Chapter 15

The Research of Dr. Ishikawa

Dr. Kaoru Ishikawa created numerous new concepts as well as various proposals. He worked hard with fellow professors to realize those proposals. In order to reveal his entire work, it would require years of research conducted from a professional standpoint, thus it is impossible to fully describe all of it within this book. Some of his researches are introduced here based on the Publication List at the end of this book. As regards QC circle, internationalization, sampling, and industrial standardization, please refer to chapters from 10 to 14. References are shown in the chronological table and the reference number at the end of the book. Reference number that begins with B means a book, and in this case, the page to be cited is also shown.

15.1 Special Features of Dr. Ishikawa's Writings

The results of Dr. Ishikawa's research about quality control and other fields have been released through books, papers, slides, videos, Japan Industrial Standards (JIS), ISO standards and other media. Here are some special features of his work that we found from a list attached at the end of this book as an appendix.

1. A huge number of works (2 pieces per month for 40 years)
2. A wide range of contents (from the concept to the method of quality control)
3. Many works published in foreign languages (16 languages, 139 pieces)
4. Clear guidelines for the possibility of future trends

Let us look at the details of these features below.

(1) A huge number of works

The sheer amount of his work reaches almost 800 pieces. As for books, we count only the first edition, and in regard to papers, we count those released with the same

title as one.

Books	31	(Revised and enlarged edn. 11, Translated edn. 32)
Papers, Articles	517	(Total serial articles 64)
Forewords, Essays, etc.	129	
Slides	48	
Videos	26	
JIS	62	(Revised items 50)
ISO standards	7	

If we add the figures in the parenthesis, such as the revised and enlarged editions, translations, the serial articles and the JIS revised items, the total figure would be more than 950. The majority of them were published, while the rest of them, such as the following, were not published nor included in the count.

1. Articles for campus newsletters, corporate in-house newsletters, etc.
2. Presentation materials which were not published as a collection of papers.
3. Textbooks for seminars
4. Reports compiled at government committees and academic conferences.

I compiled these works according to the list of books and papers written by Dr. Ishikawa. In so doing, I found and added many of his works that had not previously been included. Probably, he was so busy writing that he could not list all of them even though he was an enthusiastic record-taker. During the compilation of this book, making the list as well as making the chronological record took longer time than any of the other parts. I tried to make the list complete but I am afraid there are still missing pieces. If we include them, the total figure would be easily over 1000. In the course of about forty years of his engagement in quality control until his death (1949 – 1989), he wrote all the works except for one (No. 513 in the list, 1944). It means that he kept writing at least 25 pieces a year, or 2 pieces a month on average, for as long as forty years. As the "2 pieces a month" included some thick books, we easily understand that he did write an enormous amount of work. Needless to say, he spent a long time writing these many pieces. On top of that, he spent considerable time researching or investigating what to write beforehand. He was really like a Superman.

(2) A wide range of contents

31 books that he wrote can be classified by content as shown below.

Quality Control	13
QC Circle	5
Quality Assurance	2
Quality Control Method	7
Sampling	2
Implementation of Industrial Standardization	2

As for the 517 papers, they can be classified as shown below.

Quality Control Concept	35
Japanese Quality Control	38
Management and Quality Control	58
Quality Assurance	93
Quality Control and Organizational Management	56
QC Circle	58
International Problems of Quality Control	50
(Quality, Reliability, Safety, Product Liability	(28))
(Quality Assurance Systems	(49))
(Environment / Pollution	(16))
Quality Control Method	46
TQC Promotion by Industry	23
Sampling	40
Implementation of Industrial Standardization	14
High Pressure Coal Molding	6

From the above analysis, we can see how broad the contents he covered were, including the concept and method of quality control, QC Circle, sampling, international problems and the implementation of industrial standardization.

(3) Many works are published in foreign languages

Among his works, in addition to one he wrote in English by himself, as many as 32

were translated into 12 languages.

English Version (Written by himself 1, Translated 5)	6
Portuguese Version	5
Chinese Version	5
French Version	3
Spanish Version	3
Dutch Version	2
Indonesian Version	2
Italian Version	2
Marathi Version	1
Hebrew Version	1
Korean Version	1
Slovenian Version	1

The number of his papers/articles, forewords/essays and slides published in foreign languages are shown in the following Table 15.1. The total figure reaches 108 in 11 languages. If the translations are included, the figure increases to 139 in 16 languages.

Table 15.1 Papers and other works in foreign languages

Published Paper	English	Chinese	Korean	French	Others
Research Paper / Article					
1. Concept of Quality Control	8	1			
2. Japanese Quality Control	11	5		4	German 1, Spanish 1, Polish 1, Czech 1
3. Management and Quality Control	2	6			
4. Organizational Management	6	1			
5. QC Circle	12	2			Portuguese 1
6. International Problems	3	5		1	Russian 1
7. Quality Assurance	4	2	2		
8. Quality Control Method	2				
9. Sampling, Analysis	10				
Foreword, Essay, etc.					
1. Quality control related	5				Italian 1
Slide	6				
Total	69	23	4	5	7 **Grand Total** 108

(4) Clear guidelines for the possibility of future trends

Dr. Ishikawa had great foresight. He thought about globalization as early as the period right after World War II. Moreover, he had already asserted the importance of QC for design when they only started to get good results from efforts on reducing product failures at *genba* (workplaces). Meanwhile, he picked up and summarized some possible future trends. In addition, he involved many people by asking about the themes in magazines or at QC Conferences/Symposiums. Of course, all the themes he chose did not always turn out as he planned. However, because he raised such a theme, it preempted problems for many people who were enabled to prepare for the new circumstances to come.

I did not have the chance to hear directly from Dr. Ishikawa about how he proactively spotted new trends, but, during the process of compiling this chapter, I think I found three points. First, the experiences and observations that he obtained from overseas business trips would have been very helpful until the early 1970s. But he did not introduce what he saw overseas as secondhand information. Instead, he considered until he fully understood what he saw, reorganized it and then introduced it to us. The development of new products and product liability are examples. Taking cross-functional management as an example, you might think that it was derived from the ideas he got during his stay in the United States. Judging from the visit of many American experts for studying cross-functional management, it is clear that Dr. Ishikawa did not just pass it on and introduce it to us. Second, a lot of information he received was from his strong curiosity for something new and from his extensive contacts. Third, it must also have been his keen interest in what was going on in the world. I will not forget that he always read a newspaper from cover to cover and organized the clippings by content. (Noriaki Kano)

15.2 Proposal by Dr. Ishikawa

(1) Thought revolution in management, Management with respect for humanity

Taking QC not only as a tool of quality control, but also as a tool for corporate management, Dr. Ishikawa had consistently asserted its importance.

"I thought proper implementation of QC ... can bring about restructuring of

the management style of the company and a thought revolution in management." (1981, [B9], p. 3)

We can clearly see the essence in his works written both in his early and later years.

"It is a new quality control that would bring an industrial revolution to the management style or organization in our country." (1954, [B1], p. 1)

"I have worked for a coal liquefaction company for about 8 years after graduation from the Department of Applied Chemistry, Faculty of Engineering, the University of Tokyo in 1939. During the period, I had a two-year working experience as an Imperial Navy officer. I was wondering why Japanese companies and societies were doing such strange things. When I studied quality control, I started to believe that proper implementation of quality control could correct these strange things, or in other words, could bring improvement in corporate structure or thought revolution in management. I have persistently strived for implementation of quality control with this idea." (1980, [60])

How did he reach the idea? As shown in the Section 8.3 above, I suppose that his father Ichiro affected his way of thinking.

He saw management as follows:

"Focusing on the management of human resources, if you properly and comprehensively control the big three management factors: quality, cost (profit) and quantity, the management would be enhanced." (1964, [B1], p. 56)

"Since a company exists in a human society, the primary goal should focus on the people related to the company (consumers, employees and their families, stockholders, people concerned about subcontracting and logistics), enabling them to fulfill their potential happily." (1980, [60])

In this way, he had asserted the importance of management with respect for humanity.

"Humanity is a human being who can act with independence, of his own will, and spontaneity, distinguished from animal, machine, or human being, not

doing just because he is told to do it. Humanity also means a human being who deliberates using his head. Humanity leads the management which makes display the infinite abilities of human being." (1980, [60])

This idea has also been known as "the Industrial Democracy." Judging from the fact that many excellent American companies have tried to take this aspect into their management, Dr. Ishikawa's point was really essential for management. He also pointed out that Quality (Q), Cost (C) and Delivery (Quantity) (D) were the secondary targets to achieve this corporate purpose, and called them as "secondary targets for good management." (Hiroshi Osada, Noriaki Kano)

(2) Company-wide quality control/Anti-professionalism

In Europe and in the United States, the idea of quality professionalism, only experts in quality that is the inspection department or quality control department had to be in charge of quality matters, was prevailing. Since Dr. Ishikawa had doubts about that idea (1981, [B9], p. 33), he insisted company-wide quality control with participation of all employees from a manager to a worker (as indispensable workers.).

"In regard to quality control, top management should be responsible for quality of its products and set it as its corporate policy. It could succeed only if all employees, including middle management, engineers, employees engaging in clerical work and workers/operators, were involved in it. Even if a few engineers study and make efforts on it, it would not succeed. What we need for the success are understanding, passion and action from the top management.

In order to carry out quality control with all employees together, we must enhance human relations. In other words, it is necessary to build a company-wide collaborative structure." (1964, [B1], p. 15)

We can see that this is an original Japanese point in quality control by comparing a teaching report of Dr. Joseph M. Juran and a summary of Dr. Juran's lecture written by Dr. Ishikawa.

"Dr. Juran reached the following conclusion after returning from a plant visit in Japan.

1. Japanese companies seemed to try to implement quality control

through the organizational structures. In this way, the training of quality control would be necessary in the workplaces. Furthermore, the factory needs to reinforce the relation between all departments.

However, if we left the quality control to the workplace, they would not understand the importance of quality problems. Therefore they care only about their own workplace and have a bias against quality control, then engineers in the workplace waste time on spending pointless matter. ... It is a problem that we assign engineers in workplaces. ... We should reconsider about this. (The rest omitted.)" (Chuuzou Kamio (1954), "Dr. Juran 4. Visiting Company & Plant ... Nippon Steel Pipe," *Hinshitsu Kanri* (Statistical Quality Control), Vol. 5, No.8, pp. 400–401)

"Dr. Juran said that quality control should be implemented by the quality control department. On the other hand, the Japanese experts said that it should be implemented by the engineering department or by engineers at the workplace with the cooperation of the quality control department if necessary." (1954, [134])

Dr. Ishikawa first summarized his thoughts about the entire quality control in Japan, probably triggered by the report which was compiled with the purpose of introducing quality control of Japan on the occasion of that the delegation (Head: Mr. Noboru Yamaguchi, Deputy Head: Dr. Ishikawa) was dispatched to the USA by Japan Productivity Center in January 1958. This report is a good source to know the implementation of quality control in Japan at the time.

"At the company which introduced the quality control concept at an early stage, a quality control activity has already been initiated around 1952 throughout the company, not only in the quality control department but also in logistics, sales, engineering and other departments. At the same time, the top management began the guidance of quality control as a part of business management." (1958, [37], (1))

From an early period, Dr. Ishikawa had insisted that quality control must be carried out within the entire company. He conveyed the following idea in an essay: "Total Management and QC" printed on the back of the front cover of the magazine *Hinshitsu Kanri* (Statistical Quality Control).

> "I hope quality control in Japan should be carried out as quality control in the broad sense or total quality control combining with cost and sales quantity, not as so-called in the narrow sense in Dr. Juran's way." (1956, [4])

> "The fundamental principle of quality control, is to produce and sell what consumers want. This principle is exactly business management." (1956, [4])

He also mentioned the influence of Dr. Juran against the movements of total quality control.

> "Such movements became more active, triggered by Dr. Juran's lecture as previously stated." (1958, [37], (1))

We are not sure where the word "company-wide quality control" came from. He mentioned as follows:

> "We tend to understand the words like company-wide quality control, total quality control or QC in a broad sense, etc. in our own convenience from the past in Japan. The word of QC is significant. Therefore it is natural to define the same meaning as I mentioned above." (1960, [78])

Judging from his statement above, the word: "company-wide quality control" was already used before the 1960s. He also showed his idea of the definition in the following manner.

> "With a series of market researches and customers' surveys, a consistent quality control is required to make up a system that will bring about good functioning in all departments, every employee from a president to a janitor, not only front line like designing, procurement (materials), inspection and sales, but also staff such as research, engineering, warehouse and logistics, design for manufacturing, equipment, maintenance, accounting and general affairs. In a word, every employee will start thinking of what his role is to improve quality." (1960, [78])

(Noriaki Kano)

(3) Dr. Ishikawa's "company-wide quality control"

Dr. Ishikawa described the image of "company-wide quality control" in his own concept shown in the Figure 15.1 below. As shown in the figure, the circle of quality control lies the most outward based on the control PDCA, while the circle of quality assurance or QC on new product development lies at the center. This idea was written in his book (1964, [B1], p. 57). QC Circle overlaps the three circles and all of them comprise TQC. It is commonly said that the ultimate purpose of TQC is quality assurance. Dr. Ishikawa had especially focused on quality assurance for new product development which was the upstream point of quality assurance.

(Hiroshi Osada)

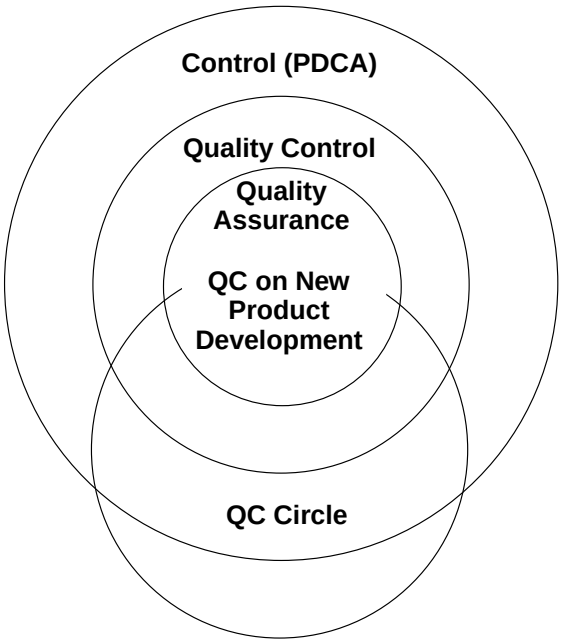

Figure 15.1 What is company-wide quality control? (1981, [B9], p. 130)

(4) Timely quotes

Dr. Ishikawa promoted quality control with a number of suitable quotes for each period.

Against trade liberalization policy announced by the Japanese government in 1960, Dr. Ishikawa asserted, "Introduce quality control for trade liberalization." (1960, [81]) He insisted that introduction and promotion of quality control was the best way for the industrial world, which was very intoxicated with free trade.

In the middle of the 1960s, he created the following two quotes:

"Secure Profits by Quality Control" (1966, [87])
"Quality Control and Customer's Benefit" (1966, [14])

The first one was presented to the management level who thought that the introduction of QC was difficult due to the effect of lowering the economic growth in 1965. Meanwhile, the second one was directed to the people who claimed that securing profits ignored the consumer benefits.

He refuted, "Since the basic principle of QC is to produce what customers are willing to buy with pleasure, QC will lead to increase sales and company's profits. Profits of a company will not be a concern if you understand QC well." (1966, [14])

Also, he asserted "To sell high quality products at high prices" against "to sell good products at low prices" many years ago, with the example of the dumping exports of Japanese products. This voice was ahead of the times. (1966, [14])

In the late 1960s, he made the following quotes:

"Quality Control Toward the World" (1968, [93])
"World Enterprise and QC — A Road to a World Enterprise" (1969, [98])

On the purpose of accelerating the recognition of Japanese products' quality enhancement, he appealed for the importance of having a global vision to the Japanese companies which inclined to have a domestic-oriented view because of an insular spirit. On the other hand, he also said the following quote to humble ourselves:

"Have a look at the world as well as enhance your business fundamentals with QC" (1968, [200])
"Eliminate the drawback by utilizing Japanese Quality Control" (1969, [43])
"Build an Affluent Society with Quality Control" (1971, [100])

In the 1970s, these phrases were presented against the pollution problems.

In the 1980s, he stressed the importance of strengthening management in order to build a prosperous world through quality control in the trend of globalization. The quotes at the time were as follows:

"No borders for quality control. It is the management ability that will be in

question." (1980, [115])

"World Prosperity through Quality" (1982, [28])

(Noriaki Kano)

(5) Quality first, Quality to meet customer's satisfaction

There has been a controversy over what "quality" means since olden times. Today, it generally and globally means the same as "customer's satisfaction." He had asserted "quality to meet customer's satisfaction" for a long time.

> "When we talk about the 'quality' in terms of quality control, it means the quality to meet customer's satisfaction." (1954, [B1], p. 6)

He asserted that, QC needs to be implemented not only at the stage of manufacturing but at the stage of designing in order to realize this concept. Furthermore, he pointed out the need for improving quality in a broad sense," which involves the cost, delivery and service, not the "quality in a narrow sense" which only deals with the product quality. In short, the "total quality control" would be required.

> "In order to produce a good quality product that customer is willing to buy, we have to consider its quality, the balance with cost and the balance with quantity. Especially in our country, this balance had not been understood. It is obvious that we have to decide a quality based on this balance. With emphasizing on this point, we could call it total quality control." (1960, [78])

In this way, he always thought about quality overlapping customer's benefits. Later, he continued to point it out by using the following word and phrases: "Quality Control and Customer's Benefit" (1966, [14]), "Consumerism" (1970, [20]) and "Consumers and Quality Control" (1985, [31]).

In addition, he told us to realize "quality to meet customers' satisfaction" as a management policy would lead the corporate profits in a long term, with the quote: "Quality first."

> "If you pursue 'quality first,' the long-term profits will increase. On the contrary, if you pursue the short-term profits, you would lose global competition

and long-term profit." (1980, [601])

(Noriaki Kano)

15.3 Quality Assurance

(1) The next process is our customer

At first, Dr. Ishikawa used the expression: "The next process is the consumer, while the previous process is the producer." (1954, [B1], p.9)

In order to realize "quality meets customers' satisfaction," he explained about who should be responsible, and what should be done under what kind of guiding principle as follows:

> "For example, at a steelmaker, the steel-making department would be a producer to the rolling department, while the steel-making department would be a consumer to the iron-making department which is the previous process. So, the steel-making department would be responsible for making a product with quality to meet the satisfaction of the next process, which is the rolling department. The steel-making department would also be responsible for receiving an investigation result on how the steel influences a product, frankly asking what the rolling department's requirements are, having a meeting with them and being responsible to meet those requirements." (1954, [B1], p. 9)

Later, Dr. Ishikawa changed the expression to "The next process is our customer." (1981, [B9], p.51)

(2) NPD (New Product Development) emphasized quality assurance

The modern concept of quality control was born in the United States around the 1930s. Its approaches involved how we achieved a specific quality standard, which meant activities to reduce product failures, as the definition of the word "control" showed. When the concept was introduced to Japan, it also became known as reducing product failures. On this point, it was Dr. Juran's lecture that made an initial impact, (*Report of Dr. Juran's lecture*, JUSE, 1954) and Dr. Ishikawa wrote about it in a lecture

summary (1954, [134]).

Looking back on the development of quality control, Dr. Ishikawa mentioned as below:

> "We must conduct quality assurance from the new product development stage. It was the late 1950s when this feeling was growing." (1981, [B9], p. 27)

When he talked about quality control, he divided it into three stages: inspection-emphasized quality assurance, process-control-emphasized quality assurance and NPD emphasized quality assurance, and always emphasized the importance of the NPD.

In the March 1957 issue of *Hinshitsu Kanri* (Statistical Quality Control), new product was a major topic in the QC course. The contents were only at a superficial level compared to today's. The aforesaid report for introducing the Japanese quality control to the United States addressed a little bit about how to determine tolerance, but it did not refer to new product development or designing at all (1958, [37]).

However, in the report compiled after returning from the States, he mentioned as follows:

> "In my theory, quality control should start from a designing stage especially in the electric or machine industry." (1958, [248])

Furthermore, in 1964, he expressed his thoughts with more confidence as follows:

> "QC in new product development is one area where I have made my effort as top priority because it is a key activity for a company to survive." (1964, [38])

In 1966, he organized a one-year lecture series under the theme of "Quality of Design" in *Hinshitsu Kanri* (Statistical Quality Control) and wrote the articles by himself (1986, [347], [349]).

Probably, it was from his visit to the United States as a member of an observation group in 1958, which triggered him to recognize the importance of a relationship between new product development/designing and quality.

(3) True Quality Characteristic / Substitute Quality Characteristic

When we try to control the quality of a certain product, we first need to figure out what is the quality characteristic. Dr. Ishikawa presented that we usually treat a substitute quality characteristic in many cases, while a true quality characteristic exists separately.

> "What we need to focus on is the quality that customers really want. — We call it a true quality, efficiency — and the first step of quality control is to find it. On the other hand, purity or tensile strength, for example, is just a factor or a cause to get a standard performance, which we call a substitute quality characteristic." (1961, [B5], p. 5)

The quality table that many companies are now using emanated from this concept.

(4) Introduction of Reliability

In the aforementioned report for introducing the Japanese quality control, the article about reliability only referred to "life test" in the chapter of "QC in the electric industry." (1958, [37], (2))

However, the report published after the visit to the United States (1959, [B3]; compiled mainly by Dr. Ishikawa and Prof. Karatsu) stressed its importance of reliability in the State over eight pages.

The AGREE report that the observation group brought from the States later became known as the bible. The outline was translated by Prof. Shiomi following the instruction of Dr. Ishikawa, and was reported at the Ishikawa Research Group. In October 1958, the reliability research committee was set up in JUSE, which was a start of thorough reliability research in Japan. Thus, we can see how significant the impact on the development of Japanese product reliability that the mission to inspect brought.

Later, Dr. Ishikawa organized a series of articles about reliability in the magazine: *Hinshitsu Kanri* (Statistical Quality Control) (1961, [298]). He also released the following articles and papers on reliability:

"Reliability in the United States" (1965, [253])
"What is Reliability" (1965, [302])
"Quality Assurance and Reliability" (1968, [303])

"Reliability and Quality Control" (1970, [307])
"Reliability and Quality Control" (1971, [309])
"Thoughts on Reliability" (1982, [321])
"Quality and Reliability –Full Check of Quality–" (1983, [322])
"Quality Control and Reliability / Maintainability" (1986, [323])

He strongly asserted that it is essential to proceed thinking about both quality control and reliability comprehensively, not separately.

Note: Valuable information was given by Prof. Hiroshi Shiomi and Prof. Kazuyuki Suzuki for this section.

(5) Introduction of Product Liability

When the phrase Product Liability (PL) was brought to Japan around the late 1960s, it was not really properly understood at first. Dr. Ishikawa made intensive research on product liability at the occasion of his visit to the United States and Europe as the head of the 7th QC Observation Team sent from JUSE in 1972. After returning from the visit, he introduced the research result through his lectures, magazines articles, books and so on. This triggered many changes and activities about PL, such as setting up the PL Research Committee in JUSE in October 1972 and sending the 1st PL Observation Team (Head: Dr. Shigeru Mizuno) to the United States and Europe in 1973.

Dr. Ishikawa wrote about PL in his book (1973, [B19]), papers and articles (1973, [312], [314], [316]; 1974, [317], [318], [319]).

He presented the following 12 pieces of advice to pay attention to in dealing with PL. Even 20 years later, they are still not obsolete.

"Clarify the safety problem. — Set up a PLP committee to raise awareness about safety."

"Check the technology for safety again. — Enhance the standard on product safety."

"Conduct thorough trial tests in the process of new product development. Never say 'I couldn't imagine the way that they used it.'"

"We need to think about safety related to reliability. — Especially, top management has the responsibility not to distribute unsafe products on the market. We are seeing many new products brought on to the market even as they were still

in-process without sufficient tests being done, because no products could be shipped. Top management must have the absolute right to stop shipping unsafe products. Otherwise, they would face a disaster."

"The data of parts and subassemblies including outsourced ones should be accumulated and recorded in a computer by lot, so that we will be able to access the appropriate data as evidence."

"An actual product must correspond to its drawing."

"Create manual for work procedure, then perform the operation according the manual exactly. To provide a foolproof mechanism is important not to make defective products. It will be also the good evidence in case of a lawsuit."

"In many companies, we are seeing 'concession,' which means giving 'ok' to the products after some adjustment even though they were rejected in the inspection. We must ensure the system of the 'concession' work without any problems."

"Failure analysis — More thorough analysis are necessary to identify failure causes."

"Design Review — How detailed we test for safety in the process of new product development."

"Review instruction manuals, advertisement, catalogue and others. — Put customers' 'Don'ts' in a very big font."

"Take records of what could be evidence (Traceability). — We have to consider to what extent data we should save. We cannot save infinite data. We have to study the limit of a computer as well as how to operate a computer."

(6) Quality Analysis / Backward Looking Quality

As stated above, Dr. Ishikawa had emphasized his thought on "quality to meet customers' satisfaction" for a long time. Meanwhile, he raised the question: "a systematic analysis on quality itself has not been conducted." (1973, [357]) Then, he made the proposal of "quality analysis."

"What would be the quality that consumers, societies, manufacturers, logistics companies and others want? It is impossible to achieve quality satisfying all the demands. However, we have to pursue the quality that consumers are willing to buy." (1973, [357])

He also suggested "forward looking quality" and "backward looking quality" as

follows:

"Failure analysis, one of the quality assurance processes, is very important, in terms of not creating failures, defects and unsafe products as a manufacturer's responsibility. However, it is a conservative and passive quality analysis. Why don't we call it backward-looking quality? " (1973, [357])

"On the other hand, we have to think about the quality that consumers would be happy with. I would like to call it aggressive, positive, strategic, or forward-looking quality." (1973, [357])

On that basis, he proposed "quality analysis."

"I would like to define quality analysis as making analysis on a product comprehensively by covering both forward- and backward-looking quality." (1973, [357])

By the time he obtained the idea of quality analysis, various things were brought together and connected in his mind. For example, cause and effect diagram, the standard rationalization committee (see Chapter 14), research of product and process capacity that he saw in the States in 1958 (especially prototype testing), and a visit to the failure analysis laboratory at Lockheed Corporation when he went to the States in 1972.

The following statement implies his expectation for quality analysis.

"In order to conduct real quality analysis in Japan, we have to conduct a realistic quality analysis like the Lockheed Corporation does. But this analysis is not enough. I want to suggest conducting further and broadly-interpreted quality analysis including the quality that consumers and the world would be happy with." (1973, [357])

Dr. Ishikawa was not really satisfied with the result of quality analysis movements at the time, in spite of his enthusiasm of creating the new word. Therefore, in 1975, he chose the theme again as a feature article in the magazine *Hinshitsu Kanri* (Statistical Quality Control).

"I chose the theme of quality analysis in 1973 and wrote the lecture articles for one year in this magazine to help the QC-related people to think about it, however,

it has not been well organized and still been insufficient. So, I decided to pick up the theme again." (1975, [364])

Later, in the quality control field, a system of new product development was established based on "quality development." Also, reliability activities were developed based on "FMEA/FTA" or "failure analysis/reliability test." Furthermore, the concept of "attractive quality/must-be quality" was born based on "forward- and backward-looking quality." Thus, today's reputation of Japanese products which is high quality and high reliability has prevailed in the world market. And, Dr. Ishikawa's pioneering idea was a start and a base of these movements. I wanted to ask him "Is today's quality analysis close enough to something you had imagined?"

(Noriaki Kano, Shinsuke Furuya)

15.4 Management Concept

(1) Process control with control chart: Build quality into the process

We can say that a control chart was well-received in the period of QC introduction because of the 8-day program lectured by Dr. Deming, who came to Japan in 1950. According to the lecture report (*Lectures on Statistical Control of Quality*, JUSE, 1950), 7 days out of 8 were spent on control chart, while the other 1 day was spent on sampling inspection. Dr. Ishikawa was also one of the editors and commentators for editing the lecture report. He must have received a huge impact from Dr. Deming.

Mr. H. F. Dodge was a friend of Dr. Deming. The lecture report introduced his words as follows. "Quality of a certain product cannot be built only by inspection." "Quality is something that has to be created." These words emphasized the following points:

"Statistical control is not the removal of bad items, by inspection."

"Statistical control means building quality into the products, by achieving a maximum degree of uniformity in the production process."

Dr. Ishikawa often said the words: "Build quality into the process." This was probably influenced by the aforementioned idea of Dr. Deming's.

One of his famous remarks is "Quality control starts with control chart and ends

with control chart." In a list of his books are included the next two works concerning the control chart.

Control Charts in Factory Management (Translation) (1953, [B21])
The Control Chart Method (Written & Edited), (1955, [B23]); (Revised Edition), (1962, [B23])

Moreover, control chart is explained over a lot of pages in the following works:

Introduction to Quality Control, (1st edition) (1954, [B1])
Introduction to Quality Control (A) (2nd edition), (1964, [B1])
Introduction to Quality Control (B) (1966, [B1])
Introduction to Quality Control, (3rd edition) (1989, [B1])

Dr. Ishikawa was the head of the Control Chart Research Group of the JUSE's quality control seminar (basic course). Thus, we can see how much he devoted his energy to control charts.

(2) Cause and Effect Diagram/Fishbone Chart, Godzilla Bone Chart, Ishikawa Diagram

Dr. Ishikawa wrote the 3 articles about how the cause and effect diagram was born (1965, [421]; 1968, [197]; 1969, [424]). Let's look at his articles to find out how it was born and where the nicknames came from.

> "First of all, we need to distinguish a goal or a target (effect) from a cause. Then, I came up with the idea of visualizing in a diagram a relationship between the goal or the target, which is the effect, and the cause in processes. I named it cause and effect diagram. This was around 1950 to 1951. At the beginning, I only used it in a classroom. Later in 1952, when I introduced it at the Fukiai Plant of Kawasaki Steel Corporation (present JFE Steel Corporation,) I found it a very useful diagram such as a tool for standardization. So, I began actively recommending it." (1968, [197])

> "One or two years later, when I visited the plant of Nippon Soda in Aizu-Wakamatsu in Fukushima Prefecture, the people at the plant called the diagram 'Fishbone.' I thought it was a really nice and easy-to-understand name.

However, as I looked into the diagram they made, it resembled a skeleton of a fish, but it only had large bones. It was not good. So, I explained that a fishbone diagram must have medium and small bones as well as large ones. I used Godzilla as an example, which was popular at the time, pointing out to write a 'Godzilla' bone diagram, since the giant monster had a lot of bones including very small bones. Anyway, I kept using the name of 'fishbone' because it was nice to understand for people working at a plant." (1968, [197])

"When Dr. Juran made his second visit to Japan in 1960, he got so interested in my explanation about the cause and effect diagram that he put it on a quality control handbook with the names of 'Cause and Effect Diagram,' 'Fish Bone's Diagram' and 'Ishikawa Diagram.'" (1968, [197])

(3) Control Step

Speaking of "Control" today, it means "Rotating the PDCA cycles." Its first stage was our awareness about both a need of standardization in control and a general step in control. He explained this point in his book: *Introduction to Quality Control* (1954, [B1], p. 10) published in April 1954 as follows:

"In terms of quality control, the steps are as follows:

1. Decide a quality standard.
2. Decide a technical standard and a work standard.
3. Teach and train people with the work standard.
4. Do the work.
5. Check the work whether it corresponds to the standard or not.
6. Re-work if it does not correspond to the standard.
7. Check if the re-work is done correctly or not."

Dr. Juran, who came to Japan in July 1954, defined control as "a system of all steps to reach a standard that we prepare."

Dr. Juran also indicated the "seven steps of control." (*Dr. Juran's lecture report*, JUSE, 1954)

"1. Choice of a control point = Discover what is important.
2. Unit of measure

3. Systematic means for measuring actual performance
4. Standard of performance
5. Interpretation of difference between actual and standard performances
6. Decision on what action to take
7. Action to carry out the decision"

Comparing with the one by Dr. Ishikawa above, the number of steps is same, whereas the contents are different. We can say the two concepts were established independently.

As the second stage, it would be a question how these steps were summarized in the PDCA cycle. With regard to this, Dr. Deming's "8 sectors of the wheel" and the next remarks in the Dr. Juran's lecture report were the starting points.

"Fundamental steps for doing something include 3 steps; planning, doing and seeing. In fact, these can be switched to planning, operating and controlling. These steps shape an upward spiral, improving or going up to the next step by spiraling.

It was the starting point and the concept was developed by Dr. Shigeru Mizuno in the late 1950s and 1960s, which is implied in a monthly report in the quality control basic seminar. Then, the monthly lecture report, written by Dr. Mizuno, for the 21st basic course held in August 1961, showed the steps of 'plan do, check and act' as the same style as we use now, with a title of a "control circle."

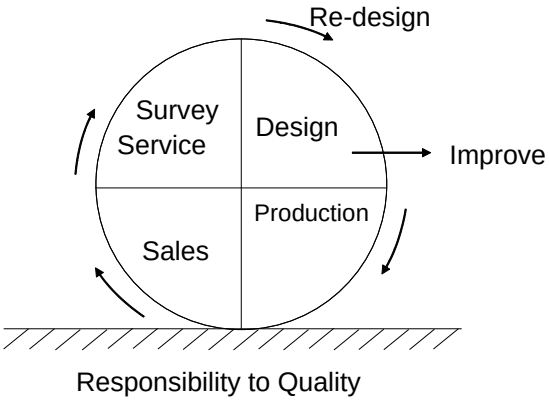

Figure 15.2 Basic Rules of Quality Control (1961, [B5], p. 7)

Figure 15.2, in the *Hinshitsu Kanri* (Statistical Quality Control) (1961, [B5]), introduced the Dr. Deming's idea with the title of "Basic Rules of Quality Control." The figure was also introduced as the control concept, the Deming's cycle" in the "*The*

Control Chart Method (1962, [B23], p. 13). On the other hand, in the articles that Dr. Ishikawa wrote, the aforementioned 7 steps were published as corresponding to the PDCA cycle, together with the next comment in the *Introduction to Quality Control* (1964, [B1]).

> "These are the more realistic and QC-style steps rather than scientific control so-called plan, do and see." (1964, [B1], p. 30)

(Noriaki Kano)

15.5 Administrative Methods on Quality Control

(1) Emphasis on Education

One of the important infrastructures of quality control is education and training. Dr. Ishikawa explained the difference between education and training derived from his own experiences and thoughts.

> "In Japan, we always speak about education and training as a set, while in the Europe and the United States, they only use the word training as 'industrial training,' not using the word education. I suppose they want to improve their skills by training rather than by education. I personally think we need to sharpen our brain and change our ways of thinking not only by training but also by education." (1981, [B9], p. 56)

I think his idea implied that Japanese quality control was built on education, aiming for human growth and respect for humanity which was one of the features of Japanese quality control.

> "Quality control starts and ends with education." (1972, [22])

The above is a famous phrase of Dr. Ishikawa. He never separated humanity from TQC. His sociological and anthropological examination through TQC was probably established based on his own experiences. (Hiroshi Osada)

(2) Cross-functional management based on a cross-functional management committee

Today, cross-functional management is an important system for TQC promotion as well as *hoshin kanri* (policy management) and daily management. Toyota Motor Corporation was the first company that introduced cross-functional management in the early 1960s. Later, Komatsu Ltd. and others also implemented it. Today the cross-functional management attracts attention from a lot of top management and managers overseas. Dr. Ishikawa described how it was developed as an advocate.

> "About the cross-functional management, I explained it with a matrix chart with variables of department and function in the year 1960. Then, Toyota Motor Corporation introduced, implemented with various efforts and succeeded in it." (1981, [B9], p. 160)

He pointed out a reason why such a system would be required.

> "Japanese societies and companies have strong hierarchical and vertical relationships, whereas their horizontal relationships are weak due to sectionalism." (1980, [60], p. 9)

> "Cross-functional management based on a cross-functional management committee means building a horizontal relationship through the committee." (1980, [60])

He also mentioned how the committee should be organized and operated. With respect to the effect, he stressed as follows.

> "Executives come to have wide views like managers, not just the representatives of departments. Directors will become the real directors. Their ways of thinking will become flexible. They will learn to help each other." (1981, [B9], p. 165)

At the same time, however, he was concerned about the actual situation that did not reach the level as he said in the statement above.

> "If the thought revolution called cross-functional management is not achieved,

the cross-functional management committee will be in name only and will not work well. Actually, a company with a strong top-down style ran by an autocrat needs to implement the management style. However, it has yet been worked well in many cases." (1980, [60])

This is one of our tasks to develop this concept and system in the future.

The background of his proposal of cross-function management might be studying hard about the organization when he wrote the manuscript of "Plant Organization" which was the first issue of the series of QC lecture of *Hinshitsu Kanri* (Statistical Quality Control) in 1957. In addition, it might also be a matrix chart he made with two sustainable management goals [quality, cost and quantity] and the measures [research, production technology and manufacturing engineering, materials, *Genba*: workplace, sales and survey], shown in his report at the visit to the States in 1958.

In addition, he asserted, "At all stages from researches to sales and surveys, the three factors of management goal; quality, cost and quantity must be considered." (1958, [249])

Therefore, I assume that he got some clues about the concept in the USA.

(Noriaki Kano)

(3) Ten QC Principles for Vendee-Vendor Relations

As previously mentioned in Section 15.1(2), Dr. Ishikawa was an all-round player of QC who handled everything from the QC of new product development to the QC of sales and services. He was especially good at "the QC of outsourcing and purchase control." Concerning the outsourcing and purchase control, he thought that top management should make the policy clear, and should especially have a priority to clarify the following points:

"1. Make a clear decision on buying or producing, which means either selecting professional suppliers and buying from them or producing within a company.
2. Make a clear decision on either two options. One is educating vendors to be professional suppliers, letting them do their own management and allowing them to sell the product to other companies. The other one is having vendors as affiliate companies, which means their management is handled with the responsible of the vendee." (1981, [B9], p. 227)

With respect to the vendee-vendor relationship, he always explained the "Ten QC Principles for Vendee-Vendor Relationship" and stressed its importance as well. The principles were established based on the Dr. Ishikawa's "Vendor-Vendee Relationship" (1960, [334]) and the "5 Principles for Vendor-Vendee Relationship" by the American Society for Quality Control (ASQC), and led by Dr. Ishikawa at the QC Conference in 1960 (1960, [335]). Later, the principles were revised in 1967 as shown in Table 15.2 (1967, [350]).

Note: The title of the principles, when it was established in 1960, was the "Ten QC Principles for Vendor-Vendee Relationship." When it was revised in 1967, the order of vendor and vendee was switched because of "placing top priority on consumers (vendees) in the QC concept." (1967, [350])

Table 15.2 (1967, [350])

Ten New QC Principles for Vendee-Vendor Relations (Provisional)

Both vendee and vendor should perform the basic rules below with mutual trust, cooperation, philosophy of co-existence, and corporate's social responsibility.

1. Both vendee and vendor are fully responsible for applications of quality control with mutual understanding and cooperation between their quality control systems.
2. Both vendee and vendor should be independent and respect each other.
3. The vendee is responsible to the vendor for offering the demand that the vendor clearly understands what he should manufacture.
4. Both vendee and vendor should sign a rational contract when they begin trading regarding with quality, quantity, price, and the data of delivery, etc.
5. The vendor is responsible for the assurance of quality that will give satisfaction to the vendee, moreover complying with a request for providing the objective data needed.
6. Both vendee and vendor should decide the method how to evaluate the products for both being satisfied.
7. Both vendee and vendor should decide the systems and procedures for the trouble resolution when the contract is established.
8. Both vendee and vendor, should exchange necessary information to carry out quality control taking into consideration the other parties' standing.
9. Bothe vendee and vendor should keep sufficient on control ordering, production, inventory planning, paperwork and organization, etc. to maintain their smooth relationship.
10. Both vendee and vendor should always take the consumers' advantage into account at the transactions.

His basic idea on outsourcing and purchase control was summarized in his word: “Manufacturers should be responsible for quality assurance.” (1981, [B9], p. 239)

Based on this idea, he created 8 levels of the vendee-vendor relationship and explained it with the Table 15.3 below. This table would be useful as a checklist when a company makes self-evaluation on a relationship with its supplier.

Dr. Ishikawa was involved in selecting a paint company as a member of an advisory group on painting, which was set up in the Japan National Railways in 1960. His activity at the advisory group was compiled in the following article:

> “An Example of Selecting a Supplier —Selecting Method for a Painting Company in Japan National Railways” (1964, [345])

In addition, he wrote the following papers about outsourcing and purchase control: “Rationalization of Contract” (1954, [324]), “Purchasing Inspection” (1962, [339]), “Outsourcing/Purchase” (1964, [344]), “Outsourcing and Quality Control” (1965, [346]), etc.

Table 15.3 Vendee-Vendor Relationship on Quality Assurance (1981, [B9], p. 238)

	Vendor		Vendee	
Step	**Manufacturing**	**Inspection**	**Inspection**	**Manufacturing**
1	—	—	—	100% Inspection
2	—	—	100% Inspection	
3	—	100% Inspection	100% Inspection	
4	—	100% Inspection	Sampling Inspection or Visual Inspection	
5	100% Inspection	Sampling Inspection	Sampling Inspection or Visual Inspection	
6	Process Control	Sampling Inspection	Visual Inspection or No Inspection	
7	Process Control	Visual Inspection	Visual Inspection or No Inspection	
8	Process Control	No Inspection	No Inspection	

(Noriaki Kano)

(4) Dr. Ishikawa's basic concept on organizational management with TQC

1) Manager's Roles

Dr. Ishikawa placed a lot of emphasis on corporate organization as a foundation to promote TQC because he thought it is the very employees who carry out the TQC management and the organization which is nothing but a group of employees.

He mentioned organizational management, referring in detail to roles and ideal status of top management, middle managers and staff, based on his rich experiences as a business person and an instructor. His book: *What is Total Quality Control? The Japanese Way* described it in a very easy-to-understand manner. I would say the book is extremely rare because it is a QC book and would also be very helpful as a business management textbook.

When he talked about the manager's roles, he used specific and appropriate metaphors. Some examples are shown below:

"Middle managers are the traffic policemen in a company."

"QC staff should be the service staff. The staff should serve as the service staff 70% and as the general staff 30%."

"Be the one who doesn't have to be at a company but be the one indispensable for the company."

The last one is one of his most valuable quotes.

2) Delegation of authority and standardization

One of the points that Dr. Ishikawa always referred during his lectures for top management and managers was "Facilitate delegation of authority."

He pointed out the importance by saying "Because of insufficient delegation of authority, managers are too busy with their daily businesses to think about the future."

He also stressed the responsibility of senior managers by saying "Authority can be delegated, while responsibility cannot be."

In response to the top management and managers who were concerned that their jobs might be taken away or their companies might be differently operated from their own thoughts, Dr. Ishikawa replied by indicating the significance of standardization.

"Standardization is required for delegation of authority."

I often saw the audience fully agreed and nodded sympathetically at this point.

The report he made after the visit to the USA in 1958 referred to delegation of authority in the section of QC team position and its function for the first time. (1958, [248])

3) Management based on a theory that man is by nature good / Management based on a theory that man is by nature evil

This also was his favorite theme, and first appeared on his book: *Introduction to Quality Control (A)* (1964, [B1], p. 6, p. 35). When he explained about the difference of QC between in Japan and in the Europe and the United States, he always mentioned this theme. Also, when his book: *What is Total Quality Control? The Japanese Way* was translated into English, the translator: Dr. Lu argued with Dr. Ishikawa on this point. As a result, Dr. Lu's comment appeared on the translation note (1985, [B9]) as objection to the Dr. Ishikawa's opinion.

There are many quotes he made and used in the TQC mentoring at companies, such as "Work on daily business and QC together," "It is essential to get a sense of QC," etc. These quotes are listed in Chapter 16. (Noriaki Kano, Hiroshi Osada)

15.6 The Statistical Method, and the Design of Experiments

What is your impression of Dr. Ishikawa? Many people would answer "Famous for QC" or "The world authority on QC." Actually, the doctor's laboratory initially belonged to the Department of Applied Chemistry (chemical engineering) and later belonged to the Department of Fuel Engineering (changed to the Department of Reactive Chemistry in 1971.) So, high pressure coal molding, or coal briquettes, was one of his research themes in the late 1940s, which might be hard to believe.

In 1954, when I joined the laboratory, there were still manually-operated coal analysis equipments, including as much as constant-temperature drying ovens and other electric furnaces. As for crushers, sample reducers, sample dividers and other items, it was almost fully equipped. One of his main research themes in the early days: "A study on sampling methods for the bulk material," which was conducted with this experimental equipment.

The hardware he used for his research included crushers and simple analysis equipment. But, it is the software, such as the Statistical Method and the Experimental Design that supported his research. Based on his experiences with these methods, he

produced a series of lecture articles in the *Chemistry and Engineering*, which was a journal of the Chemical Society of Japan. Then, based on this series, he published 3 books from Tokyo Chemistry Coterie.

Statistical Methods for Chemists and Chemical Engineers (1964, [B26])

Design of Experiments for Chemists and Chemical Engineers (Vol. 1) (1967, [B27])

Design of Experiments for Chemists and Chemical Engineers (Vol. 2) (1967, [B27])

These books were written by Dr. Ishikawa in collaboration with Dr. Hitoshi Kume and Dr. Toshimi Fujimori. Since the target readers were chemists and chemical engineers, not QC engineers, the books were slightly different from usual textbooks about statistical methods in that they contained many chemist-friendly examples instead of difficult theories and formula. Therefore, it became very popular especially with many people engaging in chemistry who had been prejudiced against statistical methods. Moreover, it has been a longtime seller from Tokyo Chemistry Coterie. The book *Statistical Methods for Chemists and Chemical Engineers* (2nd edition) was published in 1990.

I think one of the outstanding features of his achievements was making direct contributions to the postwar economic reconstruction of Japan by linking his research results with production worksites. These 3 books could be said the examples of his results.

In spite of the fact that Dr. Ishikawa has now been famous for QC, the books covered his original background of starting in a chemistry department.

(Toshimi Fujimori)

15.7 Transfer of TQC to Overseas

Today, in the globalized world, we have seen the increasing importance of technology exchange and technology transfer to other countries in Japan. Dr. Ishikawa thought that spreading the Japanese TQC abroad meant a kind of transferring a management technology. Besides, he set up the following criteria to indicate when a transfer was completed, which was really a QC style.

1. Quality control and the subsequent cost down can be achieved by themselves.
2. New products can be developed by themselves.

Furthermore, he touched upon the importance of increasing the number of QC instructors who could see and act from the other person's point of view. This was a timely and critical remark right in the middle of discussion on Japan's global contribution. It was surprising that he made the remarks even ten years ago.

The main point of his theory about transferring TQC abroad was "Don't transfer TQC directly to a place with a different social background because the TQC which is a needed management technique and different from other sciences, must involve people in order to be operated properly. As the Japanese quality control was brought up in Japanese culture and society, the TQC in a certain country should be implemented in the certain country's way. Therefore, he identified 14 items of difference between Japan and the western countries.

Table 15.4 14 social background differences (1985, [289])

1. Great emphasis is placed on professionalism and specialization in western countries. "QC only for QC specialists"
2. Labor unions are trade unions in western countries and enterprise-wide unions in Japan.
3. Elitism and class-consciousness among university graduates
4. Great emphasis is placed on the Taylor Method in the western countries.
5. Wage system: performance-based pay system (to motivate people by money alone), versus a seniority-based pay system
6. High turnover rates and layoffs in the western counties, while a life-time employment system in Japan
7. Organization: Japan has a hierarchical and vertical society, sectionalism —the tendency is strong in Japan.
8. Religion: Christianity, Buddhism and Confucianism, a theory that man is by nature good or by nature evil
9. Literacy: People using Chinese characters are generally more interested in education.
10. Education: General education & QC education in Japan. In western counties, training only.
11. Ethnically homogeneous nation vs. Multiethnic nation
12. Vendee-Vendor relationship: Us or Them, To Trust or Not To Trust, To develop a supplier as a group company or to have it as just one of the suppliers, Outsourcing rate: 50% in the States and 70% in Japan
13. Old-style capitalism vs. Democratic capitalism: Having an owner or not, Aiming at Short-term or Long-term profits
14. The roles of governments: Control, Stimulation, Freedom, Competition

The above 14 points would be useful in transferring TQC abroad as a checklist.

(Hiroshi Osada)

15.8 QC in the Service Industry

Dr. Ishikawa had also done pioneering work in the service industry for a long time by asserting the importance of QC and the ways of facilitating it. He wrote many books on this topic as shown below:

"Service — With no service, no product sell well" (1963, [12])
"Trading Company" (1964, [443])
"Sales People" (1966, [146])
"Distribution System" (1968, [447]; 1968, [448])
"Sales/Services, Logistics, Service Industry" (1974, [B20], p. 222, p. 727, p. 750)
"Service Industry" (1975, [450])
"Hospital" (1982, [453])
"Sales and Distribution Industry" (1982, [454])
"Software" (1981, [451]; 1983, [455]; 1984, [456])
"Utility Firms" (1985, [458])

In these books, we could see his foresight. Probably, it was his first time to visit the USA in 1958 when he got an idea of applying quality control in the service industry too, which was implied in the report written at the time (1959, [B3]).

After his death, a book *TQC in the Service Industry* (JUSE Press, 1990) was published. Although, he had agreed to write an article for the book, it was not in time unfortunately. In order to praise his foresight on the service industry, the first page of the book is the list of his works in the field. (Noriaki Kano)