

Encouragement of “Robust” Design -For a Tough and Sustainable Manufacturing and Society Keio University Professor Yoshiyuki Matsuoka

Learning from the “Unexpected” of the Great East Japan Earthquake

How many times have we heard the word “unexpected” after the Great East Japan Earthquake struck us on March 11, 2011? The word “unexpected” appears in the media for several times as if it was the symbol of disruption of the safety myth of Japan, giving people uneasiness, which leads to the distrust towards technologies.

Here, we will pay attention to the two types of meanings “unexpected” has. First is the “was not assumed”, due to the low priority of the phenomenon. Second is the “was unable to be assumed”, due to the level of the phenomenon being far from expectation.

The “unexpected” from “was not assumed” is a phenomenon that could have been expected by current technologies. However, due to the phenomenon’s low possibility of outbreak and priority, other factors are prioritized in using the budget for development. As a result, the phenomenon that could have been expected and prevented is excluded during the development stage, leading to the “unexpected”. This kind of “unexpected” may be the most frequently occurred problem in development, and the tsunami disaster and nuclear melt down caused by the earthquake on March 11, 2011 falls under this category.

The International Atomic Energy Agency (IAEA) points out that, “The Fukushima Daiichi Nuclear Disaster could have been avoided if precise measures with decent cost were taken”. The right or wrong toward this statement and its effects are not yet sure. However, there are possibilities that this indication may be effective, and lets one recognize the seriousness of various problems and importance of giving precise and general judgment.

On the other hand, the “unexpected” from “was unable to be assumed” is a phenomenon that cannot be expected even with current technologies, and is impossible to make countermeasures during development stage. However, even if the assumption is impossible at the development stage, as technology progresses, the assumption and countermeasures can be put into consideration. This technological development can be said especially in nuclear power plant with long-term usage. However, the costs are likely to be very expensive when inserting countermeasures in use stage. Therefore, it is also

important to give precise and general judgment by understanding the seriousness of the problem, possibility of outbreak, and various factors.

As stated above, in order to prevent “unexpected”, the ability to be able to give precise and general judgment can be understood as the key factor. However, in actual development exists many trade-off (antinomy) problems like, “It is hard to please all”. Then again, this trade-off problem is the root cause of the “unexpected”.

Nonetheless, present technologies are not just standing and watching against this trade-off problem. There are relations that may seem like a trade-off problem, but depending on how the problem is managed, can enable the coexistence of the relations. Thus, methodology called the “robust design”, is currently drawing attentions.

Paying Attention to the “Robust Design” Corresponding to Various Circumstances

Robust is translated as “toughness”. However, robust means to have stable toughness to various circumstances (external environments, surroundings, usages, and conditions). The robust design is a methodology in which the manufacture is done by choosing out the most suitable mean from various means to ensure robustness.

For example, toughness may not be always desirable to be stiff toughness. The flexible toughness that bamboo has may be appropriate at certain times. Thus, there are various ways to keep toughness. Out of all the techniques to keep toughness, the “robust design” is a methodology that can ensure stability of the functions for various circumstances.

The origin of robust design started from a methodology to ensure stability of the function against variability of a product (such as dimension error and unevenness of materials). To this day, the Taguchi method, developed by Genichi Taguchi is known as one of the most common robust design method. However, various methods are being developed and rapidly growing for the past years. For example, a technique to ensure stable function by considering the outbreak frequency and seriousness of various possible circumstances is being developed. In addition, examining whether the adjustment mechanism is necessary or not is important at a development stage. Nevertheless, the method to minimize the judgment towards the necessity of the mechanism and the adjustment range, to be the most effective are currently developed. Furthermore, the robust design, which can cover variety of needs of the market effectively by setting the precise variation and lineup of the product, is also being studied.

The appearance of these new robust designs allows the securing of the robustness that was considered difficult before. Therefore, it is necessary to solve an unexpected problem caused from trade-off matter by employing the robust design methods.

The Merits and Demerits of Large Scale and Complex Products

I have many opportunities to evaluate designs, throughout the evaluation process, I have one thing that concerns me. My concern is that the requirement of a product and an artifact targeted for evaluation are “advance technology” and “multiple functions”. As a result, the society is leading towards large scale and complex product manufacturing. It is indeed, important to develop product with advanced technologies and multiple functions to raise its value, and it is a fact that these requirements have realized high productivity and convenience.

However, as a fact, the enlargement and complication of the product and artifact has let a serious side effect relating to the safety and reliability problem. Generally, the detailed management of a large scale and complex product and artifact is considered difficult. Therefore, the enlargement and complication causes the “unexpected”, and it tends to raise the risk of violating safeness. In addition, the large scale and complex product and artifact, leads to the enlargement of the disaster. The Fukushima Daiichi Nuclear Disaster caused by the Great East Japan Earthquake can be given as an example of disaster caused from large scale and complex artifact. The large scale and complex product and artifacts are becoming disrupted due to its fragility.

To ensure robustness that can consider various circumstances under large scale and complex product manufacturing is becoming an important issue. Therefore, to promote the development of products and artifacts with reliability and functions that can be provided stably under various environment; and the realization of a tough and sustainable manufacturing is currently demanded.

A Robust Manufacturing Industry and Society

-Towards the reconstruction of the world's most reliable and safest Japan

The disaster caused by the Great East Japan Earthquake has given the people of Japan, a chance to think back and learn about the mistakes of current way of manufacturing. Also, from another point of view, the sense of values towards the society is changing.

The respect towards the bonds and gentleness between people has shifted the sense of values from throwing away products to keeping products with care.

Under such conditions, manufacturing may be at the time when its senses of values are shifting from short-term optimality to establish aspect in the economical effectiveness, into long-term sustainability to establish aspect in the robustness. Through such manufacturing, the manufacturing industry is challenged to establish a tough and sustainable way.

I believe that we must aim to become the world's most safe and reliable society by reacknowledging and realizing the manufacturing that considers robustness to achieve philosophy and technique of manufacturing.