

Appendix D

The DTCN/DTC Success Story

* Printed from the "Defense Engineering", Defense Engineering Society, January, 1990 by permission of the Journal of Society of Japan Value Engineers, No. 129, May, 1989.

New Concept and Procedure of the Design to Customers' Needs (DTCN) and the Design to Cost (DTC), and Their Successful Application by the Defense Agency in the Development Project of a New Mid-Class Jet Trainer Aircraft

Michihiko Esaki
Kawasaki Heavy Industries, Ltd.
Gifu Plant

Q: Mr. Esaki, could you tell us about this new concept and procedure for Design to Cost?

I understand the method was successfully applied by the Defense Agency in the development of a new mid-class jet trainer aircraft.

A: Let me explain how I came to develop the method, how the method came to be applied in that project, and how things have developed since that. However, before going into details, I would like to touch on the basic methods constituting this new concept and procedure of DTC.

Q: What are those basic methods?

A: There are five basic methods and each one corresponds to a particular part of the decision-making mechanism. Namely,

- (1) The Key Word method, which is used for creating proper purpose-measure relationships.
- (2) The Steplist Management method, which is used for forming a faultless scenario and procedure.
- (3) The 3-Phase Improvement method, which is used for parallel three-pattern approaches to be taken to improve or develop an object.
- (4) The FBS technique, which is used for creating the structure of an image.
- (5) The WBS Phasing Theme technique, which is used for extracting all the possible themes or ideas from the people concerned and examining them in the proper order to realize an ultimate goal.

In the case of DTC, these methods are combined to set a target cost and prepare peripheral conditions. In the case of DTCN, although the target cost is replaced in line with the customers' needs, almost the same procedures are followed. The details of some of these methods are described in a book

published by Sanno Daigaku Publishing Co. in 1989, "A New Thinking and Its Procedure for Design to Cost" (For information: Tel. 81-3-3724-9101). As shown in Table 1, the most appropriate method is chosen among the five basic methods and other auxiliary methods depending on the purpose.

All these methods are created by clarifying the mechanism of decision-making and creative thinking, which we perform unconsciously in our daily lives.

Q: There are many methods found in Table 1. How were these methods created and how did they come to be applicable?

A: I felt that the conventional VE method did not work well in some of Japanese society in terms of the positioning and the context in which the method was being used. However, what made me develop these methods was in relation to how reasonable prices were calculated. I remember that in 1972, our company was striving to lower the cost of a certain product. Although no measure had been taken, the cost of one of the components of the product in question plunged to one fifth. My colleague who was in charge of purchasing materials came to me for help. He was afraid that his boss would criticize him for not doing his job properly.

I referred to the "systematic approach to developing new products" (SJVE, No. 14), which the late Professor Tamai of Sanno College and Mr. Nemoto of Japan Air Brake Co. had researched. The approach focused on understanding the research and development process in input-output relationships.

I thought it was possible to explain the drastic plunge in the cost if we added at least one new factor or perspective to the conventional VE method. Steplists for Reasonable Price listed in Table 1 was created based on this idea (presented at the VE conference in 1973 as well as at the U. S. VE conference in 1974).

Q: I see. You wrote a paper based on the ideas and procedures you came up with when you were working on the issue of reasonable price. Could you tell us what happened after that?

A: After presenting the paper at the VE conference in Japan, I went to the U. S. VE conference held in Los Angeles in 1974 and presented the paper there. Our company paid for half of the travel expenses. At that time, Mr. Tsuchiya, who is a professor at Sanno College, proposed that things could be better understood if put into input-output relationships or relationships between the pre- and post-assurance activities per output.

The U. S. VE conference was cosponsored by the American Defense Preparedness Association (ADPA) and the main theme of the conference was DTC. At the conference, I heard a speaker saying “the DTC is a policy and a concept, and a procedure has not yet been established.”

Q: At that time you thought it would be possible to establish a procedure by expanding the thinking and procedure of the steplist for reasonable price?

A: Yes. The following year, our company was confronted with a project whose management and cost control was in chaos. A study team was formed in an effort to resolve the situation. We tried to resolve it by combining the empty framework of the steplist for reasonable price with the KJ method. By doing so, we began to see problems we hadn't seen before. For instance, it was clear to me, although I was quite an outsider in sales department, that there must have been some kind of notification in the Defense Agency. In fact there was one. It was proved later on through our investigation.

Picture 1 Professor Kawakita(Originator of KJ method i.e. affirmative method) and the author (March 28, 1977)



I obtained permission from Professor Tamai and Mr. Nemoto to expand the “systematic approach to developing new products”. In addition, I explained my idea to Professor Kawakita (Picture 1), who invented the KJ method, and got his approval to combine these two ideas into a wider-ranging method. As a result, the steplist management method, which is one of the five basic methods, was created.

I came to realize that it was possible to imitate the natural process of thinking and decision-making if we divided the process into eight different phases, that is, four inductive-thinking phases and four deductive-thinking and action phases.

Q: I understand you also presented a paper pertaining to this idea in the United States. When was that?

A: That was in 1977. I remember telling Mr. L. D. Miles, who is the originator of the VE method, that this method would open a new era for the VE method. He also made a kind remark to the audience after my presentation was over. Another American fellow commented that the paper was significant and was based on deep thinking, unlike other papers.

That year, I also presented a paper entitled “A method of decision-making for management” at the Industrial Conference of Production Research held in Tokyo in 1977 under the auspices of the Society of Management Engineering. The paper was about how to settle the mechanism of decision-making as well as direction of vectors on a piece of paper. In this paper, “the mechanism of decision-making by information difference” was better clarified through engineering methods.

Q: About that time, I understand you began working more seriously on establishing procedures for DTC. Could you tell us about that?

A: Starting sometime around 1972, there was an idea being discussed within our company to develop a new helicopter. I distributed a preliminary memorandum to my colleagues involved suggesting that DTC should be applied to the project. However, the project was put on hold. While the project was on hold, my colleagues and I formed a study group. We got together after work and held serious discussions. In the end, we were able to compile the results of these discussions into briefs.

Later, our company jointly developed a helicopter with Messerschmidt Boelkow Blohm of West Germany. There was a need to create methods and procedures for DTC based on existing methods. Mr. Masashi Yamaguchi and myself worked together for 16 hours in total, and created the original

framework and procedure for DTC.

This preliminary method is the basis of the “A New Thinking and Its Procedure for DTC.” Mr. Hisatomi Mori, a colleague of mine, supported me in creating a temporary method. Professor Masakazu Nakayama, who established the NM method, gave me the approval for linking the preliminary method with the NM method, and set a high value on it (Picture 2). Based on a series of trials of the tentative method, I compiled a paper pertaining to basic procedures of DTC, and presented it at the U. S. VE conference held in Washington in 1979. I paid all the travel expenses myself because our company was doing poorly in its business achievements. Mr. J. Strickland of the Department of Defense, who was Chair at the conference, complemented me on presenting a significant paper for 25 minutes in English. I was also given high compliments by Mr. Miles. Picture 3 was taken on that occasion. My feeling at that time was that presenting the method in the U. S. would lead to its success in my own country.

Q: The paper attracted the attention of the System Research Group at the Defense Agency last year. Could you tell us more about it?

A: The agency has recognized, since early 1981, that cost control is an indispensable condition in developing a new mid-class training aircraft. Experts at the National Defense Academy and relevant officials at the Defense Agency conducted research on appropriate methods and procedures. At the same time, they searched worldwide for papers on the subject. The officer in charge (Officer Iwabuchi) looked for papers online in the science and technology information center in Tokyo and found several papers written in English on microfilm. Based on the research, it was confirmed there was only one paper written in relation to the specific procedures of DTC. That was the paper presented by myself in Washington the year before. As a result, I was asked by the Defense System Research Group to give a presentation on “A New Thinking and Its Procedure for Design to Cost” in the big auditorium of the agency on October 22, 1982. By that time, I had completed two methods of the five basic methods of DTC, namely the Key Word method and the FBS technique. There was a report in the “Management Annual report 1982” published by Sanno College in relation to the talk I gave to Defense System Research Group. **(see the boxed article on the next following page).**

Picture 2 Professor Nakayama(Originator of NM Method) and the author



Picture 3 Mr. L. D. Miles and the author (in Washington in 1979)



**From an article published in “82 Management Annual Report: DTC of Defense Agency”
(compiled by Sanno College) in 1982:**

1. Interest in Prominent Management Methods

As indicated in the basic principles of national defense, the Defense Agency is responsible for preparing effective defense capacity. To this end, preparing economical and efficient equipment is crucial. The agency has been interested in using prominent management methods when it proceeds with a specific project. For instance, the agency invited an expert to give a talk to its executive officers regarding “A New Thinking and Its Procedure for Design to Cost” in October, 1980. It is said that this method is unique in the sense that its detailed procedure enables one to apply DTC to actual projects in this country.

The agency has conducted research on DTC since the 1970s at related institutions. However, it seemed unfeasible to seek DTC applications suitable for the actual conditions in Japan as far as instructions given by the Pentagon and literature pertaining to the DTC were concerned.

(Paragraphs no. 2 through 4 are omitted)

5. Applications to New Projects

As awareness about the roles and effect of DTC increased, the agency and knowledgeable people in related industries began to realize that DTC applications suitable for Japanese culture were highly valued by American experts.

Because of this, there was mounting need for DTC to be used in new large-scale projects. For example, cost control, including DTC, is being included in the development of a new mid-class training aircraft (MTX) from the design stage. The project started in 1981 and good results are expected.

An outline of the MTX is shown in Table 3. By the time of its maiden flight, scheduled in 1986, it is expected the MTX will be the no. 1 aircraft in the world, surpassing its competitors of the west, the Hawk, the Alpha-jet, and the VTX of the U. S. Navy.

Approximately 37 billion yen is expected to be injected into this project as of 1980. It is clear how high the government's expectations are with regards to the future of the MTX if we compare the amount to the money spent in developing the XT-2. About 8.5 billion yen was spent on the development of the XT-2, although the initial estimate was 6.5 billion yen.

Q: Finally in September 1983, a joint development project was awarded and begun between Kawasaki Heavy Industries, Mitsubishi Heavy Industries, and Fuji Heavy Industries. Kawasaki Heavy Industries was chosen as the prime contractor.

A: Yes, that is true. I heard the design done by Kawasaki was excellent. I believe one of the reasons why Kawasaki was designated the prime contractor was that we had DTC know-how. One hundred twenty people in total from three companies gathered at the Gifu plant of Kawasaki Heavy Industries and started working on the project. I felt “we have to create one more method that enables us to transform all the wisdom of the participants into an excellent design because billions of yen in taxes, and many people and organizations are involved in this project.”

After striving for two weeks, I was able to create the WBS Phasing Theme technique based on the Key Word method and others. This technique is designed to extract all the knowledge and wisdom from participants and to examine it step by step. This technique is different from conventional techniques in the sense that conventional techniques require participants to come up with complete ideas while the WBS technique allows participants to present not only incomplete ideas, but also themes to be discussed. With the help of Mr. Otsuka, Mr. Konohara, Mr. Nawa, and Mr. Nakamura of Kawasaki Heavy Industries, Mr. Maruno of Mitsubishi Heavy Industries, and Mr. Notake, and Mr. Sengoku of Fuji Heavy Industries, knowledge was compiled from participants representing the three airframe makers, as well as other manufactures of more than 90 major components. The “Method of WBS of the Mebius-belt- type,” which enables one to realize what to discuss and how to discuss it in the early stage of a development project, was also created and put into practice.

Q: Could you tell us about the difficulties you had in proceeding with DTC with the other two companies, and things we should know about for the future application of DTC?

A: The most difficult part was setting a target. The hardship was overcome thanks to strong initiatives taken by the government as well as efforts made by Mr. Otsuka, who acted as a liaison between Kawasaki and the other parties. In addition, we were all aware of the responsibilities given us for setting a target based on knowledge compiled between the three airframe makers and other component manufacturers.

The secret of success, which should be stressed, is that we created a DTC steplist showing a step-by-step procedure to draft a DTC implementation plan in a certain stage of a project, how to

obtain approval, and how to proceed with DTC according to the plan. We included this steplist in the DTC implementation plan, obtained approval from the Defense Agency, and proceeded with DTC in line with the plan. What is significant about this is that both the public and private sectors approved the same procedure. By doing so, the public sector was able to make use of organizations in the private sector, and vice versa

This concept is consistent with an idea described in the preface of the MIL-STD 499A Engineering Management included in the contract, as well as an idea of “To be tailored” in section 1.2 Application.

Another unknown success is that the government allocated the budget necessary for DTC implementation in the contractor of private sector. Once given the budget, the contractor of private sector was obliged to take action and file reports to the government. Once the reports had been submitted, the government had to examine and approve them. This way, the most efficient and effective measures came to be taken from the beginning of design, and the most was made out of the national budget .

Q: Could you tell us once again about the more practical design process?

A: There are two things I feel I need to mention here. The first is that the procedures to be followed before and after a drawing is prepared are slightly different. More specifically, before a drawing is prepared, participants are expected to give their ideas on certain topics. Once a drawing is before their eyes, discussions are held with respect to the drawing.

Within the brain, the right and left spheres communicate with each other. I created a similar system.

The process to make the plan drawing is carried out mainly starting from the left sphere, while the process to make the manufacturing drawing is thought to start within the right sphere. I also made sure ideas were always amassed in advance. For example, I made one status graph for each manufacturing drawing a month or two before the drawing was prepared to check whether enough ideas had been gathered. By doing this, not only were we able to compile as many ideas as possible, but also a sense of responsibility was formed among the participants that they would do the same again if there was something wrong with the ideas they had come up with. I was able to include a mechanism in the procedure which prevents one from thinking “why do I have to do this to make up for somebody else’s mistake?”

The second point I'd like to make is in relation to a few requests I made. First of all, I requested DTC from the components manufacturer to be conducted according to the same procedure. Secondly, I requested that "Delete," "Add," and "Replace" of costs that occur when changing design by using "the price/cost breakdown table format" be clarified. Thirdly, I requested suppliers to prepare quotations according to the escalation method that puts the brakes on increases in prices in the future due to fluctuations in the labor index and price index. I also took learning curve factors, gradual decreases in lot size and production size into consideration.

Q: Through the development of the MTX, the DTC method that was developed by you and your colleagues blossomed.

A: Yes. After being verified through the project, DTC began to be applied in various fields. For instance, the National Space Development Agency (NASDA) started using the method in 1985, and so did Kawasaki Heavy Industries in establishing a certain market creation.

In addition, DTC began to be used in developing new software, which previously no one had had any idea of how to start. Through this development, not only the 3-Phase Improvement method developed into the 5-Phase Improvement method, but also other methods that transform the complex mechanisms of the human mind into plain procedures and maps were developed. In addition, phenomena that were unknown to psychologists were discovered.

At the same time, it was thought that DTC would add a new algorithm to research conducted in the past on the algorithm of mechanical brains.

Q: I understand you gave a talk at the U.S. Defense System Management college last year.

A: As I mentioned earlier, I went to the US VE conference to present the WBS Phasing Theme technique. At that time, I was invited by the Defense System Management College of the DoD in Virginia to give a lecture. After the talk, I had an opportunity to exchange ideas with professors of the college, officials of the Pentagon, and people in business circles. The following day, I was also invited to the Defense Logistics Agency (DLA) and asked many questions. The feedback I received at that time was "The conventional value engineering or DTC methods did not allow one to enter from a value perspective, while this new concept and procedure for DTC is a method both 'Political

People' and 'Tactical People' can jointly use because it shows how to clarify the decision-making mechanism and how to create the same thinking and action vectors among the people and parties concerned."

Somebody asked me why I came to develop the procedure. I told them listening to a speech at the U. S. VE conference in Los Angeles in 1974 in which the statement "DTC is a concept, and a procedure for it has not been established yet" made me realize the need to develop such a procedure. A man sitting in front of me, Mr. R. Gilbert, told me he was also there at the conference listening to the same speech. Coincidentally, he was wearing the same watch as I was and both our watches had the identical cracks in the exactly same spot of the glass. Another person named S. Young Shinn asked me why I offered the United States such a wonderful thing in spite of the fact that the United States used to ill-treat Japan. My answer to that question was "For global peace. If this method was passed to the Soviet Union prior to nations in the Free World, global peace would not be possible to maintain. The Soviets do not care about other nations' opinions. On the contrary, countries in the democratic world listen to the opinions of all the parties concerned in order to maintain the peace. Therefore, I am happy to provide the Pentagon, the strongest leader of the Free World, with the method I created. In a sense, this is a token of my gratitude to the United States for inventing the VE method based on which this method was created."

Q: I see. This method leads to global peace. Is there anything you would like to say in conclusion?

A: Lately, we having been hearing about C3I in the context of the defense systems of Japan and the United States. C3I stands for "Command," "Control," "Communication," and "Intelligence." I would like to propose adding one more "C". All cause-effect relationships can be put into a four-frame steplist. Suppose a war broke out because of inevitable conflicts and as soon as the war started, both parties wanted to end it. Why don't we add one more "C," "Complete or End," to C3I with the hope to "complete or end" the war? If we could control the order of "Offer" and "Acceptance" relationship based on C4I, we would be able to create an information system which precludes war from occurring. Recently, I created a promotional figure to show what the concept and procedure of DTC can do in addition to meeting and creating customers' needs (Figure 1). In the figure, DTC is portrayed as a method for resolving issues which nobody knows how to tackle.

Q: From your explanations, it is clear to us that the new concept and procedure of DTC are created not only to create costs and customers, but also to maintain peace. We hope we will have another opportunity to hear your story.

A: Any time, as long as time allows me.

Supplementary Explanations

1. Subsequently, there was an inquiry from the Defense System Management College as to whether the DTC method could be used as a strong tool for TQM (Total Quality Management). In response to this, the author visited the Defense System Management College again to give further explanations on May 16, 1991.

2. The author was invited by the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry to give a talk on “the new method of project implementation designed to establish large-scale software” at the computer technology subcommittee (composed of representatives of various ministries) on June 12, 1992.

Table 1 The combination of basic methods and sub-methods

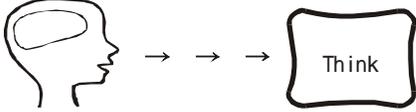
How to use the tools for each purpose

		Main tool		Sub-tool													Key								
		Purpose measure diagram	Steplist	FBS technique	WBS phasing management technique	3-Phase improvement	N-M Method	Work breakdown structure	Method of key question	Price/cost breakdown table	Steplist for reasonable price	Escalation formula	Offer and acceptance	Breakdown structure method	Pre-evaluation method	Grade of estimate	Grade of thinking	Theme-PMD	Fore and after brain	Left and right hand brain	Implementation document				
As the measure																									
In order to																									
Purpose																									
1. Focus 2. Get same vector 3. Where we start		Purpose measure diagram	-																						
1. Establish the phases 2. Faultless scenario		Steplist management		-																					
1. Create image 2. Make WBS		FBS technique			-																				
Gather themes and ideas to realize the target and examine them		FBS phasing theme management technique				-																			
Start the improvement taking future improvement into consideration		3-Phase improvement					-																		
Design to cost		DTCN/ DTC	Design to cost																						
Design to target			Design to target																						
Materialize customers' needs			Realize customer' needs																						
Create customers' needs			Create customers needs																						
Cost down		3-5 Improvement Method and DTC																							

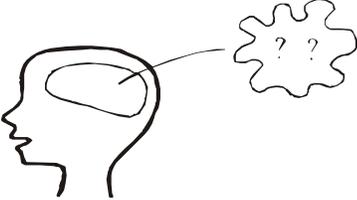
Figure 1 What can Design-to-Customers'-needs thinking and procedure be used for?

Have you ever been the following situations ?

1. Can not organize the procedure to reach the objective result


2. Every person speaks at same time because the procedure is vague


3. Can not find what must be created or imagined, because there is no key to the image


4. Everyone remains silent, because no one has any ideas, or wants to express them, or there is no procedure


5. Others: _____

In these cases

"The thinking and procedures for Design-to-Customers'needs and Design-to-Cost" would solve the problem.