AN ALTERNATE APPROACH TO THE UNDERGRADUATE THESIS

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The chemical engineering department at the Technical University of Nova Scotia (TUNS) has recently undertaken an approach to the senior undergraduate thesis which is different from the more traditional route. In the 1986-87 academic year, most of the thesis projects involved the design, construction, and testing of a piece of equipment for the undergraduate laboratory. In previous years, each student had selected a topic which was based on a professor’s area of expertise and research.

Our method of organizing and handling the projects is described here, and the benefits and disadvantages of conducting undergraduate theses in this manner are discussed. We have concentrated more on the educational aspects of our approach than on the projects themselves.

ORGANIZATION

The chemical engineering department at TUNS is relatively small, with a typical total enrollment of forty to fifty undergraduates in the three years. In 1986-87, our senior class consisted of twelve students. The students worked singly on a project which was conducted under the supervision of a professor (or professors) in the department. One faculty member also served as overall coordinator. As well as being an additional resource person for the students, he reviewed the final designs before components were ordered and also gave lectures on topics such as project management, instrumentation selection, and the design process.

A graduate student was assigned to the course as a teaching assistant. The student was selected for his practical knowledge of piping, electrical, and construction techniques and, as such, was invaluable as a resource person for the students. He also coordinated the purchase orders from the twelve projects.

An important aspect of the course structure was a schedule of events which the class was expected to

TABLE 1
Staged Progression of Thesis Work

<table>
<thead>
<tr>
<th>First Term</th>
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<tr>
<td>1. Topic Selection</td>
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<tr>
<td>2. Functional and conceptual design</td>
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<td>3. Dimensional design</td>
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<td>4. Framework and support structure requirements</td>
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<td>5. Order list for components</td>
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<tr>
<td>6. Mid-term oral presentation</td>
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<td>7. End-of-term oral presentation and written report</td>
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<th>Second Term</th>
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<tr>
<td>1. Control panel dimensions and layout</td>
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<tr>
<td>2. Beginning and end of construction</td>
</tr>
<tr>
<td>3. Beginning and end of testing</td>
</tr>
<tr>
<td>4. Mid-term oral presentation</td>
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<tr>
<td>5. Final oral presentation and written report</td>
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follow. Deadlines were established for the items shown in Table 1.

PROJECTS

The twelve topics offered were categorized as shown in Table 2. The three research-type projects all have potential for use in the undergraduate laboratory.

BENEFITS

The most obvious benefit from this work has been the addition of new experiments and the subsequent deletion of outdated equipment. This has resulted in a general strengthening of the undergraduate lab, particularly in the unit operations area. For example, we have replaced a large plate heat exchanger with a smaller, more versatile unit.

We have also been able to increase the use of computers in the lab, primarily in the areas of

- Data acquisition (drying)
- Data acquisition and control (single and multi-variable control experiments)
- Data reduction (plate heat exchanger)

There is no doubt that the work described here has held significant advantages for the department; but what about the students? Judging from their reaction to the work (and the quality of the finished products), they have also benefited from the experience. Student development was fostered by several factors:

- Familiarization with aspects of design and project management
- Knowledge of instrumentation
- Hands-on, practical experience
- Interaction with technicians, salesmen, etc.
- Sense of pride in the work; enhancement of class spirit
- Exposure to state-of-the-art equipment (e.g., Laser Doppler Velocimetry in the freeboard particle measurements)

Apart from the technical aspects listed above, each student was required to give four oral presentations during the course of the year, as well as two written reports (Table 1). In all cases, a noticeable improvement in communication skills occurred; with three students the improvement was almost unbelievable.

PROBLEMS

An undertaking of this nature has its inevitable drawbacks. Although, overall, the experience was considered a success, several problems arose which are described below.

Cost

Laboratory equipment is expensive, especially if one wants to incorporate the latest advances in technology. There is a big difference in measuring temperature with a thermometer and using thermocouples with associated A/D conversion and computer data-logging. We chose, in general, a middle ground, and installed primary transducers with digital read-outs which would allow eventual upgrading to computer data-logging and control.

Total costs for each project varied from about $500 to $8,000. However, the alternative of purchasing off-the-shelf units (if possible) would have been many times more expensive. Some funds should be set aside to purchase those forgotten or emergency items which are always necessary at the end of the project or during initial testing.

Time

Time plays a major role in this type of thesis approach. The students, faculty and support staff devoted many hours to the work. Normally, three hours...
per week for twenty-six weeks is scheduled (78 hours). It is estimated that the total time that the students spent is closer to double this figure. However, the nature of these projects is such that much of the time must be spent at the end of the final term, which is, of course, when it is the most scarce. We were concerned that the students would be unable to complete the projects in the available time. This is probably the largest risk in such a venture. A high degree of success was achieved, however, with most students meeting the objectives of the work and producing a piece of laboratory equipment which worked. Shortfalls in the program occurred in testing and preparing detailed laboratory procedures. In most cases, additional work is needed in these areas so that the experiments can be used routinely in the undergraduate laboratory.

Scheduling

The time for equipment which was slated for upgrading and which was also part of a current laboratory course required careful scheduling. Fortunately, only one project (packed column gas absorption) fell into this category. We found that it was necessary to run all the laboratory course experiments on packed column gas absorption in one time block at the beginning of the first term. Once this was accomplished, the equipment was turned over to the thesis student and the upgrading proceeded without interruption.

Type of Student

The laboratory projects require that a student have a certain degree of mechanical know-how and dexterity. Since technologist time is limited, a major amount of actual construction is necessarily performed by the student. There were a few students who lacked basic skills in this area and who had no interest in learning them. The result of this situation was that the faculty member had to put in a fair amount of time doing the actual construction.

Research Aspect

One disadvantage of this type of project is that students wishing to pursue a post-graduate degree will not be exposed to some of the concepts or techniques of research. There is no doubt that development of skills in the areas of literature searches, experimental design and general research philosophy suffered. However, development of other skills relating to equipment construction, communications and general project management is also important in research.

SUGGESTIONS

In contemplating this type of project, the following important points should be considered:

- Only do as many projects for which there is adequate funding.
- The larger projects would probably be more successful with two students working together instead of only one.
- Do not have only laboratory-type projects available; research or theoretical projects should be provided for those students who have no interest in a laboratory project.
- Ensure that enough technical help is available. Machinists, plumbers, and electricians are necessary resource people.

CONCLUSIONS

An alternate approach to the undergraduate thesis has been described. This approach lies somewhere between the traditional research-oriented thesis and the work normally done in a process and plant design course. The size of our senior class has made it possible for us to offer this experience to all members of the group. In a large institution it would still be possible to adopt this scheme, but with a smaller percentage of the seniors. While a strategy of this sort is neither desirable nor feasible to implement on a continuous basis, our one attempt has brought numerous benefits to both the department and the students involved.

REVIEW: Direct Contact
Continued from page 11.

any wall resistance and low capital cost. In specialized situations these advantages certainly will lead to further commercial use of direct contact exchangers.

The book is the product of an NSF-supported workshop held at the Solar Energy Research Institute in 1985. It contains fourteen chapters written by the organizers and principal speakers. Five chapters deal with two-phase fluid systems. Three chapters treat heat transfer between particulate solids and gases. A chapter each concerns evaporation and condensation processes.

Several valuable functions are fulfilled by this book. At the most basic level it should serve to re-emphasize to the heat transfer specialists that this kind of heat exchanger is an option with certain strong advantages. The book is a good source of ideas and configurations for possible applications. A valuable feature of the book is a set of design examples included as six appendices. In the final chapter the editors present a summary of research needs.