

**MANUAL WORK ANALYSIS AND SIMULATION SYSTEM FRAMEWORK FOR
PERFORMANCE IMPROVEMENT IN MANNED ASSEMBLY LINE**

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ABSTRACT

Presented in this paper is a framework for analysis and simulation for performance improvement of manual work in a manned assembly line. In a manufacturing system, productivity is a key of competitiveness for output products, and the manual work performance is one of the decisive factors of productivity of a manned assembly line. However, existing approaches to the manufacturing systems are limited to matters of the plant layout or the robot tasks design in the automated factory and to the manual work are concentrated on the ergonomic based workload analysis. Consequently, the modern approach for the manual work performance improvement has not been researched. As a solution of the current problem, this study proposes a system that analyzes manual work based on work design approach using video-recording, and the system executes a brief simulation of newly derived work standard from the analysis.

1 INTRODUCTION

Productivity of a manufacturing system is one of the important elements that decide the enterprise competitive power, such as market flexibility and quality management. Manufacturing enterprises must carry out an activity for productivity improvement continuously. The manned assembly line is a process of manufacturing systems, which is suitable to massive manufacture having better flexibility than the automated system. This process has been adopted in the industry for electronic appliances, i.e. television and refrigerator. Because the industry has many different product types and frequent changes, to design the manufacturing system as fully automated using dedicated tools is hindered by the view of cost effectiveness. The process is structured by three factors of machine, worker and material, and the productivity is determined by machine capacity, worker performance and product design(Chang & Wysk, 1985).

Despite much former research for productivity improvement of manufacturing system, the research for worker performance improvement is still stayed in the traditional approaches that are focuses on partial efficiency issues of manual work which can be described by single chart. Although many latest technologies are adopted in ergonomic approach, it demands too much of the costs, efforts and time to apply with the whole assembly line. In the research for the line balancing problem of the assembly line process, labor productivity for line productivity improvement was mentioned, but the research spotlighted the stabilization of cycle-time balance of work stations using cycle-times assumed as constant values (Askin & Mitwasi, 1992). Thus, from the current research situation for the manual work itself, there is no solution for improvement of overall manual work performance to meet recent IT based technology trends. In the manned assembly line, manual work analysis for worker performance improvement should be the first activity to improve the line productivity (Bazargan-Lari, 1999; Co & Araar, 1988), but the lack of the related research causes impediment for applying the research for the next activities of productivity improve-

ment into the real system. This study proposes a framework to solve the lack in manual work analysis system. The implemented system based the proposed framework was applied for worker performance improvement in manned assembly lines of a global electronic manufacturer.

2 APPROACH

Manual work of a manned assembly line is a repetitive work by a worker. Therefore, this paper defines the manual work as next. Manual work is made by an aggregation of cycles. A cycle that means a single operation contains several tasks, and a task is composed of worker's motions. As an example, a task of the worker can be described as 'tighten a screw using a power screwdriver'. The task also can be described as three motions; 'grab a power screwdriver', 'move a power screwdriver' and 'tighten a screw' (Freivalds & Niebel, 2009).

3 FRAMEWORK

The system proposed in this study is a software tool to help users to analyze a video which was recording manual work of workers and to derive improvements based on the analysis of existing work. The system requires a work video as a resource, and it plays a video file on a screen. A user defines sections of the video, and each section is input an analysis from a user. The system provides a chart for allowing a user to input analysis data and stores the data in the database. The analysis result is displayed using graphs, such as a Gantt chart and bar chart, to represent the current state of a work process. A user is able to revise the existing work process based on the analysis result, and the revised work process allows to be simulated in the system by exclusion of deleted elements from the analysis result. The revised work process is exported as a new standard work process of the field and as a work station performance for line balancing of a line. As a result of the system, a working time of the workstation is obtained from a standard cycle time of the analyzed work. A manned assembly line is structured by several workstations, and the minimum process time of the line is calculated by the sum of a cycle time of workstations. However, a real process time of the line is larger than the sum, because there are many chances to occur idle on workstations by various reasons. The most possible cause of idle states is from unbalanced cycle times of workstations, therefore, the line balancing of a line is required. The line productivity is able to be simulated by the discrete simulation system using the revised cycle times of workstations.

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