

(page.22-23)

What Trains a Designer

– My Experience of Body Structure Design for U.S. Projects –

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As an engineer engaged in design, I was often asked questions about differences between the design of vehicles used in Japan and that used in other countries. When asked about the characteristics of body structure design for U.S. projects, I usually present, by way of an answer, such technical details as difference between Japan and the U.S. in welding method and collision strength. Due to differences in national character and social circumstances, there is a considerable difference between these countries regarding the basic concept of desirable vehicle body structure design. Welding and strength indices are salient features of this basic concept. In this article, however, I will take a mental approach, instead of a technical one, to reviewing the process of body structure design.

So far, Kinki Sharyo have carried out six U.S. projects. I have been involved in the design processes of most of these projects. Frankly speaking, in none of the projects I could tackle my task with aplomb. Also, I believe that I will feel the same way again and again in future projects.

The greatest reason for my unease is the involvement of customer specifications and consultants in the projects. Design requirements are tightly restricted by specifications, and one must face a strong contestant named consultant to solve problems related to this situation. A consultant is not an individual, but a large group of specialists. They always intervene between end users and designers, and do not care the circumstances of a manufacturer in almost all issues.

The Consultant Comes

A consultant contracts with an end user to work at the beck and call of the latter (and, in some cases, as its brain). It is an organization that poses difficult problems to us in U.S. and other overseas projects. If seen from a different point of view, our unease with the consultant means that Japan is the only place where its presence is rarely felt. If I may put it in a sweeping manner, a Japanese customer is cooperative with us regarding vehicle manufacture, while a consultant for the customer seems to take it as its main business to obstruct our design and manufacturing procedures. Invested with a potent discretionary power by the customer, a consultant acts more like a faultfinder who has something to say for about everything, though its original business should be to have a manufacturer make better vehicles within a budget. In most cases, a consultant is involved in a project from the preparation of specifications, and therefore informed about details of the project. Accordingly, it often points out issues regarding which a manufacturer is not well prepared, and sometimes employs

specialists in relevant areas. All this makes the consultant a strong adversary for the manufacturer.

In a case showing the strong power of a consultant, my colleagues and I were requested by it (or him in this case) to conduct a body structure load test all over again. A large-scale load test consists of four different tests, and takes nearly one month. In the project in question, we finished three tests successfully, but got partly unsatisfactory results in the fourth test. To clear the test, we added some reinforcement to our vehicle. We thought that this improvement was all we had to do, because the reinforcement ensured that the fourth test would be a pass, while enhancing the overall strength of the vehicle. However, the consultant strongly requested that we should conduct all tests again, naturally including the ones we had passed, because specifications provided that the same vehicle should be used for the tests; though it acknowledged that the reinforcement would probably make the body structure stronger. He contended that reinforcement, however minor, made the vehicle different from the original one. At that time, we firmly refused the request, as our schedule was too tight to permit another round of tests; and this matter seemed to have come to an end. However, he requested the redoing of tests again, after his return to the U.S. Eventually, we conducted all four tests again as requested, even though the mass-production of vehicles had already begun at another part of our factory. This was the result of a single consultant refusing to give his consent, with his contention backed by only one sentence in specifications; though I admit that his action can be justified on the ground that he had to see all terms of the contract (or specifications in this case) observed strictly.

Secrets of Specifications

Next, I will briefly touch on the interpretation of specifications. After winning an overseas project, the first thing a designer should do is to grasp specifications as soon as possible, to understand what kind of vehicle the customer wants us to make. To do this, however, the designer must read through specifications that are wearily voluminous, and that are written in English from beginning to end! He summons his courage, tries to decipher the specifications, and begins to hope that it will be possible to complete a vehicle design by satisfying every concrete requirement described in each article. However, the reality is harder than he thinks, as there are many requirements that seem to contradict each other. Also, he often gets into trouble

because his interpretation of some part of specifications later proves to be different from the intended one.

For example, a body strength requirement in a project read: "The car body structure shall withstand a compressive force equivalent to the car body weight." I started to design the body structure assuming that the "car body weight" meant the weight of vehicle body proper. However, the customer request actually meant that the entire vehicle weight, including that of bogie, had to be withstood. Presented with my design, the customer naturally pointed out the deficiency of strength. After a long discussion, we were obliged to make a considerable reinforcement and otherwise review the body design. At that time, the customer remarked that the proviso "without trucks" would be added if they meant a body proper, with bogie excluded. The fact was that they had not adhered to this principle in every part of the specifications. However, we could not argue down the customer.

While experiencing some more projects, I came to learn that for American consultants, it was a matter of course to include the bogie weight in the body weight. Though insisting on the literal observation of specifications, they also rely on some common understandings. In U.S. projects, there are many other types of common understanding. Kinki Sharyo has amassed a valuable asset by learning about such understandings through its experience.

It is difficult for us to deal with consultants and specifications. However, it is also true that we become battle-hardened by dealing with them, though unintentionally. We should humbly admit that they will remain indispensable prods for us to improve our abilities, though it may be somewhat mortifying to do so. My best hope is that the gentle enemies will become a bit gentler in future dealings.

Groping for the Best Solution

Next to the grasping of technical requirements, I had to confront another difficult challenge, that is, the scarcity of experience on which we could base our work. In Japanese projects with JR and other private railways as customers, we could base our design development on some concrete model, though imperfect, which had to be worked out to suit requirements for a new model. In a U.S. project, however, the only design guideline is to meet specifications, as well as standards cited in them. The first problem is that we do not have any clearly drawn vehicle limits. We must determine these limits by patching together coordinates shown in specifications, prepare some drawings, and determine body section dimensions using the drawings. This process is very uneasy for us, because there is always some possibility that our interpretation of specifications may be different from that by the infrastructure developer.

A difficult question is to what extent a designer should consider the vehicle movement when designing an optimum section, because the body size can vary widely depending on

this consideration. The easiest way to meet specified limits is to use a small section size; however, this may cause problems in meeting size specifications on position relationship with the platform. Also, a small body must nevertheless be spacious enough to meet a capacity requirement. These factors lead the designer to make the body size larger and larger in each modification, until he realizes that the size has become too large to clear a strict weight limit. He must now reduce the number of frames and the plate thickness. However, this, in turn, may prevent the vehicle from meeting specified strength requirements. Now, the designer begins to feel as if he were playing some kind of cat-and-mouse game.

In making these considerations, the designer typically notices another problem, namely the use of inches, pounds and the duodecimal system for a unit system. These are a counterpart of Japan's traditional "shaku" and "kan" system for measurement. A Japanese unfamiliar with the Anglo-Saxon unit system is inevitably confused by many strange words. Whether they refer to a weight or a length is a mystery; and in worst cases, they may make it impossible for him to grasp even a general context. Regarding this matter, the only thing the designer can do is to make a separate study by consulting a reference book etc.

On the other hand, there was a list of prohibited materials which I found to be a clear and easily understandable way of doing things. If it has been found that any prohibited material is used due to an insufficient examination, we must promptly take remedial measures for all vehicles we have already begun to manufacture. Among typical substances prohibited in the U.S. are asbestos, lead, urethane foam and vinyl chloride (because its use may result in the occurrence of a poisonous gas in the event of fire). The prohibition of the use of vinyl chloride is highly uncommon in Japan, but it is a reasonable practice from the viewpoint of ensuring passenger safety, and should probably be introduced to Japan.

In this article, I discussed the handling of customer requirements and specifications at an early stage of design. I have to end my article here, because I would fall into endless grumbling if I started talking about characteristics of U.S. projects at a stage of full-fledged design. If you are interested in this subject, come to me and listen. You can be sure that I will talk and talk the whole night through.