Toyota Chairman vs. a Mathematician

Fujio Cho
Chairman of the Board,
Toyota Motor Corporation

Toshiyuki Kobayashi
Professor,
Graduate School of Mathematical Sciences,
The University of Tokyo and Kavli IPMU

A Dialogue Between a Mathematician and Toyota's Chairman: Think, Think, and Think Again.

What Lies Beneath

Kobayashi (K): I believe that there are a variety of things that are fundamental but rarely perceived, that are important but too obvious to attract our attention. Do you think the value of honesty for a company is such a thing? I surmise that a sound company does not have to think about "the value of honesty" so often because people there just take it as a matter of course. On the other hand, dishonesty—needless to say fraud, but also pretending to know everything without performing investigations, which I also consider a kind of dishonesty—seems to result in a long-term loss even though it may produce a large short-term gain.

Today I would like to talk with you, by highlighting things that we are usually unaware of. Of course, there are two opposite cases for these things, namely, because they are so natural that we take them for granted, or simply because they are not important.

Mathematics might be the former case. The smoother mathematics is functioning within society, the more people are unaware of it. Mathematics is thought of as fundamental in science and technology. Nevertheless it might go well for the time

being even if we ignore mathematics and forget thinking about reason and logic. But this would not be the right way if we hope to achieve long-term success.

If mathematics could be useful in the real world, how? Since I am a mathematician, I am afraid that my answer to this question would be biased. Instead, I would like to hear opinions of a Japanese business leader.

Cho (C): How clear your explanation is! Since I was a law student at the university, I did not take math classes after finishing my sophomore year. So, my knowledge of mathematics is very limited, especially when my conversation partner is a professional. However, I believe mathematics is the science that has the most logical and reasonable structure.

(Mathematical) Reason and Sentiment

C: Reason is antithetical to sentiment. It is very important to use rationality while organizing information. I think mathematics is the best practice for developing our reason.

Math Is Fun

C: Until I was a sophomore in high school, I was more interested in judo and kendo than classroom studies. I studied math very hard over the next two years. I had been told by my father that the family's economic circumstances did not allow me to go to a private university. So I had to study eight subjects, including Math I and Math II. But I liked math because math valued logical thinking.

My father also graduated from a law school, and he was a very logical-minded man. When I was in junior high and high school, he used to talk me down logically by asking the reason for my argument. When I said something off the top of my head, I was often scolded, with him saying, "You have to think more logically." When I studied math, I realized how my father's advice was valuable. In the second year of high school, I decided to major in the humanities in college, but math was still fun to me. Looking back, the relationship with my father had an influence on my bent toward mathematics.

Mathematics and "Kaizen"

C: After graduating from the university, I started working for Toyota. Six years later, I was told to do "Kaizen" (improvement of production processes), although what I had majored in was law, not engineering. Kaizen is an engineering person's job, I thought. I was embarrassed and tried to persuade my boss to reconsider his decision,

but in vain. I have now been doing Kaizen for 15 years. Looking back on these 15 years, I find I learned many things, mainly two lessons.

The first lesson I learned was the fact that production processes consisted of many numbers. It seems there is something related to what Prof. Kobayashi mentioned previously with regard to the term "honesty": If people in a factory do their jobs based on numbers, there can be little room for cheating and fudging. To be based on numbers is the same thing as to be based on honesty. Production planning–which sort and how many vehicles will be produced, how much sales are expected, how much the cost price will be, etc.–is totally based on numbers. Without numbers, we can say nothing but subjective remarks like "That vehicle looks cool" or "This one provides a comfortable ride." When we have to develop a new car, we cannot depend on such empty words. What we need is information that is expressed with numbers, such as bulk weight, noise level, vibration level, etc. By "numbers," I am not talking about technical calculations that are conducted in laboratories. I am talking about simple arithmetic, such as addition, subtraction, multiplication and division. Numbers and arithmetic are what Toyota's 300,000 employees share as the fundamental communication tool.

Ask "Why" Five Times

C: The first lesson I learned from Kaizen is the importance of numbers, which are objective tools for us rather than abstract ideas. On the other hand, the second lesson I learned has something more fundamentally mathematical. Doing mathematics and being logical seem to me to be rather the same thing.

"All things have their causes." Everyone knows that. However, people in our company do not stop here, but keep thinking that "All things have their causes, and all causes also have their real causes." They should track back from causes to causes until they find real causes. To do so, they should ask themselves the question "why" at least five times.

They should go to factories themselves, observe what's going on there, and use their own hands to measure and count. They should not make their tasks self-contained. When there is a good business, there is a sound logic behind it. Everything derives from logic and numbers, and nothing in the world will happen by chance. So, I was always tracking back problems until I found effective measures. I kept asking questions like "Why does the cost price keep rising?" "Why did this machine break down?" and "Why are there so many defective parts?" After thoroughly asking myself such questions, I was able to understand the real causes of a particular problem.

One day in a factory, I encountered a strange case. The blade in a certain machine, which was supposed to last at least one month, was dead in the first week. I guessed the supplier of the blade might have mixed in the wrong ingredients, but it was not the case. Then, why? What made the blade break so quickly? That the machine's blade broke once a week meant that one could observe the instance of a break if one

kept watching it for a week! We worked in rotation and kept watching it. We noticed that the blade broke because iron scraps wound around it and exerted a strong force on it. Then, why did the scraps wind around the blade? We found many plausible causes for this phenomenon. The solution we finally found was to attach a cutting device to the machine, so that the produced scraps were made too short to wind around the blade.

These experiences made me develop a habit of seeing things logically. If my father were still living today, he would be a little proud of me.

K: I am delighted to know your "5-Whys" principle in the Toyota Company! As a mathematician, I think that such a spirit is crucial also in creating a new theory of mathematics. As an educator, this is what I am trying to emphasize in classrooms. Though I usually teach graduate students majoring in mathematics, I like giving elementary courses for undergratudates, in particular, for students majoring in the humanities, law, or economics, when my schedule permits it. In these courses, I advise students not to memorize individual mathematical formulas because what is crucial is to understand them systematically. I feel it more important to make an effort to understand the logic and the rationale and to see through something universal. For this I suggest that they cultivate the habit during my semester course in the following way: "Do not avoid the things that you do not understand," "Try to clarify, capture and pin down by your own language what you do not understand" and "Keep thinking about it again and again."

C: That's a good idea!

K: Toyota's 5-Whys seems to me to share a quite similar basis. A blind acceptance of knowledge is a facile solution but may result in an obstruction to making further progress. We often realize that we have understood nothing. Starting from this, we work hard to try to understand something better, and eventually we may reach the painful realization that there are even more things that we do not understand! I think this is tough but important training for thinking with concentration. I would like to cultivate students by giving them the opportunities in my classes to deeply contemplate rather than giving up quickly or just memorizing. In fact, this is my primary motivation for giving undergraduate courses in mathematics.

C: I see your point. When studying math, we have to think, not memorize.

K: Exactly. Further, also in economics, I would be afraid an attitude to memorize "laws" and "formulas" or even the "notions" would end up misusing them in the real world. This would be dangerous. Instead there is another discipline not to memorize but to analyze what is crucial by thinking and thinking about what is more fundamental. It takes an enormous amount of time. In my opinion, deep thinking for the universal truth is the essence of mathematics.

C: As a high school student, I was trying to solve trigonometry problems. They were very difficult ones, and I did not even have an idea where to start. I had been thinking about one of these problems for a whole day and finally found the answer. After solving the first problem, however, I could solve the remaining five to seven problems almost instantly. It seemed something inside me had changed after taking a whole day to solve the first problem. It was unforgettably impressive to me. I learned from this experience the importance of thinking things through.

K: The whole day that you spent by thinking with “I-don’t-sees” must be a really special time to bring you the breakthrough afterwards. As a mathematician, I always have many I-don’t-sees while attacking difficult problems that nobody in the world knows how to solve, or trying to develop a new mathematical theory without existing methods as if I were in complete darkness. No matter how uncomfortable I feel the I-don’t-sees, I am still optimistic and want to grapple with them face to face,

C: It seems that mathematical research embraces quite many “whys”.

K: That’s the point! By that very reason, your 5-Whys motto is impressive to me. It is a clear, nice and encouraging message that will be retained in the memory.

Company Profile of Toyota

Toyota Motor Corporation was founded in 1937. The company’s headquarters is located in Toyota City, Aichi prefecture. It manufactures and sells conventional passenger cars such as the Toyota Corolla, as well as hybrid and other types of eco-friendly vehicles. Toyota has overseas manufacturing companies in 27 countries/regions, and its vehicles are sold in more than 160 countries/regions.

Toyota is listed on the New York and London stock exchanges, as well as on the major markets in Japan. In the fourth quarter of FY2011, it made a net profit of 283.5 billion yen by selling 735,000 vehicles worldwide. As of March 2012, about 320,000 employees were working for the company.

A Brief Biography of Fujio Cho, Chairman

Fujio Cho was born in 1937. Following graduation from the University of Tokyo with a Bachelor’s Degree in Law, he joined the Toyota Motor Corporation in 1960. In 1988, he became a company director and was appointed CEO of Toyota Motor Manufacturing, USA. After holding posts as executive director, senior executive director and executive vice-president, he became the company CEO in 1999. He was appointed as the company chairman in 2006 and also served as director of Sony Corporation and Central Japan Railway Company. He is also the chairman of the Japan Sports Association.

His awards include the Grand Cordon of the Order of the Rising Sun and the Medal of Honor with Blue Ribbon.

About the University of Tokyo

The University of Tokyo was founded in 1877 by succeeding older schools from the Edo government, applying the education systems and curriculums introduced from the West after the restoration of Imperial power in 1868.

Among prominent people graduated from Japan’s oldest university, there are seven Nobel laureates (Yasunari Kawabata, Reona Ezaki, Eisaku Sato, Kenzaburo

Oe, Masatoshi Koshiba, Yoichiro Nambu and Ei-ichi Negishi) and a Fields Medalist (Kunihiko Kodaira).

Known by his contributions to education and research in Japan is Dairoku Kikuchi, one of the university's founding professors. After working as President of the university, he became President of Kyoto Imperial University (the predecessor of Kyoto University), Minister of Education and the first president of the Science Research Institute of Japan (RIKEN).

According to Thomson Reuters' World University Rankings, the University of Tokyo was ranked 11th in 2010. There are 30,000 students in the graduate and undergraduate schools combined, and 15% of the graduates consist of international students.

A Brief Biography of Toshiyuki Kobayashi, Mathematician

Toshiyuki Kobayashi, a mathematician, was born in 1962. When he was 25, he proved a necessary and sufficient condition for the Calabi–Markus phenomenon, which led him to create a new theory of discontinuous groups beyond the framework of Riemannian geometry.

Further, he has successively created his original theories of mathematics, including the "theory of discrete decomposable branching laws" on infinite-dimensional spaces and "visible actions on complex manifolds" aiming for the unification of multiplicity-free representation, to name a few.

His academic honors include the Spring Prize (the Mathematical Society of Japan), Osaka Science Prize, JSPS Prize (the Japan Society for the Promotion of Science), Sackler Distinguished Lecturer (Israel) and Humboldt Research Award (Germany).

He is a professor of the Graduate School of Mathematical Sciences, the University of Tokyo and also is a Principal Investigator of Kavli Institute for the Physics and Mathematics of the Universe (IPMU).