# The Importance of Evaluation Technology

**Senior Adviser, R&D Research Unit**
**Business Research Institute**
**URAKAWA Takuya**

Last autumn, I was given the opportunity by Nitto Denko to give a lecture with the title 'For Improvement of R&D Productivity'. The thrust of my talk was that evaluation technology is very important for raising the quality and speed of research and development because of the way it visualizes things that have not been visible so far, that evaluation technology is an important weapon in improving the productivity of research and development, and that expense should not be grudged when investing in mechanical analysis equipment and other evaluation facilities. It was in connection with the lecture that I was offered the chance of writing the present article. But actually, I am not an evaluation technology expert. I simply stated plainly that, because I had worked for a long time in research and development management at Bridgestone Corporation, I had developed a direct appreciation of the importance of evaluation technology.

As luck would have it, just before writing this, at the New Year seminar organized by Toray Research Center, Inc., to which I was invited again this year, my eye was caught by an article in the New Year edition of "The TRC News" in-house journal entitled Measurement Evaluation Technology for Nanotechnology Development and International Standardization written by Dr. Shingo Ichimura (The National Institute of Advanced Industrial Science and Technology). He appeared to be writing about good examples of things that remind us of the role of measurement and evaluation technology in industrial technology development. He started off by writing:

'In the world of science and technology, it is only when one has looked (measured and evaluated) that one can appreciate and understand a phenomenon (and develop a science of it), which makes it possible to generate and control functions (develop technology). In the future I think that measurement and evaluation technology should occupy a mainstay position in research and development in all industrial and scientific technologies'.

I have quoted him literally as he expresses the same point about the importance of evaluation technology more accurately from the standpoint of a specialist.

When attempting to develop new technology or products, in nearly all cases fresh knowledge or information is needed on the science and technology front. The source of that knowledge or information is research and also evaluation technology. One can even say that evaluation technology is the mainstay of research and development. In the following I would like to discuss some of my everyday thoughts on the importance of evaluation technology, in a wider sense than simply what is called mechanical analysis, focusing especially on the connection with new technology and new product development.

## Evaluation Technology Visualizes User Needs and Gives Direction to Development

In the development of new technology and new products, the area where evaluation technology is most powerful is in making user needs apparent. In recent years, as user demands have become more qualitative in nature, for instance the demand for friendliness to people and the global environment, evaluation technology to realize these demands has

become increasingly important.

It is an old story, but just after the Tokaido bullet train line between Tokyo and Osaka was opened, the related noise became a major social issue. Because of the limited strength of the railbed, it was not possible to install the normal heavy and tall concrete noise barriers. The railway company wanted to see if it could develop noise barriers that were lighter.

In response, they wondered whether soundwaves could be bent just like light is refracted by a prism. If they could, then the barriers would not need to be tall. Based on this idea, they researched the concept of a 'sound prism' or more exactly a soundwave control device. Just as expected, they were able to bend soundwaves and they also found that interference between the sound refracted by passing through the prism and the waves direct from the sound source caused the formation of a marked region of noise reduction. If this noise reduction region could be arranged to cover the houses along the track side, it should be possible to achieve the target noise reduction. This was the idea on which development was taken forward and the result was the low and lightweight special sound barrier shown in the photograph and known as *Calmzone*.

What proved decisive here were two evaluation and analysis technologies.[1, 2] In the process of development, the first problem was that, although it was known that the trains in operation at the time produced around 100 decibels of noise, the detailed structure of the noise, in terms of which part of the train produced which type of noise and in what proportion, had not been worked out. As long as this remained unknown, there was no way of designing a 'sound prism'. To resolve this issue, they devised a special sound-gathering microphone to record the noise of the passing train and developed technology to measure, evaluate, and analyze the features of the noise such as noise type and sound pressure distribution. This allowed them to identify the content of the noise and so to identify the detailed user needs in quantitative terms. This set a concrete development and design guideline for the noise countermeasures.

The other decisive element was sound visualization technology. As mentioned above, a distinctive feature of the sound prism was the interference between the refracted sound waves and the direct waves, which produced a marked sound reduction effect. But to

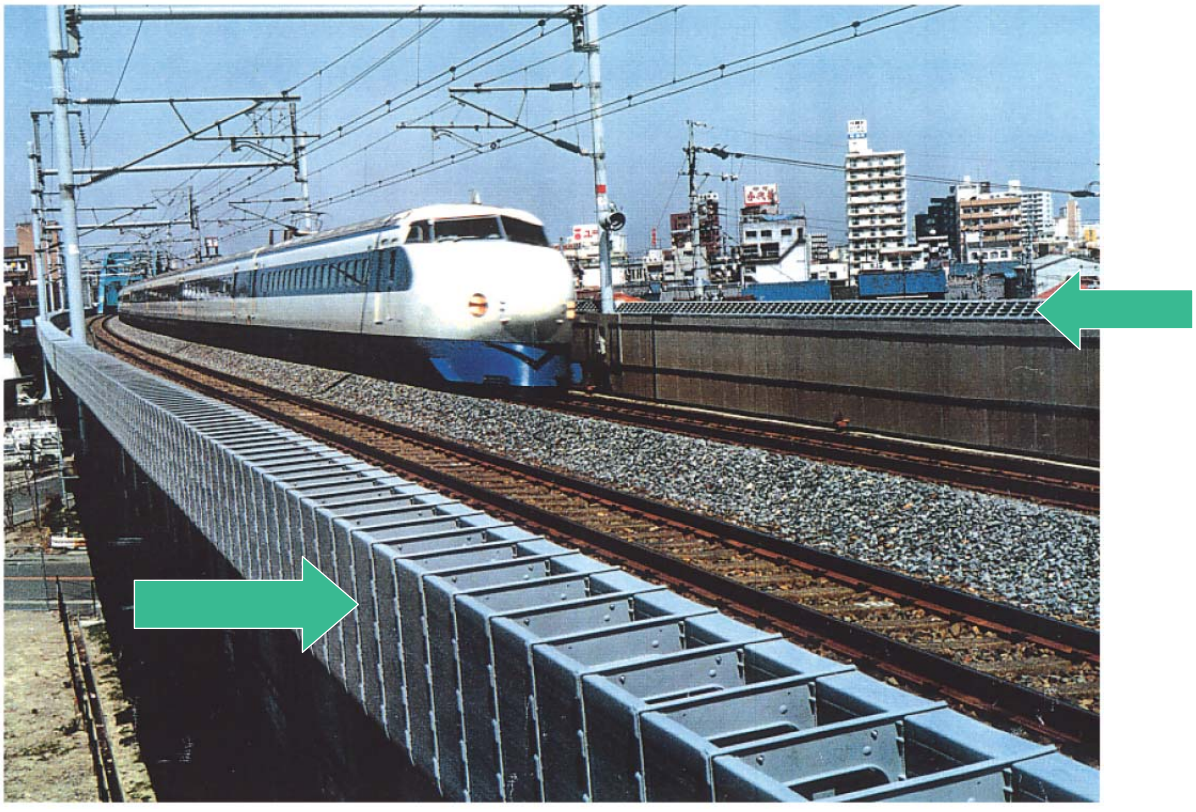

**Photo. 1 *Calmzone* special noise barrier**

explain this effect to people other than experts using ordinary measurement data alone is no easy task. If the sound field could be visualized, it would be possible to obtain data not from single points but from a continuous surface. This would also make the sound source and the sound transmission clear at a glance and make it very easy to understand for members of the public.

What they developed in response was a unique microphone system that converted microphone signals into flashing LED lights and created a photograph in a darkroom of the track of the lights. It literally visualized the situation in the sound field, which had until then been difficult to grasp. This made it possible to proceed with study of design conditions to maximize the sound-reducing effect in a very accurate and rapid fashion and with user involvement.

In this way, evaluation technology can visualize situations and phenomena which have been hidden. Through evaluation technology, it is possible to grasp the detailed concerns and issues which users have and to devise more concrete methods of resolving them. Evaluation technology is an important tool in giving direction to technology and product development.

## Evaluation Technology that Gives Superiority Over Other Companies and if Possible Over Users

The sound prism technology described above was a breakthrough that changed the concept of sound barriers that had been current up till then and therefore attracted great attention at the time in industry and science. As the reader will know, to survive in the intense competition that surrounds development today, the key is to stay one step ahead of competitor companies in offering users attractive technology and products. The basic requirement is to be ahead of other companies in taking action to explore the essence of user issues (especially latent issues), to understand the problematic situations and phenomena, and to clarify their causes. To do this, evaluation technology is indispensable. Moreover, having evaluation technology superior to that of competitors is in my experience often a very effective element in differentiation strategy.

To move further toward the ideal, having evaluation technology superior to that of the user is an invincible weapon in presenting new technology and product solutions because it heightens the ability not just to sell products and materials but to promote their functions also.

Put the other way round, having evaluation technology that places a company in a superior position to raw material manufacturers makes it able to request that is should be the sole supplier of the unique materials. For instance at Bridgestone, we once independently developed a polybutadiene rubber with excellent resistance to wear and tear and, in a joint project with a raw material manufacturer, developed a specially structured SBR for use as a rubber for tire treads (the rubber that contacts the road surface), which possessed the excellent fuel economy characteristics described below. We commissioned the mass production to the raw material manufacturer of course, but the reason why we were able to develop these unique materials was because we had explored the relationship between the properties required of tires and the polymer microstructure and set targets in advance for polymer synthesis; and because we had exploited to the full the analysis and structural analysis technologies necessary for molecular design and material design.

## Development of Evaluation and Evaluation Technology from the User Perspective

As the reader will know, in order to strengthen international competitiveness and achieve sustained development, innovation is nowadays demanded in all areas of corporate activity. It goes without saying that a central role in this is played by research and development. Great expectation rides on innovative research and development results that create new value. Inevitably, there are an increasing number of technologies and products that are described as ‘world firsts’ on the strength of a modest differential. This trend is particularly strong among technology and products in cutting-edge fields such as information technology, bioscience, and nanotechnology.

When such new technologies and products are put to practical use in the world, there is intense questioning of their social value and customer value, which are preconditions of their economic value. In other words, before these new products and technologies are recognized and become widely available on the market, there are many cases where a whole range of technical and social infrastructural preparation is necessary, for instance technology standardization, environmental and safety checks, and legislative adjustment. Evaluation of practical use

through validation testing is of course also necessary. Evaluation of technology and products from the perspective of customers as they use them and the development of new evaluation technology for that purpose is essential.

For this reason, we are now in an age when more time and money needs to be spent on evaluation. It is an unavoidable condition for promoting the application of new technology and new products.

## Importance of People who See and Sense Phenomena

In this way, evaluation technology has an important role in disseminating and supporting the new knowledge and information that provides direction to research and development and is thus in an inseparable relationship with technology and product development. As is evident from the example described above, evaluation technology has a great impact on the productivity of research and development. Relevant corporate divisions need to unite in close partnership.

Additionally however, it is essential to realize the great importance of observing phenomena and of the people who observe, as these elements are the starting point of evaluation. What brought this home to me was the time when we developed the specially structured SBR with the high fuel economy which I mentioned above.

Using rubber that is as hard as possible to reduce the rolling resistance of the tire and reduce heat generation during travel improves fuel economy. On the other hand, braking characteristics deteriorate and safety performance is sacrificed. How to resolve this Catch 22 was a great barrier looming before us. It was then that we noticed that the oscillation behavior of the tire tread was completely different during travel (low frequency) and during braking (high frequency). The results of observing the heat generation from the tire with infrared thermovision corroborated this observation.

We then hypothesized that the problem would be resolved if we could synthesize a polymer with a viscoelastic characteristic that produced low heat loss at low frequency and high heat loss at high frequency. After repeated efforts in molecular design, synthesis experiments, and microstructure analysis, we finally succeeded in developing the specially structured SBR.

It is true that we would not have succeeded if we had not had access to evaluation technology using sophisticated measurement and analysis equipment for measurement of heat generation from the tires, distribution of polymer molecular weight, microstructural analysis, and so on. But more importantly, supposing we had not noticed the difference in oscillation behavior between travel and braking? This example reminds me again of the importance of the sensitivity of the people who observe phenomena.

Today evaluation technology and of course evaluation and analysis equipment is making remarkable progress. The education of specialist technicians who can make full use of them is naturally an important task, but at the same time I would like to emphasize the crucial significance of educating people with the keen sensitivity (awareness of problems) to observe phenomena.

Looked at from a corporate-wide perspective, there is a large number of other areas relevant to evaluation technology, including production control and quality assurance, technology standardization, environmental and safety measures, and intellectual property activity. Evaluation technology well and truly occupies the position of a common platform technology for the technology activities of the whole company. As one important aspect of technology management, it will grow increasingly in importance. We should look forward to vigorous activity by relevant departments.

**[References]**

1) K. Iida, K. Mizuno, “Noise control”, Systems and Control, 29 (12) (1985).
2) K.Iida, “Visualization of sound fields through microphone systems and exploration of sound sources”, J. of JSNDI, 47 (7) (1998).