td>
</tr>
<tr>
<td>ノイズ (車内)</td>
<td>ノイズ (車内)</td>
</tr>
<tr>
<td>携帯性</td>
<td>携帯性</td>
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<tr>
<td>耐摩耗性</td>
<td>耐摩耗性</td>
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<td>耐外傷</td>
<td>耐外傷</td>
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<td>品質性</td>
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<td>クリーム</td>
<td>クリーム</td>
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<td>新製品</td>
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</tbody>
</table>

As for the main quality to be made a target and the quality of a high target, it is "Technological opportunity" and NG in easiness when catching.
(4-2) Promotion device①: Quality property of tire development

Low fuel cost tire (example)

It doesn't approve only by the breakthrough of the quality property that improves a main quality property, and contradicts.
### (4-3) Promotion device①: Example of developing design and problem setting

#### Low fuel cost tire (example)

**Main quality property**

<table>
<thead>
<tr>
<th>基準品</th>
<th>開発品</th>
<th>質量（軽量化）</th>
<th>RRC（低燃費）</th>
<th>WET（制動）</th>
<th>WET（排水）</th>
<th>撃入（GP）</th>
<th>撃入（転向性）</th>
<th>乗り心地</th>
<th>ノイズ（車内）</th>
<th>ノイズ（車外）</th>
<th>摩耗ライフ</th>
<th>摩耗摩耗</th>
<th>耐久力</th>
</tr>
</thead>
<tbody>
<tr>
<td>基準品</td>
<td>130</td>
<td>120</td>
<td>110</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<td>100</td>
<td>100</td>
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</tr>
</tbody>
</table>

**Cause analysis of the best estimate as difficult quality characteristic ⇒ technological problem to achieve in existing technology**

- **促進装置①:** Example of developing design and problem setting
- **低燃費タイヤ（例）**
- **主要品質特性（目標レベル：基準品100）**

<table>
<thead>
<tr>
<th>設計展開見積</th>
<th>品質特性見積（目標レベル：基準品100）</th>
</tr>
</thead>
<tbody>
<tr>
<td>構成品</td>
<td>設計パラメータ（例）</td>
</tr>
<tr>
<td>トレッド</td>
<td>積み</td>
</tr>
<tr>
<td>カスタンドーク</td>
<td>基準品</td>
</tr>
<tr>
<td>ベルト補強</td>
<td>積み</td>
</tr>
<tr>
<td>ベルト</td>
<td>積み</td>
</tr>
<tr>
<td>カーゴスプライ</td>
<td>積み</td>
</tr>
<tr>
<td>サイド</td>
<td>積み</td>
</tr>
</tbody>
</table>

**【判定結果】⇒** 130 OK 不足 100 OK OK OK OK OK OK OK 105 OK OK OK OK

**【見積値】⇒** 130 120 90 100 100 100 100 100 100 100 100 100 100 100 100
(5-1) Promotion device②: Cause MAP and contribution analysis

**Cause MAP**

- **Contribution is analyzed with AHP.** (Hierarchical analysis weight judgment)

- **Problem**
  - Lack quality
    - Example: WET braking

- **DIV 1**
  - 主原因 A
    - 30%
      - 次原因 A1
        - 30%
          - 原因A1-a
            - 原因A1-a1
        - 20%
          - 原因A1-b
            - 原因A1-b1
  - 主原因 B
    - 30%
      - 次原因 B1
        - 21%
          - 原因B1-a
  - 主原因 C
    - 10%
      - 次原因 C1
        - 10%
          - 原因C1-a
  - 原因A1-a2α
  - 原因A1-a2β
  - 原因A2-a1α
  - 原因A2-a1β
  - 原因A2-a1γ
  - 原因A2-a2α
  - 原因A2-a2β
  - 原因A3-a1α
  - 原因A3-a1β
  - 原因A3-a2α
  - 原因A3-a2β
  - 原因B1-a
  - 原因B1-b
  - 原因B1-c
  - 原因B2-a
  - 原因B2-a2
  - 原因B2-b
  - 原因C1-a
  - 原因C1-b

- **DIV 2**
  - 原因A1-a1
  - 原因A1-a2
  - 原因A1-a2β
  - 原因A2-a1α
  - 原因A2-a1β
  - 原因A2-a1γ
  - 原因A2-a2α
  - 原因A2-a2β
  - 原因A3-a1α
  - 原因A3-a1β
  - 原因A3-a2α
  - 原因A3-a2β
  - 原因B1-a
  - 原因B1-b
  - 原因B1-c
  - 原因B2-a
  - 原因B2-a2
  - 原因B2-b
  - 原因C1-a
  - 原因C1-b

**Notes:**
- After thoroughness and logical analysis, a cause is analyzed, it matches and the hierarchy is arranged by the logic tree form.
- Because the fact exists together to the cause based on the hypothesis, contribution is analyzed by AHP among members.
- It extracts from the foundation cause candidate with a high priority and it shifts to this TRIZ process.
(5-2) Promotion device: Cause turning around analysis

- Whether from which primary cause conception it is analyzed turning around after this TRIZ process (idea conception).
- The cause contribution is used by the TRIZ post-processing (idea summary) putting up the string to the idea.
If it doesn't lead to development and the research of early seeds, a length mid-term concept becomes "Picture rice cake".

The high-quality one will not go out easily in a short term though an epoch-making concept at a mid/long-term level arises.
### Evaluation item and evaluation figure

- **Lack quality (problem)**
  - Current state: 0
  - Idea 1: +5
  - Idea 2: +3
  - Idea N: +1

- **Cause Contribution**
  - Idea 1: 30%
  - Idea 2: 18%
  - Idea N: 21%

- **Q1 (Main quality)**
  - Idea 1: -2
  - Idea 2: +1
  - Idea N: +3

- **Q2 (Main quality)**
  - Idea 1: -1
  - Idea 2: +1
  - Idea N: +1

- **Qn**
  - Idea 1: -1
  - Idea 2: +1
  - Idea N: ±0

- **C** (Cost of manufacturing)
  - Idea 1: 0
  - Idea 2: -2
  - Idea N: -1

- **D** (Development period)
  - Idea 1: 0
  - Idea 2: ±0
  - Idea N: ±0

- **N**: 2~5

### How to bring idea together

- **Concept Idea A**: +2.4
  - ±0
  - ±0
  - ±0
  - ±0
  - -1
  - ±0

---

**The idea evaluation dares to spend time and seen turning and idea summary of Q/C/D are processed automatically.**
(6-3) Promotion device ③: Confirmation of commodity application possibility

Condition ①: Extraction of Q balance zone

• Are there an improvement level of the problem quality and a balance with the entire quality?

Condition ②: Extraction of Q/C/D balance zone

• Is there the quality by the C&D item even if it is possible to achieve it and is reality?

It distributes it to product development/early development/research zone depending on the combination of ideas.
- TRIZ is a very effective as technological problem solution technique. However, it is not easy to connect directly with the product development though it leads to speed UP and the quality improvement of the invention (patent application).

- Various devices are necessary for the former process and the post-processing of TRIZ to revolutionize it to "TRIZ that can be used" by an actual product development.

It aims at a further strengthening of the in-house innovation promotion activity, and "Is there a surprise of the tire?" is made an embodiment though it is still a stage in the road middle of the trial and error.

It wants to deepen the discussion about "TRIZ that can be used" practicing it, and to spread the product development etc.
I wish to express my gratitude to Mr. Kasai of the idea Ltd. to judge validity from the broad outlook from the introduction to development when this innovation activity is promoted and for new "Awareness" and appropriate advice to be offering deeply.
Thank you for listening.