WORKING PAPER

NEW ADVANCES IN DECISION SUPPORT SYSTEMS CORPORATE SYSTEMATIC THINKING AND ITS IMPLEMENTATION: One of the Traditional Japanese Management Concepts

Kaoru Kobayashi

Matsushita Electric Works, Ltd

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Foreword

Research in the field of Methodology of Decision Analysis and Decision Support Systems is one of the topics investigated during several years within the System and Decision Sciences Program. Beside theoretical and methodological research, applications are considered as a very important component of this research. Developing methodologies and computer systems requires practical verification of these concepts as well as the learning of decision making styles and practices from organizations implementing up-to-date management techniques. Application and experimentation is the only possible approach for the validation of new concepts developed by researchers and feedback from practice is one possible way for generation of new ideas.

Recognizing the importance of the above mentioned feedback, the System and Decision Sciences Program organized joint Seminar Days with the Japan Institute for Systems Research with participation of managers from leading companies of Japan industry. During this seminar they presented experience on implementing new management and decision making technologies in their organizations. The given paper presents several aspects of management in the context of introducing innovative technologies as well as organization of the research and development process at Matsushita Corporation.

Alexander Kurzhanski
Chairman
System and Decision Sciences Program

Author

For about half a century Mr. K. Kobayashi has devoted his work to keep Matsushita's technology outstanding.

After he graduated from Kanazawa Technical High School, he joined Matsushita in 1940. He started his career in the areas of mechanical engineering and production engineering. His unique ideas and everlasting efforts have resulted in lots of products, world famous electro-magnetic relays and electric shavers, wooden materials (which are described in this executive report), and so on. He has also won many prizes and awards, one of which is the Blue Ribbon for the contribution to the relay industry. In 1961 he joined the management board as an executive, and has been its president since 1982.

He still helps his colleagues as a corporative technical consultant.

NEW ADVANCES IN DECISION SUPPORT SYSTEMS CORPORATE SYSTEMATIC THINKING AND ITS IMPLEMENTATION: One of the Traditional Japanese Management Concepts

Kaoru Kobayashi

I studied mechanical engineering and graduated from the university in 1940. In these days, there had been high aspiration among my colleagues that they wanted to be the expert in "machine making" like in making machine tools or motors. One of my seniors, who I respect, suggested me that I would be better off being a production engineer, so I decided myself to join Matsushita Electric Co., Ltd., which is now called Matsushita Electric Works, Ltd.

In early days in the company, I started my career as a production engineer which is popular these days. I was first assigned to work at the chemical factory, where a lot of plastic materials are consumed for the electric appliances. My first job was to maintain the production machine and fix the problems. The level of my work was far below the production engineering standard now.

What most embarrassed me in those early days was the gap between what I had studied in the university and what I actually experienced in the company. I was very nervous about this gap because I was not able to identify what the gap was. In fact, without any theoretical process, products were in any case manufactured.

Notwithstanding, I had many questions which I could not solve by myself. All those questions might have been easily solved if I had asked the workers who have their know-how and professional intelligence. However, I was not aware of this at the time and I was so nervous as to resign from the company.

The whole process of my work had been a repetition of establishing desk theory, identification at the production site, getting information from foremen, implementing ideas and again, establishing desk theory. Why should I assert that I must go to the production site? Since I have studied the mechanical engineering, I am able to understand the machine equipment itself. However, I have little knowledge of the parts and materials which are being used by that equipment to produce the finished products. Then, I decided to study the subtle balance between the machine and the parts to be processed by it, while entering the production site to get in contact with the workers there to obtain their intelligence and know-how myself. By making it a rule to keep access to the production site, I repeated this study cycle by which I could know many technical know-hows from the workers and foremen in those days.

Through my experience of repeating the reviewing and spiraling cycle, I came to think how to systematize the facts concretely and quantitatively is the most important thing to promote the business or production. I learned that the most important thing is to understand the arts of the workers and bring them to the common technology.

What I want to emphasize here is not only the importance of possessing the on-the-spot principles and polishing up such sense, but also to establish some know-how to integrate the field information to theoretical conclusion. We may have better judgement if we have good field experience, and accordingly we are able to easily check the extent of technology in each production process and further to readily pick up the data to subject them to the quantitative analysis. I think that it is of the primary importance for the

manager to go to the site himself and see what is actually proceeded by his own eyes. Without this, I think that any company will not realize its rationalization, process improvement and promotion of the worker's labor efficiency. First of all, the manager has to solidify his intention to do so. In addition, the fact that manager has constant access to the site may constitute the first step to the concept of the automation, and the systems analysis in the company strategy.

When I am at the site, I try to consider what programs the worker there conceives when he is making his jobs. And I recognize that each worker has some knowledge about his works, whatever level is different among them, and I am willing to study them through AI (artificial intelligence) concept which may improve and rationalize the business. At the site, I can imagine what the workers or supervisors are thinking and I consider them systematically - this is one of the reasons why I often go to the site and I recommend other managers and officials to do so as frequently as possible.

Even in case we analyze the process based upon the field data, it is important for managers to fully understand the fact and then require further analysis of key issues to the experts. When the manager calls for the experts to consider such major points, it is of most importance to make the discussion free so that their opinions may be freely exchanged. Without such discussion, what the experts are doing will not agree to the manager's intention. This will decide whether or not the study results would satisfy the manager's expectation to the future company strategy. I think the manager has a key position to generate the profit by starting the project and integration of the experts opinions.

Generally, there are three elements to yield the company profit (see Figure 1.).

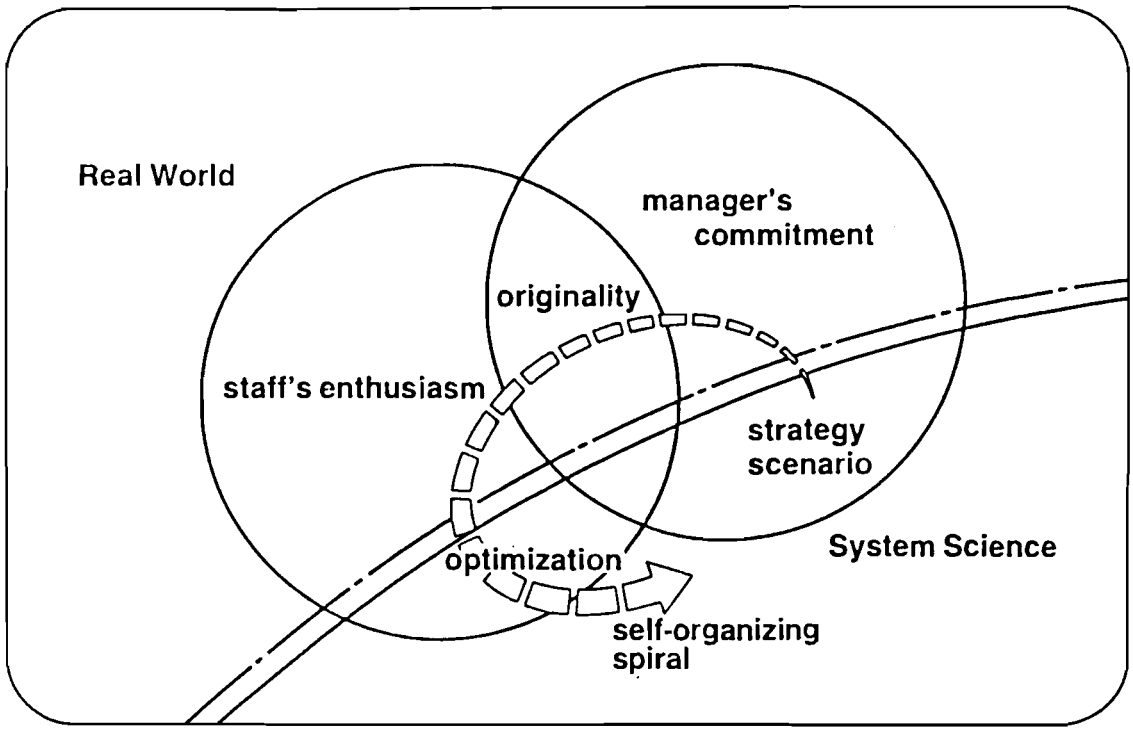

Figure 1. Three Elements to Yield Profits

1. Commitment of the Manager,
2. Enthusiasm of the Staff,
3. Systematic thought and analysis.

The manager has to manage these three and let them combine together.

I call such manager's tasks "Self-organizing Spiral" (see Figure 2.) and I tell you here how I have conducted this Spiral Operation in the past, while citing the actual examples:

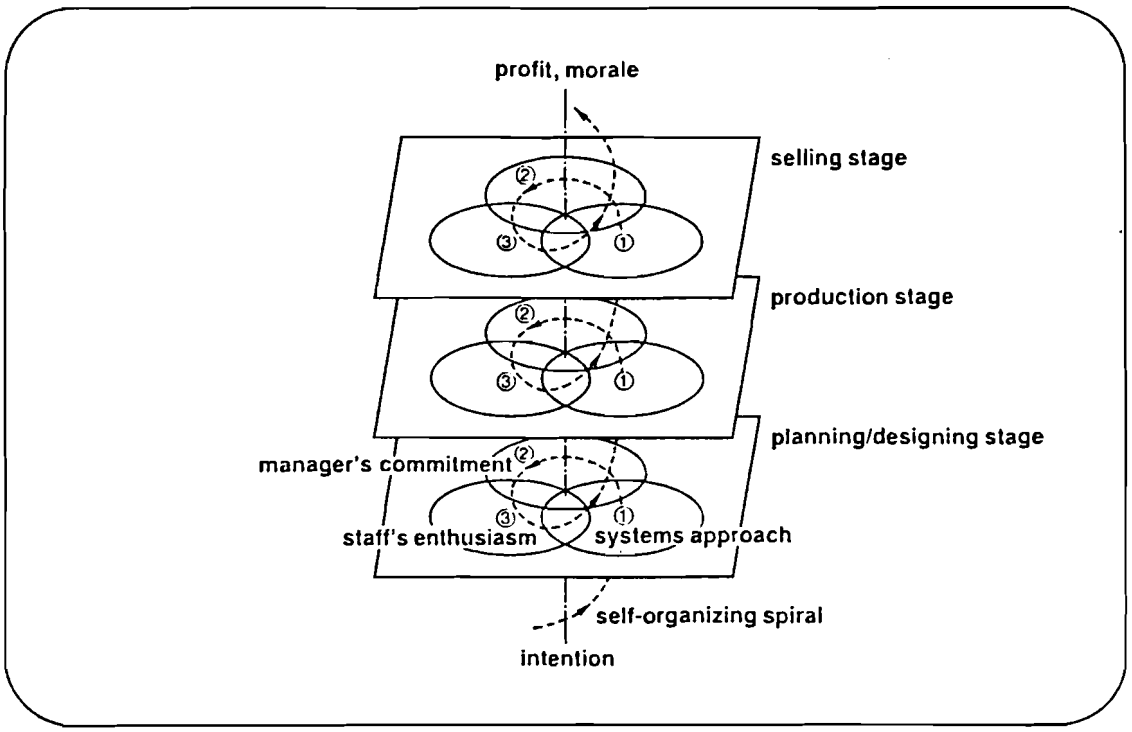

Figure 2. Self-Organizing Spiral

1. Originally, based on development of the relays,
2. Strategic scenario, based on development of the electric shaver,
3. Optimization, based on promotion of production/sales/inventory control system.

Before discussing the above-mentioned cases, I want to look back at the systematic thoughts of our company employed until now:

- In 1950: SQC; impressed by its systematic problem solving method,
- In 1960: Finite Element Method; under guidance of Professor Ohta of the Osaka University; the method is widely applied by the designers of our company,
- In 1965: Multiobjective Optimization; this method has been made use of in a wide variety of applications inside the company, under the guidance of Professors Sizunoki and Nishikawa of the Kyoto University,
- In 1970: VE,
- In 1975: Multiobjective/multivariable decision support procedure; under the guidance of Professors Sizunoki and Nishikawa, the method has been applied to various intra-company problems,
- In 1977: MT; this is the concept developed by our company and it is intended to minimize the number of the parts in stock to meet the requirement when the production of a wide variety of items in small quantity is expected,

- In 1980: TQC.

We think that it is the most important thing to fully exploit MCDM technology and AI technology in order to activate and to promote the company strategies in the future.

Development of Polarized Relays

Sticking to the principle and general rules leads to a successful result

Since 1965's, we have made our efforts to develop "Polarized Relays". The relays available before were electromagnetic type. Development of the polarized relay was to realize a miniaturization, high fidelity, high performance and excellent function, etc., through proper combination of electromagnet and permanent magnet. About a half a century ago, Potter and Brumfield Inc. of the U.S.A., developed the electromagnet, named Hammer relay (Clapper-relay), and in the heyday of its popularity, we decided ourselves to develop a new product making such electromagnet with the combination of permanent magnet. Our decision was based on the following reasons:

1. The power consumption can be reduced to the level of 100 mw order in terms of calculation and design,
2. In addition, the new product features a quick and quiet operation,
3. The output power is higher as compared with the input,
4. The product assures a long life and increased reliability (for example, at present there are some items which are able to show 100 million opening/closing cycles of the mechanism).

Thus we had a successful theoretical result. There remained the problem of the manufacturing cost, but we started to develop anticipating the emergence of the modern relay. We have suggested the staff to observe the following points prior to the development:

- To realize a simplified mechanism and its optimization,
- Balance analysis in magnetic force between electromagnet and permanent magnet,
- Study on the contact mechanism and material used for the contact (either mechanically or electrically),
- Development of new contact plating technology (by micron order),
- New development of the evaluation equipment (for arc analysis and evaluation of the mechanism optimization results).

In simple words, the success in making higher performance relay depends on how we can incorporate many functions in the limited space. We were determined to develop the new relay which would meet the two factors of signal and power at a time, and then finally we have succeeded in completing the polarized relays that we are now presenting to you. Thanks to the rapid progress of electronic industries and their associated growth of information sectors, the polarized relays developed by our company will be enjoyed in the various manufacturers not only in Japan but throughout the world including the U.S.A. and European countries in the following areas:

- For consumer products application use: Telecommunication, PBXs, VTRs, microwave ovens,
- For industrial use: Robotics, measurement/control appliances, NC machine tools and others.

Our polarized relays have been used by the leading manufactures throughout the world and their market share has increased year by year.

Strongly enough, the reputation of our product has been first enjoyed in Europe, then America and lastly Japan. There has been a case that our relay was employed as a control part by a German machine manufacturer and then the machine produced by that manufacturer was imported by some Japanese manufacturer. As a result, the Japanese manufacturer contacted our sales office for further details. This is the fact I still remember even at present. In those days, such relays were considered as the most promising item among others. But when we entered the actual stage of their development, there has been many difficult problems. In fact, we were about to give up three to four times to develop it.

The most difficult issue was whether or not we would employ plastic materials for the bobbin which used to be ceramic to obtain higher performance. However, if the ceramic is used it will raise the cost, and therefore, we are unable to hit the cost target for the consumer products. With this in our consideration, we had been trying to solve the cost problem by using the plastic instead of the ceramic materials. In those days, the plastic had a lower reliability on it than at present, and then we were going to make sure of its reliability through the electrical-characteristic analysis and evaluation by our own methods; our final judgement at the time reached to a decision of using the plastic instead of the ceramic. There still exists many hard-to-solve problems about employment of the plastic. For instance you will see the "Brown" surface of a contact, which is the plastic brown powder. This can be seen in any of the relays, whatever size they may be. To solve this problem, we think, is the focus point aimed at solving in the future development.

We have thus, experienced lot of complications during the development of such relays, and yet we have continued to do it and succeeded in finally developing the new product. I think that this is attributable to our confidence that "the excellent relay with outstanding performance" can be realized through combination of electromagnet and permanent magnet as long as its development would be promoted based on the principle and general rules concerned. All the people who are engaged in the development made their efforts based on their conviction that they followed the principles and general rules which led to the successful results. This relay has been developed in collaboration with some German companies, and we think that our success comes from our repetition of ever-continuing spiral operation through our continuous exchange of thoughts and knowledge of both side. Citing only one example of the successful results obtained from the development of such relay, the number of acknowledged patents amounts to 629 in the domestic market and 210 in the foreign market. Speaking of how such relays met the users' needs, I made an automobile trip over the distance of about 200,000 kilometers in West Germany, and to do the sales engineering activity to confirm users' needs.

From my experience in this development, I could say that it is important to tackle the project in compliance with its principle and general rules. And I learned that we could yield the originality only through using the mathematical approach backed by the tenacity and the know-hows acquired during the development and by sorting out the pile of problems. The method called systems approach is based on the same basis and I think that it requires a theoretical study primarily, and yet is also required to meet the users's specific needs. Therefore, I think that it is essential for the people to become aware of the know-hows on the site by themselves and then make out the on-the-spot-applied theory to solve the problems they are facing. This is sure to result in an increased and efficient role that the systems approach in the future will play. By the way, the engineers of our company have two faces depending on the jobs and in order to let them exchange their opinions freely, and to have the different-standing persons stimulate each other for their performance. That is:

- The engineers are entrusted to make their own researches on the individual basis,
- They, if requested to develop a certain, concrete product, are asked to do their work on the development team basis.

For instance, we make it a rule to let the appropriate production engineers take part in a development team of the specific product(s) at its earlier stage, and we put those, able to work together in collaboration with each other, together in a large room. This, I think, is sure to help realize the most desirable environment where the researchers are allowed to have free and informal discussions with each other and then they could cooperate with each other on the project team basis. As Professor Sizunoki has told us, any scientific research needs its combination of flexible human factors, and I, as one of the managers of the company, hold it, as the most important fact for any manager, to create an environment which the researchers or the staff want to be as they desire.

Development of Electric Shavers

Philosophy/Master Planning is the critical issue

Next let us cite an example of development of electric shavers. Matsushita Electric Works, Ltd. is engaged in producing and marketing a wide variety of products consisting of electric materials (50%), building materials/housing equipment (25%), industrial-use materials (15%), and personal care products (10%). I believe no other manufacturer carries such wide variety of products from housing materials to electronic products in the world. Our company started in 1918 with the wiring devices and then has continued to show its progress as an electric equipment materials manufacturer in 1955. The company expanded its strategy drastically and entered into the field of housing/building materials. We had an idea at that time that the users would require a house as movable property rather than a house as real estate, and we thought it would be profitable to supply the materials to meet the new type of houses. At present, we have a subsidiary housing company, whose production and sales output as a whole is worth about Y 120,000 million annually.

Now let me tell you how we have developed our products, by citing the electric shaver as an example. In Japan, people begun to get accustomed to use electric shavers in the late 1950's, while in Europe and in the United States the electric shavers had been used before those days. At present in Japan, 1/3 of people use the electric shaver, 1/3 use the ordinary razors and another 1/3 of people use both electric shaver and safety razor in combination. However, there is a trend that the people who used the safety razor change to use the electric shaver, and it is becoming a sort of a "morning ceremony" of a male to use an electric shaver in the morning. The physical behavior of "shaving" is very simple, but we intended to develop an electric shaver most fit to the morning ceremony. We determined that "the objective is to develop the electric shaver of optimum shaving performance", and then we started the development. We started marketing electric shavers in 1956. The products continued to improve and were remodeled from time to time while we had the technical tie-up with the foreign partners. Gradually every fragment of information became integrated to form one specific concept. The theme was "Development of an electric shaver, which provides the optimum shaving effect and easy-to-use feature". If I call this a "philosophy" of the shaver, it could be an exaggeration. It would be better to call it a master plan of the shaver. This way, I solidified my thoughts on the development of electric shavers. Thereafter, we have made trias and errors and experienced and studied many aspects which gradually ascertained the property of shavers to increase the performance. However, we were not able to attain the original target at one stretch and there still remained a number of problems and tasks to be solved. Therefore we tackled the problems step by step and solved them while employing a mathematical analysis

method from time to time.

"To shave mustache or beard" consists of the fundamental physical behavior of "cutting". I tried to investigate the scissors first to analyze a performance of "cutting". When I went to West Germany in 1980, my family asked me to buy German-made scissors as souvenirs. When I visited the "HENKEL" dealer, I asked for scissors. However, the salesperson asked me many questions, with persistence, on what purpose I was going to use such scissors. It was as if he would not sell me any scissors without knowing the purpose. This sales manner was very appropriate to identify the needs. There were every kind of scissors on display, one for cutting the cloth, one for plant, wool, metal paper, etc. The experience of purchasing "Solingen" scissors gave me a great impression and inspired many ideas for the development. Based on this experience, I started to study the mustache, beard and skin of the human being, and to investigate the cutting mechanism. We proceeded further with research and development of the outer and inner cutting blades, and thus tried to obtain the optimum design on the outer cutter blade's pattern, blade's materials, cutter drive mechanism, format, maneuverability, switch position, shape, weight, balance and many other factors in human engineering. The themes we were then facing were diversified ranging from the fundamental issue to the designated ones. According to my impressive experience on the "German Scissors", I was able to solidify the development philosophy and scenario so that we could produce and market a wide variety of our electric shavers, although we have experienced many turns and twists during that process.

What I want to express is that we should research and develop the new product based upon our own philosophy, scenario and systems approach toward the target. This is the most important for any of the research and development activities.

Development of Production/Sales/Inventory Control System

Solving the multiobjective problems will yield a company profit

As to the development of production/sales/inventory control system employed by our company, we are dealing with as many as 110,000 items. Because of such great number of items, the inventory increased up to the level of 45 days at its worst, worth about Y90,000 million. Although the top management gives regular instructions every year to reduce the inventory, we usually find no actual effect even with such orders. One of the measures which we saw frequently until now every year, is to let the workers improve the accuracy of their sales projection. However, if this is expressed in other words, it may mean that the persons in charge would have thought "The sales projection is poor and my inventory schedule is correct".

With this in my consideration, I had the staff study through the systems approach on how the persons in charge would decide the future inventory level, and I found something very interesting. I found that although they calculated the reference value for the safety inventory of each item through EDP method, such reference value was decided regardless of the accuracy of their projected sales. The person in charge of inventory control is ready to set up the production schedule to meet the upper-limit inventory obtained from calculation by EDP method. Yet I would say that this established upper-limit inventory has nothing to do with the accuracy of sales projection. In other words, we found that all the figures in sales, inventory and production are all associated as figures in book keeping, but it may have odd figures when it is analyzed from the viewpoint of "INVENTORY CONTROL". In addition, I think that the decision standard for the inventory level employed by any company is almost the same and everyone wants to make such a schedule that makes no shortage of goods, no excessive stock and lessen the overall period of stock as much as possible.

Notwithstanding, the senior officers are forced to judge these problems from their standpoint if the balance sheet is getting better or not. What I have discussed may refer to the "hierarchical multiobjective problem" if I use the professional expressions (see Figure 3.). If we increased profit from the production by one percent, what about the shortage of goods and the period of inventory? When these problems can be calculated instantly by EDP method, we will be able to make sure the relationship (trade-off) between profit of production, and the level of inventory, and then it becomes easier for us to set forth our decision.

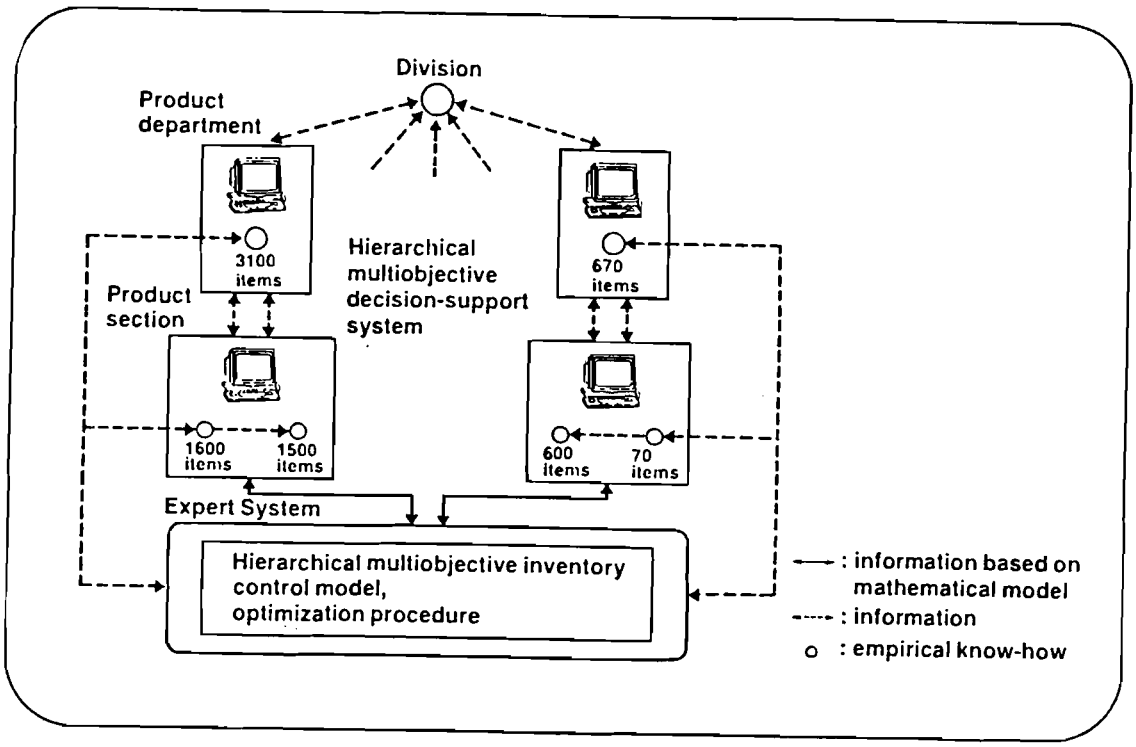

Figure 3. Hierarchical Multiobjective Problems

Until now, I think that such hierarchical multiobjective problems as mentioned above were handled only by such instruction as saying "improve one more percentage of profit in balance sheet", and the results were almost meaningless. The solution of the hierarchical multiobjective problem will make the manager be able to understand the profil level based on the analysis-oriented attitude, and in other words, all the specialized jobs were once again organically and effectively integrated. Therefore, if we have the ability to solve the hierarchical multiobjective problems in one way or the other, it will bring about a new nervous system in the organization body called a company, where you can expect better response. The system analysis group, based upon those considerations, has prepared an inventory control model in compliance with the accuracy of sales projection and performed the simulation on them. Then, we have obtained the result of the inventory level half reduced under the condition while maintaining same service to customers. This means that we can achieve the rationalization worth about Y10,000 million every year. Although this is the simulation, we estimate at least 10%, i.e., Y1,000 million will be rationalized. The details will be explained by the staff who has been engaged in this development. Anyway, we started to study and review this system five years ago, and last year, we succeeded in completion of the first phase of the inventory control system for the staff level and we find it is fully executed throughout the company. The prototype system for the manager level is now underway and it is in the evaluation stage (see Figure 4.). Furthermore, we are determined to standardize all of the existing job pro-

cedures of both staffs and managers and to establish a perfect inventory control system in the future. When such a perfect system is completed as we expect, we are sure that we will be able to put all of our company's items covering as many as 110,000 under control by several persons, and also the company's essential jobs will be treated through OA system.

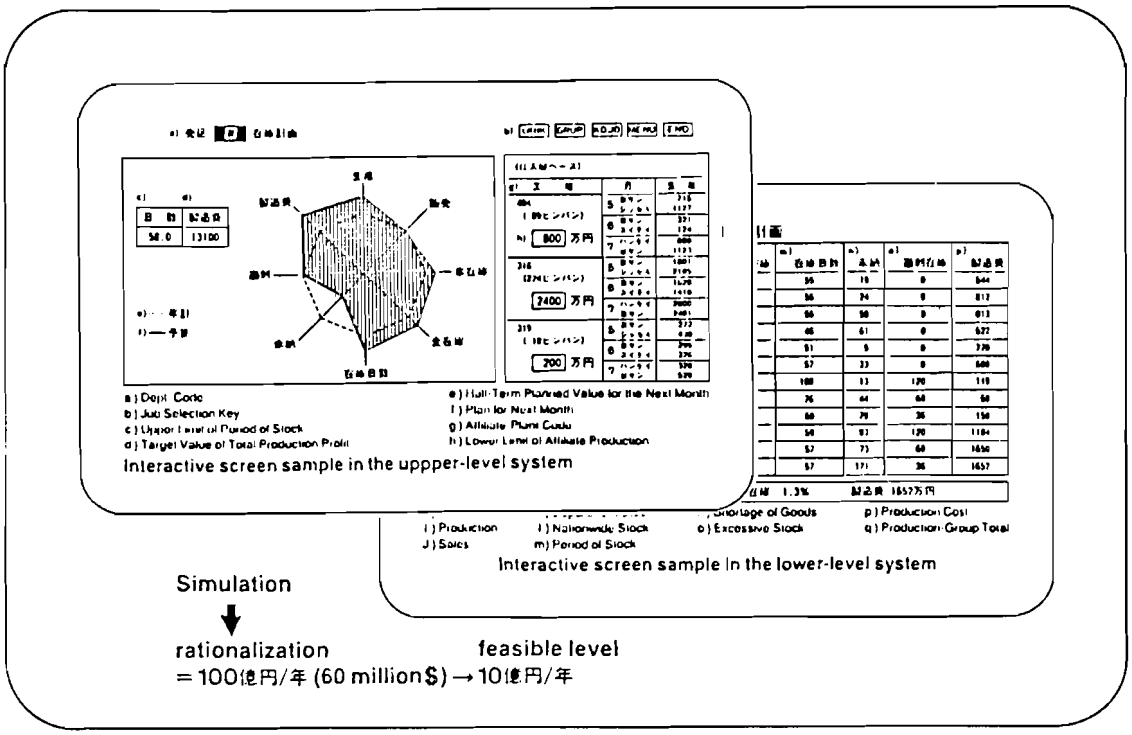

Figure 4. Systems Development Effects

What is of most importance, I felt during the course of the system development, is to yield lot of profit for the company if we could manage the multiobjective problems in the appropriate manner. Without this, even if the top management decides his business objectives, it will not easily make profit. I think that this issue depends upon the degree of self-awareness of the top management rather than their subordinates.

Conclusion

We have established various Decision Support Systems (DSS) including the system I have explained, and I think that the points to make the established DSS successful are composed of the following "3M". Those "3M" are as follows:

1. Man-Machine interface,
2. Man-Model, Method interface,
3. Man-Man interface.

It is very natural for us to aim at the better Man-Machine interface for the DSS first of all. In addition, we are required to improve the interface concerned with the fundamental models and methods. In this sense, the top or senior management should always be ready to consider the connection of their daily-used words with the mathematical model and of their business instructions or the one like the DSS method. What I emphasize refers to the modeling or optimization methods required for the intelligent DSS that Professor Sizunoki has stressed as his opinion for a long time.

Besides, the Man-Man interface will play a key role to make all the decisions in each stage of the company activities such as planning, design, development, engineering, manufacturing and sales be related with each other to constitute an organic body showing the activities as a whole. However, there are the facts that the most optimized results at the merchandize development stage are of no use or completely negated in the manufacturing stage. Why? I think it is attributable to the possible deviation between the results obtained from the local optimization and those from the total optimization. Accordingly, although the mathematical model could be prepared to consider the managerial problems we are facing from time to time, it seems that the mathematical solution is often unrealistic in the actual level. I think that one of the reasons why the mathematical method is not omnipotent in solving the managerial problems is the existence of human factors which will greatly affect the system as a total organization. There is an oriental thinking about the human factors, which is based on Buddhism. In Buddhism, the minds of human beings arising for a moment are generally classified into 10 stages as follows:

1. "Jigoku (Hell)" world,
2. "Gaki (Preta)" world,
3. "Chikusho (Beast)" world,
4. "Ashura (Asura)" world,
5. "Ningen (Mankind)" world,
6. "Tenjyo (Heaven)" world,
7. "Seimon (Supreme Hearing)" world,
8. "Enkaku (Destiny-awareness)" world,
9. "Bosatsu (Saint)" world,
10. "Hotoke (Buddha)" world.

I will explain here the above-mentioned ten Buddhism worlds in a simple way.

1. The people suffer physical torture ("Jigoku"),
2. They become famished with lack of foods ("Gaki"),
3. The people are satisfied only with the life as beasts ("Chikusho"),
4. Being of strong envy against the others, one continues to be in a struggle with them ("Ashura"),
5. Joys and sorrows arise alternately ("Ningen"),
6. The people are given peaceful joys, but are not yet free from the torture like illness and death ("Tenjo"),
7. One can have a spiritual enlightenment by hearing the teachings of Buddha ("Seimon"),
8. One acquires a spiritual enlightenment by himself by pondering the sacred law of Buddha ("Enkaku"),
9. One is trying to practice asceticism together with the others so as to obtain a spiritual enlightenment ("Bosatsu"),
10. One experiences a spiritual enlightenment by himself and also he makes efforts to let the others have the spiritual enlightenment as he has experienced ("Hotoke").

For example, there are some people in the company conference who are sticking to their stand and claiming that everything inconvenient to them are attributable to the responsibility of the others rather than themselves. Such people are possessed with the envy against the others. If the conference is controlled by such people, the desirable decision would never result. This is because they are likely to express their opinions only from the viewpoint of their local optimization while negating the total optimization at all.

In fact, there is almost no mutual understanding among the participants.

Meanwhile, there is the desirable conference where all of the participants are aware of their own positions and their opinions are issued based on the prime consideration for the total balance among the others. Naturally, in such a conference, the opinions exchange will be very positive and the moral thereof will be increased. This is sure to bring about the technical ideas of originality. In this way, if everybody's mind naturally agrees to each other aiming at both the local optimization and total optimization, we can call it the equivalent of "Hotoke" world when discussing the managerial problems. Then, isn't there any method which to attain the "Hotoke" world? I am sure that such exists. In Buddhism, there is the term "En" and it seems to be rather hard to translate it into English. When the "En" is created in the mind of everybody, I think that the "Hotoke" world appears naturally to let them be intimately related with each other.

I think that what plays a role in this "En" in solving the managerial problems, is the systems approach in one way and the commitment of the manager in another.

The top manager or senior manager himself should go to the site and be determined to create and foster the "Hotoke" world with the workers including their supervisors and himself through repeated discussions among each other. I believe that this is true self-organization, most desirable for the management of an enterprise.