

THE USE OF DEPENDENCE STRUCTURE MATRIX AND SU-FIELD OF TRIZ IN SIMPLIFYING THE COMPLEX PRODUCTS

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ABSTRACT

The purpose of this paper is to introduce a Dependence Structure Matrix and Su-Field of TRIZ that enables the complex structure simplify in project. The characteristics of the complex products performance in DSM is that it exists in the cross situation of the two blocks after reordering rows and columns. The Su-Field model which is made by flow arrow contains useful and harmful effect about all of the blocks after partitioning. Then, the 76 standard solutions in TRIZ are involved in to improve the complex system.

Keywords: Dependence Structure Matrix, Su-Field model, 76 standard solutions

1 INTRODUCTION

It is a complicated process for product design and development in mechanical engineering industry with the changing needs of customers, especially in performance between various components which cooperate and influence with each other. The Dependence Structure Matrix (DSM) (Browning, 2001; Danilovic and Sandkull, 2005) is an approach to managing complexity that provides a simple, compact, and visual representation of system connectivity. The characteristics of the complex products performance in DSM is iterative loops in the blocks.

Although, the advantage of DSM is that clearly express complex system by taking focus on interdependencies and information flow within different components, and there are tools of manipulation to for partitioning (David and Steven, 1991; Daniel and Frederick, 2004), which is the reordering of rows and columns to eliminate or reduce the number of feedback relationships above the diagonal. After partitioning and banding, the most pleasure state is that two blocks do not depend on each other. While, it is a common phenomenon that there will be existing cross situation in the adjacent two blocks rearrange rows and columns. And this case is called complex product in this paper. For this problem, it still has no specific solution. Especially, the pursuit of designer is that the structure of the products is comprised of multiple independent modules.

Su-Field model (Tan, 2003) of TRIZ describes an actual system by two substances and one field. The function relation between the cross blocks which have been partitioning and banding can be presented by Su-Field model. 76 standard solutions of TRIZ based on Su-Field model can give Su-Field model a direction according its large number of examples and analogies.

Therefore, in this paper, it is focus on the cross blocks after rearranging rows and columns for actual system, and Su-Field model is involved in analyzing this problem, according to 76 standard solutions.

2 ABOUT DSM AND SU-FIELD MODEL

DSM is widely used in mechanical engineering industry. Numerous researchers take their work based on DSM in modelling design processes in order to understand iteration and reduce rework by changing the order in rows and columns .

2.1 About DSM

To help people understand the complexity of system and process, the DSM use matrix to record system level knowledge, and help lack of experience people to get more information quickly. DSM uses the information flow to guide the decomposition of the design activity by mapping the relations between tasks in a precise order which makes interdependence explicit. The characteristic and superiority of DSM is block, which is rearranging rows and columns to model and band. However, the situation that there are two obvious comparisons should be focus on (as Figure 1). In figure 1, a presents that the two blocks are independent each other, which is engineers' hope, and b describes that the two blocks have cross and repeated area.

For a, the two blocks are modelling. When design and modification, the impact of each other is small, even almost have no effect. And this case is the maximum advantage utilizing DSM. While for b, the two blocks are crossed and this case is called complexity. Sometimes, decisions have to be made expediently in order to minimize the potential of delaying the start of the small block. This is difficult because design should according to the actual situation and not be literally separation. Therefore, a precise and feasible method is necessary and critical.

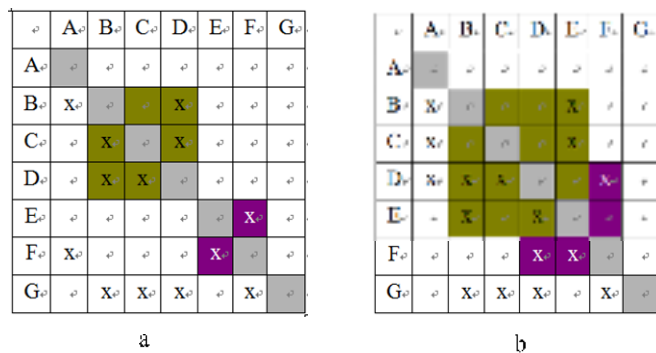


Figure 1. Two kinds of results

2.2 Su-Field Model

Su-Field Analysis is a TRIZ analytical tool for modeling problems related to existing technological systems. The desired function is the output from an object or substance (S1), caused by another object (S2) with the help of types of energy. Some symbol system are introduced in Figure 2.

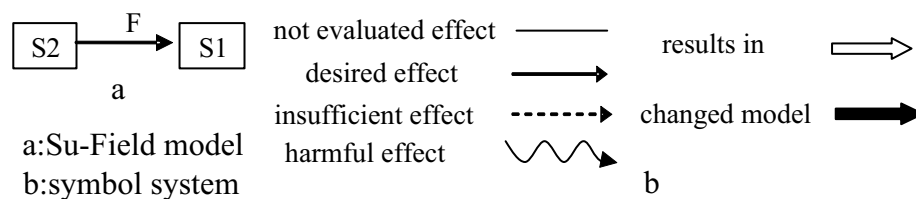


Figure 2. Su-Field model

3 DSM BASED ON SU-FIELD MODEL

The matrix associated with the example presented above is shown in Figure 3(a). According to the basic building blocks above and the information flow, the relation model about all the blocks can be described in Figure 3(b). According to actual engineering, the relation model can be added into energy field. It is obliged to explain that there may be more than two blocks and the function relations between blocks have some hypothesis which can be used different description symbolic: not evaluated effect, desired effect, insufficient effect, harmful effect, results in and changed model.

76 standard solutions can be used as problems template for improvement or testing or simplified the

system. When the DSM based on Su-Field model has been built, it should choose appropriate standard solution in accordance with the desired effect, insufficient effect or harmful effect. In this several relationships, 76 standard solutions have different classification and distinct solutions. Compared with only using DSM, the competitive advantage is that there are a large number of categories examples for designers to reference and contrast. In this way, not only can save a lot of time, but make the generous in thought.

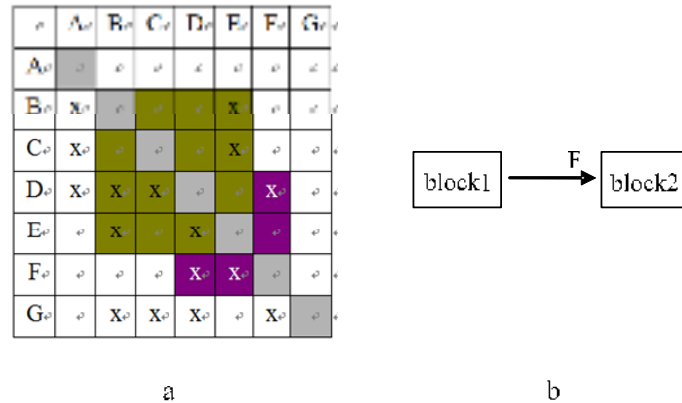


Figure 3. DSM based on Su-Field mode

4 FLOWCHART ABOVE

At the beginning, it has been emphasized that for actual system, it is relatively easy to describe the relationship of the parts, compared to concept design, using DSM. For actual system, the structure and problem concretely exist, so it does not need to spend a lot of time to decide relationship of the parts, especially for complex systems. After rearranging rows and columns in DSM, if there is a repeated area between the two nearby blocks, the Su-Field is introduced. It should choose the appropriate standard solution in accordance with the desired effect, insufficient effect or harmful effect, before making use of 76 standard solutions.

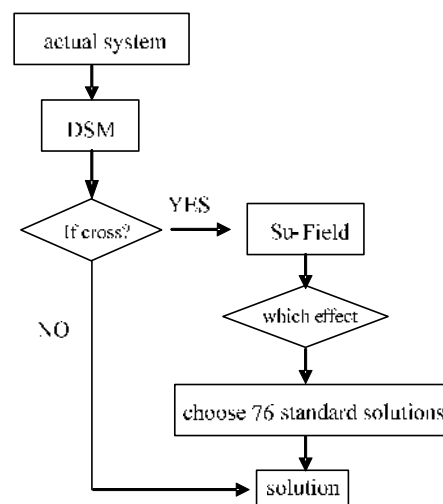


Figure 4. Flowchart about the process

5 CASE STUDY

JYS - Z electric brush type filter used in the process of industrial wastewater treatment, steel cinder

water, power plant process and cooling water, paper processes, chemical production process and irrigation systems, to filter the hard particle from 3,500 to 130 microns diameter in water to ensure the security and reliable operation of the system. As shown in figure 4, raw water run into the filter body, through the coarse mesh and the fine mesh, and then go through centrifugal axis to decompose wastewater water and clear water. At last, by filter remove impurities.

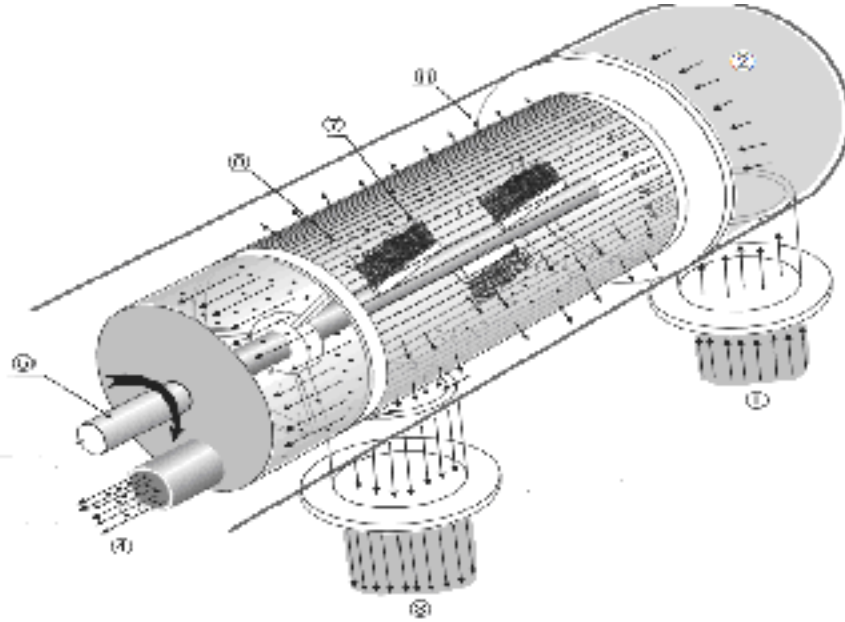


Figure 5. Working principle diagram of brush type filter

Problems analysis in actual system: This filter in actual work may be wear easily in steel wire brush, and after wearing it is not easily to brush impurity particles in fine mesh.

DSM to be used. Structure matrix of the electric brush type filter would be as follows:

Table 1: final partitioned matrix

		1	2	3	4	5	6	7	8	9
Feed water system	1		x							
Level 1 filter (coarse mesh)	2	x								
Level 1 separation (axis)	3				x			x		
Level 2 separation (electric brush)	4		x				x			
Level 2 filter (fine mesh)	5							x		
Wastewater recycling	6			x	x					
Water recycling	7			x	x	x			x	
Quality detection	8							x		
Maintenance	9		x	x	x	x				

Su-Field to be involved in. Add hypothesis F and D in the environment. The above matrix, from left to right is A, B, and C block (as Figure 6a).

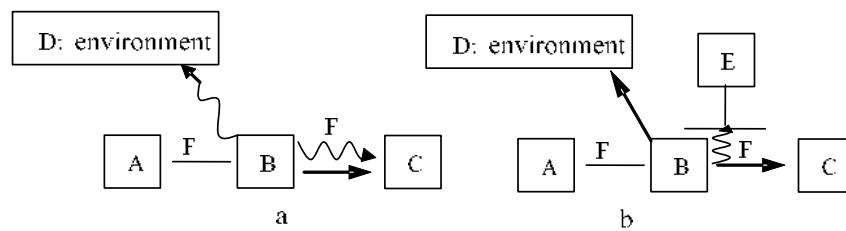


Figure 6: Su-Field model

Using 76 standard solutions. “Strengthen the measurement system” and “introduction of new material eliminate harmful effects, when useful and harmful effects are concurrence”.

Solution: A removable vibrating device can be added on the external body (E), and to regulate the vibrating device and spindle speed to meet the constraints. Strengthening the measurement system can improve the environment (D).

6 CONCLUSION

Improving the DSM based on Su-Field model and 76 standard solutions of TRIZ, the strong advantage is that there are lots of examples in 76 standard solutions, and designer can make an analogy rapidly. In addition, computer about TRIZ can help designers found an answer.

However, for this idea, it still has immature sections, and DSM can combine with other tools of TRIZ.

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Index

- Introduction
- DSM based on Su-Field model
- Design process
- Summary
- Contact data
- Thank you





Introduction

- The advantage of DSM is partitioning and banding by reordering rows and columns.
- The characteristics of the complex products performance in DSM is iterative loops in the blocks.
- While in this article, the characteristics of the complex products performance in DSM is that it exists in the cross situation of the adjacent two blocks after reordering.
- The function relation between the cross blocks which have been partitioning and banding can be presented by Su-Field model. 76 standard solutions of TRIZ based on Su-Field model can play a directive role according its large number of examples and analogies.



Introduction

- “a” presents that the two blocks are independent from each other, which is the expectation of the engineers, and “b” describes that the two blocks have cross and repeated area.

	A ₁	B ₁	C ₁	D ₁	E ₁	F ₁	G ₁
A ₁	o	o	o	o	o	o	o
B ₁	x	o	o	x	o	o	o
C ₁	o	x	o	x	o	o	o
D ₁	o	x	x	o	o	o	o
E ₁	o	o	o	o	o	x	o
F ₁	x	o	o	o	x	o	o
G ₁	o	x	x	x	o	x	o

a

	A ₂	B ₂	C ₂	D ₂	E ₂	F ₂	G ₂
A ₂	o	o	o	o	o	o	o
B ₂	x	o	o	x	o	o	o
C ₂	x	o	o	x	o	o	o
D ₂	x	x	x	o	o	x	o
E ₂	o	x	o	x	o	o	o
F ₂	o	o	o	x	x	o	o
G ₂	o	x	x	x	o	x	o

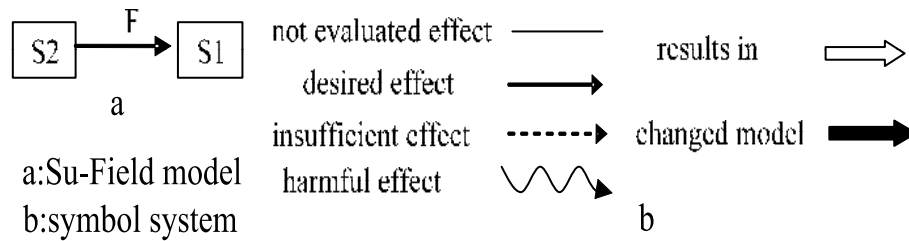
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DSM Based on Su-Field Model

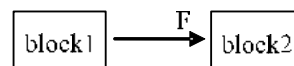
- Su-Field Analysis is a TRIZ analytical tool for modelling problems related to existing technological systems.
- There are some symbol systems to introduce:



DSM Based on Su-Field Model

- The relation model about all the blocks with the adding field (sometimes it is a assumption field) can be described in here:

	A	B	C	D	E	F	G
A							
B	X				X		
C	X				X		
D	X	X	X			X	
E		X		X			
F				X	X		
G		X	X	X		X	



a

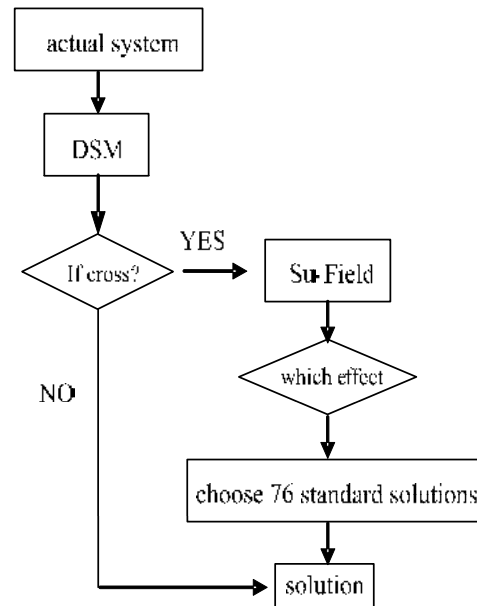
b





Design Process

- Problems analysis in actual system
- DSM to be used if it needs reordering
- Su-Field to be involved in
- Using 76 standard solutions



Summary

- Advantage: Improving the DSM based on Su-Field model and 76 standard solutions of TRIZ, the strong advantage is that there are lots of examples in 76 standard solutions, and designers can make an analogy rapidly. In addition, computer about TRIZ can help designers find an answer.
- However, for this idea, it still has imperfect sections, and DSM can combine with other tools of TRIZ.

