

Technical Paper

Reduction Activity for Mounting and Assembly Trouble by Utilizing 3D Model Data

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Most construction machines now utilize the 3D model in their development. The concurrent development for the design division and manufacturing division has expanded. (For example, consideration of front – loading, problem parts detected at an early stage, quick response)

Compared with the previous 2D development, the development lead time has shortened and problems have decreased.

However, to integrate customer's needs early, and to introduce the products, delays in the development schedule must be avoided.

Moreover, it is necessary to establish quality at an early stage of development so as not to lose the customer's trust in our quality.

I would like to describe the activity that reduces installation and assembly problems before the prototype is built.

Key Words: 3D model, mounting and assembly problems, quality, concurrent development, before prototyping

1. Introduction

1.1 Background

The activity to reduce mounting and assembly problems was kicked off in August 2005 triggered by frequent difficulties experienced in installing wire harnesses.

To reduce problems with wire harnesses, the current method was analyzed and measures to eliminate problems were studied to improve the operation and system.

In addition to problems with wire harnesses, problems in installing components in machine bodies were raised in December 2006 and the whole improvement activity is undertaken at present also as an activity designed to reduce mounting and assembly problems.

The activity aims at eliminating problems in mounting and assembling components in construction machines.

Efforts are being made to improve operations to upgrade product quality for the customers and to ensure smooth development and production schedules in house.

1.2 Problems

The prolonged period of time required to correct mounting and assembly difficulties has become a problem (Fig. 1).

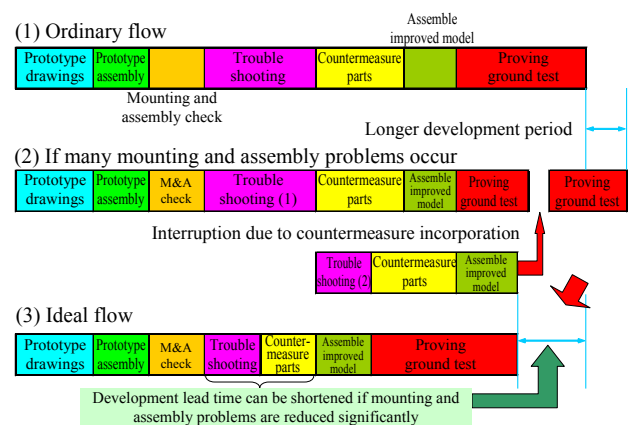


Fig. 1 Impacts of mounting and assembly problems on development lead time

This paper reports some of the improvement activities undertaken so far and describes future challenges.

2. Awareness of Mounting Before Prototyping

2.1 Check of mounting and assembly problems

“Specialists” (called “mounting masters” at Komatsu) in the lines who perform mounting and assembly checks after prototyping of construction machines or after assembling models of high volume production check quality problems with actual machines. If quality problems are detected, remedies are recommended by specialists.

The design department studies countermeasures on remedies and consults and rechecks the remedies with other relevant departments and problems are eliminated before mass production starts.

This has been the mode of operations so far, always tackling problems that are detected after prototype machines are built. Recently, however, front loading has become the trend in 3D development and various checks are required to be performed before making parts that incorporate improvements (Fig. 2).

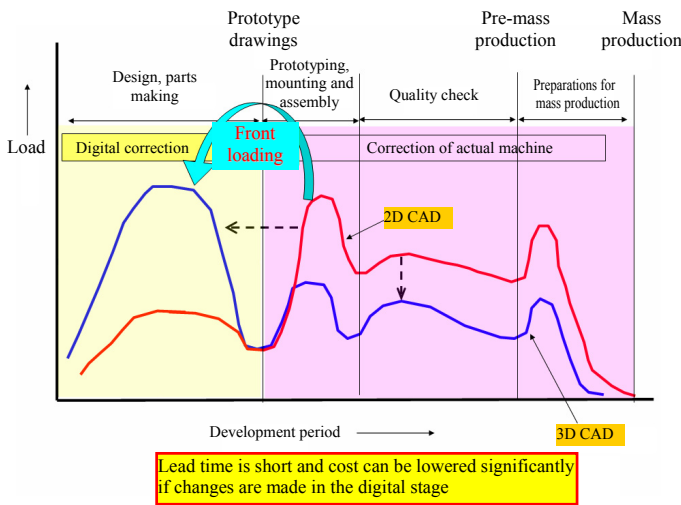


Fig. 2 Front-loading development

2.2 Direction for improvements

In problem checks, possibilities that may become a mounting defect will be checked with a 3D model and problems are solved before assembling actual machines (Fig. 3). An effort is made to divert the man-hours required for reworking mounting defects to other work.

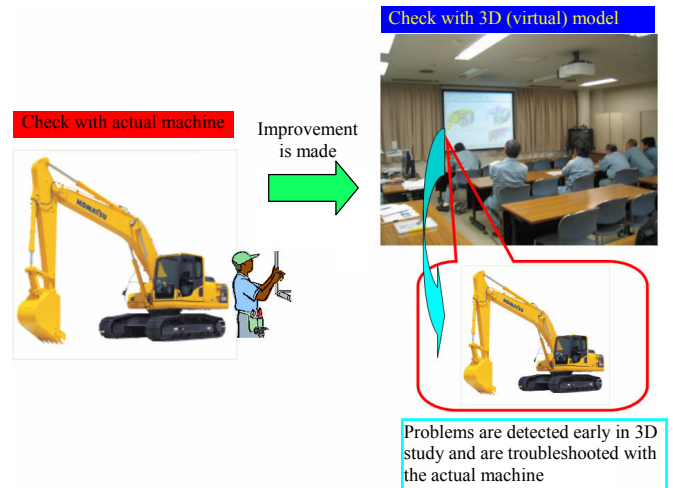


Fig. 3 Direction for improvements

3. Analysis of Problems and Priority Activity

3.1 Analysis of mounting and assembly problems of wire harnesses

Initially, mounting and assembly problems of wire harnesses occurred frequently and the activity was started by analyzing problems with wire harnesses as electrical parts.

The analysis showed the following results.

- 1) Adequate time could not be secured by design staff to prepare models and to study layouts on actual machines.
- 2) Recognition in interpretation on mounting and assembly differed.
 - Recognition by design staff: No problems presented in mounting and assembly.
 - Recognition by mounting masters: Problems are presented in mounting and changes are required.
- 3) Intentions of design staff in writing descriptions in drawings and interpretation of suppliers in reading drawings and manufacturing differed.

When these situations were translated into a graph, a shortage of design work time was found responsible as the factor for mounting and assembly problems of wire harnesses (Fig. 4).

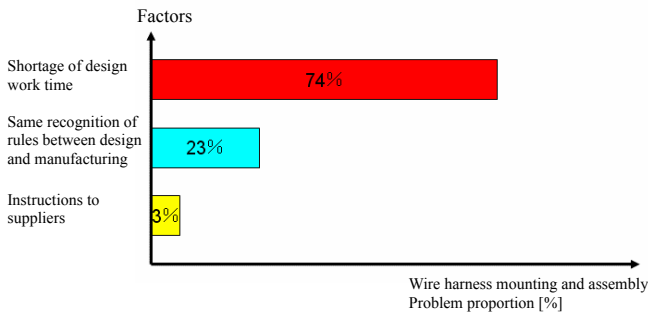


Fig. 4 Proportions of factors for wire harness mounting and assembly problems

3.2 Priority activity on wire harnesses

Performing work to link between circuit diagrams and parts drawings and to check circuits using MC/W (Micro CADAM for Windows) as circuit diagrams and parts drawings were not interlocking. The 3D system was not interlocking with wire harnesses and the design staff checked the necessary information manually. The check work was complicated as the number of circuits was large, several hundred circuits (Fig. 5).

CAD for circuit diagrams and parts drawings has been modified into a mechanism allowing its use on an operation basis by incorporating the customizing functions of electrical CAD: AutoCAD Electrical Wire Harness of AutoCAD (alias “ACE Harness” within Komatsu) instead of Micro CADAM that has been used in the past. Circuit diagrams and parts drawings are now interlocked so that losses caused by check

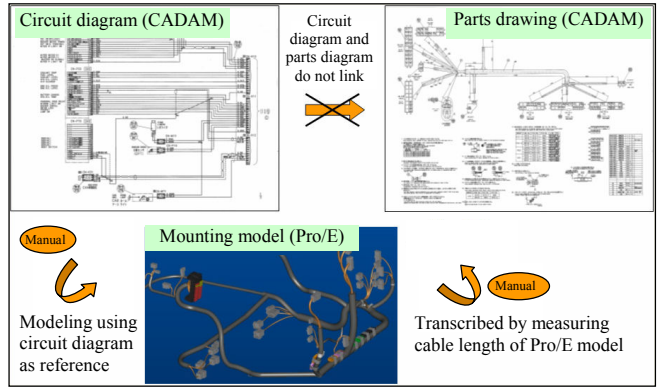


Fig. 5 Potential problems with harness CAD

work performed by the design staff and work losses due to negligence in updating work and overlooked work can be eliminated, thereby making the work more efficient.

4. Expanded Improvement Activity

4.1 Activity to improve mounting and assembly problems of entire machine

After deciding to install a wire harness CAD system, it was pointed that many mounting and assembly problems occurred in entire machine bodies. The activity to improve the mounting and assembly work was therefore started by analyzing what was the cause of mounting and assembly problems with construction machines (Fig. 6).

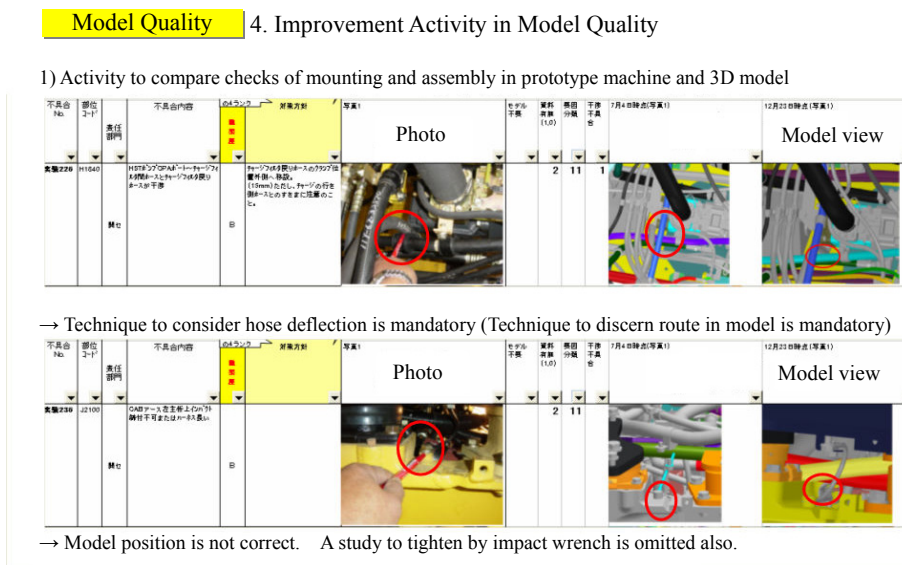


Fig. 6 Example of mounting and assembly problems at present

While comparing and analyzing mounting and assembly problems among several models, mounting and assembly problems could be classified generally into (1) Problems that occurred similarly among other models, (2) Problems that occurred with tube-like parts that deflect by their own weight such as hoses and wire harnesses and (3) Problems that occurred independently.

- 1) Deviation between actual machines and 3D models in shape and layout. (Mismatch: Mismatches of parts, especially tube-like parts)
- 2) Comparison of problems among models is insufficient.
- 3) Interference between devices and between equipment was sometimes overlooked in checks.



Fig. 7 A scene at a meeting to study mounting and assembly before prototyping

Based on this analysis, a mounting study meeting was convened between the design staff and mounting masters.

A scene at a study meeting is shown in Fig. 7. The initial method to study mounting and assembly problems is illustrated in Fig. 8.

Changed initial method to check mounting and assembly problems

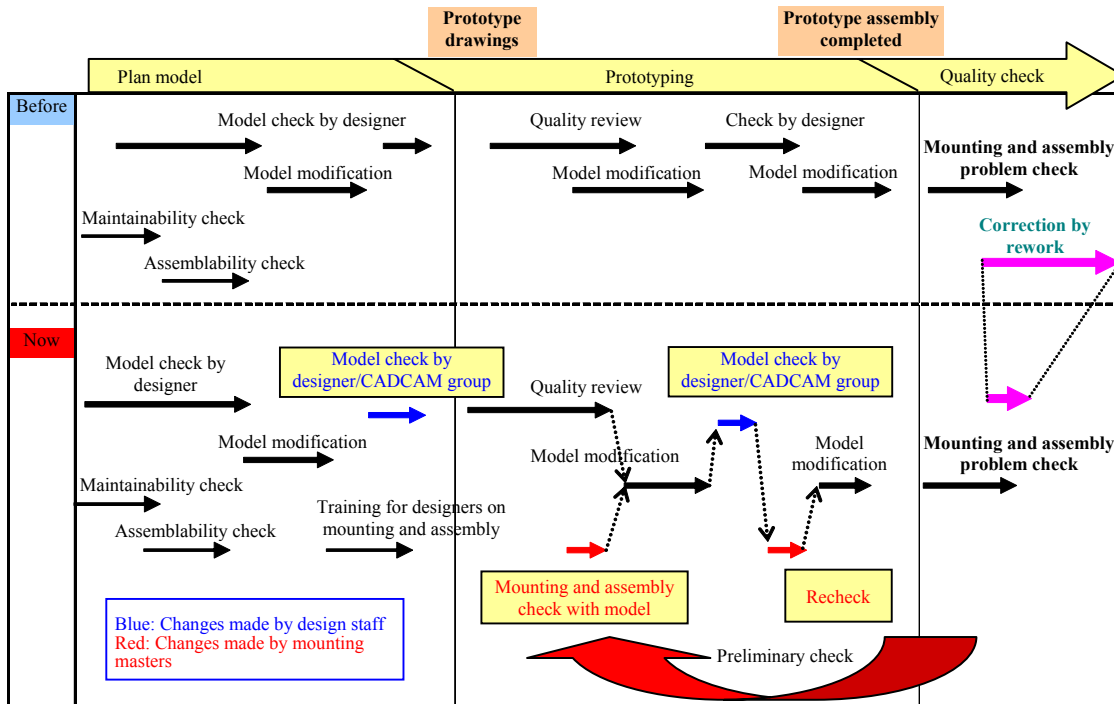


Fig. 8 Initial method to study mounting and assembly problems

5. Upgrading of Improvement Level

5.1 3D mounting study meeting between design and production divisions

In some cases, the interpretation of non-quantitative mounting and assembly rules differed between the design staff whose design was checked and mounting masters who checked mounting and assembly. Also, rechecks made after incorporating improvements were sometimes not perfect.

Believing that the tackling of these situations was important, the activities outlined in 1) to 4) below were undertaken. The activities to improve mounting and assembly were refined on the condition that a joint 3D study meeting on mounting and assembly would be convened between the design and production divisions (Fig. 9).

- 1) The equipment that is common with the current models will have a model layout that matches the model layouts in the actual equipment.
- 2) An interference check on the entire surfaces of machine bodies will be conducted. Information will be supplied to the designers.
- 3) Before assembling actual machines, a joint meeting to study mounting and assembly on a 3D model will be held between the design and production divisions to iron out differences between the suggested remedies and level of problems.

- 4) Trends of mounting and assembly problems and basic matters contained in suggestions for remedies will be saved in a database. The information will be provided to the designers.

5.2 Improvement of mounting and assembly tools

In a study of layouts for wire harnesses, hoses and other parts that deflect by their own weight, design of these parts using 3D models is difficult to study as various conditions are imposed on them such as they must be inserted into narrow spaces.

Linkage with 3D CAD models will be important for wire harness CAD and improvement is attempted to achieve linkage with 3D CAD models. (A system has been developed allowing linkage among three elements, namely, circuit diagrams, 3D models and parts drawings. A patent application has been submitted.)

Figure 10 illustrates the flow for mounting and assembly problem checks before the improvement was incorporated.

Trials are being conducted with hoses also trying to analyze hose layout using several patterns.

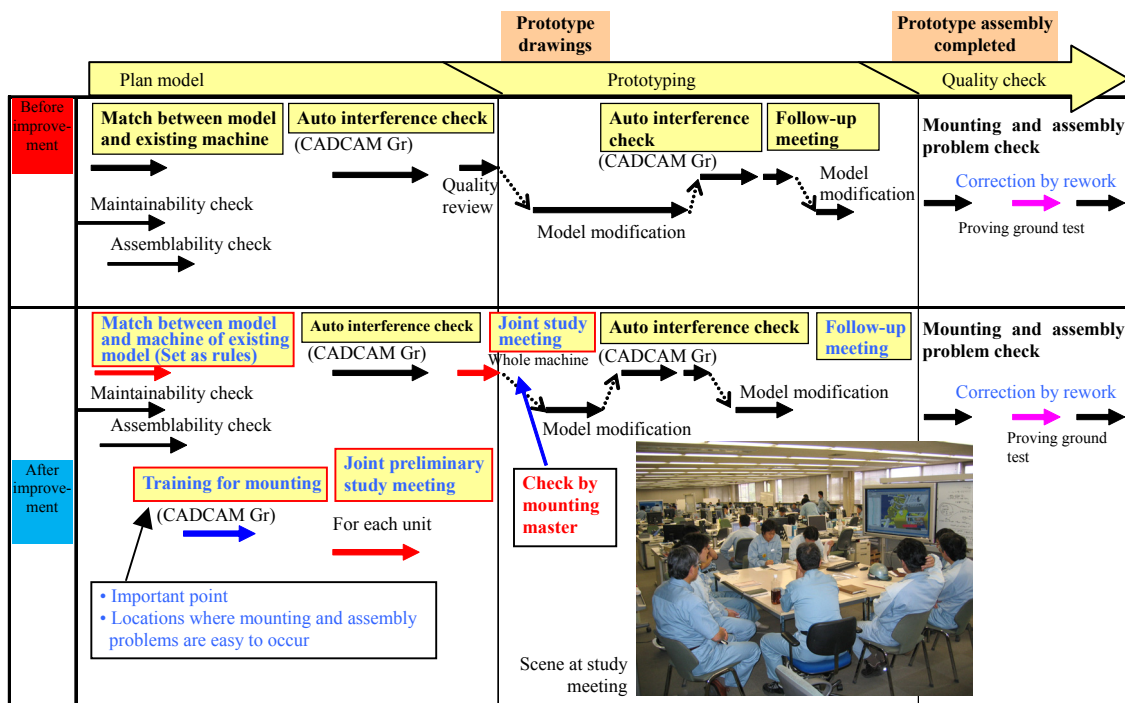


Fig. 9 Advanced method for studying mounting and assembly problems

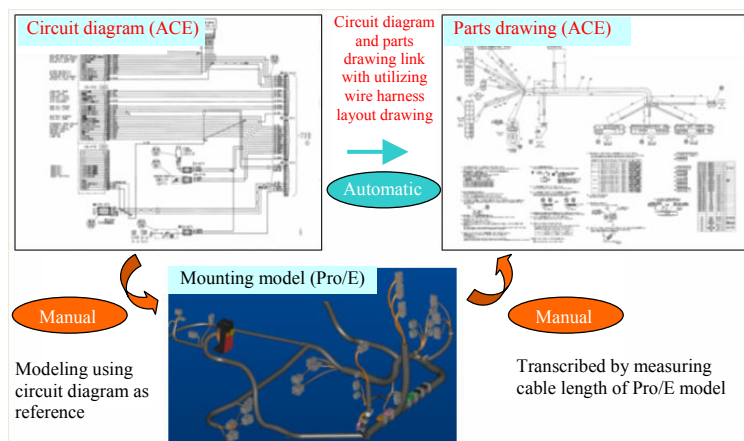


Fig. 10 Improvement in Wire Harness CAD (3D Linkage)

6. Next task

The following items are cited as challenges to improve mounting and assembly in the next stage.

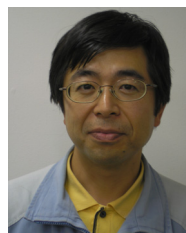
- 1) More equipment tends to be installed to meet environmental regulations and a higher fuel consumption efficiency and much more time will be required to secure clearances between parts.
 - 1-1) Improvement in design techniques that allow a layout even with small clearances including analysis and calculation of layout in techniques such as study of use of forced guide parts.
 - 1-2) Research and development for miniaturization and integration of equipment.
- 2) Transfer to other organizations and comparison of mounting and assembly remedies and comparisons of remedies for designers.
 - 2-1) Training on mounting and assembly remedies.
 - 2-2) Training of trends (comparison) of mounting and assembly remedies.
- 3) Enhanced study efficiency and study accuracy of tube-like parts.
 - 3-1) Study of development of tools for hose layout analysis.
 - 3-2) Study of development of interlocking tools from wire harness layout drawing to 3D model.
- 4) Efficient checks on clearances between parts, tool layout and tool work spaces and spaces for workability of workers.
 - 4-1) Check of clearances between parts and faster work to verify tool layout and work spaces.
 - 4-2) Building of a tools and operation to analyze the workability of workers (work spaces, posture and work load) are necessary.

- 5) Medium and long term fostering of personnel who can check mounting and assembly.

5-1) Personnel with a sense to check mounting and assembly on a model need to be fostered.

5-2) An organization to transfer basic check items and recent trends needs to be built.

Introduction of the writer



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[A few words from the writer]

Mounting and assembly problems cannot be improved by the power of one person alone, unless problem awareness is changed through problems of equipment involving the design staff themselves, problems of equipment involving other design staff and changes in safety, quality and the environment of the society. It is felt that the comprehensive power of development division, manufacturing department and other divisions, as well as of suppliers, is very important to implement improvements of mounting and assembly problems.

Notes:

“ACE Harness” is a product of C.A.D. Corp.

“MC/W” is a product of IASC (IBM Japan Application Solution Co., Ltd.).