Promoting Undergraduate Research in ECE (PURE) Proposal

on behalf of Eta Kappa Nu, Alpha Chapter

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I. Disclaimer

Analysis presented in this paper is largely based on the authors’ personal understanding of ECE undergraduate research, as well as feedback from a small number of students and faculty members. We understand that the current source of information is limited and may not fully represent the complexity of the real situation. Surveys will be sent out to both undergraduate students and faculty/graduate students before any major assumptions/conclusions are made in developing the actual project plan.

II. Motivation for Change

Undergraduate students in ECE who are interested in doing research often find themselves in a dilemma. During the first two years of college, they are fresh, motivated, and have a lot of free time. However, the lack of knowledge and skills at this stage makes it very difficult to find a faculty mentor and to get involved in research projects. When approaching professors, most are advised to take more advanced courses in specific areas in order to qualify (ECE 410, ECE 430, ECE 440, etc).

With little sense of what their interests really are, they choose some electives based largely on their intuition. By the time they become a junior, some of them are finally able to start their undergraduate research. Nevertheless, many later realize that the actual research is quite different from what they expected, but there is little time left for them to change directions. For the lucky ones who really find their work interesting, they still feel that it is difficult to concentrate on research and make progress given the extremely high course load for third and fourth year students.

As current ECE undergraduates, we feel that it is necessary to stress the importance of starting undergraduate research earlier in one’s college career. Earlier exposure to research would lead to better career decisions and more time would lead to higher quality undergraduate research.
III. Current Model for Typical Undergraduate Research

The following model can be used to illustrate the typical process for ECE undergraduate research (refer to Appendix A for a complete description of the research roles):

Figure 1 – Current Model for Typical Undergraduate Research

Students’ roles in a research project are broken down into three categories:

Stage I. Helper/Learner: The student generally serves as an assistant in the group. Duties may include maintaining lab equipment, documentation, data collection, coding, etc.
Potential Participants: All

Stage II. Independent Project (May be skipped): Students at this level are able to conduct a project on their own, while the project may not be theoretically oriented. A good example will be a student project in ECE 396/ECE 397.
Potential Participants: 1. Exceptional freshmen
                        2. Sophomores and above

Stage III. Undergraduate Thesis: Participants will work on a thesis and make contributions to the literature of research.
Potential Participants: 1. Exceptional sophomores
                        2. Juniors and above

The arrows in the model represent the flow of students. In the current model, the faculty body serves as the main interface between students and research projects (i.e. “talk to professors if you want to do research!!”). After interacting with the faculty, students are directed into different paths based on the nature of the research and/or the student’s experience. Some start
on independent projects / thesis under the direct supervision of the faculty member, while others are passed to graduate students for further guidance.

As shown in the figure, we feel that the current model of undergraduate research presents a serious issue. Namely, there is a "Wall" that prevents the typical freshman or sophomore from accessing research opportunities. These younger students are generally not encouraged to participate, the reason being their lack of course work and experience. The current model results in serious discontinuities in regards to undergraduate research – students get minimal exposure to research during the first half of their college career, but then are expected to do quality, independent research in the little time that they are given.
IV. Recommendations

We propose a new model for undergraduate research, addressing the issues above.

Figure 2 – Proposed Model for Typical Undergraduate Research

The major changes made in this model can be illustrated by the three numbered arrows in figure 2.

Arrow 1: Breaking Down the Wall

Essentially, the new model aims at creating a channel that allows freshmen and sophomores to obtain opportunities in undergraduate research.

Arrow 2: Providing Opportunities

Graduate students will serve as the major force in providing research opportunities for motivated freshmen and sophomores. The underclassmen will start by working as a helper/learner under the guidance of a graduate student. They will progress through the Ladder of Independence as their experience/knowledge expands.

Arrow 3: Faculty Involvement

While the graduate student is the major force in providing research opportunities for these freshmen and sophomores, these opportunities will be developed under the guidance and supervision of their research advisor.
V. Benefits

This new model will provide benefits for everyone.

Student
- Gains research experience earlier in their college career
- Has more time to do higher quality research
- Makes more informed decisions in choosing concentration

Graduate Student
- Has access to additional assistance for their research
- Gains verbal communication skills and teaching experience

Faculty
- More opportunity to discover exceptional talent
- Enhanced overall group productivity
- Help your graduate students graduate faster :-) 

Department
- Better qualified graduate school candidates
- More government fellowships coming from quality undergraduate research
- Improved overall reputation and prestige of department
Students’ roles in a research project are broken down into three categories:

**Stage I. Helper/Learner:**

**Description:** The student generally serves as an assistant in the group. Duties may include maintaining lab equipment, documentation, data collection, coding, etc. This role requires the least amount of knowledge on the topic, but will give the student a comprehensive experience of what the research is about, and is therefore a crucial stage in the student’s learning cycle. Moreover, for some areas that rely heavily on instrumentation (bioengineering, semiconductor, etc) experience gained at this stage is necessary regardless of the student’s theory background (i.e. students will have to start at this level even if they start research as an upperclassmen).

**Potential Participants:** All

**Stage II. Independent Project (May be skipped)**

**Description:** Students at this level are able to conduct a project on their own, while the project may not be theoretically oriented. A good example will be a student project in ECE 396/ECE 397 (Individual Study in ECE Problems). While projects at this stage may be a replica of other people's creation, students will still get tremendous experience with project management. The nature of this stage requires more independence, and serves as a preparation for an undergraduate thesis.

**Potential Participants:**
1. Exceptional freshmen
2. Sophomores and above
Stage III. Undergraduate Thesis:

Description: This stage is the highest level of undergraduate research. Participants will work on a thesis and make contributions to the literature of research. This stage requires deep understandings of the subject, abilities to manage an independent project (Stage II), as well as the basic skills of conducting research (Stage I).

Potential Participants: 1. Exceptional sophomores
                       2. Juniors and above
Appendix B  Tentative Implementation Scheme

- **Ownership**
  - **Short-term ownership**
    - Tentative time range: Until end of Fall 2008
    - Eta Kappa Nu (HKN) in charge of initiative
  - **Long-term ownership**
    - We see this program being an integral part of the ECE culture
    - Given the tremendous amount of efforts and resources needed to maintain such a program, in the long run, we feel that the department needs to take ownership of the program if it is going to be successful

- **Pre-launch Efforts**
  - **Department-wide initiatives**
    - The success of this program will hinge on the cooperation from various parts of the department
  - **Pre-launch Core Team (and roles)**
    - Tentative time range for core team: Until end of Spring 2008
    - The Pre-launch Core Team consists of four major groups in the department:
      1. Eta Kappa Nu
      2. Department Leaders
      3. Faculty
      4. Graduate Students
  - Eta Kappa Nu [10-15 people]
    - Lead core team
    - Survey
      - Understand potential market to set expectations
    - Communications
      - Create an effective website
      - Campaigning, "testimonials"
    - Program development
      - Work closely with graduate students to develop templates for specific programs (i.e. roles, evaluations, feedback, logistics, etc)
  - Department Leaders [2-3 people]
    - Constant involvement
    - Convince faculty members to come on board (see below for faculty requirements)
    - Marketing (i.e. publicity within department)
• Potential course development

- Faculty [5-10 professors from *different* areas of research]
  - Be supportive of the PURE initiative
  - Be willing to find suitable roles for freshmen and sophomores
  - Be willing to accommodate them within their research group

- Graduate students [5-10 graduate students from associated research groups]
  - Work with faculty advisor to develop template program
  - Create appropriate job descriptions for freshmen and sophomores within research group
## Appendix C  Tentative Timeline for Fall 2007

<table>
<thead>
<tr>
<th>Action Items</th>
<th>Dates</th>
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<tbody>
<tr>
<td>Submit department proposal</td>
<td>October 22</td>
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<tr>
<td>Recruit for HKN survey, communications, and program development teams</td>
<td>October 30</td>
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<tr>
<td>Recruit Department Leaders and Faculty</td>
<td>November 2</td>
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<tr>
<td>Complete surveys and set initiative expectations</td>
<td>November 30</td>
</tr>
<tr>
<td>Complete pilot program plan for Spring 2008</td>
<td>December 15</td>
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