The Accelerated BS/Master's Industry Program In Chemical Engineering at Texas A&M University

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ABSTRACT - This paper describes a program, started in 1991, which enables the better students in Chemical Engineering to begin work toward a Master's degree at the end of their junior year. These students can receive their BS degrees at the end of the normal four-year curriculum, and complete the requirements for a Master's degree after one additional year. A unique feature of the program is a two-summer research or engineering project requirement which the student conducts in industry. About 30 students have participated in the program to date, which has been well received by both industry and the students.

HISTORY - In 1991, the Chemical Engineering department at Texas A&M established an Accelerated BS/Master's Industry Program, which enables students with a GPA of 3.25 or better to begin work toward the Master's degree at the end of their Junior year. The BS degree can be completed in the usual four years, and all requirements for either the Master of Science or Master of Engineering degree can be completed in one additional year. A key feature of the program is a research or engineering project which is conducted in industry, during two summer periods or equivalent. A total of twenty students have been accepted into the program in the first four years - five in the first year, four in the second year, six in the third year, and five in the fourth year. An additional ten students are expected to be accepted into the program this year, who will start their industry projects in the summer of 1996. Ten of these students have graduated, five with the MS degree and five with the ME degree, and another one or two should be finishing within the next six months. Three left the program before finishing to accept a job with the BS degree. Feedback from both the students and companies participating in the program so far has been uniformly very positive.

HOW IT WORKS - The accelerated aspect of the program is a provision by which these students may take up to three graduate courses during their regular senior year, and also qualify for credit-by-exam for corresponding undergraduate electives required in their curriculum. The industrial project requirement is normally done during the summers preceding and following the senior year, at the company location. This project may be either a research project for the MS degree, or an engineering project for the ME degree. Since graduate credits are also earned for the project work periods, the student can earn up to 13 hours of graduate course credit prior to receiving the BS degree, and an additional 4 hours in the following summer.

Program Requirements - The only requirements for the students to enter the program are junior level (or higher) standing in the Chemical Engineering curriculum, and a GPA of 3.25 or better. Students who qualify for the program are contacted directly at the beginning of their junior year, and asked to submit a resume' to the program director if they are interested in participating. They are then matched with a

participating company during that semester by an interview process, with the companies given the opportunity to select the student(s) with whom they wish to work.

Industry Participation - Companies are recruited to the program by direct contact. When they agree to participate, they are asked to provide a brief description of one or more projects or project areas which would be suitable for the research or engineering projects. The companies are provided copies of the students' resumes, and the students are given the companies' project descriptions. Interviews are then arranged between the company representative and the students on the basis of mutual interest. There is no obligation for the company to choose any student, nor is there any guarantee to the student of a project. The companies offer positions to the students in the program much like they would for permanent employment.

Faculty Involvement - After a match between the company and student is made, a faculty member having an interest in the project technical area is solicited to advise and work with the student and the student's industrial supervisor in joint supervision of the research/engineering project. A meeting is arranged (usually in the Spring semester) with the student, the faculty advisor, the program coordinator, and the industrial supervisor to define the project objectives and requirements for the student, particularly with respect to reporting requirements. The faculty advisor works closely with the industry supervisor and the student, and will visit the company location at least once each summer. The industry supervisor also serves as a Special Appointment member of the student's graduate advisory committee, and participates in the final oral exam in addition to approving the final research thesis or engineering report.

A side benefit of this program is the possible synergism of the interaction between the faculty and the company, which can lead to other forms of interaction such as research support or consulting. For example, as a result of a project started through this Accelerated BS/Master's Industry Program, one faculty participant worked up a cooperative research arrangement with one of the companies, which led to a research grant of about $250,000 for cooperative research in the area of property-processing-product relations for blown film polymer processing operations. We have also started six students in the program with Motorola in the area of wafer manufacturing, which has led to considerable interaction between the faculty working with those students and the company, and may form the basis of a larger program with other similar companies. So far, about six different faculty members have participated in the program.

Compensation - During the summer work periods, the students are paid by the companies at a rate commensurate with their level and qualifications. This rate is negotiated between the student and the company, and is normally higher than for a typical summer intern position. Although not a requirement for participation, the companies are also asked to provide a $2500 fellowship to the student for each of the two years that he/she is in the program, to help defray tuition costs while on campus, since Master's students normally do not qualify for research fellowship or assistantship support through the department. The majority of the participating companies have agreed to, and are providing, this support.

Course Requirements - Students participating in the program may work toward either the MS or the ME degree. The choice is determined primarily by the nature of the intern project, since the MS is a research oriented degree with a thesis requirement, while the ME is engineering oriented with an extensive engineering or design report required in lieu of the thesis. The MS degree requires a minimum of 32 hours of graduate course credit (including thesis), and the ME degree requires 36 hours (including the report). Four hours of credit are earned toward this requirement for each of the two summer work periods.

The accelerated aspect of the program involves the possiblilty of the student obtaining dual credit for selected graduate and undergraduate courses in the curriculum. The BS Chemical Engineering curriculum includes a requirement for three courses (9 hours) of Chemical Engineering electives, to be taken from a prescribed list of courses. The courses on this list include such topics as Intro to Polymer Engineering, Intro to Biochemical Engineering, High Tech Materials, Process Safety Engineering, Electrochemical Engineering, Risk Analysis, and various other Special Topics. The department also offers graduate level courses in many of these or related topics, which encompass and extend the material in the corresponding undergraduate course. The students in this program may take the graduate course for graduate credit, and also receive Credit by Examination for the corresponding undergraduate course. Since the students also receive four hours of graduate credit for each of their summer work periods, by the time they complete the requirements for the BS degree, they can have up to 13 hours of graduate course credits toward the Master's degree. One additional year is then sufficient to complete all additional requirements for the Master's degree.

Project Requirements - The MS degree requires a research project and a thesis. Those students doing their projects in industrial research labs will normally work for the MS degree, whereas those doing projects in plant or production facilities normally work for the ME degree. The specific project objectives and requirements are agreed on prior to the first summer work period by the student, the faculty advisor, and the industry supervisor.

In all cases, extensive reporting requirements are part of the program. After six weeks on the project (e.g. in the first summer), the student submits a detailed Project Proposal, in which he/she describes the project scope and objectives, and outlines the methods and procedures they expect to follow in order to achieve the objectives. The student also submits progress reports and a comprehensive report at the end of each work period. The final project report (normally at the end of the second summer) also constitutes the documentation for the Engineering Report required for the ME degree, whereas the MS degree also requires completion of a thesis, to the specifications of the Office of Graduate Studies. A final oral exam is required of all students, in which the industry supervisor participates as a Special Appointment Member of the student's graduate advisory committee.

Example Projects - The following table gives a brief description of some of the projects in which the students in the program are involved, listed by the sponsoring company. The students working for the ME degree may be involved in more than one project, but the projects listed in the table are the primary ones that are documented for the degree requirement.

SUMMARY - Although this program has been in existence for only four and one-half years, it has attracted considerable attention from both students and participating companies. Both the companies and the students are very pleased with the program and the performance of the students on the projects to date, and we are anticipating a significant expansion of the program in the future. This promises to be the primary focus of the Master's program in Chemical Engineering at Texas A&M, as the present research focus is almost entirely on the PhD degree. The primary limitation on the program at present is the availability of time to develop the industrial contacts and the student projects, which has also been impacted by the reorganization and structural realignment which many companies have undergone recently.

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TABLE I

Companies Participating in the Texas A&M Accelerated BS/Master's Program

COMPANY	DEGREE	PROJECT
Texaco Research Port Arthur, Texas	ME	Experimental evaluation of a the kinetics of the reactions responsible for octane reduction during dehydrogenation with a new catalyst.
The Dow Chemical Co. Freeport, Texas	MS	Experimental and analytical study of mixing efficiency in a tank with jet mixers in various configurations.
Brown & Root Houston, Texas	ME	Process design for removal of low level impurities from feed stream to a polyethylene reactor.
Lyondell Chocolate Bayou, Texas	ME	Analysis of relationship between properties and processing conditions and product properties for HMW HDPE blown film.
Core Laboratories Houston, Texas	MS	Modeling of waxy crude oil phase behavior using polymer solution theory.
SAIC Clear Lake, Texas	ME	Computer aided procedures for Process Hazards Analysis and Process Safety Management reviews.
Alcoa Point Cornfort, Texas	ME	Modification of the non-Newtonian properties of bauxite mud residue for maximum solids loading and minimum viscosity.
Texaco EPTD Houston, Texas	MS	Computer modeling of crude oil phase behavior and recovery by steam flooding. A second student will start this summer on modeling three-phase flow through a high pressure well-head choke
FINA Technical Center Deer Park, Texas	MS	Experimental and theoretical modelling, initiator optimization, and scale-up for a free-radical polymerization reaction.
BASF Freeport, Texas	MS	Experimental evaluation of a fluidized bed process as a substitute for a fixed bed catalytic process.
Phibro Energy, USA Houston, Texas	ME	Computer optimization of a catalytic cracking refinery unit for variable feedstock and product properties.
Hoechst Celanese Corpus Christi	MS	Experimental evaluation and mathematical modeling of a molecular still.
Alcoa Point Comfort, Texas	MS	Mathematical model and optimization of a crystallization unit.

TABLE I (continued)

Companies Participating in the Texas A&M Accelerated BS/Master's Program

Motorola Austin, Texas	ME	Three students are working on projects at Motorola related to wafer manufacturing, rapid thermal processing, etching, and vapor deposition. Three more students will start the summer of 1996 on projects at other Motorola locations.
BASF Freeport, Texas	ME	Optimization of distillation/separation processes in caprolactam unit to remove bottlenecks and improve efficiency.
BASF Freeport, Texas	ME	Investigate feasibility of incorporating membrane technology in cyclohexanone production area to improve recovery and performance.
Dow Chemical Freeport, Texas	MS	Theoretical and computational description of gas phase reactions for simulation and optimization of reactors.
Dow Chemical Freeport, Texas	ME	Engineering design and experimental description of the aeration technology for water purification in a biological wastewater treatment process, to improve efficiency.
Dow Chemical Freeport, Texas	ME	Optimization of hardness in a water softening process for an epichlorohydrin process, accounting for both scaling and corrosion.
Texaco EPTD Houston, Texas	MS	Modeling of the three-phase flow behavior in a high pressure choke as a function of flow rate, for various fluids,
Du Pent Orange, Texas	MS	Thermodynamics of the high pressure phase behavior of ethylene copolymer-solvent mixtures.