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## A HARDWARE BASED CIM SIMULATION LABORATORY MODEL TEST

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### ABSTRACT:

A hardware based simulation laboratory of a computer integrated manufacturing (CIM) environment for business students studying production and operations management (POM) is described. A method for evaluating the educational effectiveness is also considered.

#### Introduction: The Problem

(1) National need for qualified factory management people: The "big picture" problem centers on the nation's unfavorable import/export payment ratio in manufactured goods. While the reasons for this situation are many and varied, the manufacturing industry cannot escape implication. One of the necessary elements in a solution to this U.S. problem is to increase the number of informed, motivated and experienced plant managers. Complex, highly automated factories are not likely to attract the millions of dollars required for development from corporate managers who are unfamiliar with automation and hence may exhibit risk avoidance to such investments.

(2) Lack of hands-on experience: Unfortunately, a purely computer-based simulation game does not provide business students studying POM with any physical exposure to the modern factory environment. Engineer's physicists, chemists and biology students all obtain (to some degree) a physical image of their "real" world through conducting laboratory-based experiments. Business students studying POM must garner their impression of the modern CIM facility from a text book- -occasional field trips not withstanding.

(3) Lack of motivation to pursue a career in factory management: It is generally conceded that very few first-year business students express any interest in careers associated with factory management. The image of the field (if any exists at all) seems to be one of "oil cans, dirty finger nails and no professional future." Thus the POM major is not one of the most popular in the business college.

#### A Solution (Maybe)

In order to attract students to the POM field it is necessary to show that the work is interesting, can provide a good career path and is not 'dirty.'

To accomplish the objectives, i.e., promote student interest and experience, a hands-on environment, hardware-based CIM laboratory was developed. The laboratory model is called a Teach-Factory (T-F).

The laboratory employs a QC inspection station, tracked vehicles to transport products and robotic loading and unloading stations. A case study problem serves as the laboratory experiment." The students solve the problem, first theoretically on paper, and then implement the solution in the T-F laboratory.

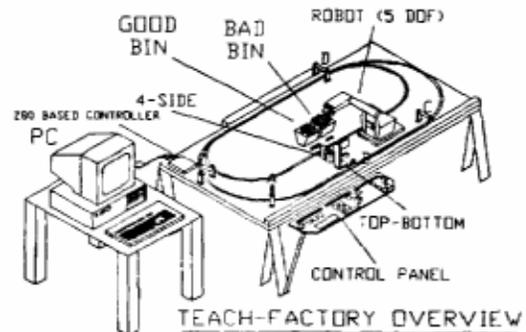
This sequence of theory and laboratory simulation provides an opportunity to translate a paper solution into a physical one. The laboratory operation is carried out by student teams who vie with one another to achieve the greatest "pay-off."

#### Teach-Factory Simulator

In the case study problem, material is received from an outside vendor, inspected for defects and sorted into a "good bin" or a "bad bin." The rate of incoming material is specified by the student; factory manager in accordance with a demand forecast created by the students from historic data. Actual delivery is modulated by a Poisson distribution so that there will be some variation in the quantities of material received. Further, the quality of the incoming material is unknown to the factory personnel; hence the amount of inspection required must be established.

The inspection process has a cost associated with it in terms of both time and money, and the goal of plant management is to achieve a desired throughput. Time is scaled to one-minute equal's one hour. Hence a typical 40-minute class experiment represents a 40-hour workweek. A cost is also associated with idle factory equipment such as vehicles and robots.

The Teach-Factory requires students to solve several basic POM problems involving forecasting, scheduling, queues and quality control. Solving these problems in a real-time, dynamic operating environment provides different insights from those obtained through mere paper solutions. Students begin to appreciate the interrelation of technology with business objectives and view the process as a total system.



#### Laboratory Evaluation

Current research is directed at evaluating the effectiveness of the Teach-Factory. Two areas are of interest: (1) The usefulness of the lab in demonstrating the theoretical aspects of POM studies and (2), to what degree student interest and motivation in a POM career path is enhanced. Point (2) is deemed as important as point (1) but more difficult to test. The evaluation plan will provide introductory POM courses, consisting of the traditional lecture series only, to a control group of students; lectures and T-F laboratory exposure to another group, and a follow-up comparison of the two teaching methods.

The availability of qualified faculty will also affect the results. Historically, business school faculty have been somewhat reticent to become involved in hardware laboratories. Whether this is due to lack of interest, lack of confidence in the idea, or lack of hardware background is not clear. Faculty are no doubt just as prone to risk avoidance in approaching new areas as are businessmen unwilling to invest in little-understood robot automation. The fact that business school faculty are not comfortable with programmable controllers, sensors, robots, lasers and other advanced hardware found in a CIM environment (and in T-F) must eventually be addressed. One solution that is becoming more prevalent is joint engineering school/business school courses in manufacturing areas.

#### Conclusions

Intense international manufacturing competition requires that new methods be found to attract and train students in the POM field. T-F L5 an experiment to introduce non-technical business students to a high-tech environment. So far engineering students taking the course have shown more interest than business students. In running T-F. Finally, evaluation may provide insight relative to business student and business department commitment to P014 programs.