

Development of scene by simulation & TRIZ & TM ~Challenge to all-Japan manufacturing scene great war~



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SWCN: Solid Works Club of Nagano

CONTENTS

Introduction	03
SWCN 『All-Japan manufacturing scene great war』	04
The first stage: Grasp of system	.....	07
·Function-attribute analysis	.....	08
·Cause-consequence analysis	.....	11
·Extraction of problem	.....	12
Second stage: Defining the problem	.....	12
and idea putting out		
·Application of definition → invention principle of contradiction	.....	13
·Application of evolution pattern	.....	19
The third stage: Taguchi method	.....	22
The fourth stage: Simulation	.....	28
Summary	.....	29



Introduction

How do you approach in the technical field without the current experience when it will be necessary to develop the product with high competitive edge in a short term?

TRIZ

**CAE
Simulation**

**Taguchi
method
Parameter
design**

I will introduce the approach of SWCN to make good use of TRIZ, Taguchi method, and CAE in the technical field 'All-Japan manufacturing scene great war' that was newly born.



SWCN (Solid Works Club of Nagano)

Pan-industry social event that exceeds frame of company...

Concept of meeting「5give 1take」 「Smile & Enjoy」



SolidWorks User Group Network

<http://swcn.web.fc2.com/nh/index.html>



Introduction of SWCN

The main activity

- 2009 July: The user by First Impact user's user.
Event of straightening (keynote address, seminar, and another)
- 2010 July : 2nd Impact
- 2011 January : Seminar in winter: Three dimension design power study meeting
July : 3rd Impact
August : It exhibits to the festival Ueda rally of the science.
- 2012 July : 4th Impact Scene great war Shinshu place holding
November : Seminar in autumn: 「TRIZ・TM・SolidWorks Motion What is the best scene design to be learnt to the analysis?」Another
- 2013 July : 5th Impact Team competition holding according to scene great war prefecture (Shinshu University)
November : Seminar in autumn: It creates it without making it. 「Challenge to all-Japan manufacturing scene great war」Another
Expert year : Technical meeting
- 2014 January : Adult HYBRID Free Plane classroom/flight association
July : 6th Impact Scene great war Shinshu Ueda place holding
November : Autumn Seminar (schedule)
Expert year: Technical meeting



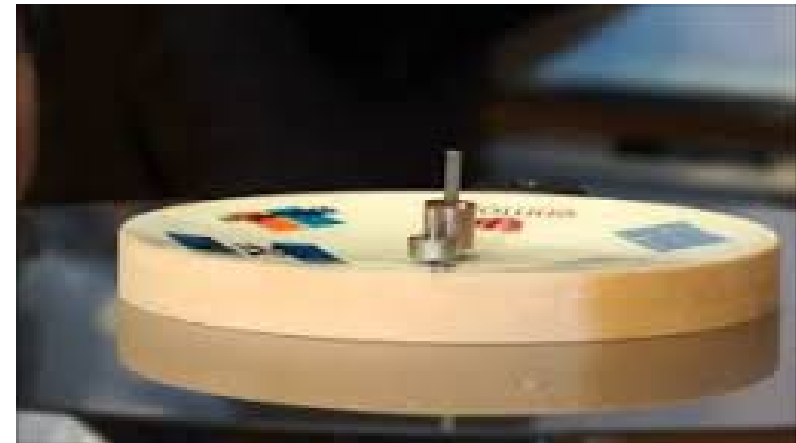
What is the all-Japan manufacturing scene great war?

What is the scene great war?

It is a rally (bringing together the scene that small and medium manufacturers in the whole country are bet the boast of its company and made, and the fight by the one to one). Manufacturing seriously designs a small scene, and everything is poured and the technology that its company can have with a professional machine is made. A professional technique is fatty soaked of the ring on each other.

What rule?

- *Having kept turning longer than other party's scene wins.
 - ?It is defeated besides the ring when going out.
 - ?Game end at two successive victories
 - ?The victor can get loser's scene.
- (It is a content total removing of booty till then.)



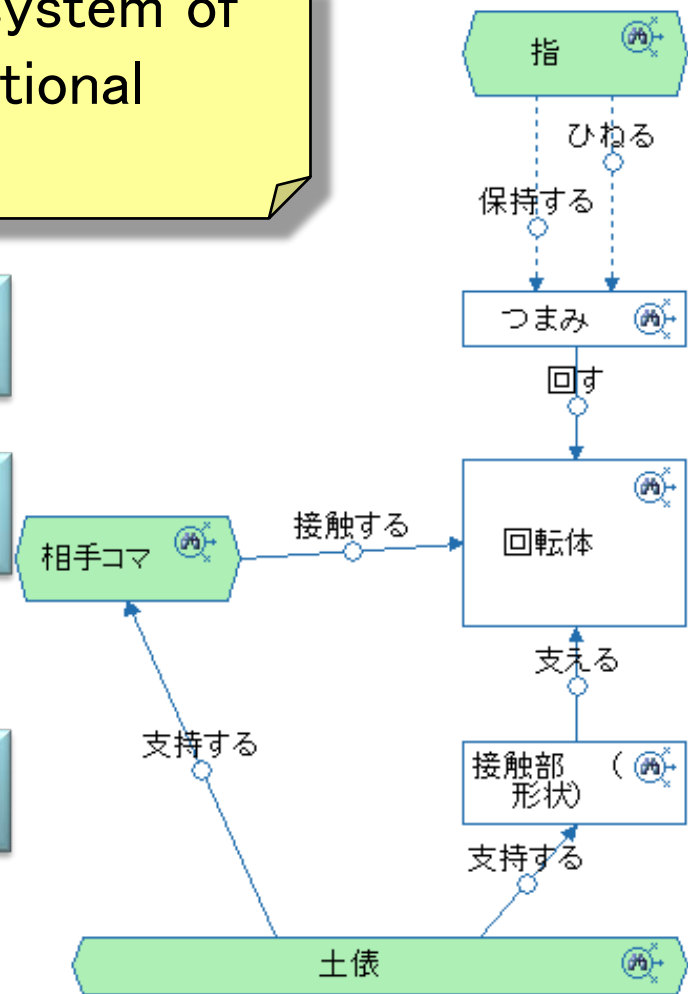
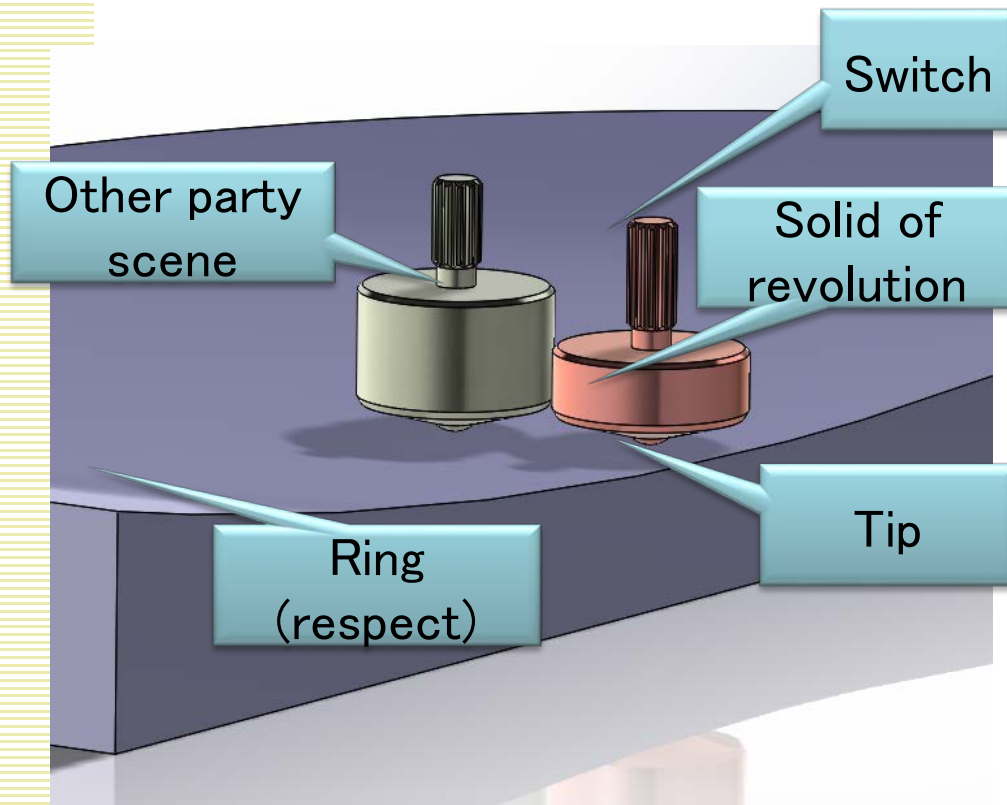
The first stage: Grasp of system: Specification confirmation (latest)

- Specification of scene
- The diameter of the scene is $\phi 20\text{mm}$ or less in the static condition against the rotation axis.
 - The size is confirmed with the ring gauge of $\phi 20.001$.
 - Turn only by the finger of one of hands.
- Victory or defeat
- It goes out or it is defeated besides the ring when previously stopping.
 - When the tread stops though the parts other than the tread with the ring move, it is defeated.
 - If the game cannot begin from point by which the referee multiplied the cheer of "Correspond" within 30 seconds, it is assumed one defeat.
- Prohibited matter
- The scene that keeps turning in the tread in two places or more is prohibited.
 - The scene into which the rotation axis changes is prohibited.
 - The scene into which externals size changes by the component replacement is prohibited.
 - It is prohibited to touch the scene at time other than the game after it accepts.
 - The use of a supplementary tool that assists and promotes the rotation of the scene from the outside is prohibited.
- Specification of ring **$\phi 250\text{mm}$ $\square R700\text{mm}$ Made of Chemical wood**



Grasp of system①: Function-attribute analysis

An output, a component, and a super-system of the system are extracted, and the functional relation is clarified.



Grasp of system①: Function-Attribute analysis

Extraction of component
(solid of revolution part and another)

Mass

Center of gravity

Moment of inertia

コマ2の質量特性:
 コンフィギュレーション: デフォルト
 座標系: --デフォルト--

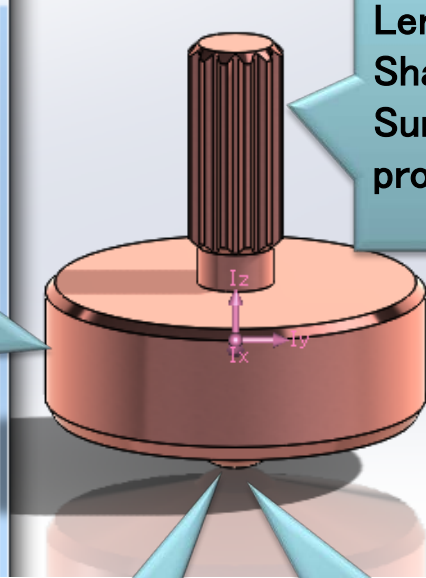
密度 = 0.01 grams per cubic millimeter
 質量 = 22.09 grams
 体積 = 2674.84 cubic millimeters
 表面積 = 1282.56 square millimeters

重心: (ミリメートル)
 X = 0.00
 Y = 6.86
 Z = 0.00

慣性主要軸と慣性主モーメント: (grams * square millimeters)
 重心:
 Ix = (0.00, 0.00, 1.00) Px = 799.19
 Iy = (1.00, 0.00, 0.00) Py = 799.19
 Iz = (0.00, 1.00, 0.00) Pz = 967.76

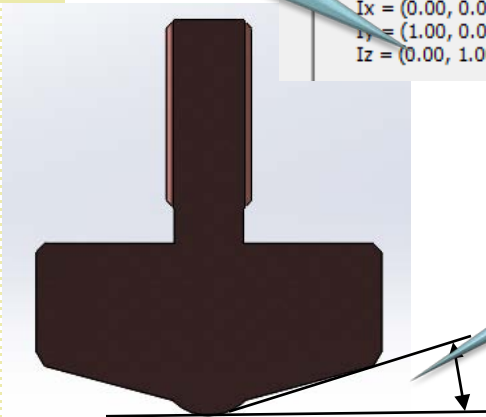
Solid of revolution:
 Material
 Outside diameter
 Angle of bank
 Shape

Switch:
 Material
 Thickness
 Length
 Shape
 Surface properties



Tip:
 Material
 Frictional properties
 Shape

Material on ring side:
 Vinyl chloride seat

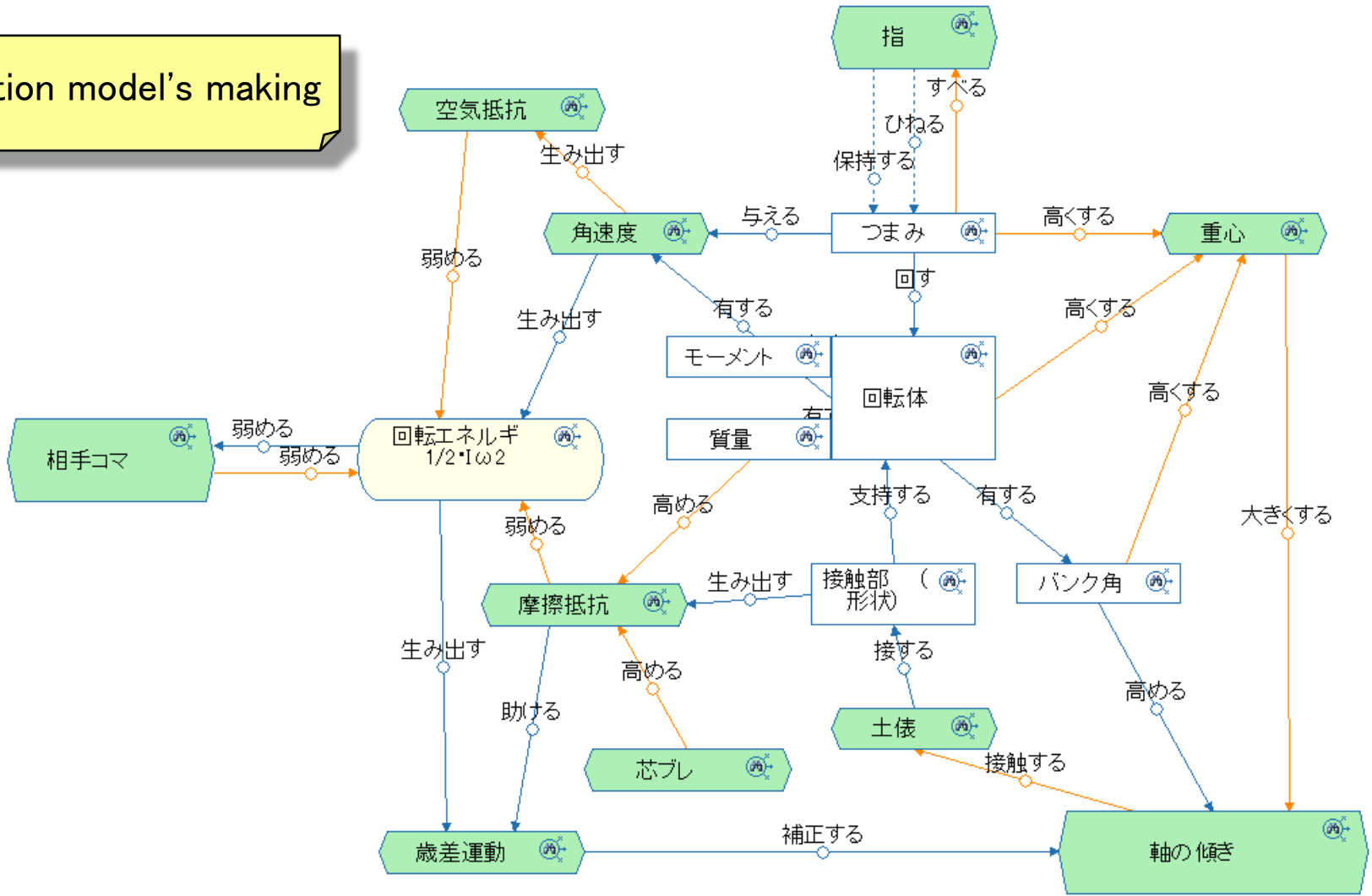


Angle of bank



Grasp of system①: Function-attribute analysis

The function model's making



Extraction of problem

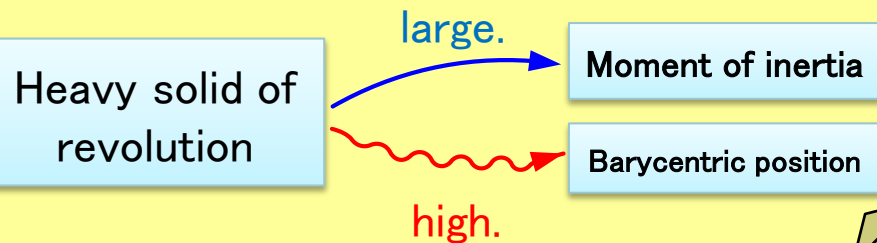
1. As for a heavy solid of revolution, \Leftrightarrow center of gravity that moment of inertia grows rises. The idea that solves this contradiction?【 contradiction problem 】
2. Torqueing is applied \Leftrightarrow fat one thin goes up the switch and the rotational speed goes up. The idea that solves this contradiction?【 contradiction problem 】
3. The switch is low \Leftrightarrow that turns length easily short and center of gravity is low. The idea that solves this contradiction?【 contradiction problem 】
4. Center of gravity rises in the angle of bank though the make a careless pitch by the axis blur when largeness turns it on is few. 【 contradiction problem 】
5. The frictional drag grows by causing friction with the ring, and the scene heavy as for the Scene point. Is a method frictional drag a little even if it is heavy? 【 contradiction problem 】
6. Let's devise the method of improving the rotational speed of the scene. Besides, does the resource that can be used :?
7. The method of absorbing only rotation energy of other party scene?
8. The method of destroying stability of other party scene?
9. The method of flipping other party scene outside the room momentarily?
10. Method of no contact with other party and the method of not receiving the other party's influence?



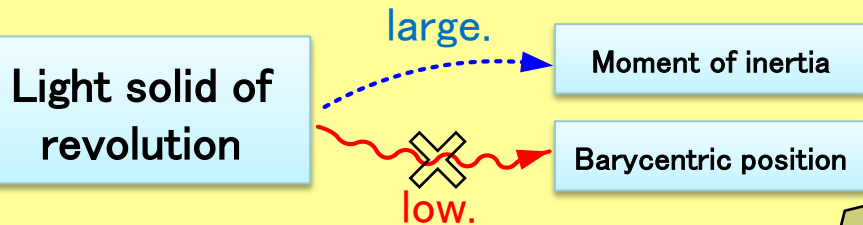
Definition → invention principle of contradiction (1)

Definition of contradiction ① Weight of solid of revolution
 Technical Contradiction

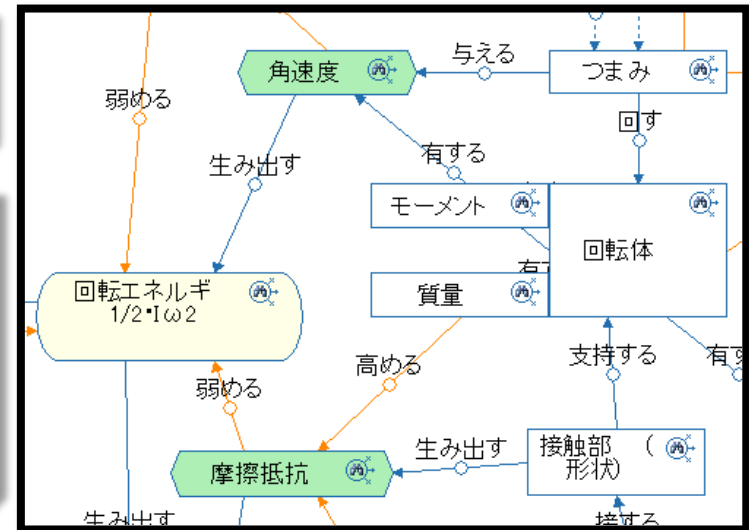
TC-1 : Technical contradiction by main function achievement



TC-2 : Technical contradiction in adverse effect solution



Characteristic to be improved: Weight of movement object
 Deteriorating characteristic: Length of movement object



【 invention principle 】
 15:Dynamic principle
 08:Balance principle
 29:Fluid use principle
 34:Exclusion-reproduction principle



Definition → invention principle of contradiction (2)

Definition of contradiction② Thickness of switch
Technical Contradiction

TC-1 : Technical contradiction by main function achievement

Fat switch

large.

Torque

Rotational speed

low.

Physical contradiction

TC-2 : Technical contradiction in adverse effect solution

Thin switch

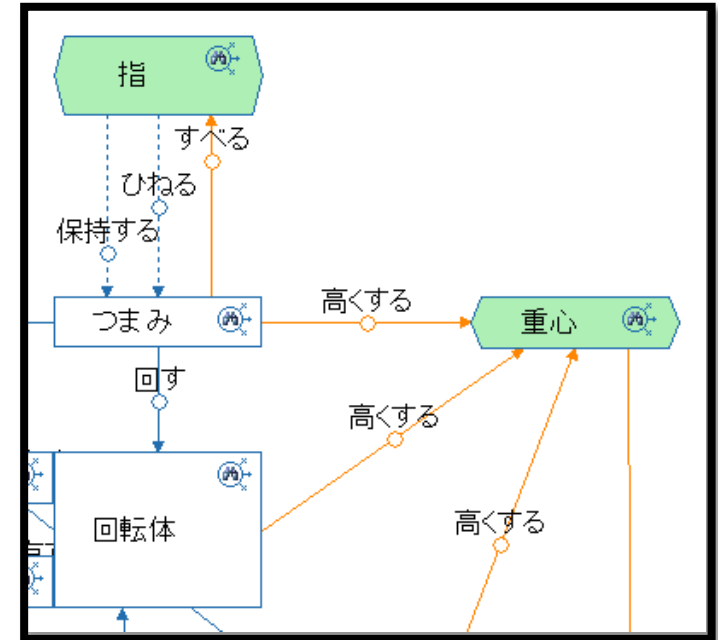
large.

Torque

Rotational speed

low.

Characteristic to be improved: Power
Deteriorating characteristic: Speed



【 invention principle 】

13:Reverse-conception principle
28:Mechanical system substitution principle

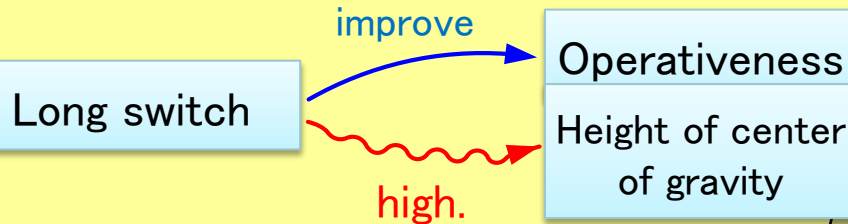
15:Dynamic principle
12:Potential principle



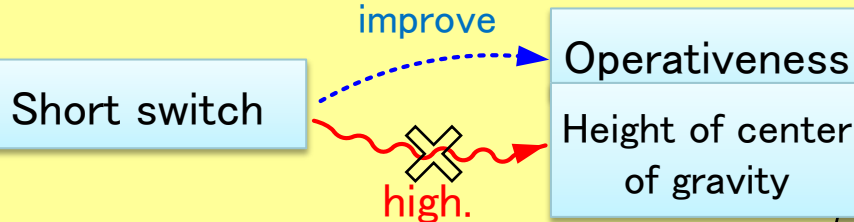
Definition → invention principle of contradiction (3)

Length of definition ③ switch of contradiction
 Technical Contradiction

TC-1 : Technical contradiction by main function achievement

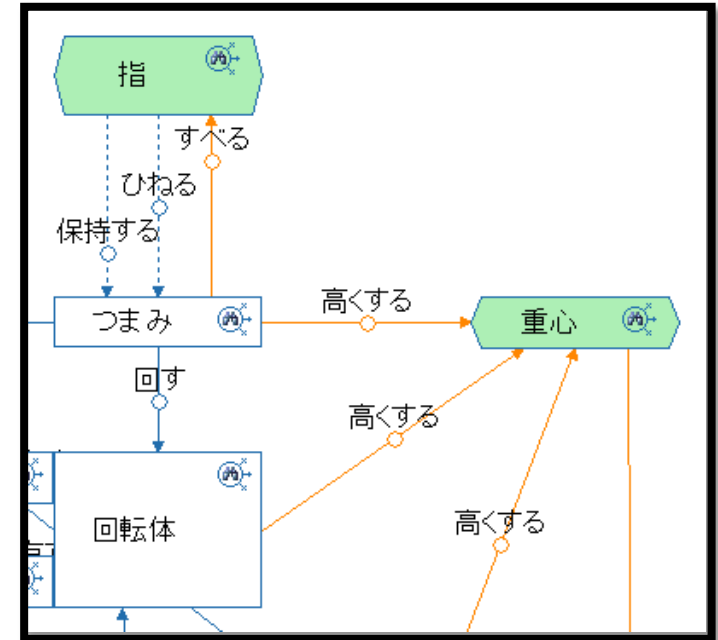


TC-2 : Technical contradiction in adverse effect solution



Characteristic to be improved: Shape
 Deteriorating characteristic: Length of body at rest

Physical contradiction



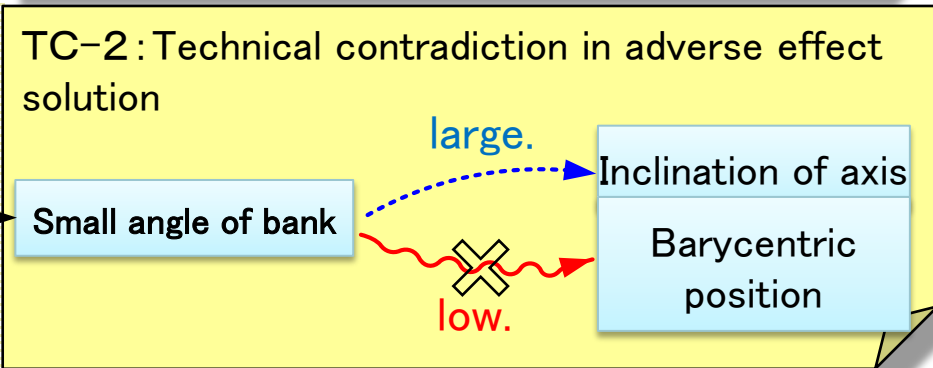
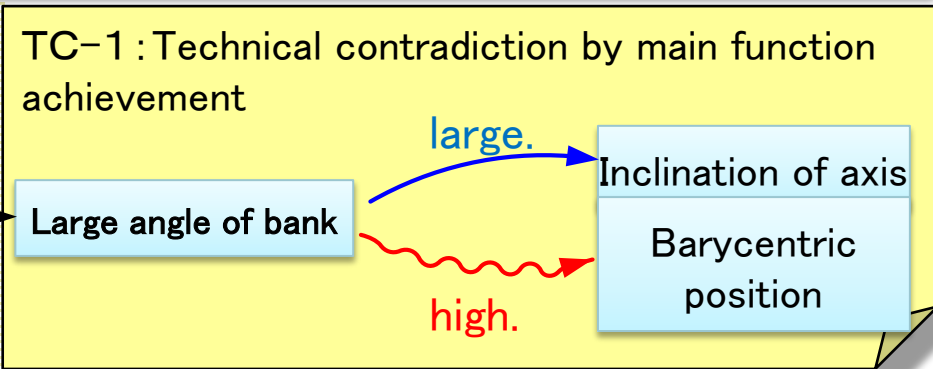
【 invention principle 】

- 13:Reverse-conception principle
- 28:Curved surface principle
- 15:Advance action principle
- 12:Nest principle



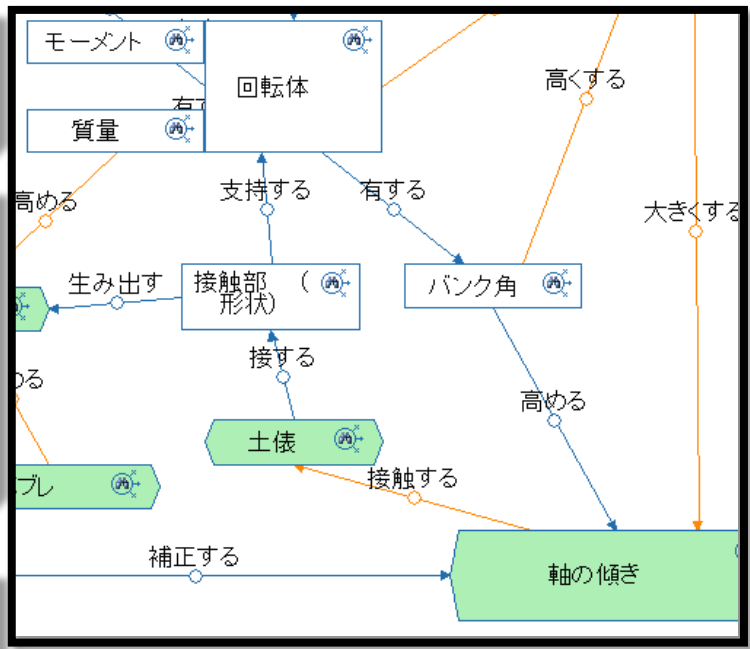
Definition of contradiction → Invention principle (4)

Definition of contradiction④ Angle of bank of solid of revolution
 Technical Contradiction



Physical contradiction

Characteristic to be improved: Adaptability or flexibility
 Deteriorating characteristic: Length of movement object

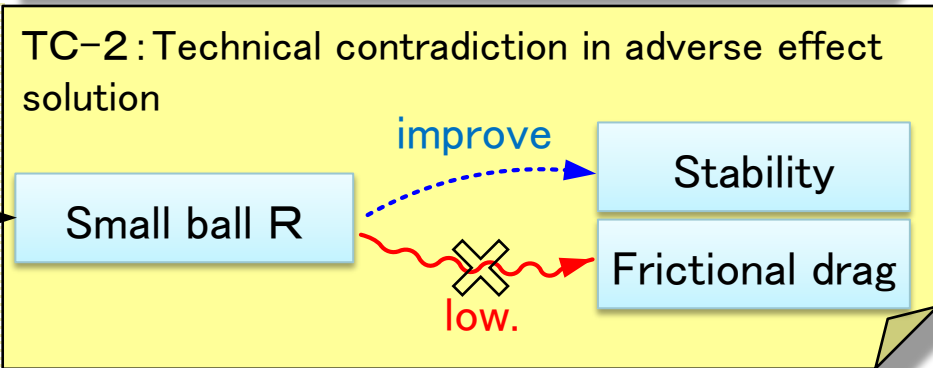
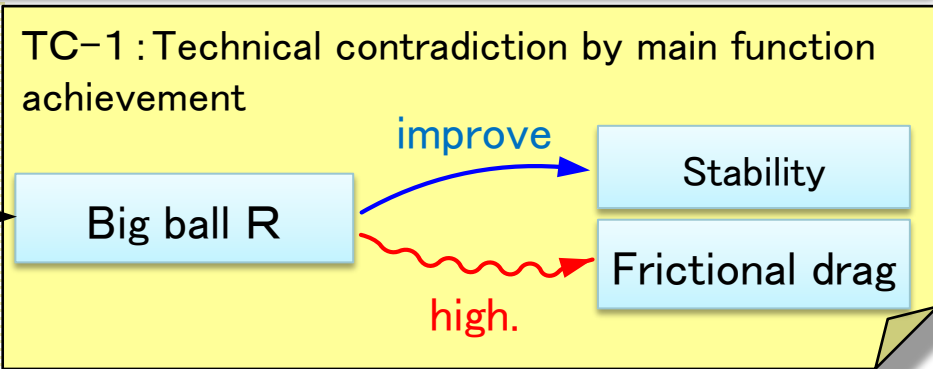


【 invention principle 】
 35:Parameter change principle
 01:Division principle
 29:Fluid use principle
 02:Separation principle



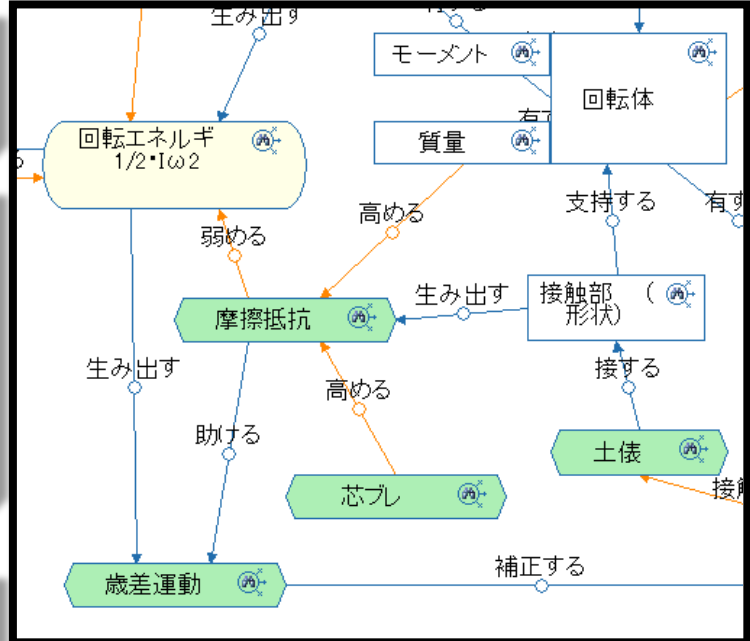
Definition of contradiction → Invention principle (5)

Definition of contradiction ⑤ Contact (point) part
Technical Contradiction



Physical contradiction

Characteristic to be improved: Weight of movement object
Deteriorating characteristic: Length of movement object

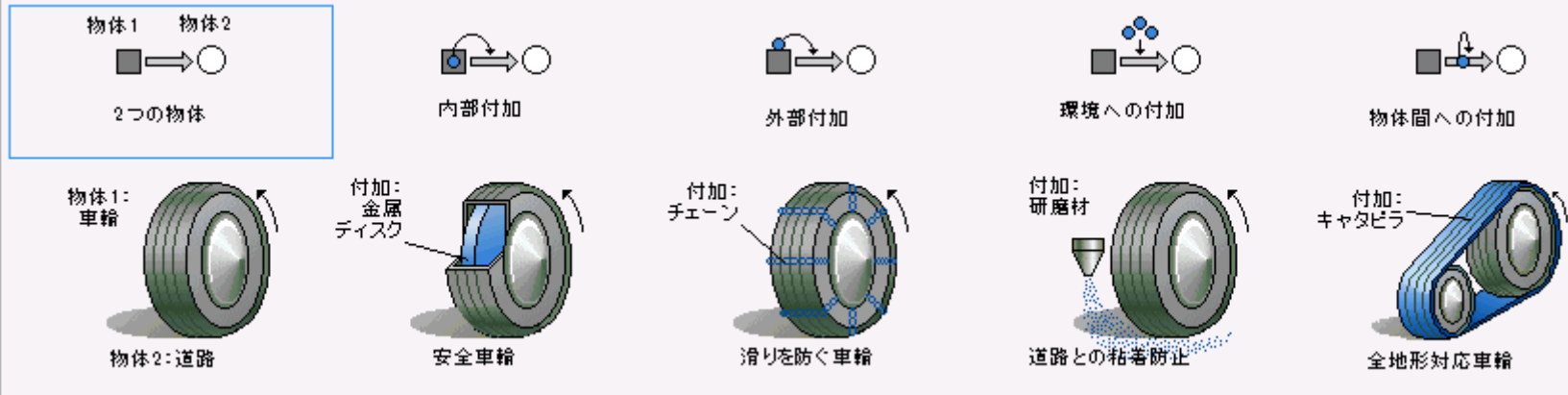


【 invention principle 】
15: Dynamic principle
08: Balance principle
29: Fluid use principle
34: Exclusion-reproduction principle

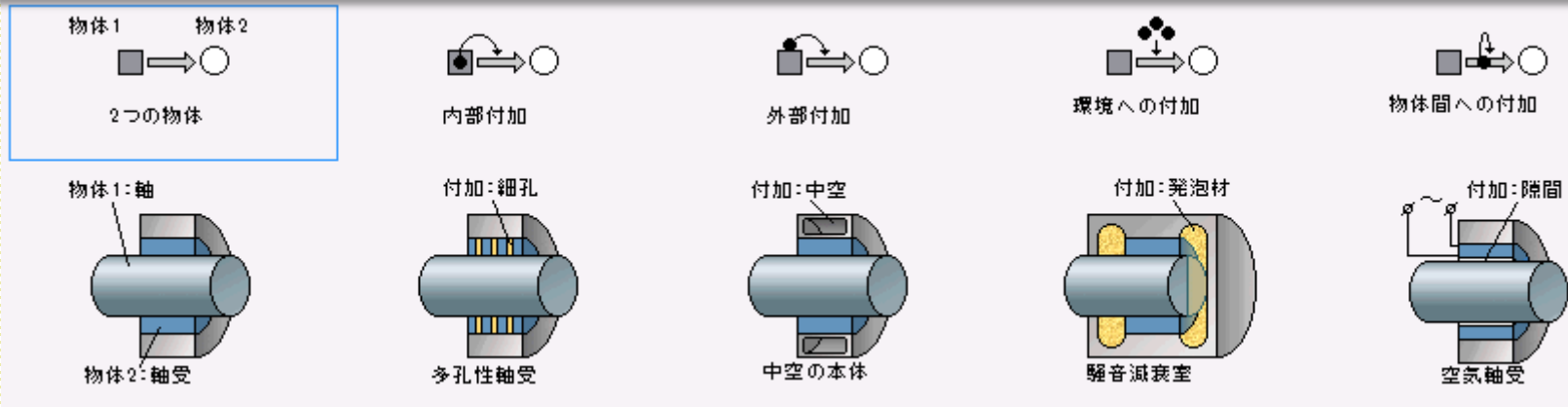


Application of system evolution pattern(1)

Introduction of new material: The energy of the other party scene is absorbed. The rotational speed is improved.



Introduction of gap: Friction reduction in contact part, Structure of scene



Application of system evolution pattern (2)

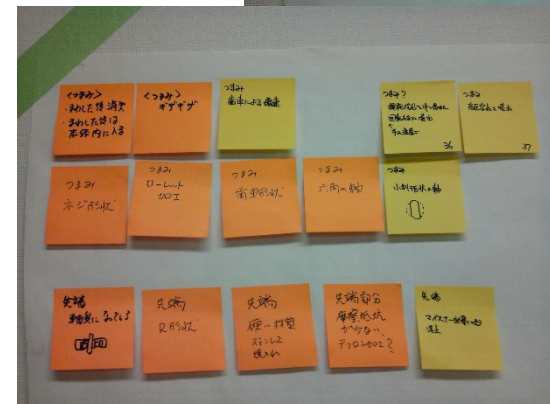
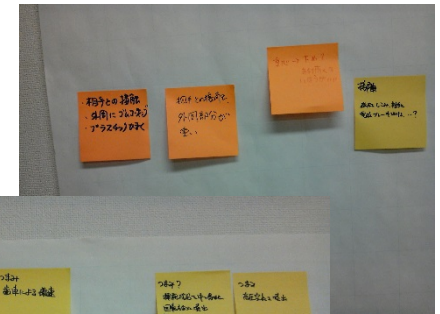
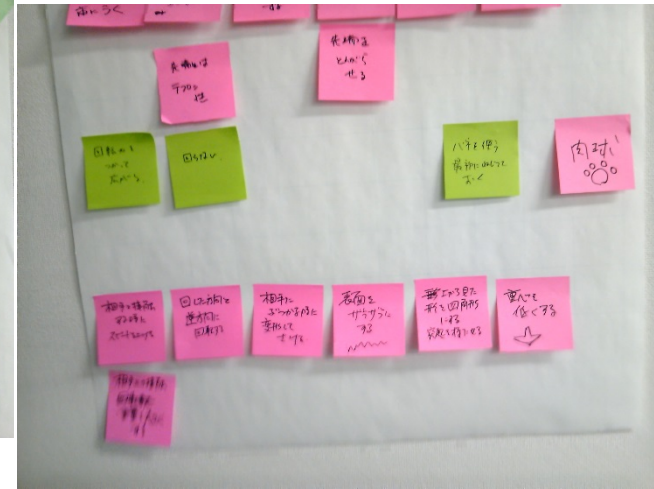
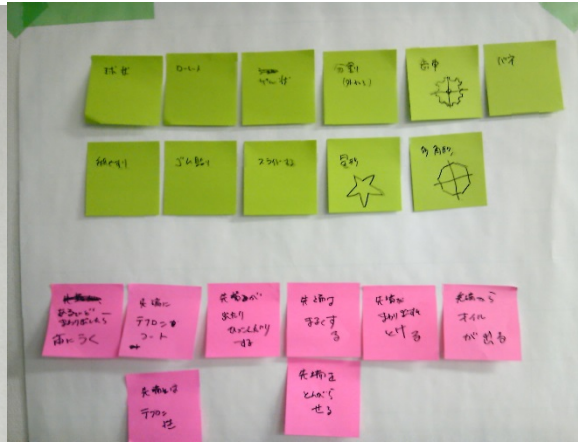
Introduction of field: The stability of other party's scene is destroyed. It doesn't come in contact. 、 Friction reduction



Movability: Structure of scene, Other party's scene is flipped. 、 It doesn't come in contact.



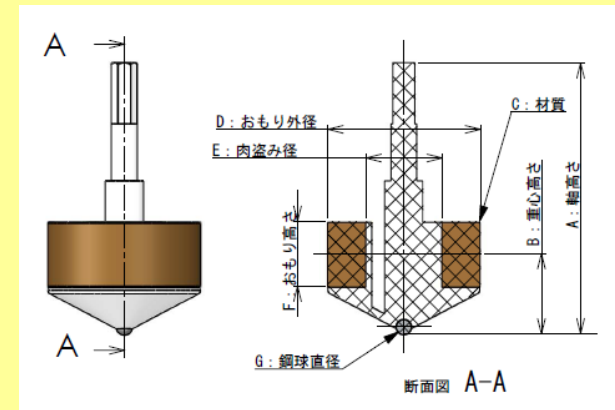
Idea putting out



What is the Taguchi method?

- Dr. Genichi Taguchi (1924 – 2012)
- Taguchi method = Quality engineering = Robustness design
("Robust" means it, that is, "It is stout" or "Strength".)
- Technological technique to make product with good quality cheaply early

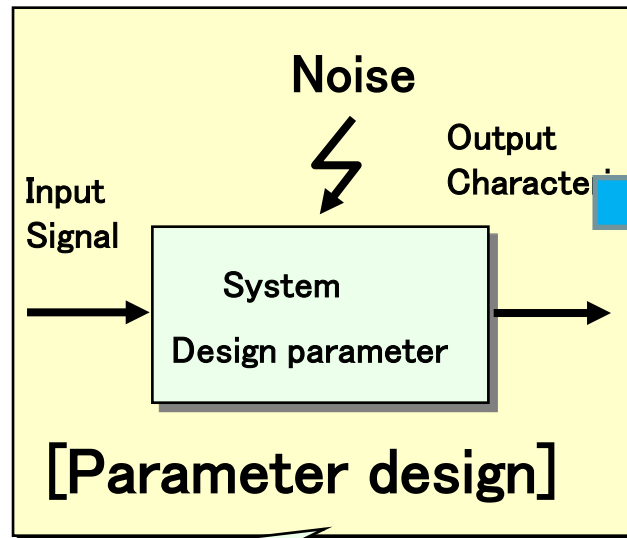
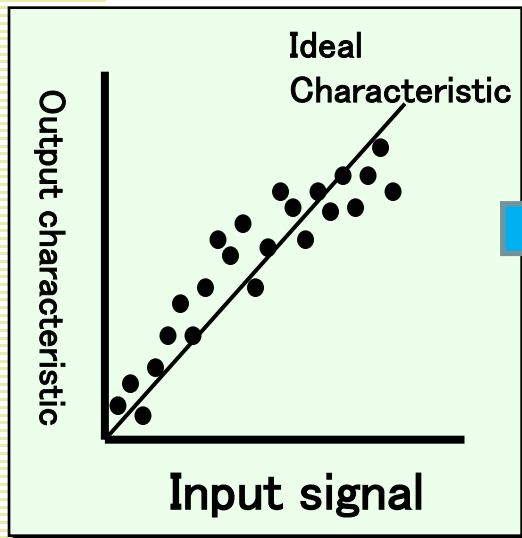
- There are a lot of design parameters that should be examined when the scene is designed.
- Other party's scene cannot be specified, and the state of the ring and pitcher's capability vary, too.
- In such a situation, the technique to develop a strong scene by "low cost for a short term" is the center technique of the Taguchi method.



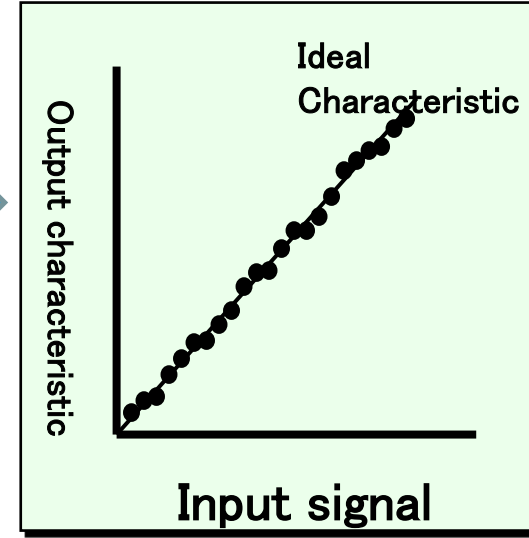
Parameter design

Concept of parameter design

[Unstable state]



[Stable state]



Factor that engineer cannot control system:

It is in the delicate state by the noise. However, the internal design parameter that the engineer can control is set.

And, the influence of the noise can be held down by optimizing it.

Feature of parameter design

1.

Two stage design

First of all, the noise-proof (robustness) is secured.
Next, it matches it to an ideal I/O relation.

2.

Signal-Noise
ratio

The noise-proof of the function of the system is evaluated.
Signal-Noise ratio (ratio of signal/noise) is used as a
standard.

3.

Error margin
factor

To evaluate the noise-proof, noises such as the civil war
and turbulence (error margin factor) are included in the
experiment.

4.

Orthogonalization
table

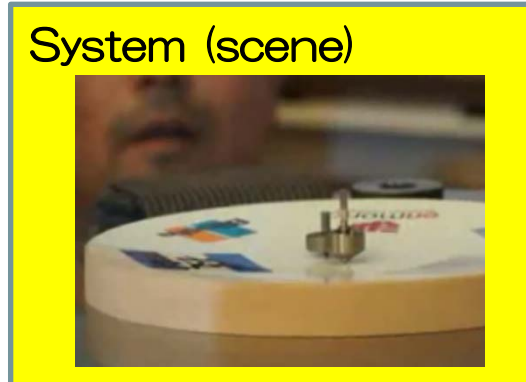
A lot of design parameters are taken up at a time.
It allocates to the orthogonalization table, it experiments,
and it evaluates it.

Application to scene

※) The designer cannot control.



Error margin factor
 · Opponent
 · Friction with ring
 · Turning person's technology



Signal
 Rotation energy



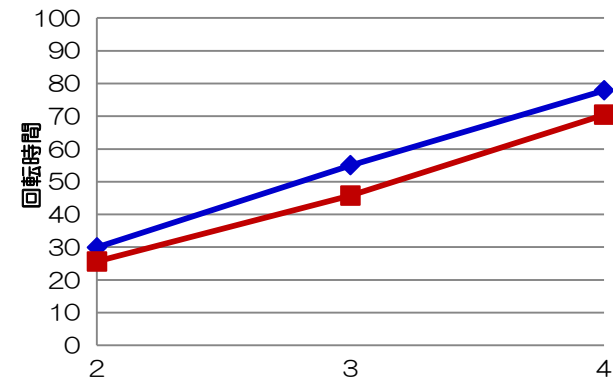
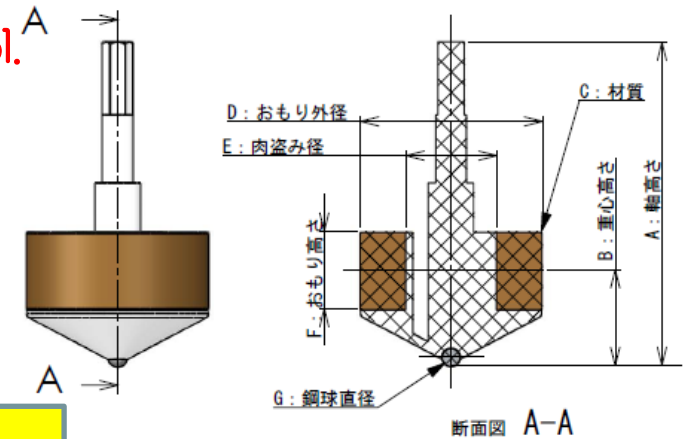
Output
 Turn-over time



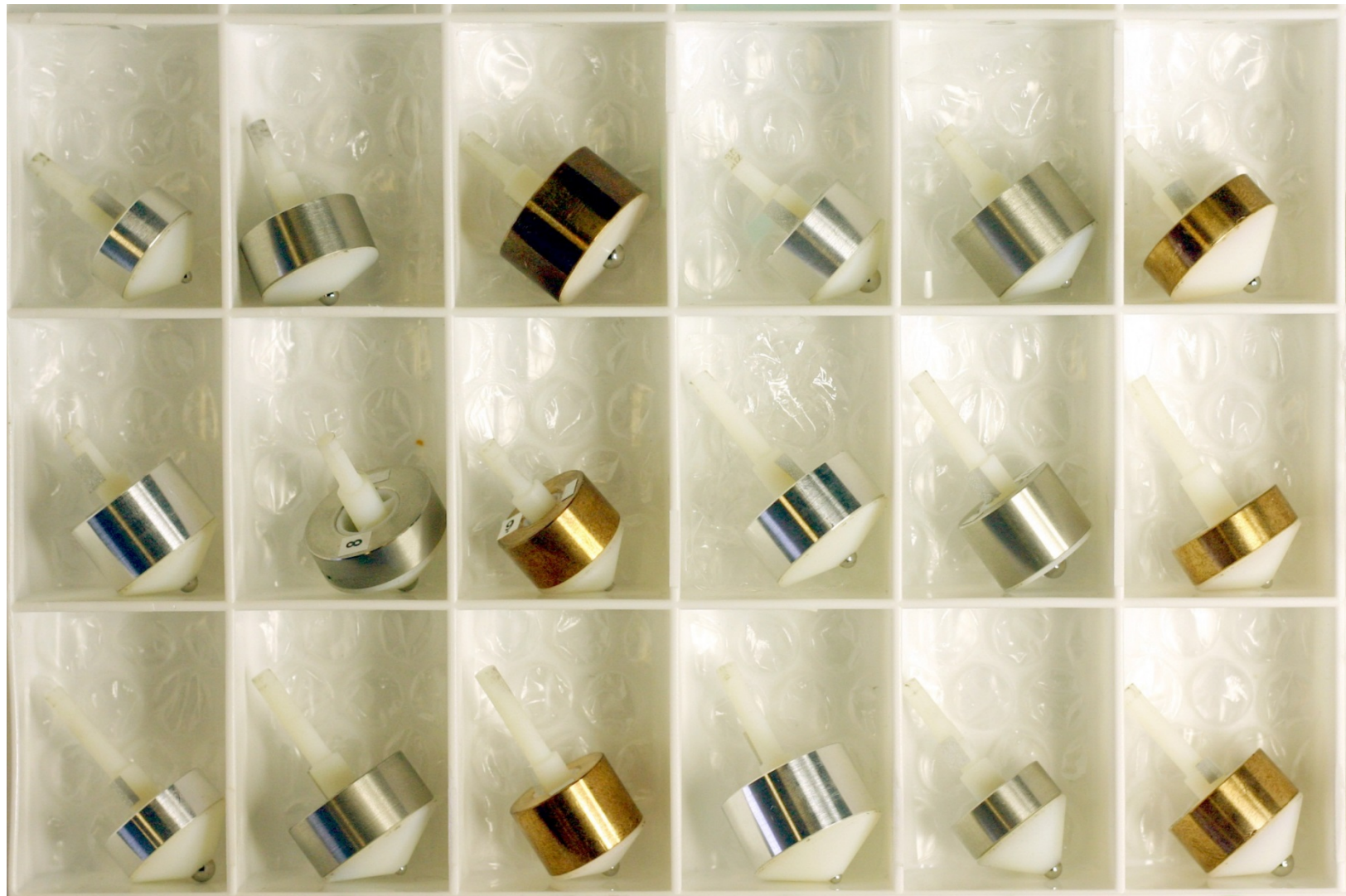
Restrictor
 · Material
 · Size
 · Structure



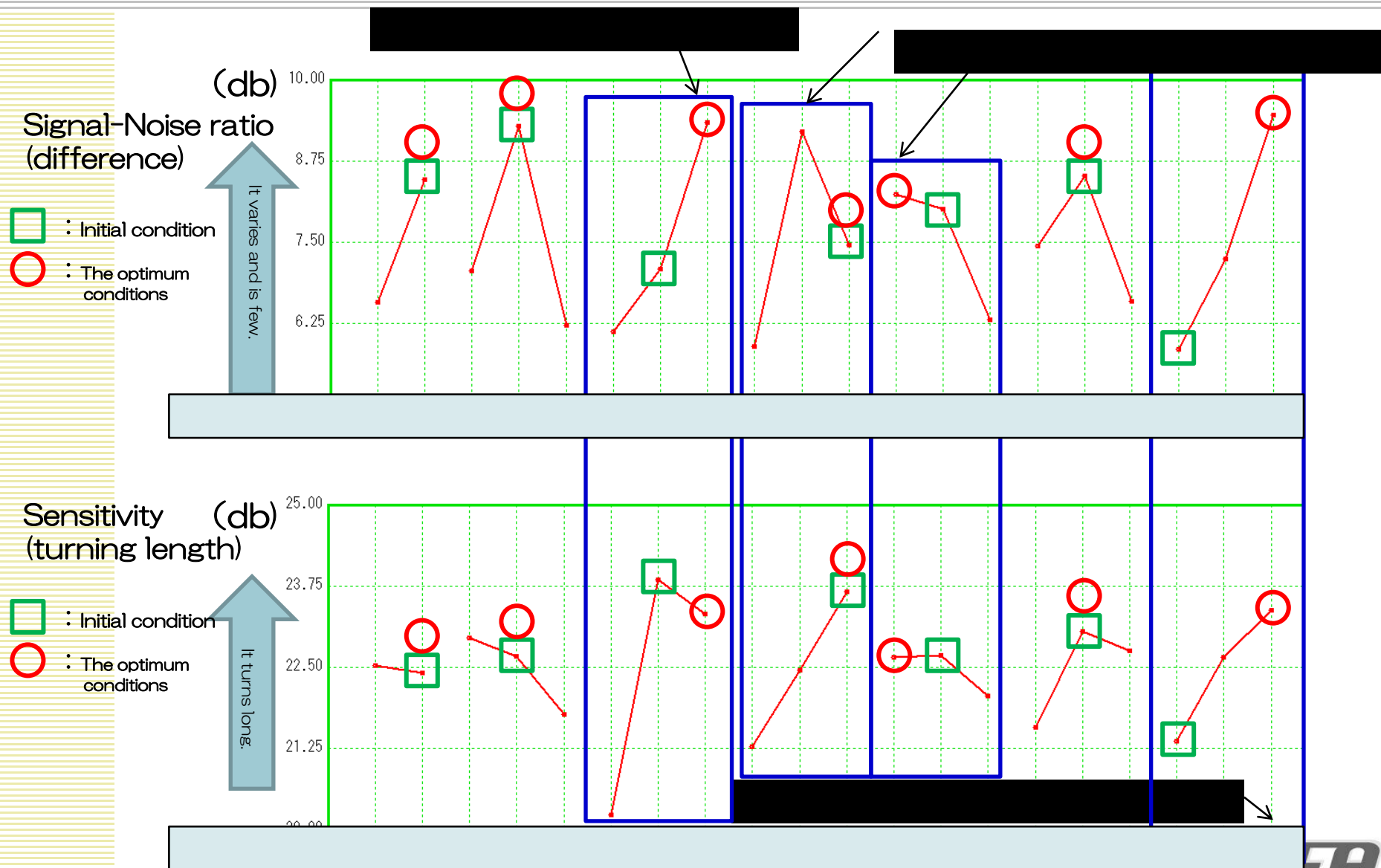
※) The designer can control.



The thing is made for trial purposes with an optical forming and metalworking.



Factor effect chart



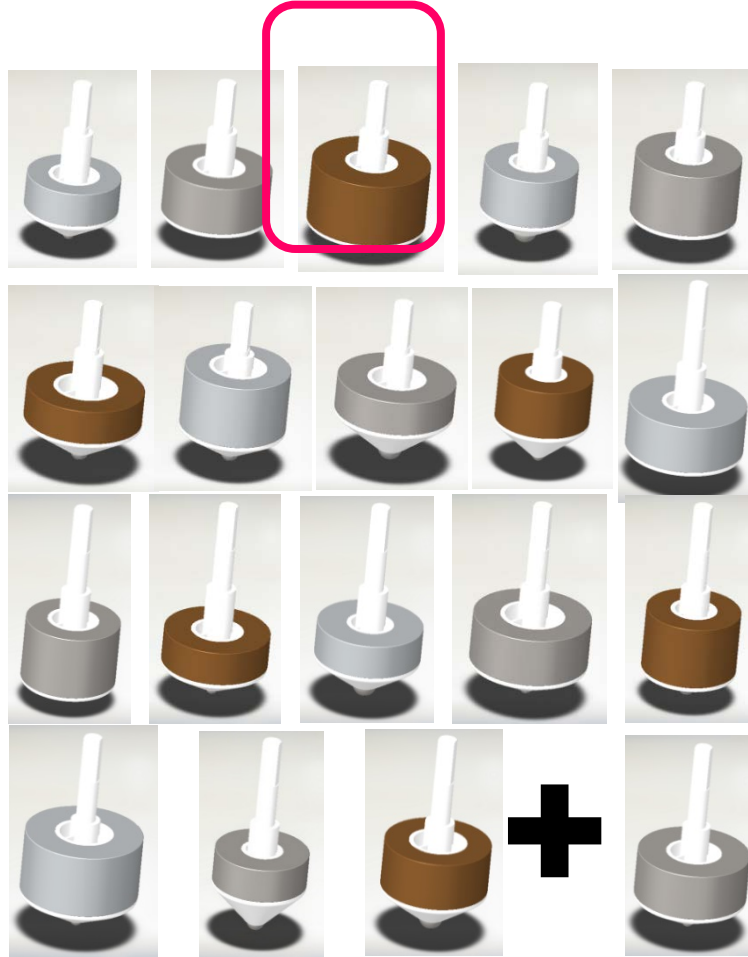
After all, was a strong scene able to be done?

- If it is a scene that turns to the noise (opponent and state of the ring) strongly, and long, it should be able to win other scenes.

↓ It defeats it only to No.03. !



The optimum conditions scene



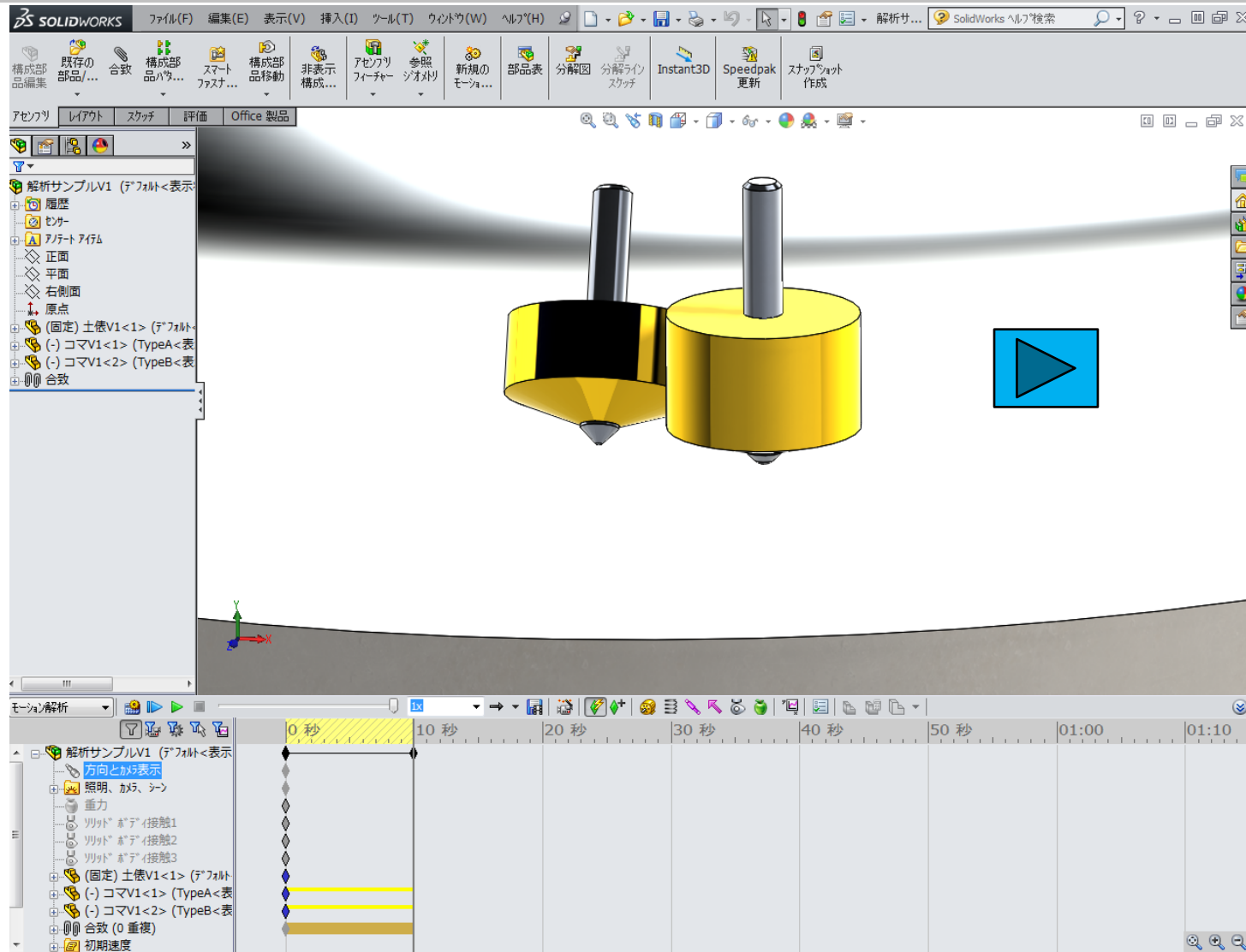
19 piece scene (L18 + Ibaraki type)

Score sheet

1	○
2	○
3	×
4	○
5	○
6	○
7	○
8	○
9	○
10	○
11	○
12	○
13	○
14	○
15	○
16	○
17	○
18	○
比較(最強)	○

18 victory one defeat !

Virtual fighting by CAE (SolidWorks Motion)



Summary

How do you approach in the technical field without the current experience when it will be necessary to develop the product with high competitive edge in a short term?

The past

Intuition?
Experience?
Idea.
Making for trial purposes to be repeated?

The first stage: Grasp of system
【 function-attribute analysis 】
Diversified, multipronged, thorough problem extraction by 【 cause-consequence analysis 】

Second stage: Idea putting out
【 TRIZ 】 Extraction of diversified, multipronged, thorough idea with tool

The third stage: Taguchi method
A scene optimum design = strong is made from the robust design cheaply early.

The fourth stage: Simulation
Delivery date shortening and testing expense reduction by CAE

TRIZで日本の製造業を支援する



Innovative Development of Engineering as our Ark

Thank you for listening.