A Novel Joint Structure To Realize Weldingless Pipe Structures

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The Preseident of Takano Co., Ltd.

English translation by Toru Nakagawa (OGU)

This talk will introduce you:

- We, a small-sized company,
- Under which situations we started to think of product development for the first time,
- What sort of product ideas we generated,
- What type of technical tasks we defined,
- How we solved it with TRIZ, and
- How we realized the first products of our own brand.

Outline of the Company

- **Company name: Takano Co., Ltd.**
- **Location: Matsumoto City, Nagano Pref. (Airport Industrial Park)**
- **Capital: 10 Million yen**
- **Number of Employees: 65**
- **Business Activities: Precise sheet metal fabrication and assembly for semiconductor and LCD manufacturing equipments, large-scale printers, electric newsboards, etc.**

Background Situations

- ☆Want to convert ourselves from an entrustor-type to a proposal-type company
- ☆Want to produce something useful for society
- ☆Want to overcome some vague anxiety about the future and to become a company with a vision

Want to realize these hopes by all means

Challenge to the Product Development for the first time

Our Development Processes

1. **Idea generation of various products**
2. **Evaluation of ideas**
3. **Decision making of the ideas**
4. **Patent survey and marketing study**
5. **Clarifying technical tasks**
6. **Solving technical Problems（with TRIZ）**
7. **Desining and manufacturing**
8. **Product evaluation** (3D CAD／CAE, Evaluation at governmental organizations)
9. **Developed products and proposals to customers**

1. Idea Generation of Various Products

Carried out the Idea Generation of various products from different views for a long time.

・An equipment for making mouth-pieces

・An equipment for automatic sack enclosing

・A device for easy snow-removal

....

2. Evaluation of Ideas

Among a large number of free ideas, are there any ideas of products we could make in our company?

・Automatic remover of barrs

・Automatic disassemblying equipment

・Sanding appalatus for sheet metals

・Wilderingless Structures

Let's select apparently most difficult one, ...

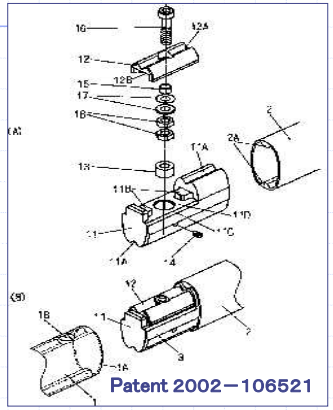
if we have to strugle with anyway.

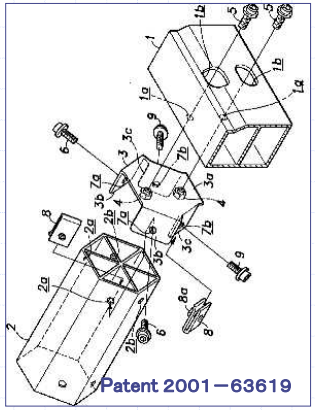
Wildered structure of SUS pipes

3. Decision Making of the Ideas

Development of Wilderingless Structures

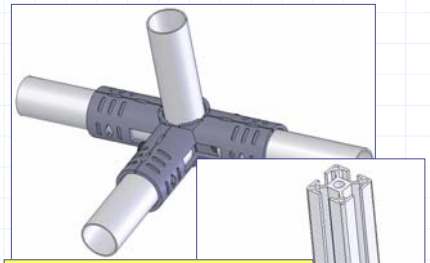
4a. Patent Survey





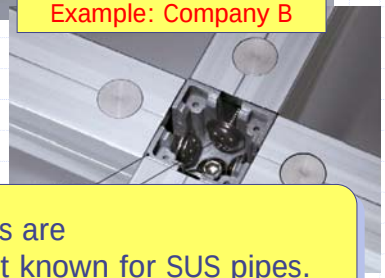
No patents yet of Wilderingless Structures which are simple, strong, and applicable to SUS pipes.

4b. Marketing Study



Example: Company A

Example: Company B



Wilderingless pipe-frame structures are known for aluminum pipes, but not known for SUS pipes.

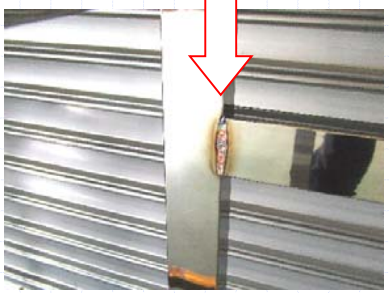
5a. State of the Art and Technical Difficulties

◆State of the Art

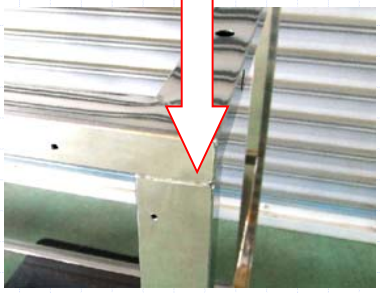
- Cuttig square-shaped pipes（vertically）
- Welderig
- Surface finishing (Buffing)

Weldering is regulated by
★Laws（Measures for preventing dust deseases)
★Green procurement （for reducing CO_2）
for ecological reasons.

Weldering



Finishing（Buffing）



5b. Clarifying Technical Problems and The Targets of Develeopment

◆Targets of Development

① Technical skill is unnecessary.
② Special Tools are unncessary
③ Finishing (buffing) process is unnecessary
④ Easy to assemble
⑤ Resulting high precision (in twisting, etc.)
⑥ Transport and assemble on the site
⑦ Easy to disassemble, and good for re-use

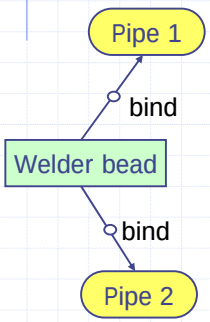
Realization of Wilderingless Strucure

6. Solving Technical Problems with TRIZ

6a. Function & Attribute Analysis (Su-Field Model)

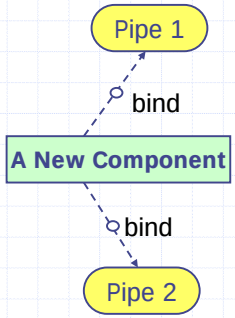
Two Basic Patterns of Wilderingless Structures

Present system with welderling

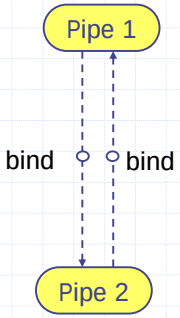


New welderingless systems

① With a new component (a joint)



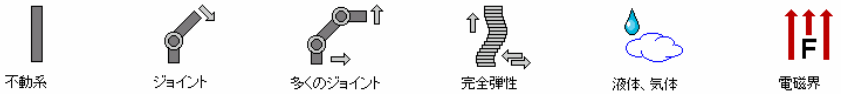
② Without a joint



6b. Idea Generation using Trends of Evolution

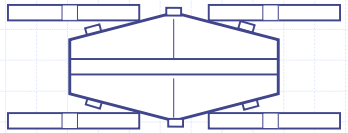
Idea ① of 'A New Component'

Trend of 'Dynamization' was applied to the New Component

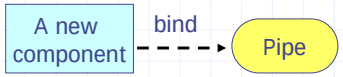


Idea ①: Press-Formed Joint Structure

- Insert a metal plate with elastic property
- Tapered
- Having a bump stopper
- Use adhesives for further fixing
- A round pipe inserted along the pipe direction for increasing the strength



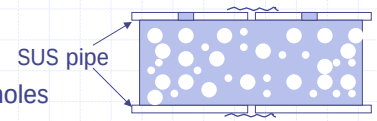
Idea ② of 'A New Component'



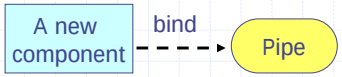
Trend of 'Segmentation of Substances and Objects' was applied to the New Component

Idea ②: Foaming Material Structure

- Foaming polyurethane rubber inside, on the site
- For preventing from slipping off, set holes (or bents) on the pipe beforehand



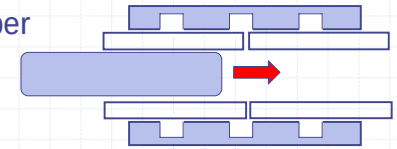
Idea ③ of 'A New Component'



Trend of 'Introduction of New Substance' was applied to the New Component

Idea ③: Polyurethane Rubber Structure

- Outer joint structure



6b. Idea Generation using Trends of Evolution (Continued)

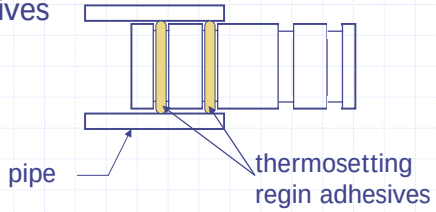
Idea ④ of 'A New Component'

A new component — bind → Pipe

Trend of 'Introduction of New Substance' was applied to the New Component

Idea ④: Thermosetting adhesives Structure

- The adhesives held at the dips of the joint insert are thermoset after fixing.



6b. Idea Generation using Trends of Evolution (Continued)

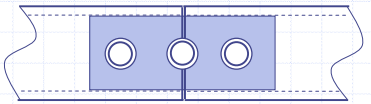
Idea ⑤ of 'A New Component'

A new component — bind → Pipe

Trend of 'Introduction of New Substance' was applied to the New Component

Idea ⑤: Caulking Joint Structure

- Minimize (the outer look of) the joint parts (round shaped)
- Insert-forming of SUS pins



6b. Idea Generation using Trends of Evolution (Continued)

Idea ⑥ of 'Structure without Joint'

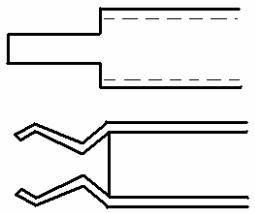
square pipe 1 — bind → pipe 2

Trend of 'Segmentation of Surface' was applied to the square pipe

Idea ⑥: Elastic Pipe-end Structure

- The end parts of the pipes are formed in an elastic structure

cf. Support of a caster wheel



6c. Preliminary Evaluaton of Generated Ideas

Table of Comparisons of Ideas

Ideas		Easy to assem-ble	Clean-ness	Reli-ability	Easy to fabri-cation	Cost		Difficul-ty of reali-zation	Over-all Points
						Ini-tial	Run-ning		
①	Press-formed joint structure	○	○	△	△	×	○	○	12
②	Foaming material structure	○	△	△	○	○	○	△	15
③	Polyurethane rubber structure	△	△	△	△	△	○	○	11
④	Thermosetting adhesives struct.	○	△	○	△	△	○	○	15
⑤	Caulking joint structure	○	○	○	△	△	○	○	17
⑥	Elastic pipe-end structure	○	○	△	×	△	○	△	10

Points: ○: Good (+3) △: so-so (+1) ×: No good (-2)

6c. Preliminary Evaluaton of Generated Ideas (Continued)

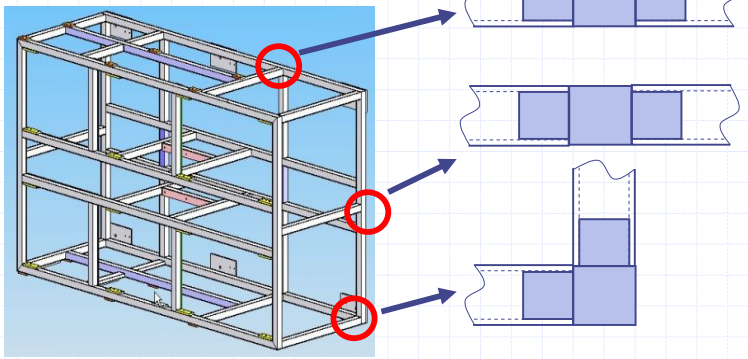
Results of Preliminary Evaluation of Ideas

Priority	Idea No.	Name of the Idea
1	⑤	Caulking joint structure
2	④	Thermosetting adhesives structure
3	②	Foaming material structure
4	①	Press-formed joint structure
5	③	Polyurethane rubber structure
6	⑥	Elastic pipe-end structure

6d. Further Problems in the Selected Idea

Problems in the Idea of Caulking Joint Structure

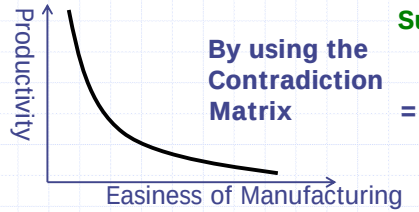
Several different forms of joints are necessary for different types of corners and extensions in the frame structures.



6e. Solving Further Problems in the Selected Idea

Solve a Contradiction with TRIZ

Define an Engineering Contradiction



By using the Contradiction Matrix ==>

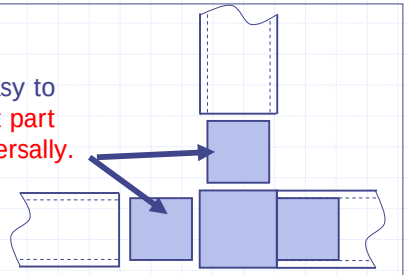
Suggested Inventive Principles:

- Parameter Change Principle
- Segmentation Principle
- Prior Action Principle
- Mechanics Substitution Pr.

Segmentation Principle

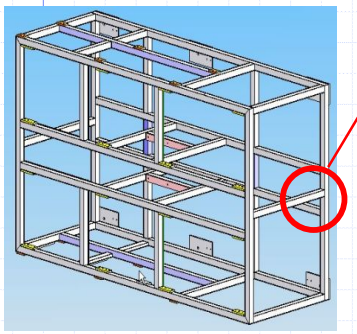
Make an Object into segments and easy to disassemble. → Segment the joint part into components which are used universally.

Birth of the Concept of 'Dice Joint Structure'!



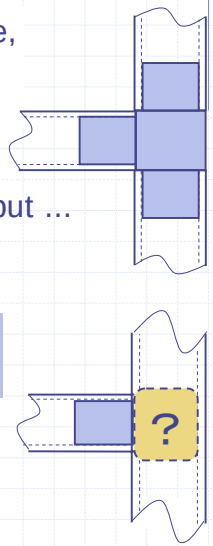
6f. Yet Another Problem to Solve

If we use the Dice Jint Structure everywhere, the number of parts increases to an undesirable degree.



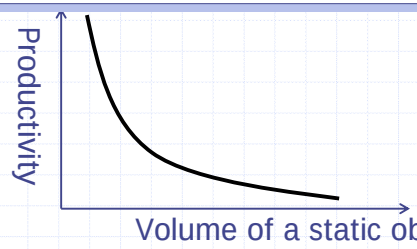
Usable at this place, but ...

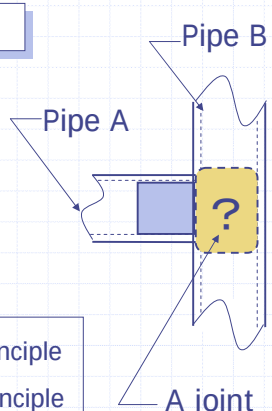
We need another method of jointing



6f. Solving the New Problem

Define an Engineering Contradiction





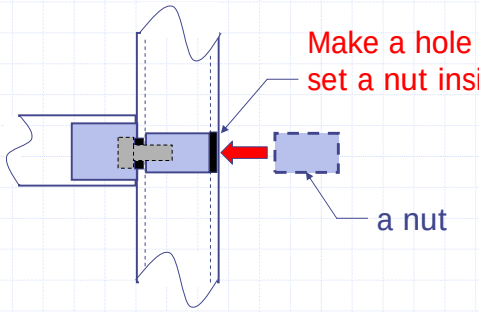
The Contradiction Matrix suggests:

- Parameter Change Principle
- Thermal Expansion Principle
- Prior Action Principle
- Taking Apart Principle

6f. Solving the New Problem (Continued)

Prior Action Principle

Introduce a useful change (either fully or partially) into an object before it is needed.



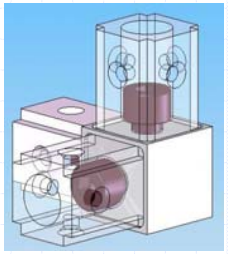
Birth of the Concept of TAKA-nut (or High Nut) !

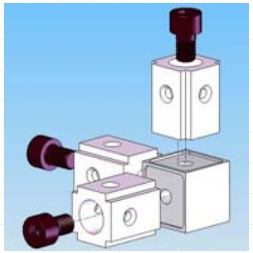
7. Designing and Manufacturing

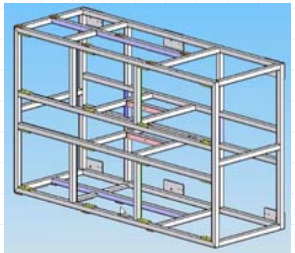
8. Product Evaluation

Full Use of 3D CAD

- Overseas outsourcing with 3D CAD data
- Evaluation of product strength with 3D CAE
- Materials for Proposals to Customers

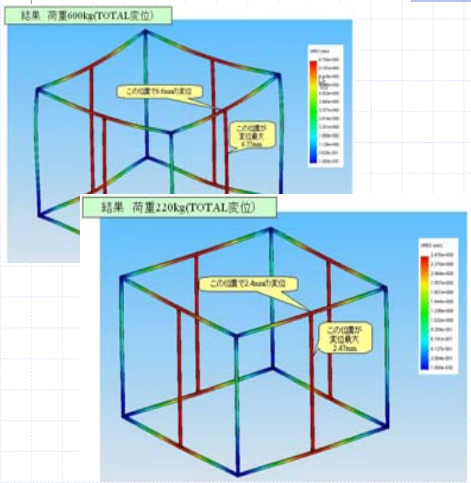




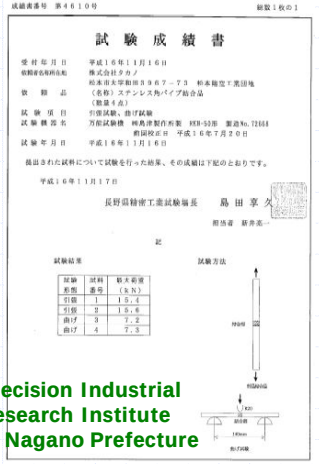


8. Product Evaluation

Evaluation with CAE



Real Testing at Governmental Organization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Precision Industrial Research Institute of Nagano Prefecture

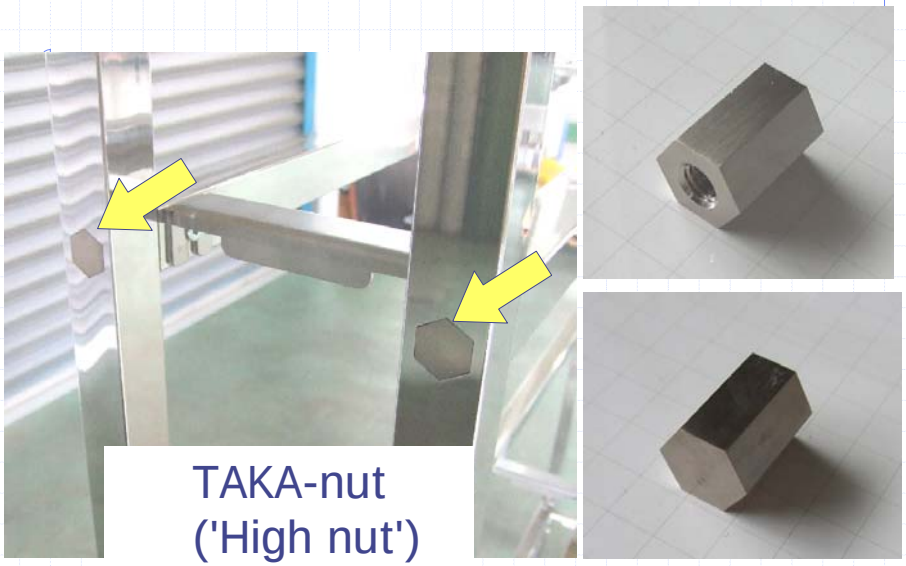
9. Developed Products and Proposals to Customers

9a. Products Developed:

TAKANO Dice Joints

Japan Patent Disclosed 2006-153266

9a. Products Developed (Continued)



TAKA-nut
('High nut')

9b. Proposals to Customers

Advantages of Our Products Especially for Ecology

- Our products are fabricated without welding, which means elimination of CO_2 disposal during the conventional welding process in buiding the SUS pipe frameworks.
- Our SUS pipe frameworks can be assembled on your site, reducing the needs of transportation and thus CO_2 disposal.
- Our SUS pipe frameworks can be disassembled and reused many times by virtue of the bolt jointing.

Best fit for Industries of Semiconductors, Food, and many others

"Ricoh requests reduction of CO_2 to parts suppliers"

Nikkei (Feb. 3, 2006)

9c. Merits of the Products Developed

Innovation in QCD

Quality: ⇒ No need of weldering and buffing,
Higer precision

in comparison with conventional weldering strctures

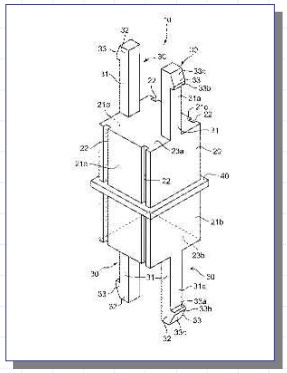
Cost: ⇒ Reduced the product cost by 30 to 50%,
Possible to mass production.

Delivery: ⇒ Reduced by over 80%

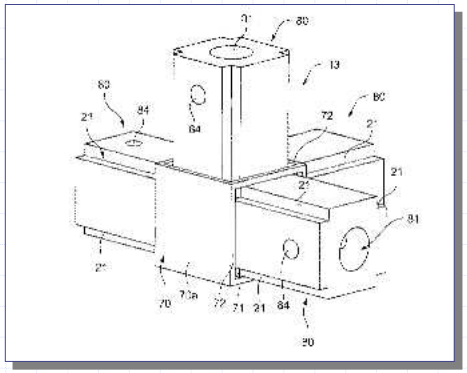
Laser Pipe Cutter equipped in TAKANO
(second installment in Japan)

9d. Patents Registered

We have filed 5 patents
of the ideas generated with the use of TRIZ.



Japan Patent Disclosed
2005-291242



Japan Patent Disclosed
2006-153266

9e. Current Status of Business

- Some companies join us for developing with business cooperation.
- A big semiconductor manufacturer decided to use our products
- A grant was given from Governmental organization for the support of the R&D funding

9f. Future

Overcoming R&D issues related to the strength and to applicability to complex forms, etc.,

we are going to sell our new products to the industries with much respect to ecology and cleanness.

10. Conclusion

- **TRIZ has supported us to solve dificult technical problems.**
- **The Product Development Process with the full use of TRIZ, shown in this presentation, is expected to be much useful for SMEs to try to convert themselves into product-development companies.**

Thank you very much for your attention!

Minoru Yokouchi

Sheet Metal TAKANO