

THE HONORS IN THE MAJOR PROGRAM

A Tool for Enhancing Excellence in ChE Students

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This article is a brief description of efforts made in the *Honors in the Major* Program in the College of Engineering (jointly operated by Florida A&M University and Florida State University) at Tallahassee, Florida, to enhance excellence in the education of its most capable chemical engineering students. The program is an effective tool in attracting and retaining this important pool of students.^[1] The Honors in the Major in chemical engineering is a thriving program that produces a relatively large number of highly qualified engineers. Most of our Honors graduates continue their careers in graduate school at universities across the country and perform particularly well. Others who decide to immediately enter the work force find success in positions with responsibility levels usually reserved for more experienced engineers.

The program has gained a reputation for producing reliable professionals. Some of the companies that have hired Honors students have returned to hire additional Honors students, sometimes from the same research group. "Word of mouth" is a great way to advertise, and as the students (as well as the recruiters) discuss their experiences with others, the more motivated high school students and entering college freshmen gain a greater interest in our program. Having earned a reputation for producing well-qualified engineers, we are successful in attracting (and retaining) students who previously would have opted to attend other universities with more traditional chemical engineering programs.

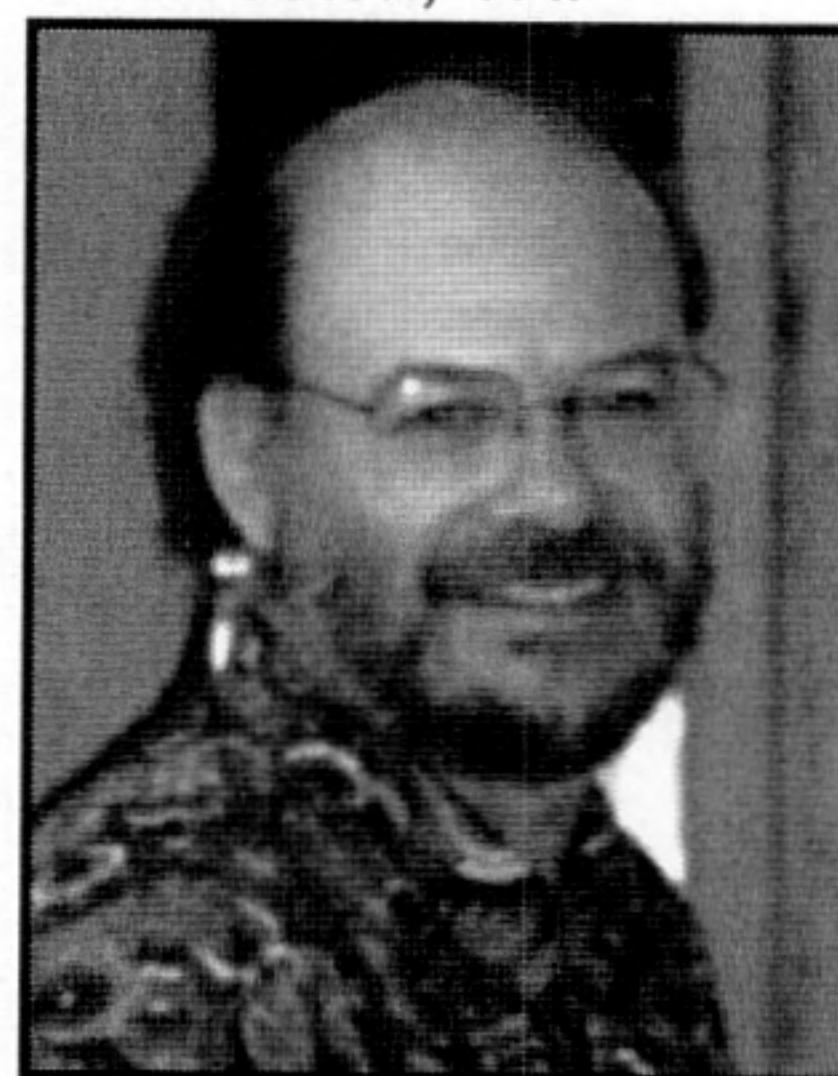
Prior to establishing the Honors in the Major Program as a viable option for engineering students, many of the more capable students found the classwork challenging to them only at an average level. Although an Honors program was available to the students, they considered its level and type of work less than what they were looking for (*i.e.*, too time consuming, too broad in scope, marginal work, not more

challenging). Therefore, the task for the College of Engineering and the Chemical Engineering Department was to make the program an *appealing* option to students and then to find candidates whose excellence would work as a "magnet" for new candidates.

After internally addressing the issues regarding the poor participation in the program, it was newly advertised in such a way that talented students now found it a feasible and attractive opportunity. The option presented to the students was to allow them to apply the Honors in the Major project (provided they successfully completed all requisites) to curriculum requirements in lieu of two technical electives (a total of six credit hours). Those who did not satisfy the requisites for the Honors Program would still be required to take the technical electives in order to satisfy graduation requirements. This approach worked very well.

In the following sections, the reader will find descriptions of several important aspects of the program. They include an overview of the program, a description of the different aspects (such as candidate requisites and time management), characteristics of research projects suitable for the program

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TABLE 1
Comparison of Programs

	<u>Regular Path</u>	<u>Honors Program</u>
<i>Qualification</i>	University entrance	Minimum GPA (3.2/4.0)
<i>Focus</i>	Structured and repetitive classroom work	Unstructured individual research
<i>Driving force</i>	Faculty and other students	Student
<i>Student goal</i>	Finish	Excellence
<i>Additional requirement</i>		Write/defend thesis
<i>Possible by-products</i>		Technical meeting presentation, publications

(along with some examples), an approach for working with Honors students, and some concluding remarks.

OVERVIEW OF THE PROGRAM

In this section, the major characteristics of the program are noted and some of the differences with respect to the path taken by the regular students are presented. Key program aspects involve the application process, selection of a research topic and an Honors Professor, the assignation of the Honors Professor, formation of a thesis committee, writing of a research prospectus, the midterm report, and the writing and defense of a thesis. The Honors and Scholar Office at Florida State University establishes the general guidelines for the program, including setting deadlines and the specific requirements for thesis format and thesis archives (Florida A&M has a separate procedure).

In Table 1 the basic characteristics of the regular path are compared/contrasted with those of the Honors in the Major program. One of the most notable differences in the programs is the type of student who pursues the individual programs. For example, students in the regular program have a strong desire to finish quickly and join the work force as soon as possible. In contrast, students pursuing the Honors path have a strong desire to excel, an established ability to learn independently, and in general, a track record of focused performance. The level of independence required in the Honors Program is also significantly higher than for students on the regular path. Furthermore, the Honors Program provides opportunities not available to those in the regular path, such as the possibility of participating in presentations at technical meetings and, in the most productive cases, refereed journal publications.

ANALYSIS OF DIFFERENT PROGRAM ASPECTS

In Table 2 we present an outline of the major aspects involved in the Honors in the Major Program, including the candidate requisites and time management on which we would like to elaborate. Although there are many ways to communicate the requirements to the candidate, one of the most effective ways is for the departmental "Honors Program Director" to personally interview the candidate. The program director has the opportunity to present the requirements in detail and to ascertain the student's level of interest. This meeting also allows candidates to ask clarifying questions and, specifically, to mention anything that they feel is pertinent to their unique situation. In order for the program director to successfully

TABLE 2
Outline of the Program

Introduction of the Program

Sophomores, First-Semester Juniors, Juniors

- Role of research in undergraduate education
- Invitation and general announcement of the program
- Meeting with the departmental program director

Candidate Requisites

- Minimum GPA (3.2/4.0)
- Independent thinker
- Enjoy looking at a given problem from variety of points of view
- Strong organization skills
- Self-motivated, requiring minimal supervision

Selection Process

- Academic record
- Written statement of purpose
- Prior activities (e.g., science fairs)
- Level of interest/personal motivation
- Joint faculty/program director evaluation

Research Prospectus and Thesis Committee

Thesis Committee

- Tenured or tenure-track
 - *The Honors Professor*
 - *Second professor from the department*
 - *External member (i.e., from another department)*
- Assist the student in directing the project
 - *Feedback*
 - *Proper crediting of work*
 - *Purpose and structure of a prospectus*

Student

- Selects committee members in conjunction with Honors Professor
- Takes ownership of the project by formulating the prospectus

Time Management and Progress Evaluation

- Tentative schedule
 - Milestones and target dates
 - Weekly (or more frequent) meeting with advising professor
 - Regular (but flexible) schedule for research work
- Mid-term report
- Presentation of report to committee
- Final draft of thesis
- Oral defense of thesis
- Technical meeting presentation (Optional)
- Journal publication (Optional)

fill the role, he must have a thorough knowledge of the various aspects of the program and have previously served as an effective Honors Professor.

One of the first things communicated to candidates is the fact that the Honors Program is not for everyone. The activities within the research project are demanding and require a strong commitment on the student's part in order to be successful. In addition, university policy does not allow financial compensation for doing honors work! (This does not exclude standard financial aid packages.) This is, sometimes, an important aspect for the candidate. Furthermore, the student is usually reminded that while the minimum GPA is a *necessary* requirement, other more personal attributes (such as organizational skills) are often enormously beneficial. Also, personal motivation is one of the strongest determinants for success. A careful explanation and understanding of all these characteristics will help avoid "false" expectations on the part of the candidate. A thorough evaluation of the student's potential success is necessary to ensure maximum retention in the program.

Furthermore, in order for the project to be successful, the student must have a sense of project ownership. It is essential that the writing of the prospectus in which the major goals of the project are stated is the result of the *student's* effort and motivation. A "research contract" written by the professor is clearly an unacceptable approach to this document.

Since students are typically very busy with course work and extracurricular activities, a tentative schedule with milestones and target dates is a vital tool for assisting them to progress in a timely manner with their Honors work. The most efficient students ordinarily make a schedule for themselves to help with organization and time management. Weekly meetings between the Honors Professor and the student are essential to ensure the student's development as an effective researcher. These meetings give the student ample opportunity to ask for input, to update the advising professor on the project's status, to refine the project as needed, etc. During this early stage of a student's development as a researcher, it is imperative that the professor closely monitor the progress to prevent the development of poor habits and misconceptions regarding the manner in which research is conducted. This includes not only time management and the other aspects previously discussed, but also the moral obligations to be honest and to main-

tain a high standard of integrity in the reporting of data and other results.

One of the most useful "milestones" in the course of the Honors project is writing a midterm report. It serves both the student and the Honors Professor well in not only reviewing the accomplishments that the student has made but also in clearly defining the remaining activities necessary for the project's successful completion. To some extent, this midterm report can be viewed as the "proposal to defend" counterpart of the doctoral candidate, albeit within a much reduced scope. The presentation of this report to the thesis committee for feedback is strongly recommended; it allows for enhanced communication between the student and the committee in that all points of concern can be readily addressed and provides the student with an opportunity to demonstrate a sound understanding of the project goals.

Depending on the status of the project at this juncture, the committee can either assist the student in finalizing plans for the project's completion in time for graduation or it can recommend termination of the project. If the later recommendation is made, the student is encouraged to enroll in regular electives in order to graduate at his/her scheduled time. In these rare situations, the primary reason for terminating a project has been a lack of student commitment and/or a misunderstanding of the level of involvement required for successful completion of the project. This point

illustrates the importance of instructing the student, *prior to entrance into the program*, regarding the intense level of dedication and self-motivation needed to successfully complete an Honors project.

CHARACTERISTICS OF RESEARCH PROJECTS

One of the central aspects on which success of an Honors in the Major Program depends is the type of research project selected. In general, the project must be: a) independent of other students' projects, in particular from work performed by graduate students for their thesis requirements; b) of a scope that allows the student to achieve some important goals while completing the project in two (or at most, three) semesters; and c) in an environment conducive to building a solid basis for future involvement in research. It is crucial that the project definition be as precise as possible since it can have significant effects on the student's progress (*i.e.*, a loosely defined project breeds confusion and an open door to many directions, while a tightly defined project provides a

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TABLE 3

Selected Honors in the Major Theses

(Year of Graduation, Honors Professor,
and Current Affiliation of the Student in Parentheses)

- “Study of Parameter of Diatomic Oxygen in Sulfuric Acid/Methanol Mixture,” Terry M. Ake (1997, Dr. E. Kalu, University of Florida)
- “Development of Computer Batch Reactor for Solution Polymerization,” Brian Bennet (1998, Dr. S. Palanki, Private Industry)
- “Micro-dynamics of Blood Particles in an Arterial Stenosis Domain: An Analysis in Terms of Blood Flow Regimes and Particle Trajectories,” Tiffany Cloud (1998, Dr. P. Arce, University of Florida)
- “Convective-Diffusive Transport in Arterial Stenosis Using Lubrication and Area Averaging Methods,” Marc Horner (1994, Dr. P. Arce, Northwestern University)
- “Drop Breakup in Mini-Hydrocyclones,” William Martin, IV (1998, Dr. D. Wesson, Private Industry)
- “Effect of Particle Deformation in Stokes Flows,” Jay Norman (1998, Dr. P. Arce, University of Texas)
- “Application of Electro-Settling to Water Clarification: An Experimental Investigation,” Chelsey Phillips (1998, Dr. P. Arce, Private Industry)
- “Solute Transport Under the Influence of Two Orthogonal Electric Fields in Laminar Flow: An Area Averaging Approach,” Sharon G. Sauer (1993, Dr. P. Arce, Rice University)
- “Development of Stratum Corneum Experimental Models to Study the Physical Properties of the Skin,” Cherri Stabler (1998, Dr. B.R. Locke, Georgia Institute of Technology)
- “Radon Transport in House Crawl Spaces,” Derek Sturgis (1997, Dr. J. Telotte, Private Industry)
- “Convective-Diffusion and Reaction in Thrombosis,” Sonia Walker (1997, Dr. P. Arce, University of Florida)

clear pathway). Honors students must realize that organization is important for achieving success, but it must be a dynamic organization with flexibility to add new developments. In any event, the student’s formulation of the activities needed to successfully complete the project is one of the first and most important aspects in the development of a potential researcher and it must not be overlooked.

The Honors program in our department has used projects of an analytical, computational, and experimental nature. Table 3 lists a sample of the different projects completed in our department in the past few years. In some cases, the candidate is the one who provided the project idea. Two of the examples (the project on arterial stenosis by Marc Horner and the project on electro-settling by Chelsey Phillips) belong in this category. Some of them involve fairly advanced techniques that are not covered in the regular curriculum courses. For example, Marc Horner’s project involved the use of lubrication approximation methods^[2] in conjunction with volume averaging methods^[3], and the work by Tiffany Cloud involved the use of concepts from

microhemodynamics.^[4]

In order for a project to be successful, it need not involve “flashy” machines where, frequently, the Honors student becomes a mere spectator of graduate and/or postdoctoral student performances or (even less desirable) they simply become assistants to graduate students. In sports, for example, Brazil has an outstanding soccer team where many prestigious players have learned, developed, and perfected their skills playing with grapefruit “soccer balls” on the streets of their home towns. Whether the soccer ball was made from paper or rolled-up socks filled with old pieces of clothes, it is the *practice*, the *innovation*, and the *determination* that formed these players long before they possessed a “real” soccer ball. It is these same individual characteristics that develop a student into a researcher.

EXAMPLES OF PROGRAM PROJECTS

Table 3 lists several examples of successful Honors projects. Here we briefly describe one of the projects that achieved an extraordinary level of accomplishment. The topic was centered on the use of fluid mechanics concepts coupled with transport theory, specifically electro-convective diffusive transport in porous beds.^[5] This work was an effort to show the effect of orthogonal and parallel electrical fields on the dispersion and convection of material in channels and involved the use of averaging techniques in convective-diffusive transport with applications to electrophoresis. To complete the project successfully required learning volume averaging techniques^[3] and the formulation of conservation equations with applied electrical fields.^[6] Neither topic is normally covered in the regular curriculum. This work resulted in a presentation at an AIChE annual meeting,^[7] in a refereed publication,^[8] and in a proceeding publication.^[9]

The efforts of several of the students^[5,10-12] have been key in initiating an “evolutionary type” of analysis of the topics covered, which are currently in various stages of research. Also, each of the students was able to produce either a proceeding or a peer-reviewed publication, which is indicative of the high degree of accomplishment achieved by these students. Each student has continued to use the research and organizational skills developed during the Honors work. Several have indicated that having learned the basics of research methodology and the interaction with an Honors Professor as an undergraduate has proved invaluable in providing them with a sound basis for their graduate research. The time and project managements skills and independence that they developed in their Honors work has also been beneficial in their industrial positions.

APPROACH TO WORKING WITH HONORS STUDENTS

Honors in the Major students are highly talented individuals who generally have a great desire to learn but often

display low confidence in their abilities. Although, due to their prior accomplishments, they know that they are capable of doing very complex and difficult tasks, they exhibit self-doubt. Typically, they are very critical of their accomplishments and are inclined to ignore (or perhaps are not even cognitive of) the level of skill that they have already mastered in their high school and university courses and activities. Consequently, they need considerable support, encouragement, and coaching by their advisor in guiding them to successful completion of a project. The professor must foster a caring environment that allows the students to laugh about mistakes and to learn from them.

Honors students characteristically pay little attention to the credit that should be given to their work, ideas, and/or results. This is an important aspect that sometimes is overlooked. For example, when an Honors student works with a graduate student who, in his/her thesis, subsequently uses the results and ideas that the Honors students produced or helped to produce, the one line thanking the Honors student in the acknowledgment section seems minuscule; it may not give sufficient credit to the level of contributions by the Honors student. This demonstrates the importance of the Honors project's *independence*, which is crucial in order to avoid a misconception on the part of the Honors students as to the role played by their project and the recognition that should be given to it. As such, the importance and methods of crediting work, ideas, and results should be among the topics discussed with an Honors student at the beginning of the project, preferably in the initial meeting with the committee.

In order to be successful in leading Honors students to successful completion of their projects, the advising professor must be able to handle a flexible schedule of meetings and to be aware of the time commitment that must be made to ensure the students' success. It is also important that the professor have the ability to recognize when the student/project match is not working to its fullest potential (and then to adjust the project topic accordingly) as well as to accept that the only "final product" may be the student's development as a future researcher.

Since students typically have a hectic schedule encompassing a wide range of activities, the Honors professor must be open to accommodating the student's time constraints in scheduling meetings that will allow the student to produce meaningful (even if they are partial) results. In addition, close monitoring of the student's progress in the regular courses is important to ensure that they are getting the full benefit of their undergraduate educational. Many of them tend to play down the course work due in part to some of the reasons listed in Table 1 (*e.g.*, repetitiveness of the tasks). Nonetheless, the Honors professor can do a great service to his advisee by conveying the relevance of the coursework to the student's future (*e.g.*, to qualify for national scholarships

for graduate school or in the job search).

The complex and vital interaction between the Honors student and the Honors professor suggests that the use of graduate students and/or postdoctoral fellows must be avoided, or at least redefined. Graduate students can be very useful in the Honors program (and vice versa), but their role must be limited to helping the undergraduate student learn new techniques, set up experimental devices, etc. They must not consider the Honors student as merely additional help for their own projects. The graduate student needs to be aware that his or her role is a "service to" rather than "a user of" the Honors program. Interaction and mutual help is always beneficial to both students; nevertheless, "one-sided" performance does not support development of the Honors student as a researcher.

The activities related to the program potentially afford the graduate student an excellent opportunity to become involved in the art of coaching and guiding a student to completion of a research project. From this point of view, the graduate student can benefit enormously, especially those who have an interest in academic positions after their doctoral graduation. A similar outlook applies to any postdoctoral students in the group.

The use of technical meeting presentations is, in general, very beneficial for the enhancement of student productivity as well as for the direction and timetable of the project. It also provides an excellent opportunity for the candidate to learn how to communicate scientific results to a highly specialized audience. The students must be able to present and defend their results in front of an audience without the help of the professor in order to make the experience meaningful. Practice that includes comprehensive questioning will help ensure that the students are well prepared to answer questions, just as if they were defending their thesis for final graduation. With practice and coaching by the advisor prior to the technical meeting, both student and advisor can gain confidence in the student's preparedness. Our program has used these presentations effectively to make the projects even more invigorating for a number of students. Several students who took advantage of these presentations were very successful in interacting with these high-level audiences, and a number of them have received "best presenter" awards in regional and/or national competitions.

Only in the most productive cases will a student be able to write an article for publication submission. While it would be superb if this aspect could be included in the overall project, only the most tenacious students (and depending in part on the specific project) are able to finalize the full round of tasks to be achieved. As such, this should not be viewed as the primary goal of the Honors project. At a minimum, most successful projects are able to establish important groundwork for future research. For example, many of our projects have been useful as support in the submis-

sion of a research proposal and/or in better defining the targets of a doctoral dissertation.

CONCLUDING REMARKS

The Honors program has a number of advantages for the student as well as for the department housing the students. Students from our program typically receive job offers long before their graduation date, with salary offers considerably higher than those for graduates from the regular path. The students who do decide to enter the work force immediately after graduation frequently advance quickly through the ranks to positions most often reserved for more experienced engineers. When the opportunity presents itself, they are typically able to change positions to other companies with relative ease.

The Honors students who decide to continue their education in graduate school are also quite successful. Some of the graduate programs that have accepted our students include Georgia Tech, University of Florida, North Carolina State University, Northwestern University, Rice University, and the University of Texas-Austin. The feedback we receive from these students indicates that our Honors Program has prepared them well for graduate work.

During the period from 1994 to 1998, the Honors Program has reached an all-time high in student enrollment, with a maximum of eight to ten students in residence working with six to eight different professors. Both the department and the college benefit from the program since many top students opt to remain in the department, and through the years these students have subsequently acted as magnets in attracting other talented students. Also, the regular curriculum classes have a group of students that introduce a steeper grading of knowledge, which often provides a greater exchange of knowledge among the students.

Some administrative improvements have also been realized in the last few years. For example, for quite a while the department did not recognize the Honors in the Major students as part of the teaching load, in spite of the fact that the students required considerable attention, involvement, and time. There is now a percentage of dedication assigned in a manner similar to the allocation of effort for graduate students. Nonetheless, to realize the full benefit and potential of the program, it needs an even wider diffusion and higher recognition within our college and university.

The Honors in the Major program is definitely a successful tool for attracting and retaining some of the best and most promising students in the department. Numerous students have indicated that one of the primary reasons they stayed in the chemical engineering program was the availability of the Honors in the Major option. Indeed, this program is proficient in producing high-quality undergraduates who are flourishing either in graduate school or in professional life. Some

of the key factors that play a part in the program's success are the careful selection of the students, matching between candidate and Honors professor, and the commitment and dedication of faculty involved in the direction of the students. Moreover, fostering a respectful environment and caring attitude towards the students participating in research has promoted a positive effect in attracting new candidates.

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