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INDUSTRY BASED LEARNING FOR FUTURE MANUFACTURING ENGINEERS

Y.L. Yao

Senior Lecturer
School of Mechanical and Manufacturing Engineering
The University of New South Wales. Australia

A subject has been introduced for the final year BE students in Manufacturing Engineering. The subject is aimed at providing real life learning experience in a less structured environment. It is also aimed at providing an opportunity of first hand appreciation of the intimate relationships between the technological and managerial aspects in a real life project. The ultimate aim is to help provide students beneficial insight to their future endeavours and help them establish a track record of industrial achievements. The author as the co-ordinator of the subject also describes the approach used, and the responses from industry and students. Two representative projects are described in details.

INTRODUCTION

The School of Mechanical and Manufacturing Engineering at the University of New South Wales offers a four year Bachelor of Engineering (Honours) course in Manufacturing Engineering. The course is structured to provide a balanced education opportunity of both technological and managerial aspects of manufacturing engineering.

The feedbacks received from our graduates and their employers indicated a number of problems. The graduates are normally able to gear themselves into technological aspects within a reasonable period of time. But they tend to be less successful in quickly familiarising themselves with the technical and managerial organisation of a company and as such, they cannot perform their duties more effectively. It normally takes time for them to interact effectively cross departmental boundaries. Such interactions are becoming increasingly important in today's climate of concurrent engineering and systems approach.

In their school and university years, the students have been used to being told exactly what to do, and what are known or unknown. They found it is hardly the case in a real manufacturing environment and as a result they tend to get lost initially. In the current economic situation, some graduates have found it is difficult to find a desirable manufacturing job partially because most of them have no track records of industry achievements. This paper describes the development and implementation experiences of a subject aimed at solving the foregoing problems.

SUBJECT AIMS

The subject is aimed at

1. providing a less structured and real life project environment under minimum supervision;
2. encouraging the final year students to apply and integrate the technological and managerial knowledge they have learned at university to a real life problem; and
3. enabling students to appreciate the essence of team work in modern manufacturing system tasks.

SUBJECT APPROACH

The subject comprises of projects that are industry initiated. Local industrial firms are approached by the author, in the capacity of the subject co-ordinator, or recommended by other academic staff members. Projects to address problems that the company is currently concerned with are identified by the company. Then the ones suitable for our student level and allowable time commitment are chosen.

The class meets only three times. Once for a brief description of projects and company profiles and distribution of project preference forms. The next time is for administrative details, such as grouping and discussing confidentiality, safety and insurance issues. The oral presentation of projects takes place at the completion of projects. Students have the other eleven weeks to carry out a project.

Although an academic adviser is assigned to each project, it is understood that only minimum advise will be provided. The adviser will not intervene unless absolutely necessary. Students are given the contact person of the company and normally organise their first company visit by themselves. Students are to carry out projects as a team with each having clearly defined responsibility. It is students' responsibility to acquire information needed for the project, and seek assistance, wherever necessary, from industry and from the academic adviser. It is students' responsibility to schedule regular meetings with their industrial and academic advisers.

An oral presentation of projects is required. All members of a team are required to participate in a coherent presentation. Industry representatives and academic advisers are in attendance. A report per team is to be submitted to the respective academic adviser for marking, after confidentiality clearance by the company concerned. The assessment is based on report (60%), oral presentation (25%) and participation and attitude (15%)

INDUSTRY RESPONSE

When the companies were approached, it was emphasised that it is not an attempt to transfer educational burden rather than seek more industrial inputs to produce more qualified manufacturing engineers. On the other hand, students projects may produce outcomes useful to the companies. Some companied expressed reservations about how much these students projects can achieve in a dozen of weeks. The result from a pilot project carried in 1991 was used to convince the companies. As a result, most companies approached responded positively and 75% and 70% participated in 1992 and 1993, respectively (Table 1). As seen, the majority of the companies participated are manufacturing companies except one.

Table 1 Company Summary

	1992	1993
Companies approached	8	10
Companies responded positively	8(100%)	10(100%)
Companies participated	6(75%)	7(70%)
Manufacturing industry	6(100%)	6(86%)
Service industry	0	1(14%)

All projects are formulated based on the company's actual needs. Typically, a company will come up with two to three possible project proposals and the subject co-ordinator will choose one or more according to their suitability to our students level and the allowable duration of projects. Table 2 shows that about a half of the projects undertaken are to directly solve technical problems, such as, bottle orientation problem in automatic filler, rat holing problem, and in-process storage. The rest requires a systems approach, such as, changeover time reduction, and alternative maintenance strategy. In many cases, there are no clear cuts indeed, such as, process optimisation and inventory reduction where technical problems can not be effectively solved without a systems approach.

Most companies organised some form of safety training. University provides indemnity for all students working in these companies. Most companies are supportive by allocating office space and phone access. Access to relevant data is always facilitated. In some cases, students are integrated into existing task forces, such as improvement groups.

Table 2 Project Summary

	1992	1993
Total projects	9	9
Technological projects	4(45%)	5(55%)
System projects	5(55%)	4(45%)

Most companies sent their representatives to attend the oral presentation of projects and participate in their assessment. The companies that found the findings are particularly relevant requested for further presentation on site. Due to the generous support of industry, the subject has been able to offer prizes for the best all round projects.

STUDENT RESPONSE

Most students' first responses to the subject have been positive but not confident how to manage in a less structured environment. Since projects are only defined in principle, students are to determine project plan and method required. Students are motivated to meet the challenging by understanding that it is the environment they will be in after their graduation and it is the opportunity to establish a track record of industry achievement.

It was amazing to find out how far students, when motivated and teamed up, can go. The minimum time requirement of the subject was prescribed as spending 1 day per week on site. But most student teams devoted much more efforts towards the projects. Some teams did not stop at making recommendations as required but took them to implementation provided the company concerned was prepared to do so. Companies commented that most projects were conducted in a professional way. As a result, majority of the projects received favourable comments from companies (Table 3). Some recommendations were implemented by the companies and substantial economic benefits were resulted in (see sample project one below). Less successful projects have been due to expectation mismatch or modest students motivation. Some students have established longer term relationships with the company they worked in. Overall, students' confidence was greatly increased.

Table 3 Student Summary

	1992	1993
Total students	29	24
Total projects	9	9
Average team size	3.2	2.7
Projects favourably received	7(77%)	7(78%)

SAMPLE PROJECTS

1. Changeover Time Reduction [1]

This project was carried out by a team of four students at the baby power area of Johnson & Johnson Australia Pty. Ltd (Botany Plant) during 16/03/92 to 12/06/92.

Changeover or setup time is an important consideration in the functioning and existence of a modern manufacturing company. Minimising changover time and subsequent cost would provide various benefits to the company. The purpose of this project is to reduce the overall changeover time in the baby power area. The essence of this project requires methodical investigations, essential analysis and effective recommendations of appropriate and implemental solutions to the problem which will effectively contribute to the reduction of changeover time as a whole.

Due to the nature of the problem the team recognised the importance of gaining hands-on experience in observing and analysing the actual tasks involved and methods applied in a changeover. They witnessed two changeovers: (i) 375g to 250g, and (ii) 375g to 600g bottle size which ultimately allowed them to review and analyse the procedures involved in the changeover. After extensive discussions and consultations, the team decided on a general procedural approach in their attempt to resolve the existing changover problems in the baby powder area.

The team's procedural approach initially includes the division of the changeover procedure into specific workstations of main concern: a. Bottle Sorter (Unscrambler), b. Filling Powder (Albros), c. Capper Line, d. Shrink Wrapper, and e. Case Sealer and Palletizer. Detailed analysis, observation and evaluations of the various tasks performed during the changeover at each of the above mentioned workstations was carried out by each member of the team. At the completion of the changeover, recorded details such as part list, tools required, tasks descriptions and estimated time for each workstations were reviewed and processed into standard form of documentation, as is specified by and appropriate to the standard forms used by Johnson & Johnson. The two documented standard forms that were used are

1. Changeover Procedure of Parts and Tools List, and
2. Changeover Procedure of Task Descriptions.

Shown in Fig. 1 is the sample task description form for changeover from 375g to 250g bottle size at the Bottle Sorter (Unscrambler).

Changeover Procedure

SHEET 1 OF 7

Line Description: Baby Powder

Change Over Description: Change from 375g to 250g bottle size

Component Description: Bottle Sorter (Unscrambler)

TRADE (Numbers) FITTER ☐ ELECT ☐

EST. TIME (Total) FITTER ☐ ELECT ☐

NO.	TASKS DESCRIPTION
1	For 250g bottles, screw stops into blocks. Also take into account the time taken in tightening loose screws in stops (allow for 5–15 secs). There is no need to change blocks since the 250g & 375g bottles use the same blocks (small variation in bottle size). Since 22 stops had to installed onto blocks, estimated time for this task is about 5.5 minutes.
2	Pick up bottle turner from cupboard (equipment storage area). Estimated time is about 4–5 minutes.
3	Remove existing bottle turning device (375g) and attache 250g bottle turning device. Estimated time is about 2 minutes.
4	Adjusting 22 pockets on Unscrambler by opening the 2 front doors at the bottom of the Unscrambler and use the 250g gauge to adjust the pockets. Estimated time is about 5–6 minutes.

Fig.1 Changeover Procedure of Tasks Descriptions

In recognising the paramount importance of the sequence and timing of changeover activities as essential elements of a changeover procedure, a GANTT Chart is subsequently constructed for each workstation that is pertinent to the whole changeover procedure within the baby power area based on the recorded details of the sequence of tasks performed and their respective estimated times. A GANTT Chart is a form of bar chart constructed to show sequence and timing of the changeover activities. Shown in Fig. 2 is a GANTT Chart for changeover from 375g to 250g bottle size at the Bottle Sorter

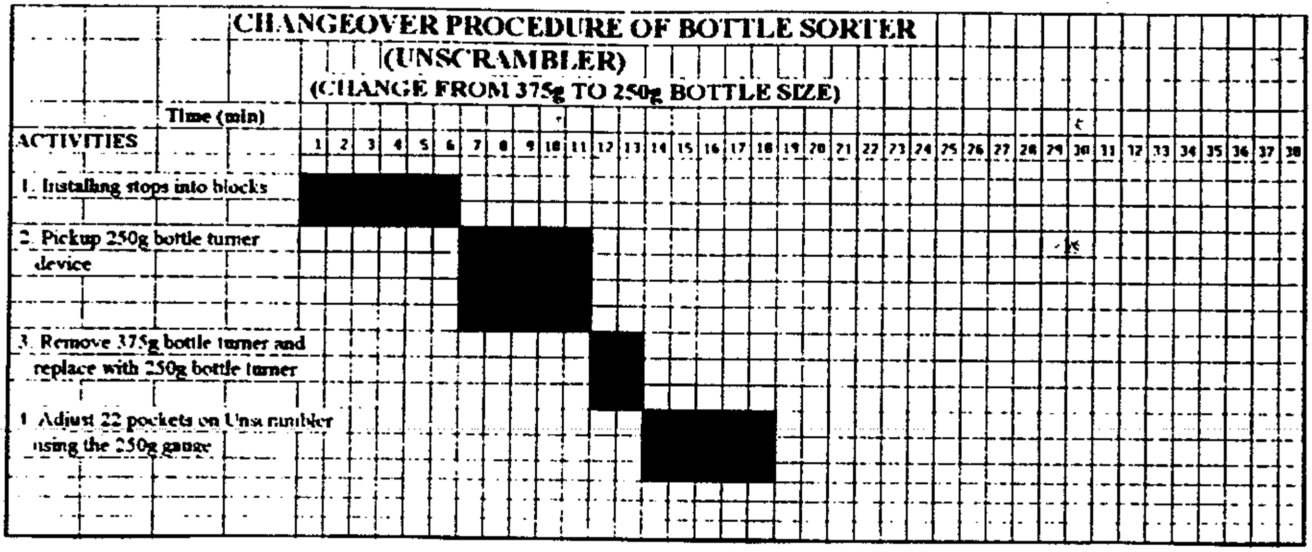

Fig.2 GANTT Chart

The primary and fundamental purpose of the construction of the GANTT charts was to permit to carry out a systematic analysis of the results obtained, evaluate existing problems at each workstation and subsequently initiate valid recommendations for the solution to the overall problem of the changeover reduction. In analysing these tasks and their actual times, the team classified them into various levels of tasks difficulty with regard to process workers skills. The levels of task difficulty are divided into 3 levels: Difficult, Moderate and Easy. The tasks which are Difficult require extensive training and supervised by trainer. Moderate tasks require training and supervision but not as intensive as the Difficult level. Easy tasks require little training and supervision only if necessary. The tasks that are time consuming and training oriented have the highest potential for changeover reduction.

As a result, three recommendations were made. The first one was focused on the time consuming changeover tasks with regard to the filling powder workstation. The second was on extensive training of the process workers to enable them to assist the fitter in carrying our various changeover tasks, including planing of the training program, design of the program, job instruction for training, recommended procedure in construction training manual, and monitoring progress and feedback. The last one was on the ideal allocation of changeover tasks among process workers and the fitter.

The recommendations were implemented by the company and the company representative commented during the oral presentation of the project that the financial benefit alone resulted from implementing these recommendations will exceed a million dollars per annum. The team considered their involvement in the project are invaluable experience that has assisted them in enhancing their practical knowledge and provided beneficial insight to their future endeavours.

2. Work Design [2]

The project was carried out by a team of three students at Woolworth's Norhridge and Eastlakes supermarkets during March to May, 1993. The project involved the evaluation of the checkouts equipped with laser scanners. The initial stage was to identify any problems involved with the manual materials handling carried out by the checkout operators during the course of their duties. This was achieved by video taping a sample of operators and by simultaneously circulating a questionnaire amongst the checkout operators.

Analysis of the data obtained from these two sources was carried out using different methods, such as OWAS, NIOSH, and Modapts Plus. The findings made by using the foregoing methods were confirmed using a simulation package Mannequin, which automatically calculates the joint torques on the wrists, elbows, shoulders, back, etc (Fig. 3). The analysis revealed musculo-skeletal problems originating from the repetitive lifting of fully ladened shopping bags.

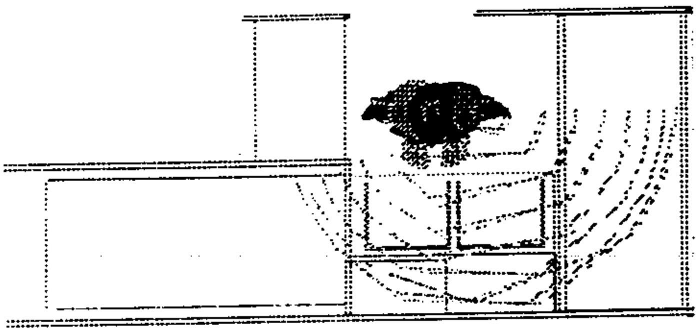

Fig. 3 Typical top view of a Woolworth's checkout in Mannequin showing the horizontal reach limits of an operator

A series of recommendations were made involving modifications to the existing checkout design. The recommendations rang from the simple alterations, such as trimming the partitions, higher checkout, sloping low friction surface on the back end, and lower back end, to more elaborate concepts, such as combined scanner/scale, rounded back end, and moving bag holder. All are aimed at alleviating the present problem by reducing strain associated with the transferral of heavy shopping bags. The company is currently considering implementing some of the recommendations.

CONCLUDING REMARKS

It has been a worthwhile experience for all parties involved. The students involved considered it invaluable experience which has assisted them in enhancing their practical knowledge and provided beneficial insight into their future endeavours. The companies involved have found most recommendations made by the student projects are of a certain value and implemented some of them. Some are considering implementing them. They have also found that sometimes it is quite convenient to have an external opinion on some sensitive issues, such as how to reduce the changeover time, and how to change current work practices. The academics involved have felt satisfaction in facilitating such an interaction between students and industry.

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