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USE OF SIMULATION ADMINISTRATION TO ACHIEVE PEDAGOGICAL OBJECTIVES

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ABSTRACT

This paper describes the administration of a production simulation in a graduate introductory production/operations management course that encourages the design and use of efficient decision systems. Student teams are required to make the 48 simulation decisions each week. A set of auxiliary computer programs customized for use with simulation data is available for use by the teams to help in their development of these decisions. The students are charged in simulation money for the use of these programs. Since the grade on this exercise is determined by the team's cost performance, this administrative technique encourages the students to make efficient use of the information in their decision system.

INTRODUCTION

This is the description of the use of a simulation approach used in an introductory graduate course in production/operations management. The course is intended primarily for MBA students and the prerequisites are a graduate course in operations research and a graduate course in statistics. The course has two major purposes:

1. To acquaint the student with the basic problem areas encountered when performing the operations/production function and the approaches used to handle each problem area, and
2. To examine the concepts of the value and cost of information, and the design and use of decision systems.

The first objective is primarily accomplished using traditional pedagogical approaches. An innovative simulation approach used to accomplish the second purpose is presented below. This innovative approach also does much toward the accomplishment of the first purpose.

For eight consecutive weeks near the end of the semester, the students in this course participate in the execution of a production simulation. It should be pointed out that it is not the simulation that is considered innovative, but the way that it is administered. The students are placed on teams consisting of three or four members. Each team must make a set of decisions necessary to run the production simulation each week. Decisions for the last three simulation periods are handed in during the eighth calendar week thus ten periods are simulated.

DESCRIPTION OF SIMULATION

The production simulation consists of a three department factory assembly, subassembly and parts. Fifteen finished goods are produced using thirty subassemblies, parts and raw materials. The structural relationships are described through a bill of material matrix. Time lags occur between releasing an order to a department and its availability for use; the same situation exists with raw materials.

The managing team must make production level decisions for each item. The work force level for each department must also be determined. Thus each team must make 48 decisions each simulation period. The decisions of one team do not affect the results of another team. Approximately one day after the decisions are handed in, the team receives the simulation results.

The grade for this exercise constitutes approximately 22% of the final grade and is determined primarily by the team's total cumulative cost relative to other teams after the ten simulated periods. The costs that can be incurred during the execution of the simulation include direct material, direct straight time labor, overtime, idletime, inventory carrying, backorder, hiring, firing, interdepartmental personnel transfer and information. Each team is faced with the same minimum ending levels for the 48 decision items. Additional penalty costs are imposed on teams that do not meet the minimum ending conditions.

The demand pattern for most of the finished goods is seasonal; some have both trend and seasonal components. Each team experiences the same set of demands for the finished goods over the ten decision periods. Several weeks prior to the beginning of the simulation, each team receives a 36 period history of demand for each of the finished goods in printed and punched card form.

During the first several weeks of this course and prior to initiation of the simulation, production/ operations topics that are especially pertinent to the simulation are covered. These include forecasting, inventory control (including MRP), and aggregate scheduling. In addition to each area being presented via the traditional modes, the student receives an oral and written description, a sample input listing, and a sample output of a computer program that can be used to help implement an approach to handling the problem area. There are four programs in all (1) exponential smoothing models (constant, trend and six-factor harmonic), (2) materials requirement planning, (3) a linear programming formulation of the aggregate scheduling problem, and (4) a program that develops departmental manpower loads given a master production schedule. Each program is available for use by any team during the semester and has been customized for use with data available during the simulation.

These programs are stored on a disk available to the campus computer network. Since the computing network is up 16 hours a day, 7 days a week, the students can make use of these auxiliary programs almost at will. The unique feature in administering this simulation is that there is cost (in simulation money) attached to the use of each of these programs. The fee schedule for each program is made available to the students at the beginning of the semester. Each team is assigned an identification number at the beginning of the course. The programs are written such that they can not be accessed unless the user has one of the identification numbers stored in the program. If

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the user does have the proper identification number and the called auxiliary program is successfully executed, then the appropriate fee for the use of the program is charged against his/her team for that period and stored by an accounting program. When the instructor next runs the simulation (once a week), the accounting program is called, and the cost of information is totaled for each team and added to the cost of operation for that period.

The primary benefit of administering the simulation in this manner is that the students are forced to explicitly recognize that information is not free. The potential benefits of having the information developed by a program must be weighed against the cost of that information. This is a prime consideration when designing real-world decision systems.

ADMINISTRATION OF SIMULATION

The innovative feature of this approach to administering a production simulation is that the students are placed in a position of designing their own decision system. In the design of this operating decision system, the team is realistically faced with the tradeoff between the cost (both in terms of simulation money and their time) of information gained through the use of the auxiliary programs made available to them and the value of that information in improving their simulation decisions. The students are free to make it as simple or complex as they desire. Each team is still faced with making 48 interdependent decisions once a week.

The primary reason that efforts were focused on developing this approach is because it somewhat realistically reflects the type of decision environment an MPA will find himself/herself in after graduation. As a potential user, and/or designer, of information systems, the student should be made aware that the information system is a limited resource with definite costs incurred with its use. By structuring the administration of the simulation in the manner described above, the student gains a vivid appreciation of this phenomenon.

The student is made aware that each time he/she wants to know the effect of some modification of problem conditions, he/she will have to pay for that information in the form of another computer run. Presumably this means that the user will think through his/her request to the information system in terms of potential benefits to be received in the decision making process before the request is made. By attaching an explicit cost to the use of this resource, the "brute force" approach of solving a problem by requesting huge amounts of information and/or simply putting the computer in an enormous do-loop until nearly all possible answers are enumerated is avoided. Hopefully the students develop more efficient means of arriving at a decision.

Since the rules of the simulation do not prevent it, it is possible that a team may develop computer programs on their own or use other available software to aid in their decision making. The students are encouraged to do so if they choose. By approaching the problem in this manner they can save simulation costs, but the complexity of the simulation and the time pressures involved mean a sizable investment of time and effort with the risk that this alternative would not yield desirable results. In the development of real-world decision systems, this situation is parallel to that of working with an available, known system versus developing your own in-house or customizing a software package to your needs.

A second reason that efforts were focused on developing this approach is that it serves as an excellent vehicle to show the students how approaches to various production/operations

problems can be integrated to operate a complex system. The student can see exactly how tools such as material requirements planning can and cannot be used. By using these tools to make operating decisions over time, the students are forced to recognize what inputs are necessary to the approach, how the approach operates, and how to interpret the output and use it to make decisions. The student also sees how the approaches used to solve various production/operations problems can be integrated to form a coherent decision system.

BENEFITS OF SIMULATION

The material in this innovative approach is organized so that it complements the traditional presentation of several production/operations decision areas. Immediately following the lecture material on the subject area, the students are presented a written and oral description of a computer program of one or more of the approaches that can be used to handle the problem. This description includes sample inputs and outputs for the program. The inputs and outputs for these programs are tailored to use with the production simulation.

During a period prior to initiation of the simulation, the teams are allowed and encouraged to operate each of the auxiliary programs without cost on a trial basis. This permits familiarization with the mechanics of using the programs and the potential benefits that might be derived from their use. After the trial runs with the auxiliary programs, each team is permitted a trial set of simulation decisions. From that point on, the teams are charged for the use of the auxiliary programs.

The students are left on their own to design and revise their team's decision system as the simulation progresses. During the course material dealing with information systems is covered but this material deals primarily with hardware and general information system design concepts. There is not much devoted to the design of decision systems. The complexity of the simulation along with time constraints force the teams to adopt a decision system of some form if they want to compete with the other teams. I believe leaving this portion of the exercise unstructured encourages the students to experiment with the use of some of the approaches presented in the classroom. They must make some hard decisions concerning the cost and value of information in a complex, competitive situation. This is a unique feature of this approach.

Student reaction to this exercise has generally been positive. Many comment that it has made much of the textbook material come alive and increased its relevance. This type of comment reinforces accomplishment of the first purpose of the course. Comments regarding the value of the auxiliary programs in helping in the decision making process indicate that the approach is also very effective in accomplishing the second purpose of the course.