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IMPROVEMENT IN MACHINE PERFORMANCE TO REDUCE DEVELOPMENT TIME FOR NEW MODEL IN AUTOMOTIVE INDUSTRY

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RINGKASAN : *Satu kajian mengenai penambahbaikan prestasi mesin bagi mengurangkan masa pembangunan bagi model baru dalam industri automotif dipersembahkan dalam rencana ini. Pendekatan yang diambil adalah dengan mengkaji amalan yang sedia ada dalam pembangunan kereta dan mencadangkan pelbagai kaedah penambahbaikan seperti pengurangan ralat semasa pengenalan perisian, penambahan pengautomatan dan penambahan keselamatan mesin. Keputusan-keputusan kajian diringkaskan dalam satu jadual melalui analisis SWOT.*

ABSTRACT : A study of improvement in machine performance to reduce development time for new model in automotive industry is presented in this paper. The approach taken are by studying the existing practice in car development and suggesting various ways for method improvement such as through the reduction in errors during software introduction, the increase of automation and the increase in machine safety. The results are summarised in a table through SWOT analysis.

KEYWORDS : Machine improvement, automotive industry, time reduction

INTRODUCTION

Automotive industry is a core contributor in a country's economic strength. Darus (1999) reported that market environment in automotive industry can be divided into various categories such as marketing, logistics, computer system, 'lower volume, wider range' and reduced product life cycle. For marketing activity, what is targeted is short lead-time from order to delivery and for logistics, what is expected is the use of JIT/Kanban, EDI and scheduling. For achieving 'lower volume, wider range' the use of Advanced Manufacturing Technology (AMT) is essential which include lean/agile manufacturing, flexible manufacturing system (FMS) and modular system. Computer system whether in the forms of CAD, CAM or CIM (CNC/DNC, CAS, PLC and ALC) is another important factor in market environment. Finally, reduced product life cycle requires halving the current product life cycle typically from 4 to 2 years, the use of CAS, CAD and CAE and finally the involvement of concurrent engineering teams (Sapuan *et al.*, 2006). Darus (1999) has classified concurrent engineering as part of the activities within reduced product life cycle.

Dubensky (1992) outlined the techniques that can be adopted in automotive industry with emphasis on ways of obtaining training in these new techniques. The proposed techniques were :

- CAD
- Analysis, simulation and modelling
- Geometric modelling
- Statistical and quality methods
- Human resources
- Management

It is emphasised in the above reviewed papers that the use of IT tools like CAD and simulation and modelling software is very important in automotive industry. In fact, the main theme of this paper is to study the use of design machines such as CAD, simulation and modelling software and other computer based system with the aim to reduce the development time of a new car model together with the consideration of tooling and production machines.

METHODOLOGY

This study was conducted in an automotive company in Malaysia and the findings in this paper could be used by the automotive industry in the world, especially in the South East Asian region. This research starts with the study of current methods of car making processes by using literature review on areas of project management, operation management strategy, new technology and quality. The research focuses on how to maintain the original project timing and pertinent planning, which is linked to product quality. The scope of study also includes project implementation by means of efficient operation and also to have a specific production strategy to tackle on the focused market segments in order to increase profit.

Data collection on new car model project implementation programme is based on direct involvement in the project, project reports and group discussions. This data is very important because it represents the actual problems during the whole process of car making. Car making process involves people, methods, materials and machines throughout the product cycle. Since the project involves many different parties, problems are almost unavoidable. Therefore, there should be room for improvements, depending on the degree of severity.

The next stage of the study is to evaluate the data on the current practice that lead to problems during a project implementation. The evaluation is important because it can identify the factors that lead to the problems and it should be focused on 4M (Man, Method, Material and Machine) analysis. However, only the machine analysis is presented in this paper.

The final stage of the methodology is to review and analyse the current project implementation practice by comparing the existing methods and the proposed methods of project implementation tools and techniques. This is an important aspect of this research because the analysed data determines whether the tools and techniques are practicable to be implemented for a car making industry.

RESULTS AND DISCUSSION

Evaluation on the Current Practice focusing on machine performance

This section describes the evaluation on the current practice focus on machine performance. Machines are very important in all stages of car manufacturing. They range from design machines (computers), tooling machines and production machines as illustrated in Figure 1.

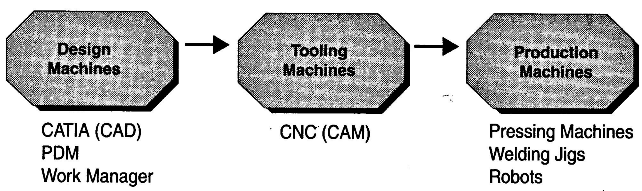

Figure 1. *Machines flow*

For design machine, the company under study used CATIA software with Product Data Management (PDM) system to link with all the related departments within the organisation. The purpose was to enable the related departments to access the data so that they can have the same level of data release. This programme is called Work Manager whereby the registered users can use those who had direct involvement in the project. The problem with this procedure was, the new drawings released by designers need to go through approval process and system registration.

The whole process would take not less than two weeks before the data was available on the Work Manager screen. It was dependent on the department's initiative to regularly check for the new release because the designers normally would not inform changes that they had already made. The computer system might be effective but the communication system showed otherwise.

CATIA software was also used for tooling design such as dies and welding jigs to avoid data loss during data transfer from product design to tool design. At that time, 2D tooling design was widely used for tooling fabrication work. A lot of errors happened during dies and jigs machining process due to over cut or parts mismatched. The main problems resulted from insufficient views and sections of the 2D drawings that were used by machinists and fabricators. The errors could only be detected during 3D machining at CNC machines because the machines used 3D surface data. The errors incur a lot of cost, quality and affect the delivery of the tooling to production.

Production site is divided into stamping, body assembly, painting, trim and final lines. At stamping, it started with blanking machines whereby coil material of different specifications were cut into desired flat shapes. These blank panels were stored on wooden pallets with special tagged waiting for part production schedules. On the production date, dies were set in the press for stamping process. The press machines range from manual, semi automatic and fully automated touched screen machines that required only four operators to monitor the pressing process. The cost of the machines for one line was close to 200 million Malaysian Ringgit in 2004.

Although the machines were very sophisticated, some accidents did happen to the dies and machines itself due to operator's mistake or poor machine maintenance. Once the breakdown occurred, the line would stop for quite some time until replacement parts arrived from the machine maker. If the machine stopped for more than 3 shifts, the whole production line would stop, as the buffer stocks were to cater for 3 production shifts. Most critical problems to the production parts were dent and hump phenomena, which resulted from dust in the dies and press machine environment. This problem could only be detected by using special lighting at the end of the conveyor line. If this happened, the production for those particular parts would be stopped and the dies would be sent to maintenance area for rectification. This would cause a lot of production down time and reduce the profit to company.

At body assembly lines, most of the machines were assembly jigs, welding robots, welding guns and hemming jigs for closure parts such as doors, hood and trunk lid. The manual assembly was done for sub-assembled parts and less critical matching tolerance. The practice was also adopted at sub assembly vendors whereby the unit was assembled at the main assembly station at the company. At the main assembly line, all the sub-assembled parts were joined together by using robots for accuracy and uniformity control.

For the case of a new model under study, the doors were a sash door method, whereby only the lower portions were metal stamping and the upper structures were roll-forming type. By using this type of assembly, it created problems to the main doors assembly due to a lot of welding joints that need to be applied and it could cause distortion to the door unit. Therefore, secondary work need to be done to the doors to make them good for closure assembly. This work in progress activity has caused additional man-hours, working area and longer production cycle time.

There was no problematic issue at painting and trim and final lines as the process involved either automation or semi automation machines. At painting line for instance, robots were used in spray painting booth for uniform layer on the car body. All data entry for colours was done on computers and programmed for robots to perform the painting jobs. For trim and final line, most of the parts were supplied from vendors or from engine and transmission factory. Most of the machines used at this station were mainly portable machines and the operators who were involved just need to follow the standard operating procedure to install the parts to the main body structure. Furthermore, only few mistakes could be found because the parts were supplied from both sides of the car, meaning that the parts were already segregated into left and right components.

Review and analysis of the current practice focusing on improvement in machine performance

The current machine performances are reviewed and analysed in order to improve the project implementation programme. The use of CATIA software with Product Data Management (PDM) is still necessary because the system can link to all the related departments within the company. Although the data release process would take more than two weeks to be available on the screen, it is still an effective system to work with. Since the project team is representing all the related departments in one task force, the issue of miscommunication should be resolved.

One way to eliminate errors during machining and fabrication of tools is by using 3D solid design software. The software can reduce design hours as it has built-in library for tool components. In addition, the software can show movement simulation so that every interference and mismatching can be detected as well as the cross sectional views for the critical areas. Another software is called Computer Aided Engineering (CAE) or part simulation analysis software. This software is purposely designed to give initial result for a certain part such as crack, wrinkle and overlap. The software is very helpful especially during dies trial as the earlier information has already been rectified during dies design stage (Schroeder and Flynn, 2001). The designer however must have trial experience because many data inputs such as bead types, blank size, cushion pressure and material specification must be as close as the actual condition. By having this type of software, the company can reduce the dies trial time by half and can reduce the die cost quite substantially.

The other method to build a quality die is through screw body technique. This technique is done during the dies trial stage whereby all the loose panels are assembled together to become a complete car body by using screws instead of spot points. Here, all the matching, gaps and spring backs will be observed and rectified to the dies. As a result, the loose panels are already perfect before the actual body assembly will take place and it also reduces errors in the next process.

Increased productivity at stamping line is through proper training programme. The training for machine operators at stamping line should be conducted starting from the machine's installation timing. This is to expose the operators to the main parts and functions of the components. Since the machines are very expensive, the training contents should cover both theory and practical aspects of the machines. At the end of the training, a test should be conducted and only those who pass the test could be stationed at that particular line. By doing this, accidents due to human errors can be minimised and productivity will be increased. For problems caused by dust, a new type of stamping machine such as Cross Cup Feeder Transfer (CCFT) machine with entire cover will help to reduce this problem. This machine is a fully automated line, which has individual blank washing unit, and uses vacuum cups to transfer panels from one station to another. Furthermore, the dies should also be washed periodically to remove the small scraps stuck inside the dies, which contributed to the problems.

At production assembly lines such as body, painting and trim and final, the use of robots should be increased in order to increase the productivity and quality of cars. This practice should also be considered for production of different models of cars at the same line to eliminate new investment on new lines.

Strength, Weaknesses, Opportunity and Threat (SWOT) analysis shown in Table 1 manifests the benefit of the new method compared to the old method from the point of view of machine performance.

CONCLUSION

From this study, it can be concluded that in the development of a new car model the method improvement cannot be underestimated. Among the issues that can be improved include the

Table 1. Strength, weaknesses, opportunity and threat analysis for machine performance

Old Approach	**S**	**W**	**O**	**T**
Machine		A Lot of Machining Mistakes Repetitive Works		High Machining Cost to Cover the Mistakes
New Approach	**S**	**W**	**O**	**T**
Machine	To Reduce Errors- Software Introduction Increase Automation Increase Safety		To produce More Output High Quality Product	High Investment Training Required

reduction in errors during software introduction, the increase of automation and the increase in machine safety.

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