Successful Use of Teams in a Human Computer Interaction REU: Combining Intensive Instruction with Strong Mentoring

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Abstract
SPIRE-EIT (Summer Program for Interdisciplinary Research and Education – Emerging Interface Technologies) at Iowa State University is a 10-week interdisciplinary summer Research Experience for 15 Undergraduates (NSF-funded) that integrates research and education in emerging interface technologies. Students are recruited from engineering, computer science, psychology, and design for an interdisciplinary mix. Classes in both content and professional development occupy approximately 35% of the students’ time: computer programming and graphics, interface design, human computer interaction, ethics, and graduate life. For the remaining time, students conduct interdisciplinary research projects in groups of three. Each group is mentored by graduate students in the Human Computer Interaction Graduate Program under the supervision of HCI faculty. The five research projects are presented at an end-of-the summer campus-wide research symposium in the form of posters, demos, and a five-page research paper. This REU Site benefits from strong institutional support and mechanisms for recruitment, mentoring and long-term retention that are particularly effective at targeting underrepresented groups in science and engineering.

This analysis offers the reader key insights into building an REU experience that successfully uses teams and motivates faculty and graduate students to be strong mentors. The paper focuses on approaches to intensive coursework in HCI, the use of interdisciplinary teams, and the development of professional skills for academic careers.

Introduction
The National Science Foundation supports over 175 Research Experiences for Undergraduates (REU) throughout the U.S. These REU sites have the goal of exposing undergraduate to the world of graduate research in STEM-related fields. The sites may vary in size, ranging from just a few students to 15 or more, and they often take place in the summer. REU sites vary enormously in their approach to exposing undergraduates to research. Some assign the participants to different labs in which they serve as interns, helping the faculty and graduate students with ongoing projects. This approach is valuable, but can lead to a sense of isolation if the participants cannot easily reflect with each other on their new experience. Other programs assign small groups of students to labs in order to decrease the potential for isolation. This research reports on the structure of a highly-successful REU site with a relatively rare configuration: 15 participants are co-located in a single lab but grouped in teams of three, and each team works on an existing research project. This approach attempts to establish a intense learning community\(^1\)\(^2\) within the REU, as discussed by other REU Site principle investigators\(^3\) in which students learn not only the relevant research content but also the critical practices of working as a team and taking initiative to study whatever is necessary to address a challenge.
While such a configuration is not physically possible in all research contexts, these results offer the reader key insights into building an REU experience that successfully uses teams and motivates faculty and graduate students to be strong mentors.

The Structure of the REU Site: SPIRE-EIT

SPIRE-EIT (Summer Program for Interdisciplinary Research and Education – Emerging Interface Technologies) at Iowa State University is a 10-week interdisciplinary summer experience for 15 undergraduates that integrates research and education in emerging interface technologies. Students are provided with classroom training and gain hands-on research experience using cutting-edge instruments, equipment, computers and technological infrastructure. Classes in computer programming and graphics, interface design, human computer interaction, and ethics occupy approximately 35% of the students’ time. For the remaining time, students conduct interdisciplinary research projects in groups of three (Figure 1). Each group interacts with graduate students in the Human Computer Interaction Graduate Program under the supervision of HCI faculty. The five research projects are presented at an end-of-the summer campus-wide research symposium in the form of posters, demos, and a five-page research paper. This REU Site benefits from strong institutional support in the form of existing administrative structures and mechanisms for recruitment, mentoring and long-term retention that are particularly effective at targeting underrepresented groups in science and engineering. See Appendix A for more details on recruiting and minority representation.

SPIRE-EIT divides the 15 students into five groups of three. Each group joins an ongoing research project led by an HCI faculty member and is mentored closely by one of the faculty member’s graduate students. At the beginning of the summer, we bring students up to speed in the field of EIT by offering a variety of courses on programming, HCI, and professional development for academic life, including ethics. As the summer progresses, students focus less on course work and more on the research projects. Our goal is to transform students from being...
**Figure 1:** Timeline of the program illustrates the heavy weighting on courses during the first four weeks, with weight shifting to the research project as student teams develop better working relationships.

dependent on course instructors and faculty guidance to independent research apprentices who can explore new ideas appropriately on their own.

HCI faculty typically compete to have their project included in the REU Site because of the high benefit of having three well-trained interns focused on their research for a summer. Students end the summer with a presentation of their work at a campus-wide REU Research Symposium in the form of a poster, a five-page academic paper, and a demo.

**Learning Objectives & Corresponding Activities**

The Iowa State University HCI program has based its curriculum on the ACM SIGCHI Curricula for Human-Computer Interaction guidelines, which define HCI as "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them." Our HCI courses thus span the areas of **design** (including not only theories of design but also the research on cognitive psychology as it applies to design and HCI), **implementation** (including courses on programming and prototyping), **evaluation** (usually statistical methods), and **phenomena** (courses in ethics and the social implications of technology). Components of SPIRE-EIT focus these same four areas of learning, but also on a fifth area: **professional development** for academic life. The table below summarizes the learning objectives.

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<th>Upon completion of SPIRE-EIT, a student will be able to:</th>
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<tr>
<td><strong>Design</strong></td>
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<td>1. Describe processes involved in human cognition and behavior.</td>
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<td>2. Discuss HCI and EIT research topics across multiple disciplines.</td>
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<td>3. Describe the technology used within emerging interfaces.</td>
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<td><strong>Implementation</strong></td>
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<td>4. Create a 3D model of an object.</td>
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<td>5. Write and compile a simple program in C++.</td>
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<td>6. Describe the key factors in successful OpenGL 3D programming.</td>
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<td>7. Create a paper prototype of an interface.</td>
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<td><strong>Evaluation</strong></td>
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<td>8. Design and conduct a simple usability test and focus group (qualitative)</td>
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<td>9. Discuss flaws in simple experimental research designs (quantitative)</td>
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<td><strong>Phenomena</strong></td>
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<td>10. Articulate societal and ethical issues of HCI.</td>
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<td>11. Discuss his or her own biases using critical theory.</td>
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Professional Development

12. Work on a multidisciplinary team.
13. Present work orally and in writing.
14. Professionally discuss EIT-related ideas with colleagues from other disciplines and/or opposing views.
15. Describe the process of graduate research generally
16. Apply to graduate school
17. Contribute to graduate research

Research Project (Weeks 1-10) – LOs 1, 2, 3, 8, 12, 13, 14, 17

Over the course of the summer, three undergraduate students work on interdisciplinary research projects in collaborative teams. The teams are chosen to mix academic disciplines, year of college, gender, and race/ethnicity when possible. Faculty members are solicited for research proposals that describe the nature of active interdisciplinary projects, the potential for student of different disciplines to participate, and the relevant skills necessary for participation on the project. Faculty members must have a graduate student available to mentor the team closely throughout the summer, i.e. stopping by once a day. Project proposals are posted to the EIT website in support of recruiting efforts. The interdisciplinary team projects are designed to help students obtain hands-on research experience, acquire new skills, become familiar with the literature relevant to a particular research area, develop mutual respect between students in different disciplines, and prepare for interdisciplinary graduate training.

The Research Project requires careful project planning with the team mentor and faculty member. Time spent on the project is low in Week 1 and increases steadily until it occupies students full-time in Weeks 8-10. In Week 3, groups make a presentation about their project’s research question and goals to the rest of the groups, citing major milestones and an anticipated schedule. The project culminates in a five-page research paper, a poster presentation, and a technology demo. Students present their posters and demos at a campus-wide REU Research Symposium. See Appendix B for a list of research projects from 2006-2008.

HCI Course (Weeks 2 - 5) – LOs 1, 2, 3, 7, 8, 9, 12, 14

This course introduces student to the key principles and theories of HCI and EIT. While in less depth than a graduate course, this course focuses on what students need to know in order to carry out high-quality research in EIT. Students explore the fundamental concepts of interactive systems, from hand-held computers to virtual environments. Activities focus on interface design, both physical and virtual, including the design factors that affect usability of systems. Case studies of human-centered design approaches are used to teach applied design methods for emerging interactive technologies. Students gain hands-on experience with the latest technologies for virtual and augmented reality including stereoscopic displays, haptic interfaces, tracking, and mobile devices. From a more basic research perspective, the course also exposes students to the theories, scientific approaches, and major results cognitive science, as well as its relationship to HCI. Finally, students will learn about scientific evaluation: qualitative approaches (e.g., focus groups, think-aloud usability tests) as well as quantitative (e.g., experimental methods, basic statistics). Some activities are done as a research team.

Programming Course (Week 1) – LOs 5, 12, 13, 14

Because students will need programming skills to complete their Research Project, this 5-day crash course in programming cover some basics of C++. The graduate student instructor gives
students an initial pre-assessment to rate their incoming programming knowledge and customizes the assignments accordingly. Each team presents a programming project after the fifth day that demonstrates what members have learned.

Some students arrive with no programming experience whatsoever, but by the end they will have compiled at least one program and understand the concepts underlying simple programming. Likewise, because of the team nature of the final programming project, students from different disciplines learn to better communicate with each other, crossing the “techie” and “humie” (humanities) gap. Interdisciplinary communication is key to their success long-term in HCI. The assignments in this class also increase the rapport of the 15 students overall as they ask each other for help with this or that code snippet while working in the lab.

**Graphics Programming Course** (Week 2) – LOs 4, 6, 12, 13, 14

Because students need an understanding of 3D graphics programming for most SPIRE-EIT research projects, this 5-day crash course on OpenGL and scene graphs by a graduate student instructor enables students to edit pre-existing code with 3D models, lighting, and 3D manipulation, as well as create simple 3D scenes from scratch. Like the C++ course, this course features a final project presentation at the end by each team, which promotes further team bonding and overall increase in the rapport of the overall group, as well as building presentation skills.

**3D Modeling Course** (Week 3) – LO 4

Understanding the process of 3D modeling is critical for understanding how to create an attractive 3D scene, as well as for understanding how most videogames are made. While some Research Projects do not take advantage of 3D models, students who have the time and ability to use these models can produce much more engaging work. This simpler, less time-intensive course consists mostly of working through self-paced tutorials in Maya or 3ds Max with a graduate student modeler available for questions.

**Ethics Course** (Weeks 3 – 10) – LOs 2, 10, 11, 14

Companies, universities and funding agencies are increasingly interested in the ethical implications of technological advances. It is important for students to have a solid training in ethics and social justice – both in how to analyze ethical challenges and how to recognize the critical lenses of oneself and others. This course explores the implications of information technologies and human-computer interaction on social and organizational systems. Specifically, it provides students with an overview of ethics and social justice theories, teaches them analytical approaches, and then guides them to independent discussion via a series of EIT-related case studies. This course meets weekly and requires reactions to case studies and a personal written Code of Ethics statement from each student. The cases discussed are based on ethics cases from the ACM, from Stanford University, and *Engineering and Social Justice* by Riley.

**Craft of Research Seminar** (Weeks 1-5) – LOs 13, 15, 17

This weekly seminar is based on Booth, Colomb, and Williams’ book *The Craft of Research, 3rd edition*. This classic introduction to writing a research paper helps students specifically with their papers while teaching them what tasks are involved in graduate research more generally. The seminar begins by asking “What is Research?” and asks students to practice evaluating the validity of various research sources. Next, with guidance from the instructor and their respective mentors, the Research Project teams define their research questions. The seminar includes a visit to the university library to learn how to use online databases and bibliographic databases.
(Endnote, Bibtex, etc) efficiently. After the seminar is over, the instructor continues to meet individually with each Research Project team to check on the progress of their papers.

**Journal Club** (Weeks 1-9) – LOs 1, 2, 3, 9, 10, 11, 13, 14
The journal club is a seminar series aimed at exposing students to a wide variety of the latest research in HCI and at promoting strong communication skills for the students. For each seminar, a recent journal article will be selected and read by all participants. Initially, graduate student facilitators choose the articles and more assertively facilitate the discussion, ensuring that everyone speaks at least once about every article. After the group learns to have open-ended inclusive discussions, pairs of students take turns selecting the articles and facilitating. Fostering and validating the expression of multiple disciplinary viewpoints help students break out of their own disciplinary perspective and value contributions from other disciplines.

**Faculty Luncheon Lectures** (Weeks 2 – 9) – LOs 2, 14, 15, 16, 17
Once or twice a week throughout most of the summer, HCI faculty members give a series of lectures covering 1) their own EIT-related research and 2) personal stories about their graduate career. The speaker then goes to lunch with the students at their usual campus dining area. Lectures topics expose students to the true interdisciplinary breadth of EIT, while the personal stories and lunchtime conversation build collegial relationships and provide guidance for students on the path to becoming a professor, which is non-traditional for some of our faculty. Faculty members are chosen by availability but with diversity in mind. Research topics include multimodal interfaces, immersive 3D graphics, haptic force feedback, art and design, video game design, visual communication, graphic design, media and society, communication technology, virtual and augmented reality, artificial intelligence, text mining, embedded computer systems, computer aided design, human factors, and e-commerce systems.

**How-To Workshops** (Weeks 1-10 when needed) – LOs 12, 13, 16, 17
The How-Tos are 60-90 minute workshops that focus on specific skills needed for an upcoming activity. We time them to offer just-in-time information that students find relevant. Early on, we have **Teaming** workshops in which students explore their Myers-Briggs personality type indicators and the implications for their team roles as well as reflect on their own communication habits in a group after a timed group problem-solving activity. To prepare for the Week 3 presentation, a **Project Planning** workshop offers guidance on milestones and GANTT charts. In Week 7, students learn **How to Make and Present a Poster**, using posters from previous years and previous REU Sites as role models and role-play for the presentation. In Week 8, the workshop on **How to Do a Demo** prepares for their symposium presentation. In Week 9 is the **How to Apply for Graduate School** workshop by a graduate recruiter on campus and the assistant director of our Ronald E. McNair Postbaccalaureate Achievement Program, which encourages minority, low-income, and first-generation college students to expand their educational opportunities and pursue graduate studies.

**Program for Women in Science and Engineering** (Weeks 1-10) – LOs 12, 13, 14, 17
SPIRE-EIT collaborates with the PWSE summer program to recruit women as well as on professional development and social activities. Examples of programs that we have partnered on in the past include panels of professional women and female graduate students, a financial planning seminar, a work-life balance panel, a professional etiquette luncheon, and a trip to a baseball game. We encourage all SPIRE-EIT members (male and female) to participate. For all students, this exposure to smart female research colleagues is critical to narrowing the gender gap in EIT fields and decreasing the masculine culture that exists in many STEM disciplines.
Industry Field Trips (2-3 times in the summer) – LOs 2, 3, 14
To expose students to the real-world application of EIT, we coordinate visits to relevant university industry partners within a two-hour drive such as John Deere (virtual reality engineering, manufacturing), Rockwell Collins (cutting edge EIT), Principal Financial (usability lab), Mechdyne (immersive VR displays) and the Great Ape Trust (using icon touch devices for ape communication).

Blogging (daily) – LOs 2, 13, 14
Students are required blog daily on our SPIRE-EIT wiki about their experience in the REU and comment on at least two other students’ blog posts once a week. Posts are to be relevant to their research or experience in SPIRE-EIT. This practice encourages reflection and offers practice presenting ideas, as well as keeping graduate mentors and SPIRE-EIT staff informed of students’ challenges and potential stress. A 30-minute time period each day is held meeting-free for blogging time.

Middle- and High-School Visitors (2-3 times in the summer) – LOs 2, 13, 14
During SPIRE-EIT, a variety of summer programs for academic enrichment of middle- and high-school students happen simultaneously at the university. To give participants practice explaining their research to a lay audience and to position them as role models, we invite groups of younger students to visit the lab and have participants explain their research and topics in EIT to the younger students.

Extracurricular Activities (Weeks 1-10) – LOs 12, 14, 17
In the initial half of SPIRE-EIT, we offer structured extracurricular activities twice a week in the evenings and on some weekends for the purpose of building rapport among the 15 participants, such as Board Game Night, Wii Game Night, ultimate frisbee, mini golf, Summer Bandshell Concerts, canoeing, hiking, video scavenger hunts, and a SPIRE-EIT T-shirt Design exercise in which students collaborate to design a t-shirt representing their summer. For some activities we partner with PWSE or other REU programs on campus. By the middle of the summer, interns usually begin scheduling and coordinating their own extracurricular events. These activities are critical to the team building and warm environment fostered at SPIRE-EIT.

The Research Environment
The architecture and interior design of the SPIRE-EIT research environment promotes open discussion and teamwork. The laboratory is located in the Engineering Teaching and Research Complex (ETRC), central to Iowa State University’s efforts to strengthen engineering education, research, and outreach. The workspace consists of five “pods” of three computers, one pod for each research team of three participants. The space is open and flexible with the one wall serving as a whiteboard and projection space for five different digital projectors, one for each SPIRE-EIT group. Students can work tightly within their pod, or confer with other students in other pods, or gather in the flexible middle of the space for seminars, lectures, or brainstorming on their own project (Figure 2). The space is centrally-located in the interdisciplinary VRAC graduate student laboratory. This dynamic environment allows participants to observe graduate students at work on cutting-edge technologies. This configuration also enables inter- and intra-group collaboration, and encourages communication between participants and current graduate students.

Mentoring
The program also provides a support network of mentors and advisors for the teams. Two program-wide graduate student mentors coordinate the participants’ activities and provide general assistance. Each research team also receives guidance for the technical aspects of their research from one or more project mentors and a faculty advisor. These mentors are available during the workday and frequently meet with the participants to provide support. Each team has a formal meeting with their project mentors a minimum of once weekly.

Prior to the start of the REU program, the mentors participate in a four-hour mentor training workshop provided by the Iowa State University Honors Program. This program consists of panel discussions and break-out sessions regarding effective mentoring of diverse groups.

All of the REU mentors are current M.S. or Ph.D. HCI students from a variety of academic backgrounds ranging from engineering to computer science to business to foodservice and lodging management. The program attempts to support a diverse laboratory: 30% of the 2008 graduate mentors were female, 40% were international students, and 20% were non-Caucasian.

**Discussion & Conclusions**

Based on the results above, the REU site is achieving the broad goal of exposing undergraduates to a graduate research experience in a STEM-related field. Moreover, it is exposing them to the
lifestyle of working as a graduate student. For many of the participants, the SPIRE-EIT is the first time they have worked closely as a team member for an extended amount of time. Also, for many it is the first time to work on an interdisciplinary team.

Both factors lead to initial challenges for some team members. Teams often require mentoring on basic project management skills such as focusing on milestones, communicating one's progress to other team members, and balancing workload based on individual's skills. Teams usually have one or two students with programming skills, and we saw students who were used to working alone on smaller college class projects, and for whom working together on a larger software project was a significant change because of the loss of control over the entire project.

Learning to value the different skills of team members was a challenge for some students, especially when deadlines approached. The non-programmers on the teams usually focused on the initial work, helping with the designs and analyzing current literature. The programmers on teams usually focused on implementing the designs near the end of the project. While this structure is typical in software development projects, the students' inexperience at project planning sometimes left the programmers with a significant burden at the end with the non-programmers left with "less" work in the eyes of the programmers, writing the research paper and preparing the poster, for example.

This challenge of respecting differences in skills and backgrounds also arose during seminar discussions of HCI articles. Early in one summer, a lively discussion of ethics cases degenerated into dorm-room-style banter in which students sometimes mocked each other's opinions and launched *ad hominem* attacks ("But I'm Jewish and you..." "But my heritage is German and..." or "But that's just because women usually..."). It was new for these students to discuss a controversial topic with social implications respectfully and with academic rigor. In these situations the facilitators reminded students that 1) different opinions may co-exist respectfully, 2) it is important to maintain an atmosphere in which everyone feels comfortable participating, and 3) men traditionally dominate mixed-sex discussions—interrupting more frequently than women—making it even more important to consciously balance the discussion and make all comfortable. In all three summers of the REU, discussions improved through the summer and students began to feel more comfortable facilitating themselves without the explicit direction of graduate mentors.

By combining co-located interdisciplinary teams with rapport-building activities (both academic crash-courses and extra-curriculars), intensive instruction, and explicit mentoring relationships, the SPIRE-EIT REU offered a powerful, life changing experience for its participants.

**Acknowledgement**

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Bibliography


Appendix A: Student Recruitment and Selection

Recruiting for the program relies on mailings of 800 postcards to educational institutions, followed by emails. Because of the interdisciplinary nature of EIT, we target department chairs, deans, of academic advisors within departments of engineering, graphic design, psychology, computer science, and, if available, human computer interaction.

Our administrative staff for the HCI program (a single individual) also coordinates the SPIRE-EIT recruiting effort and maintains a database of all relevant contact information. Institutions that we target for our SPIRE-EIT mailings and emails consist of the following:

- From the US News and World Report:
  - Top 20 Doctoral Institutions
  - Top 20 Liberal Arts Colleges
  - Top 20 Midwestern Comprehensive Colleges
  - Top 20 Diverse Institutions with Doctoral Programs
  - Top 20 Diverse Institutions with Masters Program
- Peterson’s Education USA’s 30 Historical Black Colleges, Midwest Region
- Institutions from which we have received previous participant applications

Our general REU webpage (http://www.hci.iastate.edu/REU), which features posters and videos of previous student projects, is an excellent recruiting tool.

Our recruiting strategy focuses on forming a cohort of five three-person project teams in which, ideally, each team has at least one woman, at least one member of an underrepresented minority, and at least one skilled programmer (these categories may overlap, of course). Secondly, we try to blend our outreach to students at lower-ranked colleges without graduate programs with accepting some students from higher-ranked schools to achieve both a diversity of backgrounds and a higher likelihood of project success. Participant application packages are therefore evaluated on the following criteria:
• Minimum 3.0 GPA
• Previous research experience
• Discipline of study, to help round out our interdisciplinary teams
• Ranking of educational institution of the applicant (see above paragraph for strategy)
• Interest in the areas of Human Computer Interaction and Emerging Interface Technologies
• Gender and race/ethnicity to achieve a diverse cohort
• Existing information technology skills
• Writing ability
• Evidence of student maturity and educational preparation based on three references

Once selected, students are recruited and upon acceptance, the student and the program coordinator sign a joint letter of agreement covering the financial and time commitments of participation. This practice arose from initial confusion about whether this experience was a "job" or an "internship" or something else. The casual student atmosphere in which graduate students often maintained later working hours led some early participants to keep shorter hours. The agreement now requires eight hours in the lab per day, but allows two hours of time shifting: students can begin anytime from 8:00am to 10am.

Facebook.com serves as a useful method of maintaining contact with SPIRE-EIT alumni for data collection purposes long-term. Also, annually, we poll our entire alumni pool to discover any achievements worth highlighting for NSF.

Recruitment of Under-represented Minorities

The state of Iowa does not contain a very diverse population. In 2006, African Americans made up 2.8% of our 3 million residents. Hispanic persons comprised 3.8%, and Native Americans 0.7%. Also, Iowa State University, like most U.S. institutions, faces a significant gender gap in enrollment within science and engineering. For ISU, this demographic situation requires that we (1) recruit substantial numbers of out-of-state, under-represented minority students, and (2) attract and retain the highest possible numbers of under-represented minority Iowans.

Iowa State University is well served by an active program of minority student recruitment at all levels. SPIRE-EIT leverages established minority recruitment programs at ISU to maximize the effectiveness of our recruitment plan and establish a strong mentoring network, and provide avenues of funding to help retain EIT students for doctoral studies. These resources include: Iowa AGEP – The Alliance for Graduate Education and the Professoriate, funded jointly by the National Science Foundation and the three Iowa Regent universities, aiming to significantly increase the number of Ph.D.s awarded to underrepresented U.S. minority students in STEM fields; GEM – The Graduate Degrees for Minorities in Engineering and Science program; George Washington Carver Doctoral Program – Assists in the national effort to increase the number of Ph.D. degrees earned by underrepresented students across all areas of study; PWSE, the Program for Women in Science and Engineering; and the Ronald E. McNair Postbaccalaureate Achievement Program, focused on increasing the number of underrepresented, low-income, and first-generation students receiving the Ph.D.

Acceptance Rate & Demographics from 2006-2008

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### Appendix B: Research Projects

All 15 projects from three years are listed below with one project highlighted from each year with additional information.

**2008 Projects**

Magic Table: Implementing Augmented Reality into the Gaming Industry on a Desktop Display Interface  
Dept. of Faculty Member  
Mechanical Engineering

iPhone Dev: Developing Multi-User Applications For iPhone: Designing Engaging Applications for Multiple Users on Next-Generation Mobile  
Mechanical Engineering

Baseplate: Creating a Collaborative Multi-Touch Computer Aided Design Program  
Psychology

Biology in VR: Enhancing Game Realism via Particle Models, Character Skeletons, and Contextualized User Interface  
Genetics, Development and Cell Biology

Electrical and Computer Engineering

This amazingly successful project included students creating a teleoperate pairing of two robot arms, designing an experiment on haptic feedback, getting IRB (Human Subjects) approval, gathering data from participants, and writing up the data. Advising faculty member Alex Stoytchev of Electrical and Computer Engineering offered the following comment about the summer experience.

*Being involved with SPIRE-EIT was a great and intellectually satisfying experience for me. I was really pleased with the hard work and dedication of the REU students in my group. In a very short amount of time, they were able to finish a great project in Human-Robot Interaction, get IRB approval for evaluation, conduct a usability study with human subjects, and write a paper. The REU program was also a great experience for my graduate students who had the chance to test their mentoring skills for the first time. Overall, it was a great success!*
ABSTRACT: This project addresses the development and usability of a teleoperation program for two robots, one local and one remote, as well as the benefits of haptic feedback in teleoperation and human robot interaction. The system allows a user at either arm to manipulate both arms simultaneously while receiving haptic feedback from the remote arm. Several tests were performed to determine the accuracy and usability of the system. The tests were performed using two state of the art Barrett Whole Arm Manipulators (WAMs). The usability test showed that the haptic feedback of the teleoperation program increased proficiency among users.

2007 Projects
Magic Box: Head Tracked Tabletop Viewing of 3D Models
Dept. of Faculty Member
Mechanical Engineering

Biology in VR: Meta!Blast- Using OpenSG to Create a Graphical User Interface (GUI)
Genetics, Development and Cell Biology

Direct Interface to Digital Communities
Mechanical Engineering

Battlespace: Advanced Visualization and Automation for Enhanced Control of Unmanned Aerial Vehicles
Psychology

OnTarget: An Electronic Archery Scoring System
Mechanical Engineering

Subject matter experts from Mathews Archery, a national leader in archery supplies posed the challenge of automatic scoring, and the participants used computer vision to build a working prototype that scored accurately, down to the broken boundary lines on the target. The lead programmer on the team was able to present her work an undergraduate computer science conference at Carnegie Mellon, and noted afterward that a scientist from IBM was very impressed with the team’s work. The team also impressed the industry experts: one representative from Mathews Archery, Inc. said, “You’re looking at a new interactive target scoring system that this team has put together. I like to see archery headed in this
direction: high-tech. What you see is far above than what I had expected. I’m pretty excited about that.”

ABSTRACT: There are several challenges in creating an electronic archery scoring system using computer vision techniques. Variability of light, reconstruction of the target from several images, variability of target configuration, and filtering noise were significant challenges during the creation of this scoring system. This paper discusses the approach used to determine where an arrow hits a target, for any possible single or set of targets and provides an algorithm that balances the difficulty of robust arrow detection while retaining the required accuracy.

2006 Projects

Addiction Education using Science and Technology

Meta!Blast: Explorations of a Virtual Plant Cell

Haptics-based Interactive Product Development in Virtual Reality

BauBlock: The 3D Sketchbook

ABSTRACT: A rear-projection multi-touch tabletop display was augmented with hand tracking utilizing computer vision techniques. While both touch detection and hand tracking can be independently useful for achieving interaction with tabletop displays, these techniques are not reliable when multiple users in close proximity simultaneously interact with the display. To solve this problem, we combine touch detection and hand tracking techniques in order to allow multiple users to simultaneously interact with the display without interference. Our hope is that by considering activities occurring on and above a tabletop display, multi-user interaction will become more natural and useful, which should ultimately support collaborative work.