Study on enhancement of the mobility for new product development in SMEs

Yoshida, M.[1], Sasakawa, T.[1], Matumoto, K.[1] and Murata, K.[2]

[1] Matsumoto Machine Co., Ltd., Japan
[2] Nihon University, Japan

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1. Introduction

Abstract:

In most SMEs in Japan, they have polished their core technologies and delivered new values to a society through the collaboration with members of their supply network of the world. This study discusses small and medium manufactures (SMMs) which are concerned in a social infrastructure construction. In particularly, Matsumoto Machine Corporation is focused as one case company of the object field. They have manufactured machine tool accessories and supplied the products to their customers who contribute to a construction of social infrastructures. This paper consists of two portions:

1) Investigation of transfer processes among main five outputs such as a) customer needs, b) KPI for customer needs, c) specification of products, d) design data and e) product in NPD.

2) Analysis of steps of focused transfer process from b) second output to c) third output through three cases studies.

As the result of this paper, the proper use of systematic approach and experience driven approach is realized to keep a mobility of NPD in the SMM company.

Keywords: Management of technology (MOT), New product development (NPD), Small and medium enterprises (SMEs) and Japanese perspective.

2. Profile of Our Company

- Name: Matsumoto Machine Co., Ltd.
- Location: Kanazawa, Japan
- Established: 1948
- Employees: 87
- Business Areas: Manufacture and sale of machine tool accessories
- Main Products: Chucking systems, NC rotary tables etc.
- Customer: Machine tool makers, Electronics, Heavy machine, Automobile etc.
- Global Network:
  Tokyo, Osaka, Nagoya, Tohoku, USA, France and other dealers.
- Business Partners:
  ATLING (Sweden)
  OTT (Germany)
  NORTHFIELD (USA)
  SMP TECHNIK (France)

3. Applied Procedure

A Change of key outputs in NPD process

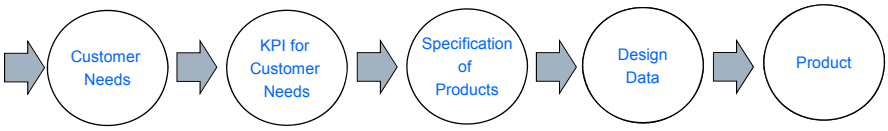


Fig 1. Deployment process from customer needs to product in MMK

Customer Needs

- Experience and intuition of president/experts by information gathering based on a lot of legwork
- Sources to dig customer needs [1][5]
  - Recent trend: Society trend, Business trend, Product trend etc.
  - Exhibition: International/Domestic exhibition, Exhibition in our factory
  - Utilization of our products in our factory
  - Maintenance activity of our products' complaints in customer's factory
  - Course/study meeting of our products by public organization
  - Opportunity of expansion into new industrial sector

KPI for Customer Needs

- Two viewpoints to deploy from customer needs to KPI
  - Processed product
  - Processing performance & environment
- What is a latent KPI?
  - from new customer needs
  - from exciting KPI
- What KPI should be improved?

Specification of Products

- Is existing product enough to match new customer needs?
- What specification item of existing product is related to improved KPI?
- What is latent specification item of existing product?
- What specification item of existing product should be improved?

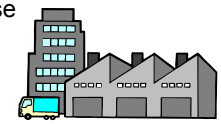
3. Applied Procedure

Design Data

- What existing product is reformed to match new requirement?
- From design by 2D-CAD to 3D-CAD
- Design for Manufacturability/Assemblability
- Is designed data enough to satisfy specifications of product?

Product

- Is new product enough to match new customer needs finally?
- Management concept: “advanced experts management”
- Kaizen activity by all employees based on one of Japanese MOT styles (human-oriented approach)[3]



4. Analysis of transfer process from needs to seeds

Focused Transfer Process

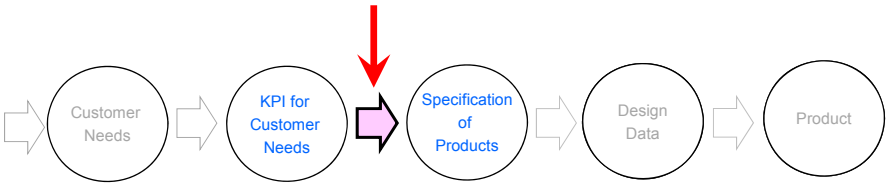


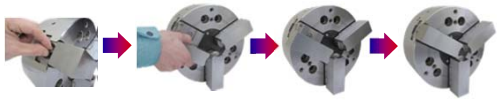
Fig 2. Focused transfer process in utilized deployment process

Analysis of Focused Transfer Process

＜Case Outline＞

Case 1: Electric Chuck for Turning Machine

Case 2: Quick Jaw Exchange Chuck



Case 3: All in One NC Rotary Table

＜Analysis method of object process＞

Table 3. A matrix for analyzing the transfer process from needs to seeds

Need side

Seed side: Product Specification \ Need side: Customer Needs	KPI 1	…	KPI j	…	KPI m
Item 1					
…					
Item i	Area for evaluating relationship between needs and seeds				
…					
Item n					

- You can express each process by 2-dimentional matrix.
- It is simple form but analyzed process is complexity.
- Complexity of analyzed process will be revealed through the analysis by the table [2][4].

Case 1: Electric Chuck for Turning Machine

- Step 1.1 – Adding to new KPI followed by the needs of the times

Table 4. A matrix for analyzing the transfer process from needs to seeds of an electric chuck development (Step 1.1)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time	Accuracy	Continuity	Eco
Component	Wight (kg)						
	Chuck Diameter (inch)						
	Jaw Diameter (mm)						
	Jaw Stroke (mm)						
	Number of Jaws (piece)						
	Chucking Mechanism						
Mechanical Capacity	Speed (rpm)						
	Gripping Force (KN)						
	Draw-pull (Thrust) (KN)						
Product Capacity	Good Valance						

Case 1: Electric Chuck for Turning Machine

- Step 1.2 – Considering new product specification item related to new KPI

Table 5. A matrix for analyzing the transfer process from needs to seeds of an electric chuck development (Step 1.2)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time	Accuracy	Continuity	Eco
Component	Wight (kg)						
	Chuck Diameter (inch)						
	Jaw Diameter (mm)						
	Jaw Stroke (mm)						
	Number of Jaws (piece)						
	Chucking Mechanism						
Mechanical Capacity	Speed (rpm)						
	Gripping Force (KN)						
	Draw-pull (Thrust) (KN)						
Product Capacity	Good Valance						
	Total Energy (W)						✔

✔・・・A relationship between a customer need and a product specification exist.

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4. Analysis of transfer process from needs to seeds

Case 1: Electric Chuck for Turning Machine

- Step 1.3 – Deploying to concrete element of product specification

Table 6. A matrix for analyzing the transfer process from needs to seeds of an electric chuck development (Step 1.3)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time	Accuracy	Continuity	Eco
Component	Wight (kg)						
	Chuck Diameter (inch)						
	Jaw Diameter (mm)						
	Jaw Stroke (mm)						
	Number of Jaws (piece)						
	Chucking Mechanism						
Mechanical Capacity	Speed (rpm)						
	Gripping Force (KN)						
	Draw-pull (Thrust) (KN)						
Product Capacity	Good Valance						
	Total Energy (W)						✔

✔・・・A relationship between a customer need and a product specification exist.

Case 1: Electric Chuck for Turning Machine

- Step 1.3 – Deploying to concrete element of product specification

Table 7. A matrix for analyzing the transfer process from needs to seeds of an electric chuck development (Step 1.3)

Mechanical Capacity \ Product Capacity		Total Energy (W)
Speed (rpm)		✔
Gripping Force (KN)	Gripping Force per One Chucking	✔
	Just in Gripping	
Draw-pull (Thrust) (KN)		✔

✔・・・A relationship between a product capacity and a mechanical capacity exist.

Component \ Mechanical Capacity	Gripping Force (KN)	
	Gripping Force per One Chucking	Just in Gripping (Product Variety)
Wight (kg)		
Chuck Diameter (inch)		
Jaw Diameter (mm)	✔	
Jaw Stroke (mm)		✔
Number of Jaws (piece)	✔	✔
Chucking Mechanism	✔	✔

✔・・・A relationship between a mechanical capacity and a component exist.

- At first sight, a decline in product capacity bring to a decline in mechanical capacity.
- Gripping force is focused because it is recognized as a main capacity for providing added value by the product.
- It is divided into sub items.

- Chucking Mechanism is focused as viewpoint of an idea generation.

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4. Analysis of transfer process from needs to seeds

Case 1: Electric Chuck for Turning Machine

- Step 1.4 – Generating ideas of component level to satisfy superior levels

Table 8. A matrix for analyzing the transfer process from needs to seeds of an electric chuck development (Step 1.4)

Component (Chucking Mechanism) \ Product & Mechanical Capacity		Total Energy (W)	Gripping Force (KN)	
			Gripping Force when Stopped Power Source	Just in Gripping (Variety of Work pieces)
Structure	Energy Source			
Wedge*1	Oil Pressure*1	Reference Value	↘	△
	Air Pressure	↘		△
	Electric Power*2			○
Cam Lever	Oil Pressure	→	↘	△
	Air Pressure	↘		△
	Electric Power*2			○
Scroll	Oil Pressure	↓	→	△
	Air Pressure			△
	Electric Power*2			○

Accept !

*1 Reference Value：Wedge + Oil Pressure (Standard Use)
*2 A electric power is one new idea for energy source of chucking.

Case 1: Electric Chuck for Turning Machine

- Summary

  - Starting point of the case is an addition of new KPI.
  - A latent specification item is dug by added KPI.
  - An existing specification item is fractionalized.
  - A consideration of a product capacity, a mechanical capacity and a component is performed by systematic procedure.
  - Subordinate specification item is considered to satisfy superior specification items.

Case 2: Quick Jaw Exchange Chuck

- Step 2.1 – Determining focused KPI in existing KPIs

Table 9. A matrix for analyzing the transfer process from needs to seeds of an quick jaw exchange chuck development (Step 2.1)

Product Specification \ Customer Needs		Processed Product		Processing Performance		
		Wight	Shape	Time	Accuracy	Continuity
Component	Wight (kg)					
	Chuck Diameter (inch)					
	Jaw Diameter (mm)					
	Jaw Stroke (mm)					
	Number of Jaws (piece)					
	Chucking Mechanism					
Mechanical Capacity	Speed (rpm)					
	Gripping Force (KN)					
	Draw-pull (Thrust) (KN)					
Product Capacity	Good Valance					

Case 2: Quick Jaw Exchange Chuck

- Step 2.2 – Disassembling focused KPI

Table 10. A matrix for analyzing the transfer process from needs to seeds of an quick jaw exchange chuck development (Step 2.2)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time		Accuracy	Continuity
				Processing Time	Exchange time		
Component	Wight (kg)						
	Chuck Diameter (inch)						
	Jaw Diameter (mm)						
	Jaw Stroke (mm)						
	Number of Jaws (piece)						
	Chucking Mechanism						
Mechanical Capacity	Speed (rpm)						
	Gripping Force (KN)						
	Draw-pull (Thrust) (KN)						
Product Capacity	Good Valance						

Case 2: Quick Jaw Exchange Chuck

- Step 2.3 – Considering new product specification item related to new KPI

Table 11. A matrix for analyzing the transfer process from needs to seeds of an quick jaw exchange chuck development (Step 2.3)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time		Accuracy	Continuity
				Processing Time	Exchange time		
Component	Wight (kg)						
	Chuck Diameter (inch)						
	Jaw Diameter (mm)						
	Jaw Stroke (mm)						
	Number of Jaws (piece)						
	Chuck-Jaw Exchange Mechanism				✔		
Mechanical Capacity	Speed (rpm)						
	Gripping Force (KN)						
	Draw-pull (Thrust) (KN)						
Product Capacity	Good Valance						
	Chuck-Jaw Exchange Time (min)				✔		

✔・・・A relationship between a customer need and a product specification exist.

Case 2: Quick Jaw Exchange Chuck

- Step 2.4 – Deploying to concrete element of product specification

Table 12. A matrix for analyzing the transfer process from needs to seeds of an quick jaw exchange chuck development (Step 2.4)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time: Processing Time	Time: Exchange time	Accuracy	Continuity
Component	Wight (kg)						
	Chuck Diameter (inch)						
	Jaw Diameter (mm)						
	Jaw Stroke (mm)						
	Number of Jaws (piece)						
	Chucking Mechanism						
	Chuck-Jaw Exchange Mechanism				✔		
Mechanical Capacity	Speed (rpm)						
	Gripping Force (KN)						
	Draw-pull (Thrust) (KN)						
Product Capacity	Good Valance						
	Chuck-Jaw Exchange Time (min)				✔		

✔···A relationship between a customer need and a product specification exist.

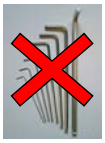
Case 2: Quick Jaw Exchange Chuck

- Step 2.5 – Generating ideas of component level to satisfy superior level

Table 13. A matrix for analyzing the transfer process from needs to seeds of an quick jaw exchange chuck development (Step 2.5)

Component (Chuck-Jaw Exchange Mechanism) \ Product Capacity	Chuck-Jaw Exchange Time (min)
Tool Utilization (Conventional method)	→
Non-tool Utilization	↘

Accept !



Case 2: Quick Jaw Exchange Chuck

- Summary

  - Starting point of the case is an analysis of an existing KPI.
  - Non main stream of a specification item is developed.

    Product Capacity ⇒ Chuck-Jaw Exchange Time (A latent specification item)

    Component ⇒ Chuck Exchange-Jaw Mechanism (A latent specification item)
  - A skip of a mechanical capacity including only main stream item.

Case 3: All in One NC Rotary Table

- Step 3.1 – Adding to new KPI followed by customer voice
- Step 3.2 – Considering product specification item related to new KPI

Table 14. A matrix for analyzing the transfer process from needs to seeds of an all in one NC rotary table development (Step 3.1,2)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time	Accuracy	Rigidity	Machine Space
Component	Table Diameter (mm)						
	Vertical Center Height (mm)						
	Horizontal Center Height (mm)						
	Thickness of Body (mm)						✔
	Weight (kg)						
Mechanical Capacity	Speed (rpm)						
	Gear Ratio						
	Clamping Torque (N-m)						
	Clamping Accuracy (Mpa)						
Product Capacity	Permissible Load (kg)						
	Indexing Accuracy (sec.)						
	Repeatability (sec.)						

✔···A relationship between a customer need and a product specification exist.

Case 3: All in One NC Rotary Table

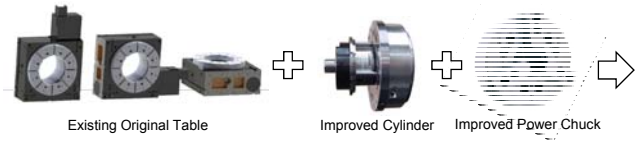
- Step 3.3 – Generating ideas of component level to satisfy customer needs

The way to tackle with a space reduction

⇩

Combination among our original table and other improved existing products such as power chuck and cylinder

Other our company products



Existing Original Table　Improved Cylinder　Improved Power Chuck

New developed table

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4. Analysis of transfer process from needs to seeds

Case 3: All in One NC Rotary Table

- Step 3.3 – Generating ideas of component level to satisfy customer needs

Table 15. A matrix for analyzing the transfer process from needs to seeds of an all in one NC rotary table development (Step 3.3)

Product Specification \ Customer Needs		Processed Product		Processing Performance			
		Wight	Shape	Time	Accu racy	Rigid ity	Machine Space
Component	Table Diameter (mm)						
	Vertical Center Height (mm)						
	Horizontal Center Height (mm)						
	Thickness of Body (mm)						✔
	Weight (kg)						
Mechanical Capacity	Speed (rpm)						
	Gear Ratio						
	Clamping Torque (N-m)						
	Clamping Accuracy (Mpa)						
	Gripping Force (KN)						⇦ A item of chuck
	Pressure for Cylinder (Mpa)						⇦ A item of cylinder
Product Capacity	Permissible Load (kg)						
	Indexing Accuracy (sec.)						
	Repeatability (sec.)						

✔･･･A relationship between a customer need and a product specification exist.

Case 3: All in One NC Rotary Table

- Summary

- Starting point of the case is an addition of new KPI.
- Consideration of superior specification categories skip.
- A part of Idea is supplied from interviews of customers.
- Only Table-Chuck-Cylinder maker able to come true the idea.

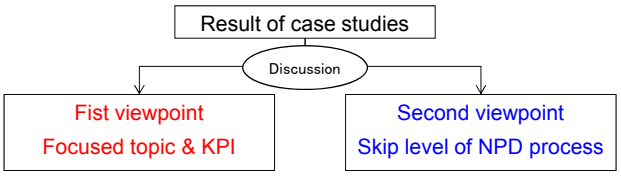

Fig 4. Viewpoint of discussion

First viewpoint: Target topic & Focused KPI

Table 16. A classification of focused KPI

Focused KPI / Target topic	Exciting KPI	New KPI	
		Disassembled KPI	Unprecedented KPI
Main topic	Conventional object	-	Case 1 (Eco)
Annexed topic	Case 3 (Machine Space)	Case 2 (Exchange Time)	-

Second viewpoint: Skip level in NPD process

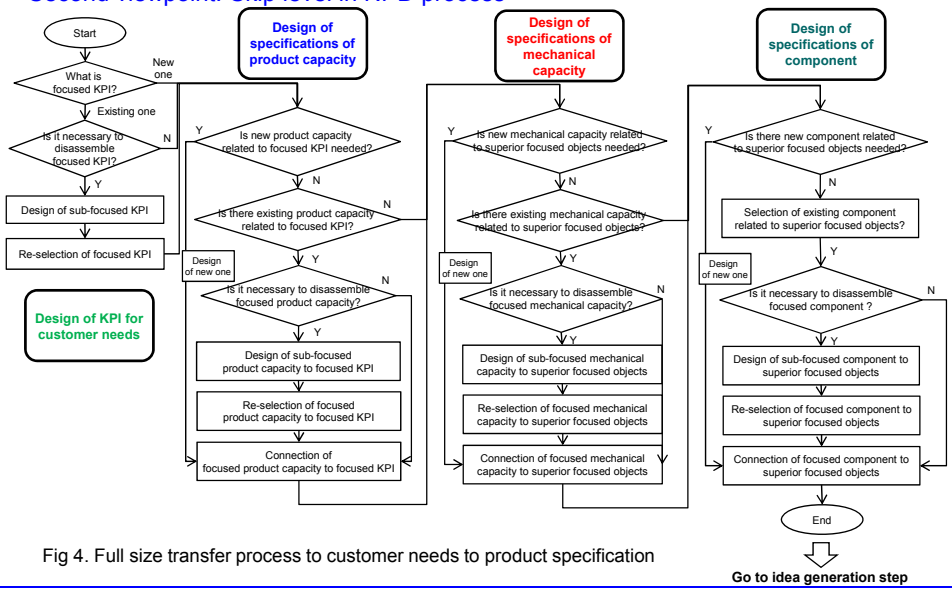

Fig 4. Full size transfer process to customer needs to product specification

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5. Discussion

Second viewpoint: Skip level in NPD process

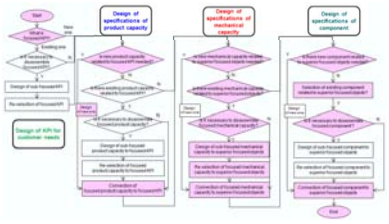

Fig 5. Result of Analysis of Case 1
(Full step)

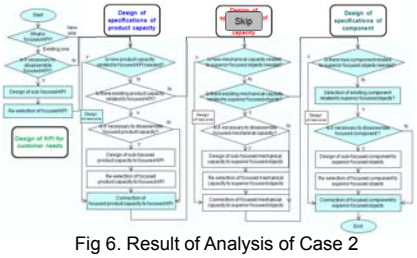

Fig 6. Result of Analysis of Case 2
(Skip one step)

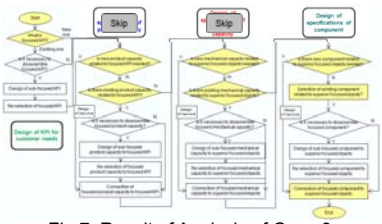

Fig 7. Result of Analysis of Case 3
(Skip two step)

- Stating point of transfer process is a design of KPI for customer needs.
- It is not necessary to pass all steps and to consider KPI and specification item .
- Both analytical approach (existing item) and/or inductive approach (new item) exist.

One factor for guaranteeing mobility of SME's NPD

6. Conclusion Remarks

Results

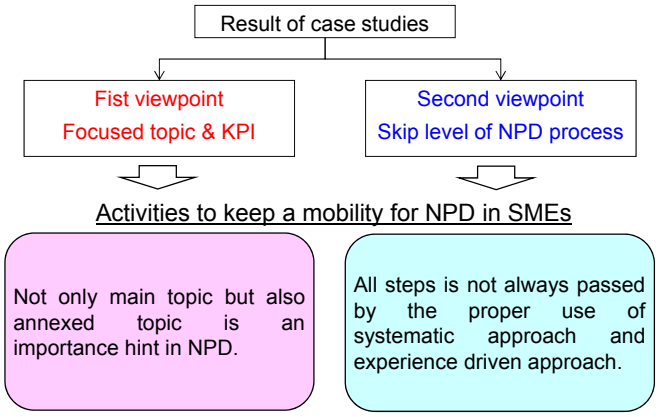

Fig 8. Result of discussion

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