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ARE YOU KIDDING? LET STUDENTS CONDUCT A SIMULATION OF A FIRM? OR A CASE STUDY OF A CAPITAL INVESTMENT SIMULATION

Ralph N. Stair, Jr., University of New Orleans
Kenneth D. Ramsing, University of Oregon

The instructor of an MBA class was asked by an analyst for a major forest products firm to analyze a large scale plant expansion. After some thought, it was suggested to the firm's management that this problem was extremely complex and should probably be simulated. It was further suggested that the MBA class should conduct and carry out the simulation study. The initial response of the company management was, "Are You kidding--let students conduct a simulation of this firm? What do they know?"

After some additional discussions and persuasion, management began to realize that many students do possess considerable expertise similar or better than that of employees in the firm. In this particular case, many of the students had been employed in managerial and analyst positions in industrial organizations prior to returning for an MBA. With convincing arguments, the firm's management, suffering some anxiety, agreed to the use of students as consultants to evaluate a multi-million dollar expansion of plant and equipment.

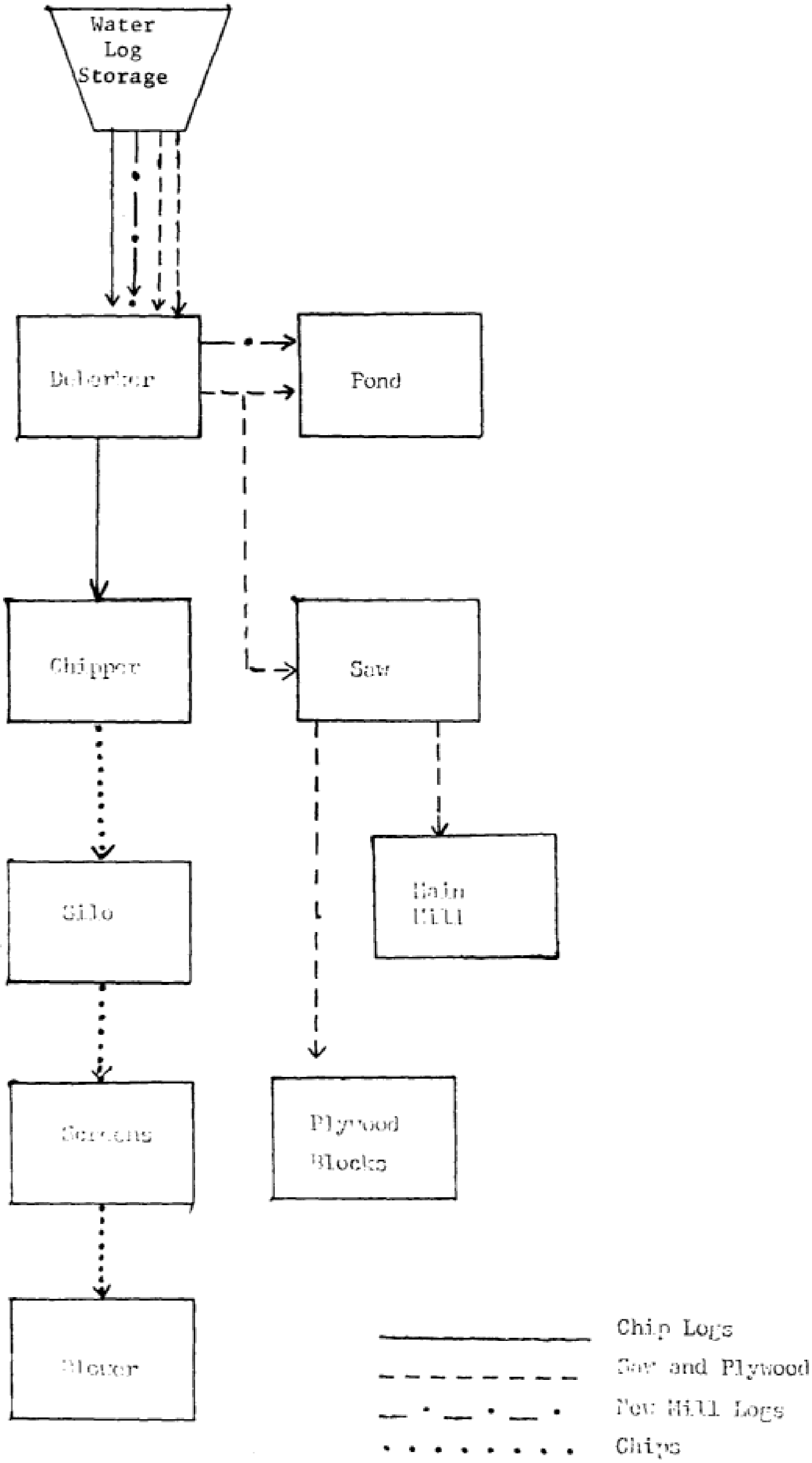
This discussion only scratches the surface into the problems of class participation of the ongoing decision-making process in our nation's organizations. What follows is a case description of both the process carried out by the firm to use the student problem-solving effort and the simulation problem itself.

BRIEF DESCRIPTION OF EXISTING FACILITIES

The company being studied by the students produced a variety of wood products from logs of various grades. Wide width and nor mal width company trucks, and independent truckers, provided the primary input of log material to the operations. Each load, regardless of its origin, is categorized into either fiber or grade loads depending upon the quality and subsequent use of the incoming load. At the time of the study, these raw materials were transformed into various types of paper, plywood, veneer, lumber, and other assorted wood products by the existing facilities. These facilities include mills and other supportive equipment around which a complex materials management system has been developed to efficiently produce the desired products.

The proposed capital investment, a new mill, could directly effect several existing facilities and the related materials management system. Figure 1 shows the facilities and flows of the existing materials management system that could be effected by the proposed new mill. It should be

FIGURE 1


Water
Log
Storage
Debarker
Pond
Chipper
Saw
Silo
Plywood
Blocks
Chip Logs
Saw and Plywood
Chips

noted that approximately 80 per cent of tile materials shown in Figure 1 are transported between existing facilities and their associated inventory storage locations by the use of several log stackers of different sizes and capacities.

The realization that the installation of new equipment may adversely affect the operation of the existing facilities should be a germain input to the capital investment decision. And, in the case of the company under study, there was considerable concern about the influences of the proposed new mill on the entire operation. Regardless of the attractiveness of the proposal using the traditional approaches, it was imperative to know the extent of the changes that would surely take place with the installation and operation of the proposed mill. An adverse impact on the materials management system could completely override the attractiveness and advantages of the new mill. Thus it became necessary to determine the effect of the proposed mill on the following before an intelligent decision could be made:

1. Grade Log Stacker Idletimes
2. Fiber Log Stacker Idletimes
3. Pond Storage Requirement Shortages
4. Undelivered Fiber Logs
5. Overtime Required to Fill the Pond
6. Grade Truck Average Queue, Largest Queue, and the Number of Occurances
7. Fiber Truck Average Queue, Largest Queue, and the Number of Occurances

THE CAPITAL INVESTMENT PROPOSAL

As in most capital investments, the proposed new mill required supportive equipment. Figure 2 reveals the proposed new mill, its supportive equipment, and the modified materials management system as it relates to the existing facilities.

Figure 2 graphically depicts the reasons for the inadequacy of the traditional methods and the need for determining the effects of the capital investment proposal on the existing materials management system. It was at this point that the students began to confront the problem of “what do we do in order to solve this problem.” With the seven elements listed above as being needed for decision making purposes, the students had the chance to evaluate whether or not simulation would be the most appropriate direction to take in determining a solution. The students began to realize that this problem renders the traditional cash flow analysis more difficult but certainly possible. However,

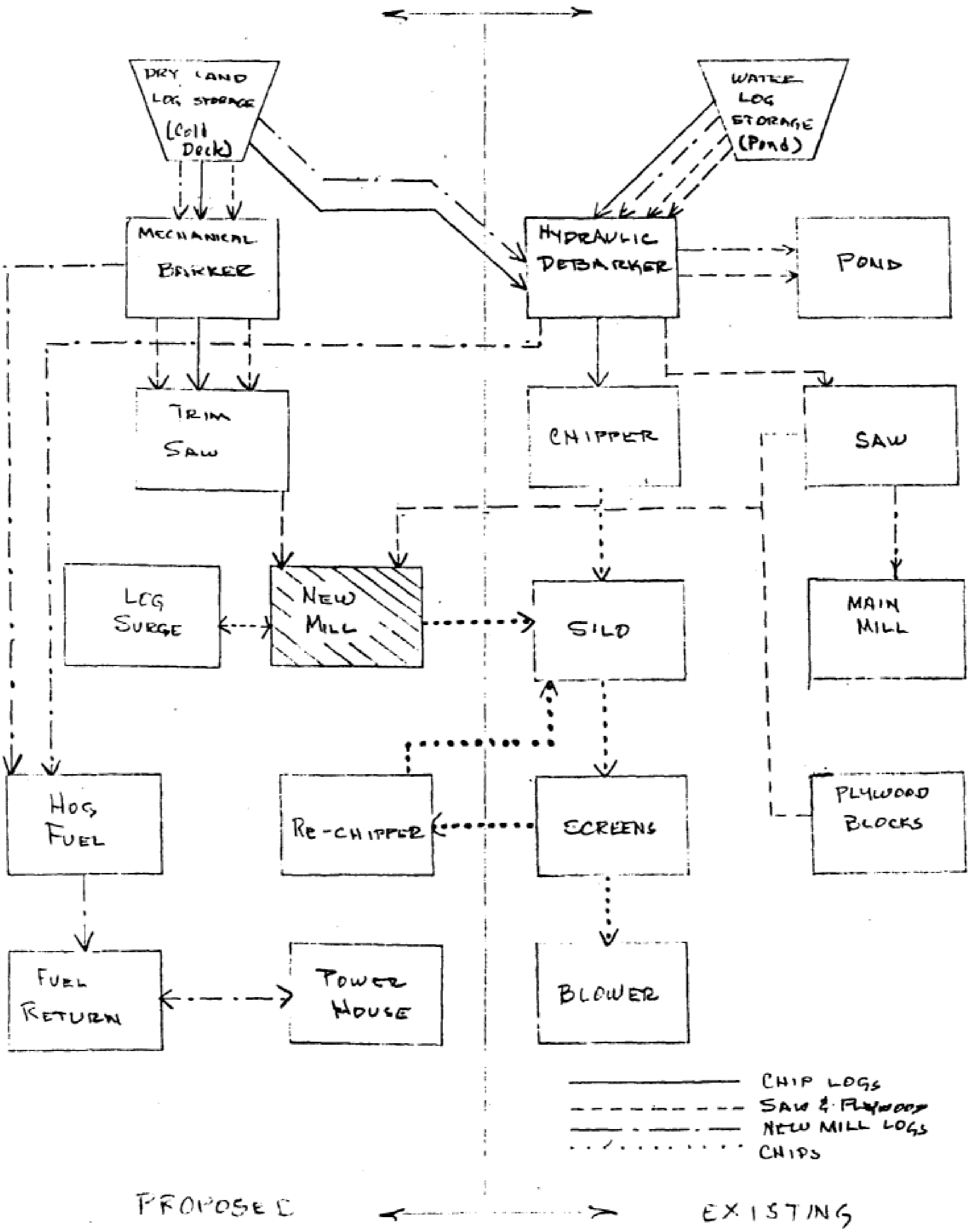


Figure 2
Interaction of Existing and Proposed Facilities

they realized that the proposed capital investment is highly related to the existing facilities and materials management system. Not only is it nearly impossible to trace these relationships using the traditional methods, but in light of fluctuations in raw material inputs, unit processing times, and equipment breakdown frequency and duration, it is evident that alternative solution techniques must be sought.

THE SIMULATION APPROACH

It quickly became apparent to the students that the problem was a realistic and massive one. For example, for fiber loads, there are over two dozen decision nodes and processing instructions for unloading and transporting fiber logs to various inventory areas and fiber processing facilities. Similarly, there is a complexity of decision nodes and processing instructions for the grade loads. Further, a number of complex priorities rules existed for unloading and servicing the mills. These rules were associated with the time of the day as well as with log inventory quantities.

To carry out the simulation, the class was divided into five- person teams. Each team of students was responsible for modeling the problem in the way that they felt best. Five different models were developed. Four of the models used FORTRAN as the computer language. A fifth team used GPSS. Before modeling, the students met with the company management to discuss the problem and to determine the needs of the corporation. Initial proposals were developed and presented to management to gain some response to be sure each of the student groups understood the nature of the problem and were not merely responding to their own “idea” of what was going on. This gave management an opportunity to convey additional information to the student teams. Each of the teams shared the same data base but were at liberty to use individualized modeling approaches. Each team took a different approach to the problem. The time unit ranged from one- second intervals to a macro model in which the students used days or weeks of operation as the time base.

As an example, this latter model was constructed using a modular design in its construction. Modularity was designed into the simulation model to allow management to use all or any part of the simulation in the future. The basic structure is displayed in Figure 3. The Driver module allows the generation of the materials input flows. In this simulation, the Driver was the mechanism that specified the arrivals of input loads via grade trucks and fiber trucks whether owned and operated by the company or by independent jobbers. This information was subsequently fed to the Responder which generated the files necessary to answer the questions related to the impact of the proposed new mill and its supportive equipment to the existing materials management system. The Responder module was designed with the flexibility to handle not only the existing configuration but an al-

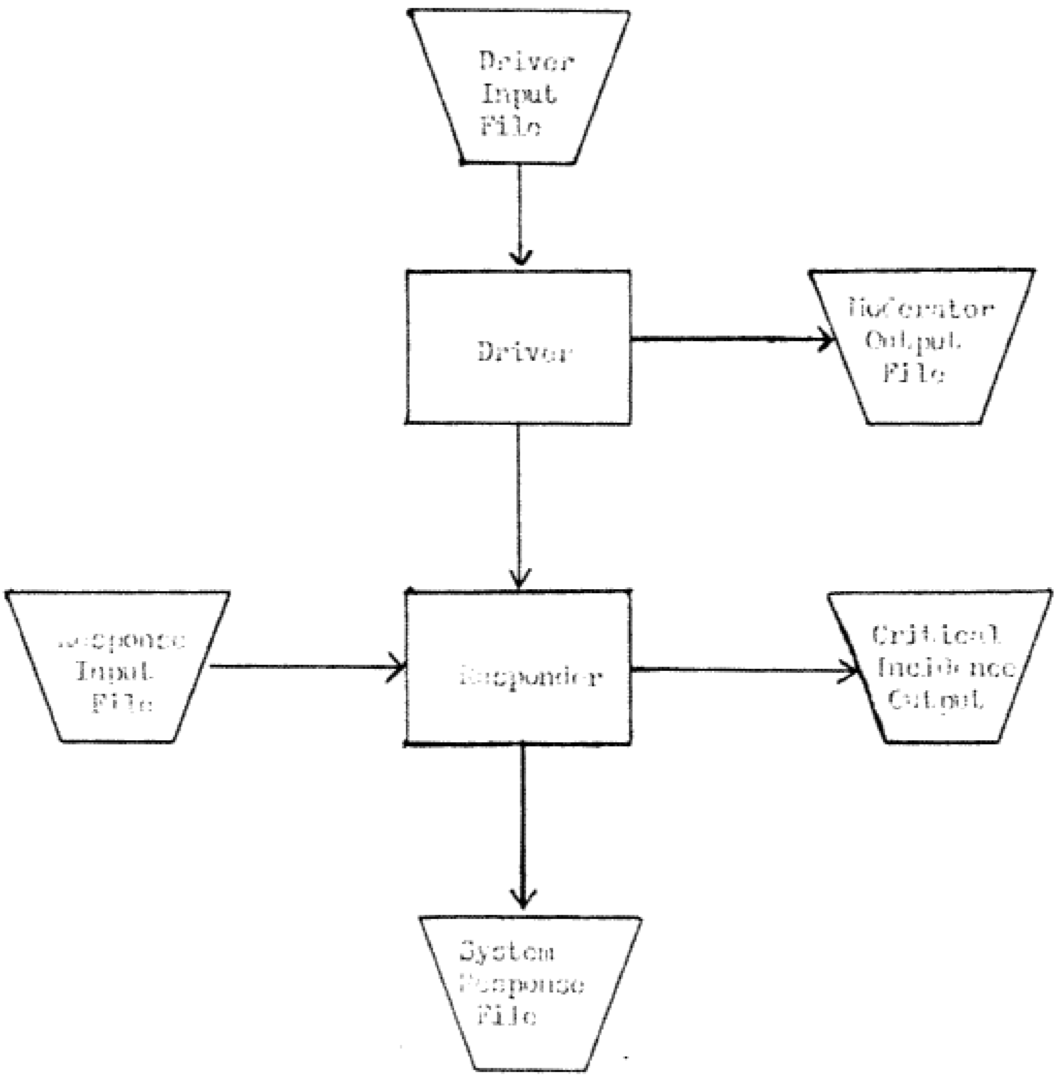

Driver Input File
Driver
Moderator Output File
Response Input File
Responder
Critical Incidence Output
System Response File

FIGURE 3

most limitless variety of situations and conditions that embodied a similar set of priorities. These priorities, which were determined primarily from the operation of the existing facilities, were not expected to change significantly even for major changes in the capital investment proposal.

The simulation embodied significant versatility, and it incorporates the capability to input over one hundred quantities through the Driver Input File and the Responder Input File. The majority of these input quantities are various rates and schedules. Although these quantities were not overly sensitive, they allowed the simulation to be used when either more refined input data became available or when conditions caused these rates to change. Additionally, the simulation generated three output files which are the Moderator Output File, the Critical Incidence File and the System Response File. The Moderator Output File was used to monitor and check the operation of the Driver Module which generated arrivals of grade trucks and fiber trucks. This file is helpful when the Driver module is separated from the Responder, but otherwise its only function is to monitor the generation of input materials. The Critical Incidence Output File revealed any critical situations that would be encountered by the simulations. Large stock shortages, for example, that might cause the shutdown of the existing mill would be included in this category. The final output file consisted of the various inventory levels and operations of the simulated facilities. This file could be generated on an hour to hour, day to day, month to month or on a year to year basis. The form of the System Response File is shown in Table 1.

RESULTS AND CONCLUSIONS

Once the student groups had completed the simulation models and written the necessary reports, the conclusions were presented before the company management. Although each of the teams took a different approach to modeling the system, they each had similar conclusions. From the extremes of the micro approach in which the time period used was in seconds to the macro model which used days as its base, management was able to learn more about their operations than they had previously. The comparison of the models and the ensuing discussions provided both the student teams and management with considerable information about the problem.

In the case of one model, with over two years of simulated outputs, it was evident that the simulation approach provided the answers to the perplexing questions on the impact of the proposed investment on the materials management system. As the students discovered, this approach is certainly not a substitute for the more traditional methods of analyzing and ranking capital investment proposals, but it does supply the decision maker with vital information not available from the traditional decision approaches.

TABLE 1

UNDELIVERED FIBER LOGS	*******		
UNMET POND REQUIREMENTS	*******		
IDLETIME-GRADE LOG STACKER (S)	*******		
IDLETIME-FIBER LOG STACKER (S)	*******		
OVERTIME TO LOAD THE POND	*******		
	LEVEL	MAXIMUM	MINIMUM
POND	*******	*******	*******
INVENTORY-GRADE LOGS	*******	*******	*******
INVENTORY-FIBER LOGS	*******	*******	*******
CURRENT STORAGE-FIBER LOGS	*******	*******	*******
BARKED INVENTORY	*******	*******	*******
	GRADE TRUCKS	FIBER TRUCKS	
UNITS REQUIRED TO WAIT	*******	*******	
NUMBER OF OCCURANCES	*******	*******	
LARGEST QUEUE	*******	*******	

System Response File

The students found that there are many hidden advantages in the use of a simulation approach as an aid in the capital investment decision. First, the simulation forced the managers to precisely stipulate the flows and the priorities. Priorities were seldom considered prior to the simulation with the same precision and emphasis. Also, as previously mentioned, the simulation was written in a flexible manner that will allow managers to use the simulation in the future with different rates, schedules, and facilities configurations. Finally, it was experienced that the managers related to the output of the simulation extremely well. They could identify with the results and outputs of the simulation with very little difficulty. It was apparent that this simulation approach was characterized with a higher degree of acceptability versus other complex techniques.

By using tile approach of consultants, the students were responsible to management for a costly modeling process. As a result, they learned that in addition to the benefits cited above that simulation approach is not a panacea and its use should be prefaced with its costs, validation difficulties, and length of run considerations. However, they did find that although the cost of simulation is usually significantly higher than other approaches which might be taken, it does generate information in many circumstances unobtainable by other methods.

This simulation illustrated that simulation can be an important tool in the analysis of capital investment decisions. This is especially true for highly interactive and complex capital equipment investments which is typically the case. Under some circumstances, simulation is the only viable approach. As with other techniques, there are limitations and drawbacks to simulation, but in light of the benefits, it is expected that these students, with their experience in the consulting role, will understand how simulation will enjoy even more popularity in the future as an aid in the decision-making process.