Planning Activities and Evaluating Student Performance for Concurrent Engineering Class Projects

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Introduction

This paper will describe student-based planning and evaluation techniques for a 300-level design for manufacturing course and a 400-level manufacturing program capstone course, in which students learn and apply concurrent engineering techniques in order to design and manufacture a product.

Background

Prior to the 400-level capstone course, the students complete a 300-level design for manufacturing course, in which the students design a product and the processes and tooling for its production, as part of a concurrent engineering design project. In the 400-level capstone course, the students finalize the design work done previously by the EMU junior-level class, order materials, and begin making tooling and setting up for production. During production in the school's manufacturing laboratory, the students use inspection and SPC techniques for quality assurance. Appearance, functionality, and quality must be high, as the products are either made as fund-raisers for the manufacturing program, or for companies outside the school.

Planning and Evaluation for Concurrrent Engineering

A key to making this project work is the combined use of (a) concurrent engineering techniques and (b) a team-based management by objective (MBO) and peer review technique for planning and evaluation of performance. Evaluation of personnel performance in concurrent engineering projects is a difficult task in industry, as well as in the classroom. However, the combined use of concurrent engineering and team-based MBO planning and peer review evaluation techniques has enabled realistic and effective planning of activities and evaluation of performance related to those activities.

Concurrent Engineering

Turino (1992) defined concurrent engineering as "a systematic approach to the integrated, simultaneous design of both products and their related processes, including manufacturing, test, and support" (p. 3).

In the junior-level course, the students are organized into (a) product, (b) process, and (c) tooling groups to design, simultaneously, the product and their related processes and tooling that will be manufactured by the students in the senior-level course. In the senior level course, the students are organized into (a) general business management, (b) product and process engineering, (c) manufacturing planning and control, and (d) factory operations groups.

The reader may recognize that these groups are representative of the major organizational areas shown on the CASA/SME (1987) CIM Wheel. It is interesting to note that while the organizational structure of the class/enterprise is based on the old 1987 CIM wheel structure, the process of the class/enterprise is based more on the new CASA/SME (1993) Manufacturing Enterprise wheel. In practice, the old Wheel model seems to better define manufacturing organization structure, and the new Wheel model better defines enterprise processes (Tillman, 1996).

Gantt Charting

While the teams in both courses are relatively empowered and self-managed, they are led through weekly planning and scheduling meetings in which design and production ideas are discussed and plans are developed or updated using Gantt charting techniques. Kerzner (1992) described the Gantt chart as the most common type of graphic display for project scheduling. Typically, task bars are used to show activity time for tasks listed on the vertical axis of the chart against time shown on the horizontal axis.

For each class, an overall project planning gantt chart showing the major activities needed to complete the entire project is developed and updated weekly. Also, team planning gantt charts are developed weekly to show the specific activities planned and completed by each member of each team.

Students are better able to understand the inter-related planning and scheduling needs among and across teams by developing the gantt charts in team and overall project groups. It also becomes a positive motivational factor for them to show that they have (or have not) completed a task on schedule, when their task bar is darkened-in to show percent completion in front of the entire class.

Management-by-Objective (MBO)

Robbins (1994) defined MBO as "A system in which specific performance objectives are jointly determined by subordinates and their superiors, progress toward objectives is periodically reviewed, and rewards are allocated on the basis of this progress" (p. 198). The advantage of this system is that overall objectives are converted into specific objectives for organizational units and individual members. The assumption with MBO systems is that if all the individuals achieve their goals, then their unit's goals will be attained, and the organization's overall objectives will become a reality. (Robbins, 1994).

In class, the students develop overall project and weekly individual objectives with their peers, according to the tasks that are determined to be completed as shown on the overall project and weekly team gantt charts. A student's performance in the course is partially based on the number of objectives set and the number achieved on time. There is more to evaluating their performance than using just MBO, however.

While MBO systems have worked for some companies in the past, MBO techniques have more recently fallen out of favor, because of the propensity for limiting of activities and evaluation of activities to only those specifically set for and by individuals, which limits creativity and team-based cooperation. The problem can be resolved by using a peer performance evaluation technique.

Peer Performance Evaluation

Tillman (1994) described a system used for evaluating the performance of individuals working in a lean/agile manufacturing environment, which includes concurrent engineering. This system of evaluation has been used for selecting individuals for hire as part of a pre-employment assessment process, and can be even more useful for periodically evaluating performance of individuals by fellow team members after employment.

In this system, potential or current employees (or students in this case) are rated on their performance by fellow team members (fellow students) in the following key areas:

1. Team leadership.
2. Team participation.
3. Problem identification and solving.
4. Initiative.
5. Meets planned tasks and objectives.
6. Quality of work.
7. Willingness to help others.
8. Adaptability to change.
9. Promptness.
10. Communication and interpersonal skills.

When employees (students) learn that they will be evaluated, as well as evaluate their peers, on these behavioral characteristics, they learn to perform better as team members working in a concurrent engineering or lean/agile manufacturing environment.

Overall Evaluation

Each student's overall evaluation, in either course, is based partly on their performance on traditional academic tasks such as assignments and tests, and partly on their performance for the project phase in the class. Their project phase performance is based on using a combination of the MBO system and the peer performance evaluation system. The more team-oriented objectives the students set and attain, and the more they exhibit the team-oriented characteristics listed above, the better their performance and evaluation.

Conclusion

This paper described the techniques used by the instructor for students to (a) plan and manage the concurrent engineering design and production work for the project teams, (b) plan and manage their own work tasks, (c) evaluate their work as related to the objectives they set, and (d) evaluate others and be evaluated on desirable team-oriented behavioral characteristics.

The advantage of this system is that the objectives that are set and achieved by the students are project, team, and organization based, and that the students maintain a team orientation due to the peer-performance evaluation system. It avoids the problems that some companies have experienced with MBO systems, while taking advantage of the benefits of MBO. This combined MBO/peer performance evaluation system can be very effective and motivational for individuals, especially in an empowered, self-directed team orientation.

This method of evaluation has been very successful academically, and provides an example to students how to organize a system for planning and evaluation of individuals working in teams in industry.

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Biographical Information

TRACY TILLMAN is an associate professor in the undergraduate and graduate manufacturing and quality programs at Eastern Michigan University. He has been involved in research and development of certification examinations and programs for the Society of Manufacturing Engineers for 10 years. Is is currently working on a book on tool design and concurrent engineering with Mark Curtis of Ferris State University.