### Development of Koma by TRIZ & TM & simulation

~Challenge to all-Japan manufacturing Koma great war~ The two



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Innovative Development of Engineering as our Ark

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# 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?



### Introduction

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 How do you approach?

The past

Intuition?

Experience?

Idea.

Making for trial purposes single-mindedly?

The first stage: Grasp of system [Function-Attribute analysis][Cause-Consequence analysis] Diversified, multipronged, thorough problem extraction

<u>Second stage: Idea putting out</u> [TRIZ]Extraction of diversified, multipronged, thorough idea with tool

<u>The third stage: Taguchi method</u> It is a robust design and an optimum design. =A strong Koma is made cheaply early.

<u>The fourth stage: Simulation</u> Delivery date shortening and testing expense reduction by CAE

### What is the all-Japan manufacturing Koma great war?

### What is the Koma great war?

It is a rally (bringing together Koma 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 small Koma, 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 Koma wins.

It is defeated besides the ring when going out. Game end at two successive victories The victor can get loser's Koma.

(It is a content total removing of booty till then. )





### Rule of Koma great war: Specification confirmation

Specification of Koma rotation axis.	•The diameter of the Koma is $\phi20$ mm or less in the static condition against the
	• The size is confirmed with the ring gauge of $\phi$ 20.001.
	•Turn only by the finger of one of hands.
Victory or defeat stopping.	It goes out or it is defeated besides the ring when previously
	•Even if the parts other than the tread with the ring move, the tread :.
	It is defeated when stopping.
	If the referee cannot begin playing a game from point that puts the cheer of
"Miatte" within 30 seco	onds. it is assumed that it defeats.
Prohibited matter	•The Koma that keeps turning in the tread in two places or more is prohibited.
	•The Koma into which the rotation axis changes is prohibited.
	•The Koma into which externals size changes by the component replacement is
prohibited.	
•	·It is prohibited to touch the Koma at time other than the game after it accepts.
	·[Tsuka] of supplementary tool that assists and promotes rotation of Koma from
the outside	
	It prohibits it for.
Specification of ring	Made of Chemical $\phi$ 250mm concave R700mm wood



# (1) Making of problem essence

### [Function-Attribute analysis] (Cause-Consequence analysis) Purpose=An efficient Koma is made.

- The input of Koma?
- •The output of Koma (target)?
- ·Component of Koma and those working?
- •The attribute of component?
- $\cdot$ The interaction and the correlation of the function and the attribute.
- •The resource (everything that exists in surrounding)?



Cause-Consequence analysis] (Foundation cause analysis) Purpose=The Koma not defeated (It is possible to win) is made.

Cause of be defeated(1): The cause of stopping earlier than other party?
Cause of be defeated(2): The cause of going out besides ring?

### Grasp of system 1: Function-Attribute analysis

For the technical field without the finding (It is few), The input, the target (output) of the system, and complete parts, elements, functions, attributes, and interactions, etc. are seized by Function-Attribute analysis.



# Grasp of system 1: Function-Attribute analysis Goldfire



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# Grasp of system 2: Cause-Consequence analysi Goldfire

Undesirable result=Lost The causal relation is clarified, and the point aimed at for the problem solving is covered.



### (2)Extraction of design challenge(1): Function-Attribute analysis

#### Problem definition from function model

## **[Definition of problem]** An adverse effect, a lack action, and an excessive action are extracted, and the minimum problem is defined.

The function that the axis slips in the finger removed?

O How does the finger strengthen the rotation of the axis?

③How is the function that the axis raises center of gravity removed?

(4) How is the function that the angle of bank raises center of gravity removed?

 $\textcircled{5}\xspace{-1mu}$  How is the function that the solid of revolution raises center of gravity removed?

6 How is the function that mass improves the frictional drag removed?

⑦How is the function that the wick blur improves the frictional drag removed?⑧How is the function that the wind drag weakens the rotation energy removed?

(9) How is the function that the other party Koma weakens the rotation energy removed?

0How is the function that the frictional drag weakens the rotation energy removed? 0How is the function that the angle rate invents the wind drag removed?

 $\textcircled{0}\ensuremath{\mathbb{D}}$  How is the function that the other party Koma invents the inclination of the axis removed?

 $\textcircled{1}\$  How does the inclination of the axis remove the function that the ring comes in contact?

 $\textcircled{\sc 0}$  How is the function for center of gravity to enlarge the inclination of the axis removed?

 $\textcircled{1}\$  How does the finger strengthen the maintenance of the axis?

#### [Definition of technical contradiction]

It pays attention to the adverse effect, and it looks for technical contradiction from the relation between a component and a useful action that generates it.

 The improvement: To make the axis easy to have, it lengthens it. Deterioration: Center of gravity rises.
 The improvement: To enlarge the moment, the solid of revolution is made heavy. Deterioration: Center of gravity rises.
 The improvement: To enlarge the moment, the solid of revolution is made heavy. Deterioration: The frictional drag grows.
 The improvement: To enlarge the inclination of the axis, the angle of bank is enlarged.

Deterioration: Center of gravity rises.

#### [Definition of physical contradiction]

The physical contradiction of the component with an opposite characteristic is defined by technical contradiction.

It is necessary to shorten it to lower center of gravity though it is necessary to lengthen the axis to make easily to have.

(2)It is necessary to reduce it to lower center of gravity though it is necessary to enlarge the angle of bank to enlarge the inclination of the axis.

③It is necessary to lighten it to lower center of gravity though the solid of revolution should be made heavy to enlarge the moment.
④It is necessary to lighten it to reduce the frictional drag though the solid of revolution should be made heavy to enlarge the moment.



#### Extraction of design challenge2: Cause-Consequence analysis

#### Problem definition from primary cause

### [Specific of primary cause]

The factor that we can control is assumed to be a primary cause among factors that the arrow doesn't enter.

(yellow, in figure blue factor)

#### [Definition of pivotal question]

The problem (contact and make a careless pitch with the other party) not brought up from function-attribute analysis is extracted as a pivotal question to be treated this time among the primary causes. (factor blue in figure)

#### [Make a careless pitch factor]

1)The nose geometry is flat. 2)It strains oneself.

(3) It doesn't have the switch easily (The axis inclines when turning it on).

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# [Contact factor with other party]

①It comes in contact with the other party in outer.

- •The method of no contact with other party?
- •Do to come in contact in places other than outer?
- (2) The frictional drag is caused by contact with the other party.
- •The method of absorbing other party's energy?
- $\cdot$  The method not to cause friction even if coming in contact?
- (3)It is lighter than the other party.
- •The method of no flight even if it is light?
- (4) When coming in contact, a transverse impact is received.
- •The structure to let impact go?

\*Paradoxical, the problem to win is defined.

### [Others]

The method of attacking axis and stability of other party?
 The method of increasing other party's frictional drag?
 The method of inviting the other party pitcher's make a careless pitch?



## (3) Parameter design





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



### Factor effect chart



## (4) Virtual fighting by CAE (SolidWorks Motion)



# (5)TRIZ1 secret (1)

Aluminum

Tungsten

Making to low center of gravity by light material and hollow construction

> Sharp edge processing that eats and takes side with flatfish Laurette and finger that doesn't slip easily

Press-fitting structure to prevent wick blur when assembling it

Contact in the state that the axis falls is a curved surface that the vector acts on center of gravity.

Optimization in inside diameter ratio, height, barycentric position, and material and outside diameter/angle of bank etc. of solid of revolution by parameter design



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Bearing







# TRIZ1 secret ③

The bearing tire (flange part) comes in contact earlier than the lower side of the solid of revolution when the rotation decreases, and the axis inclines with rings. As a result, a rapid decrease in the turning force because of friction with the ring is prevented, and it stands dominant when having a close game.

It absorbs by rotating the flange part even in case of the make a careless pitch with the axis inclined and it recovers.

Solid of revolution Bearing (flange Steel ball type) Ring



### TRIZ1 war record

<u>September 16, 2014</u> <u>Preliminary contest G2 of Chunichi</u> <u>this block</u> <u>The north Nagoya Sumo Tournament</u>

The preliminary contest the first: Win by the complete victory.

The preliminary contest the second: It loses by a narrow margin at the same rate. The world rally doesn't participate.

October 25, 2014 Exhibition match G3 Regional Ueda industrial exhibition place

Wire-to-wire victory without defeat.





# (6)Summary

The first stage: Grasp of system [Function-attribute analysis][Causeconsequence analysis] Diversified, multipronged, thorough problem extraction

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# The challenge to the Koma great war by TRIZ continues.

# May the TRIZ be with you TRIZとともにあらんことを・・・

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# Thank you for listening.