TOYO TIRES
driven to perform

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 ～

12th Japan TRIZ Symposium 2016

2016/09/02

J23（Room B　15：00～15：25）

Tire Technical Center

TOYO TIRE & RUBBER CO., LTD.

Naoto Kashihara

Leading Tire Technology Development Department

Outline of announcement（Contents）

TOYO TIRES
driven to perform

(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

(1-1)Company introduction： Outline

TOYO TIRES
driven to perform

Company	Toyo Tire & Rubber Co., Ltd.
Established	August 1, 1945
Paid-in	30,484,627,991 yen
Number of Issued Shares	127,179,073
Number of Employees	(Consolidated) 11,333
Headquarters	1-17-18 Edobori, Nishi-ku, Osaka

Lines of Business

[Tire Business]
Tires (for passenger vehicles, trucks & buses, construction machinery, industrial trucks), other related products
[DiverTech Business]
Automobile components, railway car components, thermal insulation & waterproofing materials, industrial & construction materials, and other materials

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

TOYO TIRES
driven to perform

Three branding strategies

TOYO TIRES
NITTO®
SILVERSTONE
The science of full contact

Technological concept

Unique conception power and innovation

Example of commodity lineup

Minivan exclusive use	Studless	Low fuel cost
		
TRANPATH mp Z	OBSERVE GARIT GIZ	NANOENERGY 3 PLUS

Passenger car LT	Commercial vehicle LT	Commercial vehicle TB
		
OPEN COUNTRY A/T II	NANOENERGY M638	M667 ZEROSYS

Business form

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

An approach (innovation) different from the past is necessary to offer "Surprise" to the customer

(2-1) Tire technology: About the basic functions

TOYO TIRES
driven to perform

① 自動車の質量を支える

タイヤは、内部に充填されている空気により、
自動車や荷物等の質量を支えています。

例 〈205/60R15 91H〉の「91」は
タイヤ1本で615kgの質量を支える
能力があることを示しています。

② 路面の凹凸等から受ける衝撃を和らげる

タイヤは、内部に充填されている空気により、
一種の空気バネの働きをしています。
そのため、路面からの衝撃を和らげます。

③ 駆動力、制動力を路面に伝える

タイヤは、トレッド部と路面との間に生じる摩擦力により、
走ったり止まったりします。

④ 自動車の方向を転換、維持する

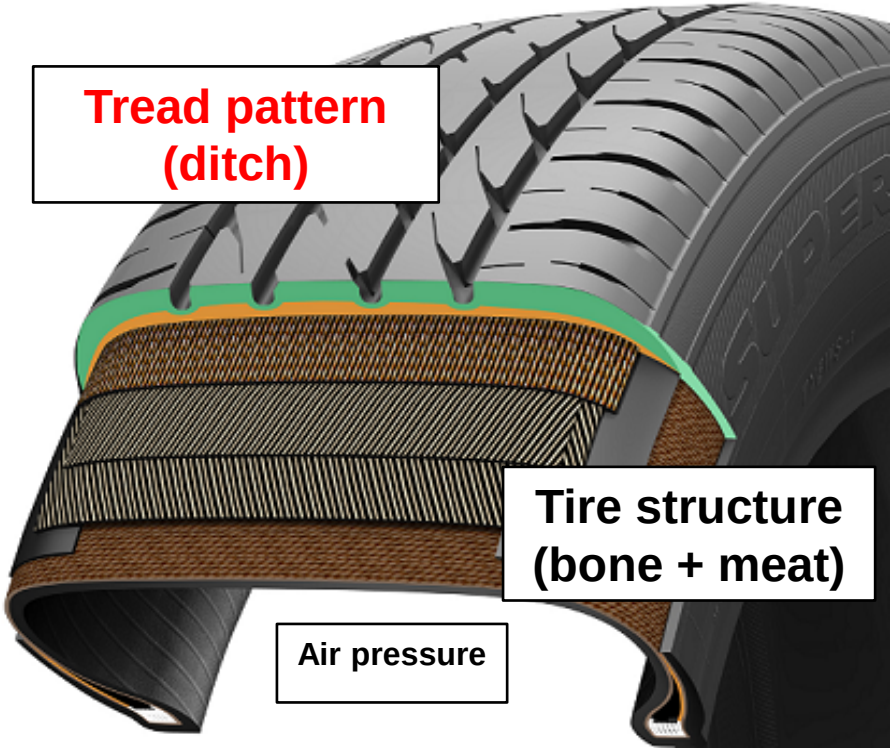
タイヤと路面との間に生じる摩擦力により、
自動車の方向を転換、維持します。

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

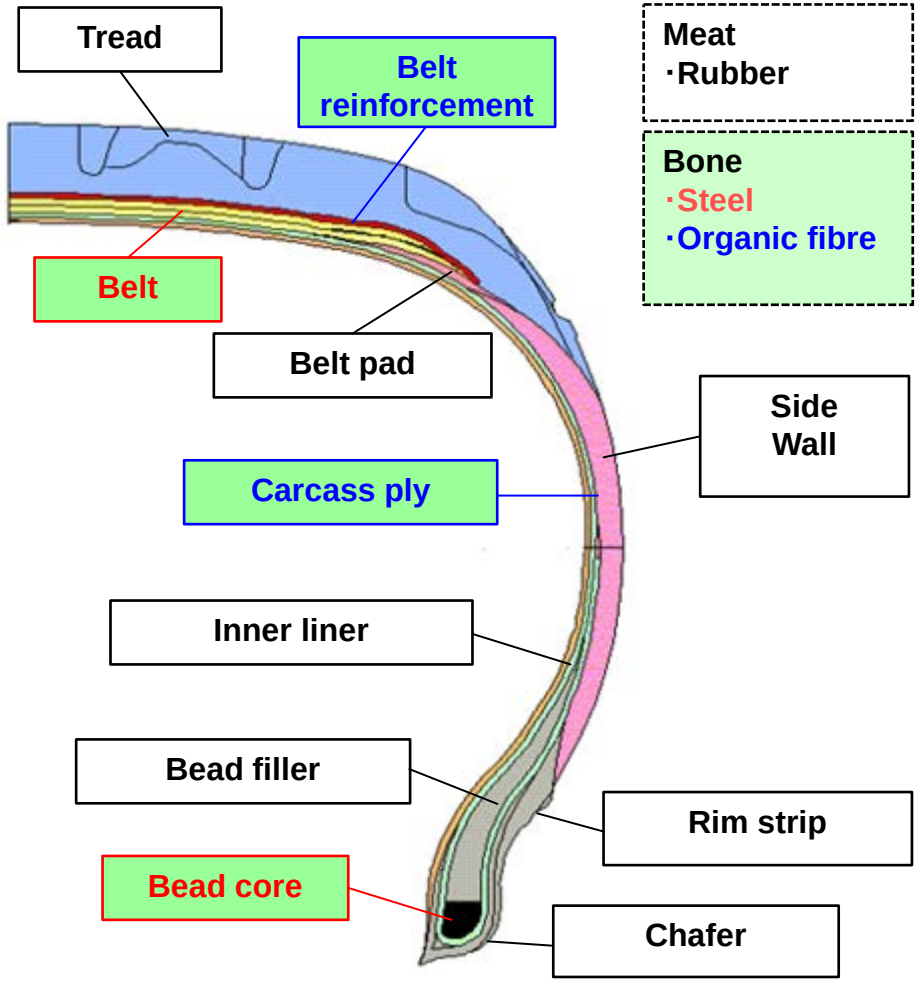
TOYO TIRES
driven to perform

■Tire structure



The rigidity is secured by the code tension

■Basic configuration



■Tire design element

・Structural design
・Configuration design
・Pattern design
（Metal mold）

・Rubber mixing design

・Fiber material design

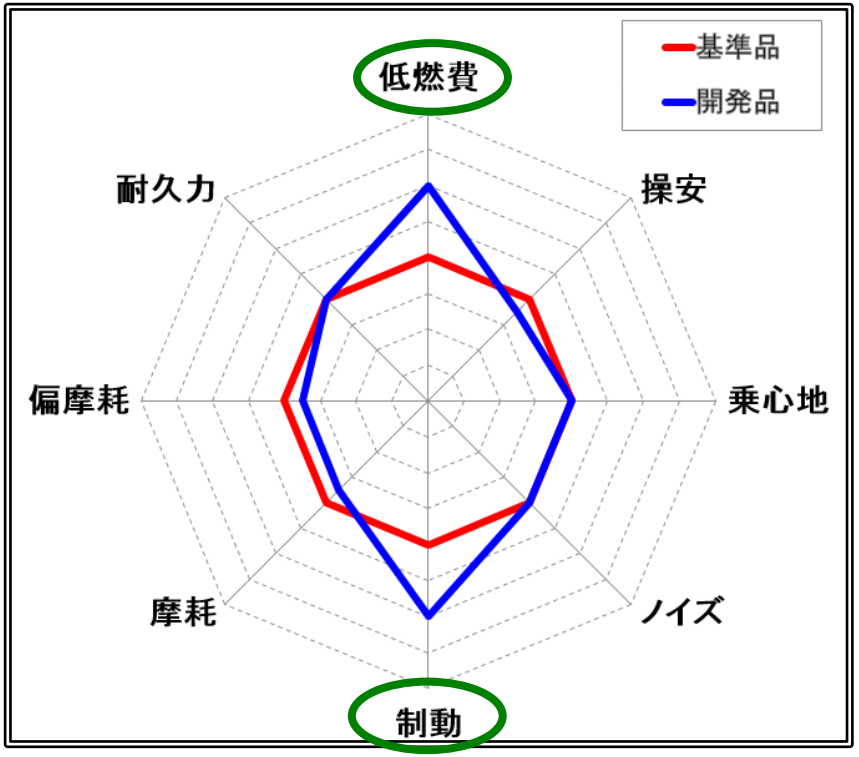
**There are various roles in the tire composition parts,
and it carries out four large functions by the optimal combination**

(2-3) Tire technology: About the contradiction of technological development

TOYO TIRES
driven to perform

Example of physical contradiction of contradictory performance

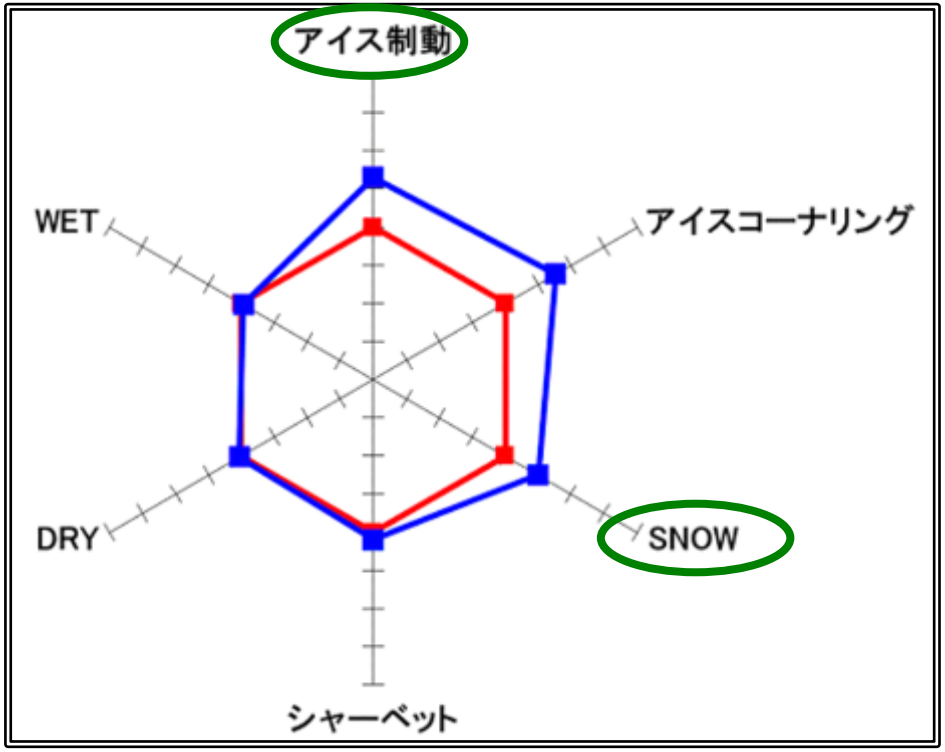
Example 1: Low fuel cost tire



Coexistence of low fuel cost and braking performance

⇒ want it to roll, but, don't want it to roll.

Example 2: Studless tire



Coexistence of ice performance and SNOW performance

⇒ want to reduce the ditch capacity, but, want to increase it

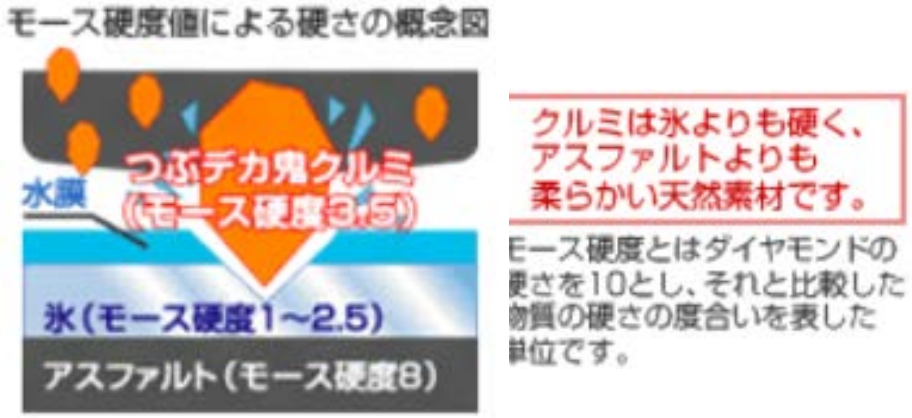
The tire technology development is a battle with many technical contradictions (physical and engineering contradictions)

(2-4) Tire technology: Reverse TRIZ example of an existing technology

TOYO TIRES driven to perform

Adoption to the rubber for studless tires

Adoption of walnut



Contradiction between ICE character and road influence (obstruction)

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)

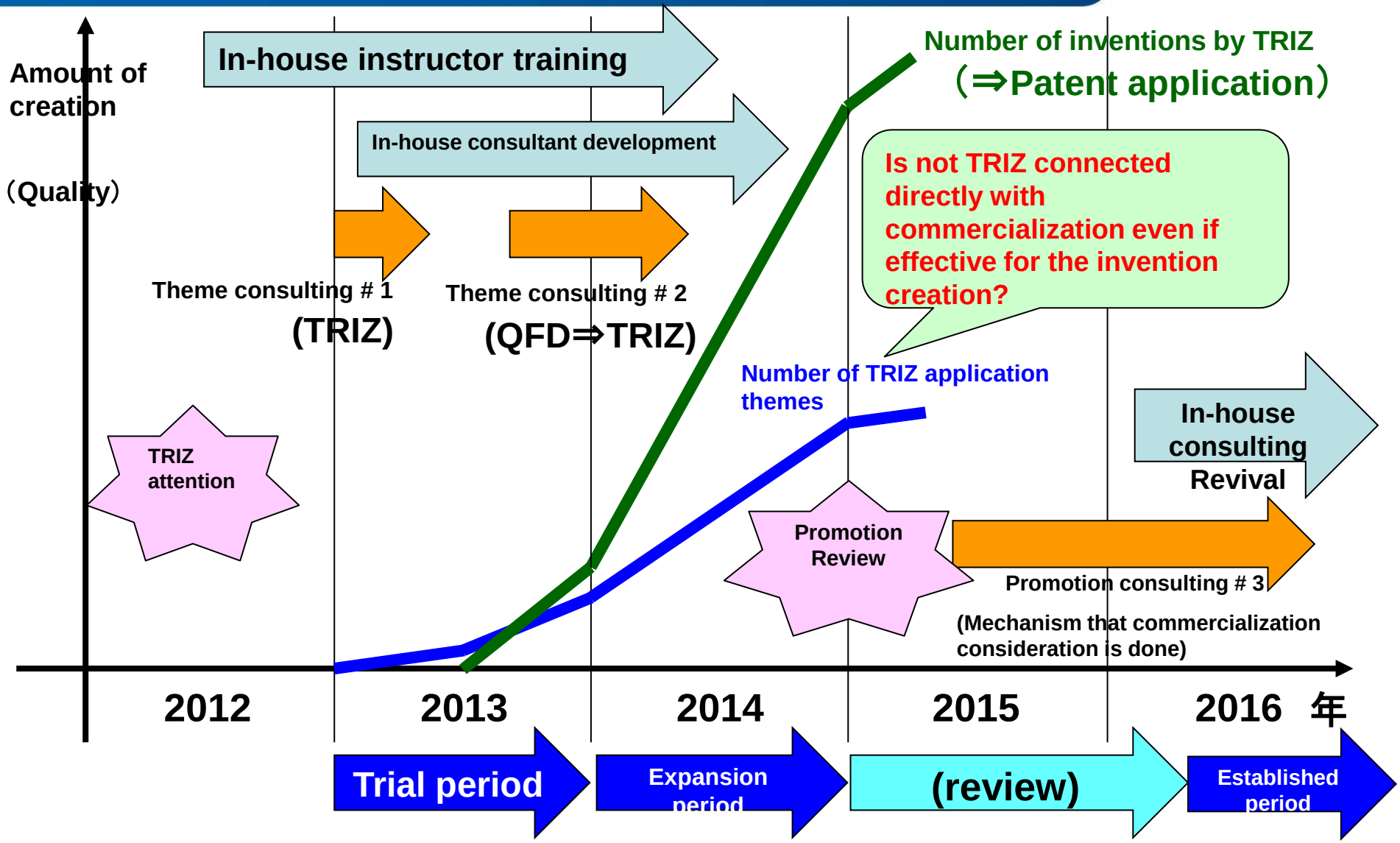
13.Reverse-conception、3.Locality quality、36.Phase change、24.Mediation

■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

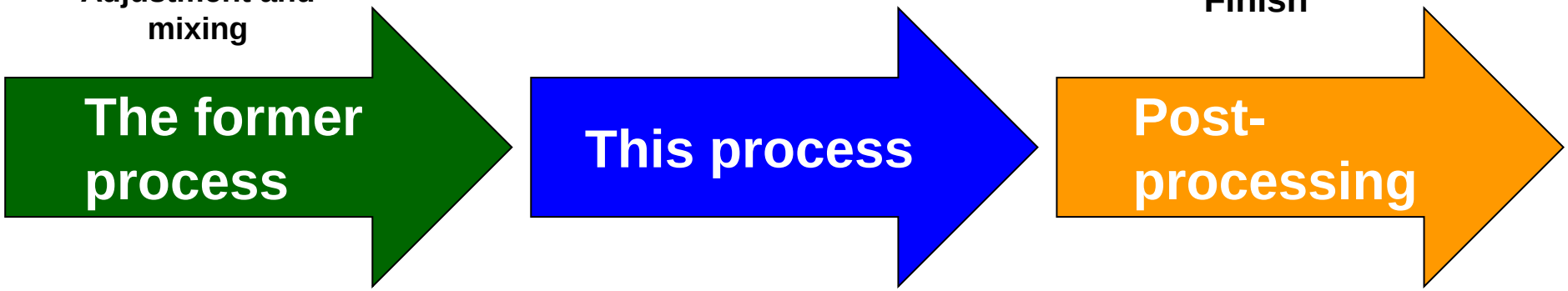


The mechanism review is necessary for the settling of the in-house innovation activity that uses TRIZ.

(3-2)In-house innovation activity：Promotion review

TOYO TIRES
driven to perform

【Example of the one-making】 Manufacturing process of tire (bread)



【Example of applying TRIZ】 Approach process of problem solution

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

TOYO TIRES
driven to perform

■ 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).

Promotion device①

◆Isn't the foundation cause selection after the cause is analyzed clear?

⇒The influence level is indefinite, and the priority is not applied.

Promotion device ②

◆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.

Promotion device ③

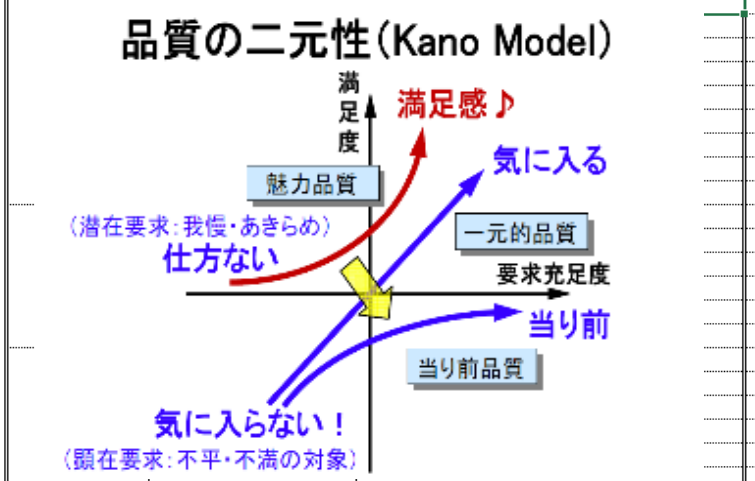
I introduce three promotion device points to the innovation established problem in this lecture.

(4-1)Promotion device①：Quality target setting by QFD

TOYO TIRES driven to perform

Low fuel cost tire（Example） ⇒Main quality property：RRC（Rolling resistance coefficient）

要求品質			品質特性														品質企画										
			環境		安全		運動		NVH			信頼										競合製品比較					
1次要求	2次要求	3次要求	質量（軽量化）	RRC（低燃費）	WET（制動）	WET（排水）	操安（CP）	操安（剛性）	乗心地	ノイズ（車内）	ノイズ（車外）	摩耗ライフ	耐偏摩耗	耐外傷	耐久力	品質の性質	重要度	クレーム	要望項目	セールスポイント	現行品	他社品A	他社品B	他社品C	新商品	レベルアップ項目
重要度																										
目標設定	競合製品比較	現行品	100	100	100	100	100	100	100	100	100	100	100	100	100											
		他社品A																								
		他社品B																								
		他社品C																								
		先行開発プロト																								
	目標値		130	120	110	100	100	100	100	100	100	100	100	100	100											
	新技術・新構造																									
重点項目	重点保証項目（ボトルネック技術）																									
	過去の重大クレーム項目																									



Customers' needs
↓
(conversion)
↓
Quality target of technology

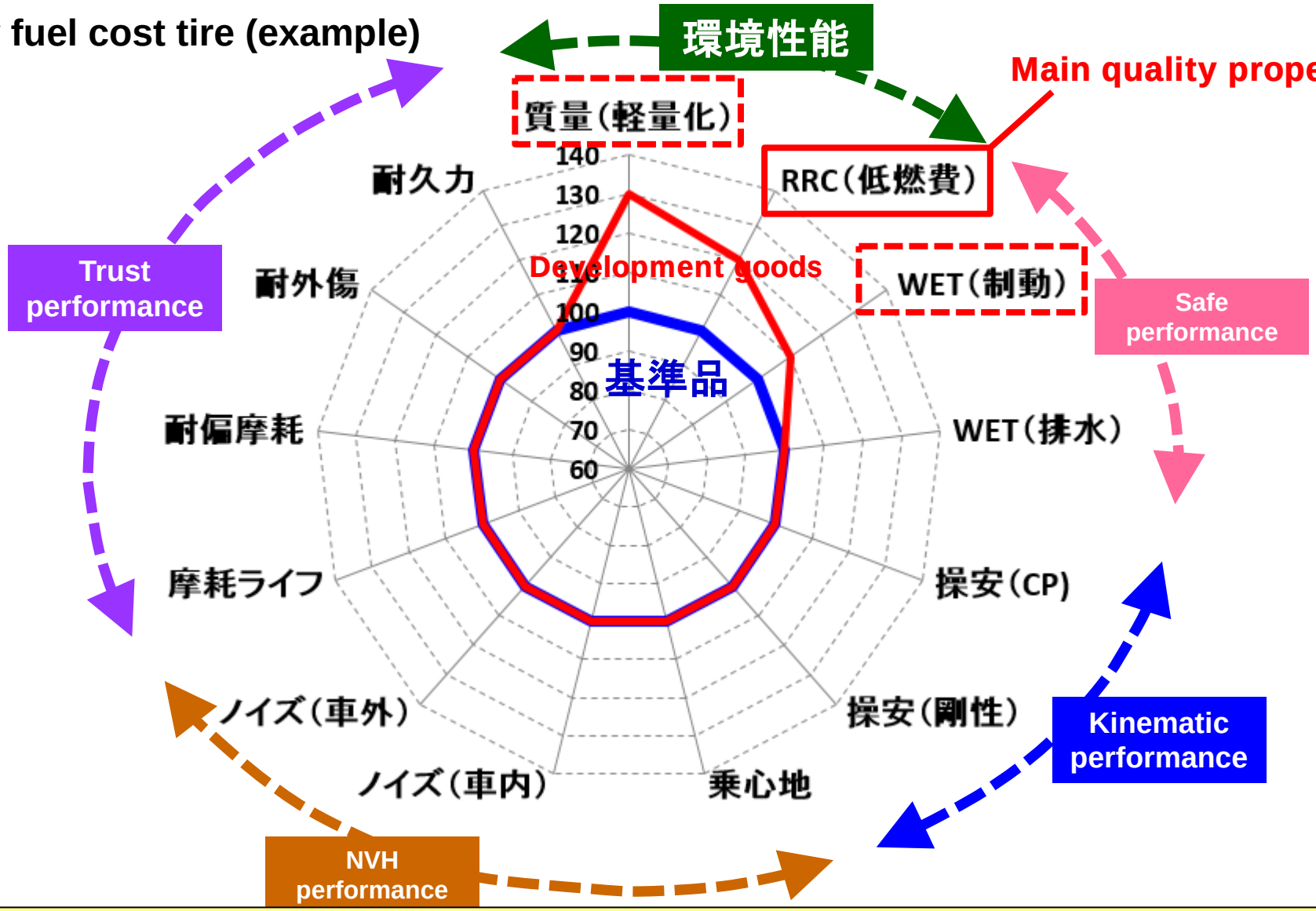
New product plan (The surprise to the customer.)

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

TOYO TIRES
driven to perform

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

TOYO TIRES driven to perform

Low fuel cost tire (example)

Main quality property

＋：性能UP方向　　－：性能DOWN方向

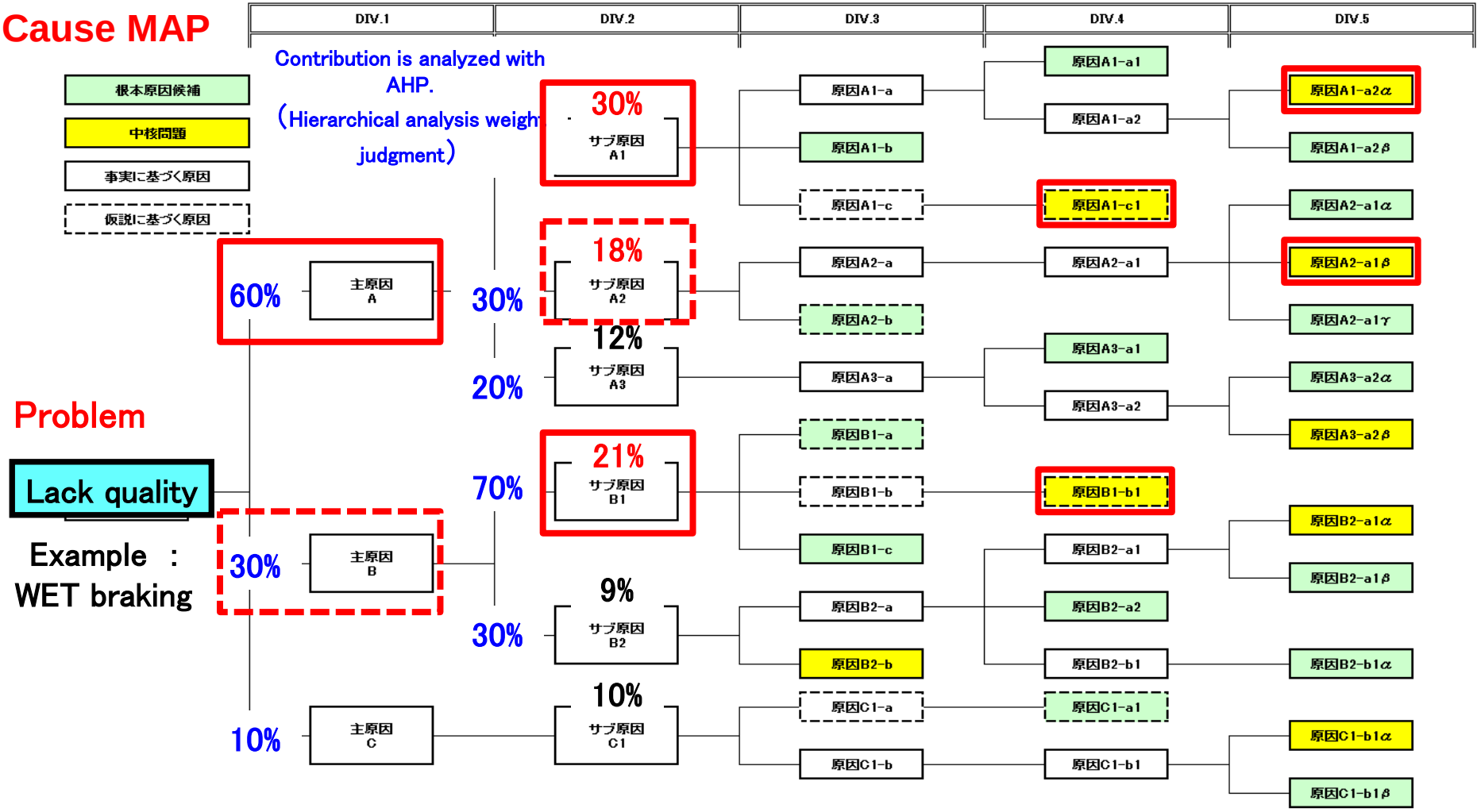
構成部品	設計展開見積 設計パラメータ(例)	基準品	開発品	品質特性見積（目標レベル：基準品100） 質量（軽量化） 130	RRC（低燃費） 120	WET（制動） 110	WET（排水） 100	操安（CP） 100	操安（剛性） 100	乗心地 100	ノイズ（車内） 100	ノイズ（車外） 100	摩耗ライフ 100	耐偏摩耗 100	耐外傷 100	耐久力 100
トレッド	幅	基準	幅狭化(-10mm)	＋	＋			－		＋			－			
	溝深さ	基準	***	＋	＋	－	－	＋		－		＋	－	＋		＋
	CAP配合	基準	***		－	－		＋			－	－	＋	＋		
	BASE配合	基準	***		－	－		＋			－		＋			
	溝底厚み	基準	***	＋	＋			＋		－	－			＋		－
	パターン溝比率	基準	***	＋		－	＋	－			－	－	－	－		
	パターン要素	基準	***					－			＋	＋	＋	－		
ベルト補強	構成	基準	←													
	素材	基準	←													
ベルト	構成	基準	←													
	素材	基準	***	＋		－		－	－	＋	＋		－			
	角度・エンド	基準	***		－	＋					＋		－			
	幅	基準	***	＋				－	－	＋	＋		－			
カーカスプライ	構成	基準	←													
	素材	基準	***	＋					＋							
	巻き上げ高さ	基準	←													
サイド	配合	基準	***					＋	＋	－	－				＋	
	ゴム厚	基準	薄肉化(-1mm)	＋	＋			－	－	＋	＋				－	
ビード補強層	フィラー配合	基準	***		－			＋	＋	－	－					
	フィラー厚	基準	***	＋	＋			－	－	＋	＋					
	フィラー高さ	基準	***	＋	＋			－	－	＋	＋					
	ビード補強	基準	***	－	－			＋	＋	－	－					
ビードコア	ワイヤ素材	基準	←													
	ワイヤ構成	基準	←													
インナーライナー	幅	基準	←													
	厚み	基準	***	＋	＋											
プロファイル	寸法諸元(外径)	基準	***	－		＋	＋						＋			
	寸法諸元(総幅)	基準	***	＋				＋	＋	－	－					
	R形状	基準	***		＋								＋			
	断面形状	基準	***		＋	＋							＋			
			【見積値】⇒	130	120	90	100	100	100	100	100	100	100	105	100	100
			【判定結果】⇒	OK	OK	不足	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

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

(5-1)Promotion device②：Cause MAP and contribution analysis

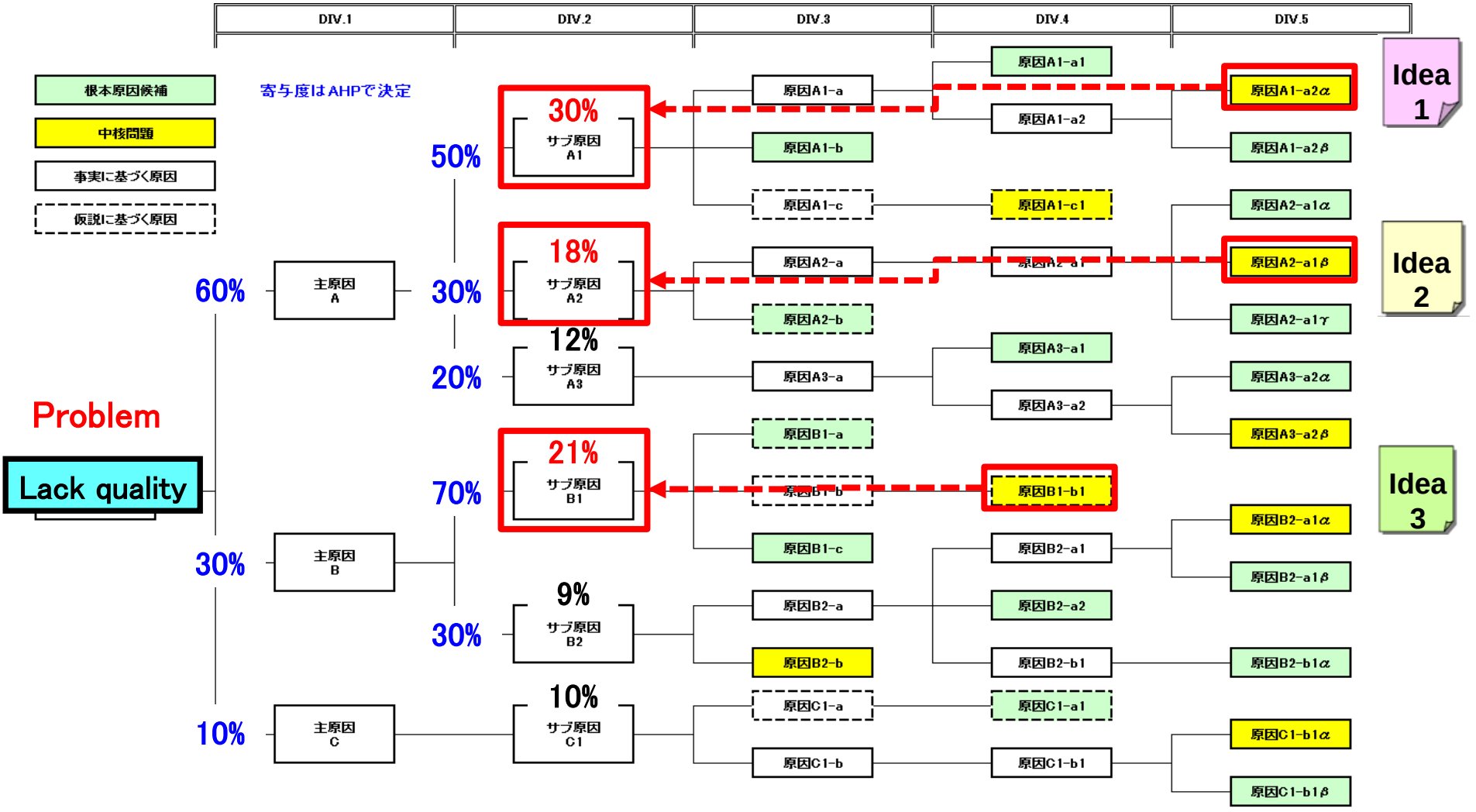
TOYO TIRES driven to perform

Cause MAP



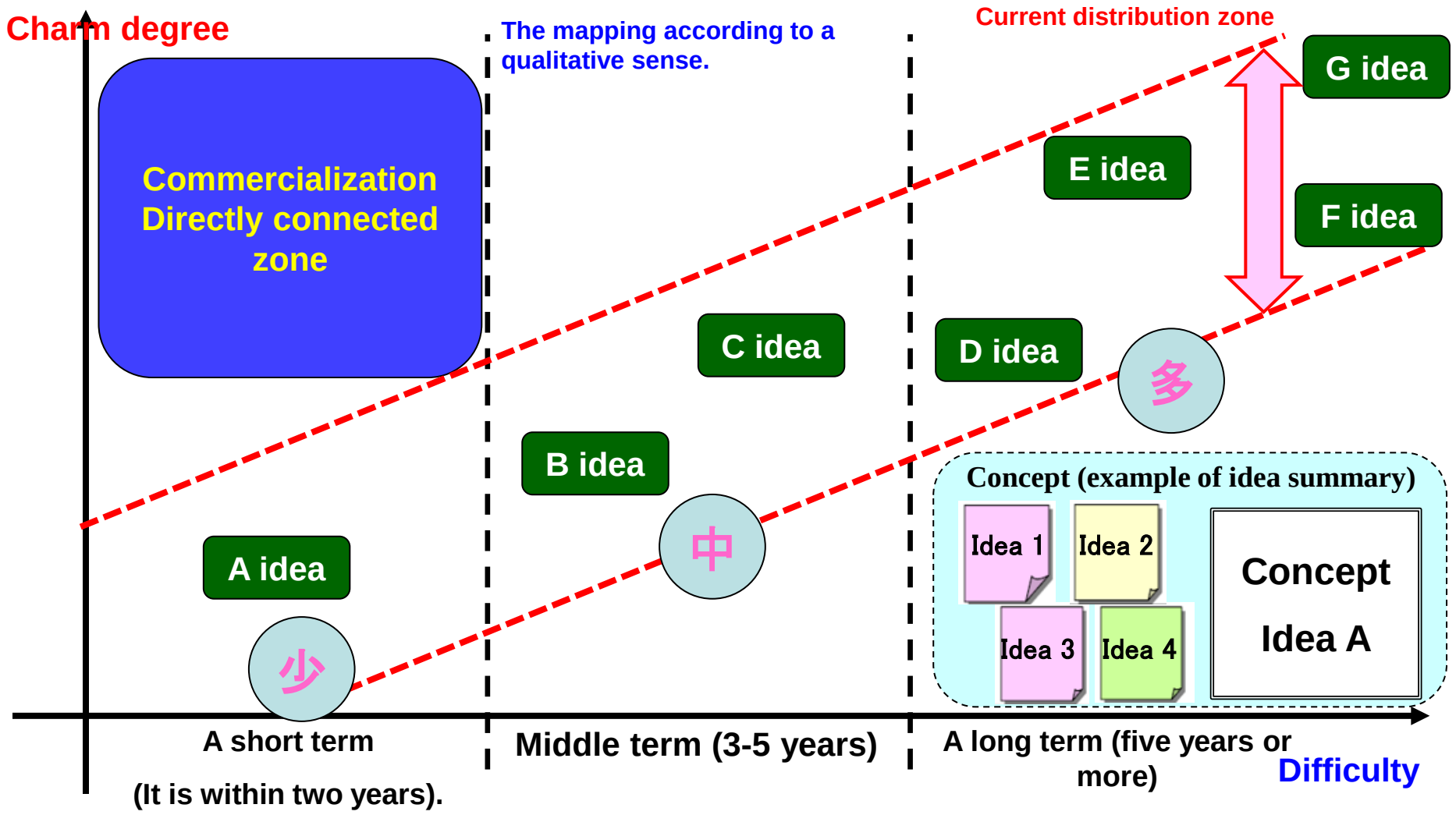
- After thoroughness and logical a cause is analyzed, it matches and the hierarchy is arranged by the logic tree form.
- Because the fact exists together to the cause based on the hypothesis, contribution is analyzed by AHP among members.
- It extracts from the foundation cause candidate with a high priority and it shifts to this TRIZ process.

(5-2)Promotion device②：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.

(6-1)Promotion device③：Current state of idea summary



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.

(6-2)Promotion device③：Evaluation and how to bring idea together

TOYO TIRES driven to perform

Evaluation item and evaluation figure

- The index level is five standard (0) <+ -5 stages < stages.
- The pass or fail of a standard ratio is judged, and the comparative assessment between ideas.

- Improvement level confirmation of problem quality
- Balance confirmation of Q (quality property)
- C&D is confirmed.

	Lack quality (problem)	Cause Contribution	Q1 Main quality	Q2 Main quality	・・・	Qn	C Cost of manufacturing For the development cost	D Development period Development approach
Current state	0	—	0	0	・・・	0	0	0
Idea 1	+5	30%	-2	-1	・・・	-1	-2	-1
Idea 2	+3	18%	+1	-1	・・・	+1	-1	±0
∫	∫	∫	∫	∫	∫	∫	∫	∫
Idea N	+1	21%	+3	+1	・・・	±0	+1	±0

N：2～5

- The combination is generated automatically (programming).
- Restriction condition setting of commercializing directly connected zone

How to bring idea together

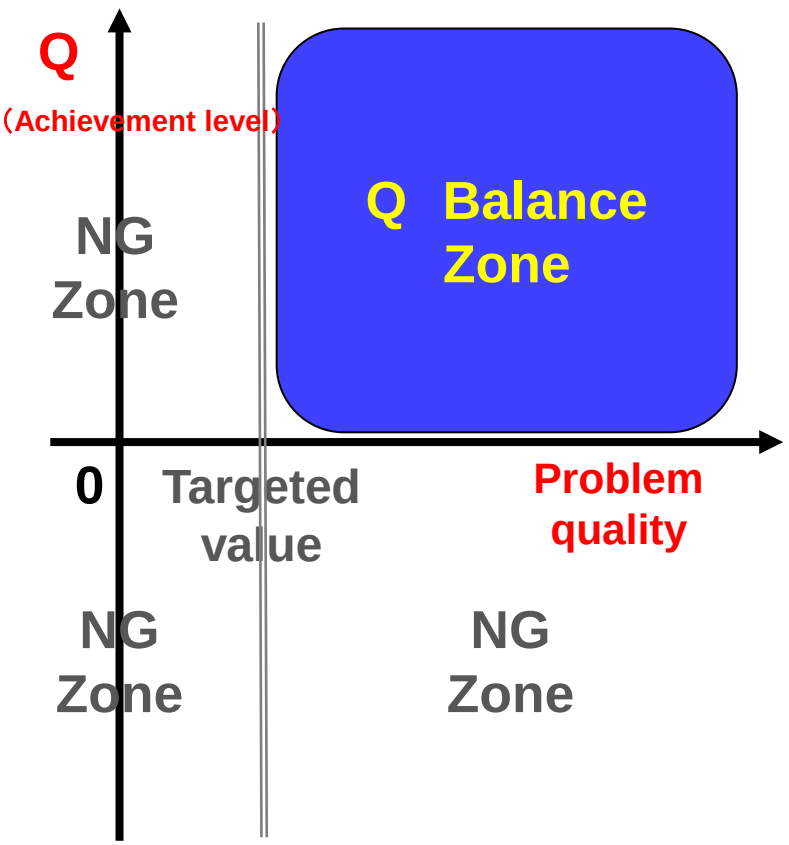
Concept Idea A	+2.4	±0	±0	・・・	±0	-1	±0

The idea evaluation dares to spend time and seen turning and idea summary of Q/C/D are processed automatically.

(6-3)Promotion device③：Confirmation of commodity application possibility

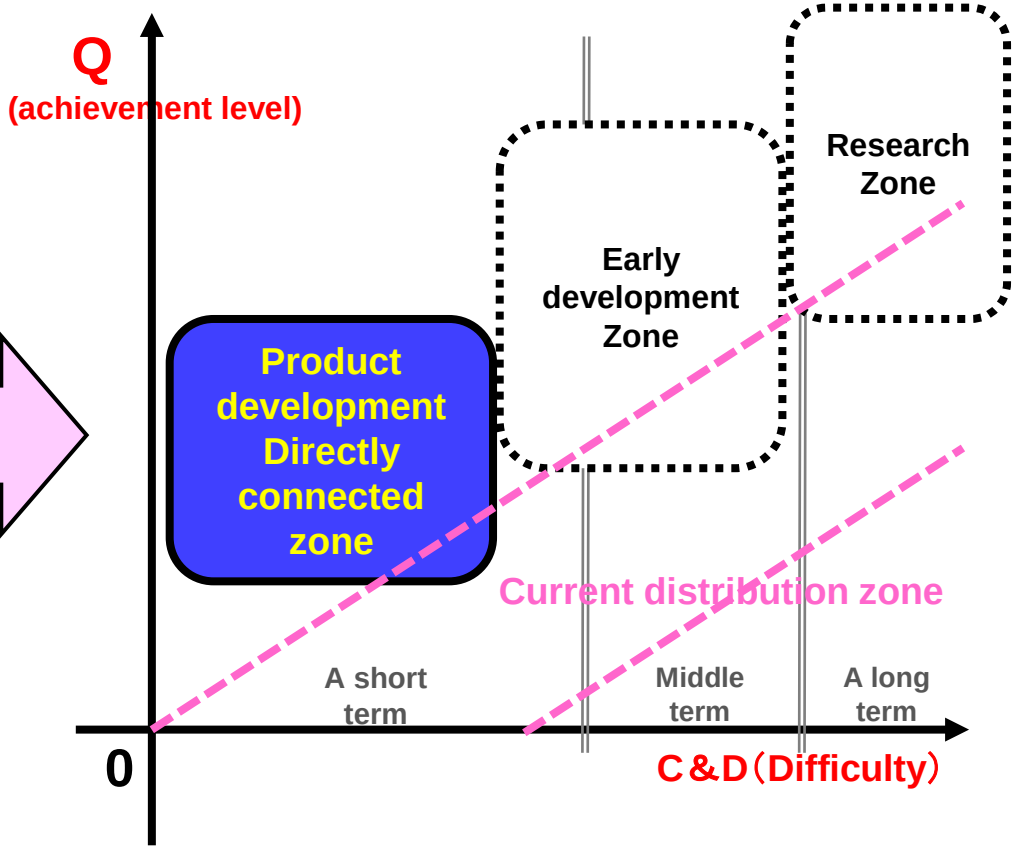
TOYO TIRES
driven to perform

Condition①：Extraction of Q balance zone



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

Condition②：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.

(7)Summary

TOYO TIRES
driven to perform

- 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.

Address of thanks

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.

TOYO TIRES

driven to perform